ECONOMIC AND COMMODITY FORECASTS FOR WESTERN AUSTRALIA TO 2032

Super Pit in Kalgoorlie, Australia
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A report for
AUSTRALIAN ENERGY MARKET OPERATOR (AEMO)

August 2022

While the National Institute endeavours to provide reliable forecasts and believes the material is accurate it will not be liable for any claim by any party acting on such information.

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TON914-AEMO-Economic & commodity forecasts for WA to 2032/AEMO/2022

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1. Introduction

The National Institute of Economic and Industry Research (NIEIR) was engaged by the Australian Energy Market Operator (AEMO) to provide supporting forecasts for the Western Australian annual Gas Statement of Opportunities.

These forecasts include economic indicators for Western Australia and commodity production forecasts for key Western Australian minerals.

The commodity production outlooks were forecast by considering the following:

- a consensus of commodity price outlooks;
- future project expansions/closures;
- world market developments and conditions;
- historical production/price movements;
- the impact of emerging new technologies; and
- the world, national and state economic outlooks, including impacts of COVID-19 as captured in NIEIR's economic forecast models.

The short-term outlooks for each commodity were largely based on expected levels of activity at existing and new mining projects. For the medium-term to long-term, the commodity production outlooks were shaped more by the world and Australian economic outlooks and trends within each respective commodity market.

Following a brief review of recent commodity production trends in Western Australia, the remaining sections discuss the outlook for each commodity. Forecasts of commodity production for the base, high and low scenarios to 2032 are presented in Section 15 at the end of this report.

The scope of work is reproduced below.

1.1 Purpose

By 31 December each year, AEMO is required to publish a Gas Statement of Opportunities (GSOO) for Western Australia (WA) in accordance with the WA Gas Services Information (GSI) Rules. Under clause 104 of the GSI Rules, AEMO is required to develop annual gas supply forecasts for a 10-year outlook period and consider future commodity output forecasts, as well as other factors.

1.2 Description of Consultancy Services, Deliverables

The Consultancy Services are commodity output forecasts by calendar year (1 January to 31 December) for the period 2023 to 2032, for three scenarios: expected, high, and low. The forecast report will be published as part of the 2022 WA GSOO supporting materials. The forecasts will be used to determine the domestic gas demand for the WA gas market over the forecast period.

For the avoidance of doubt, the Consultancy Services includes the provision of the following Deliverables.

Deliverable	Description
Deliverable 1 – Commodities outlook report (Draft)	The Consultant must provide a written report (in Microsoft Word format and to remain confidential) and corresponding forecast data (in Microsoft Excel). As a minimum, for the expected, high and low scenarios, the report must: (a) Determine and deliver annual projections of mineral production output for WA for each calendar year over the period, 2023 to 2032 (inclusive) for the following minerals: ■ Iron ore; ■ Alumina; ■ Gold; ■ Nickel; ■ Lithium; ■ Copper; ■ Zinc; ■ Ammonia (manufactured product); ■ Mineral sands; ■ Lead; ■ Cobalt. (b) For each mineral listed above, discuss: ■ Any changes to global mineral production output which have occurred over the 12-month period, from 1 July 2021 to 30 June 2022; ■ Any relevant global or Western Australian trends which have contributed to changed production or are expected to influence the annual projections of mineral

Deliverable	Description
	production output. Relevant factors for discussion may include: - Commodity price; - International trade; - Commencement or closure of mines; - Policy or regulatory changes; - Australian Dollar to United States Dollar currency exchange rate.
Deliverable 2	The Consultant must provide a written report (in Microsoft Word format and to remain confidential) and corresponding forecast data (in Microsoft Excel). As a minimum, the report must: ■ Determine and deliver annual economic forecasts for the forecast period 2023-2032 that are consistent with the projected mineral outputs (listed above). Annual forecasts for the low, expected and high economic scenarios must include: - Gross Domestic Product (GDP) for Australia; Gross State Product (GSP) for WA; - State Final Demand (SFD) for WA; - Household Disposable Income (HDI) for WA; - 10-year bond rate for Australia; - Australian Dollar to United States Dollar currency exchange rate. ■ For each economic measure above, discuss the impact of other key variables on the annual forecasts over the forecast period, including: - Population growth; - Unemployment rate; - Migration; - Australian Dollar to United States Dollar currency exchange rate;

Deliverable	Description
	- Private consumption expenditure; - Private dwelling expenditure; - Private business investment; - Government expenditure.
Deliverable 3 – Commodities outlook report (Final)	The successful Consultant must develop a final written report (in Microsoft Word format and to remain confidential) and corresponding final forecasts (in Microsoft Excel) for Deliverable 1 and 2above, incorporating any feedback provided by AEMO on the draft report and forecasts prior to delivery.

1.3 Acceptance criteria

All tasks must be completed to the reasonable satisfaction of the AEMO Contact and all work is subject to approval by the AEMO Contact, acting reasonably.

1.4 Timetable

Deliverable/Milestone	Due date
Deliverables 1 and 2 – Draft written report and commodities and economic forecasts for AEMO review.	20 July 2022 or earlier
AEMO to provide comments on **Deliverables 1 and 2.**	5 August 2022 or earlier
Deliverable 3 – Final written report to AEMO.	12 August 2022 or earlier

2. The economic outlook for Australia to 2032-33

2.1 Introduction

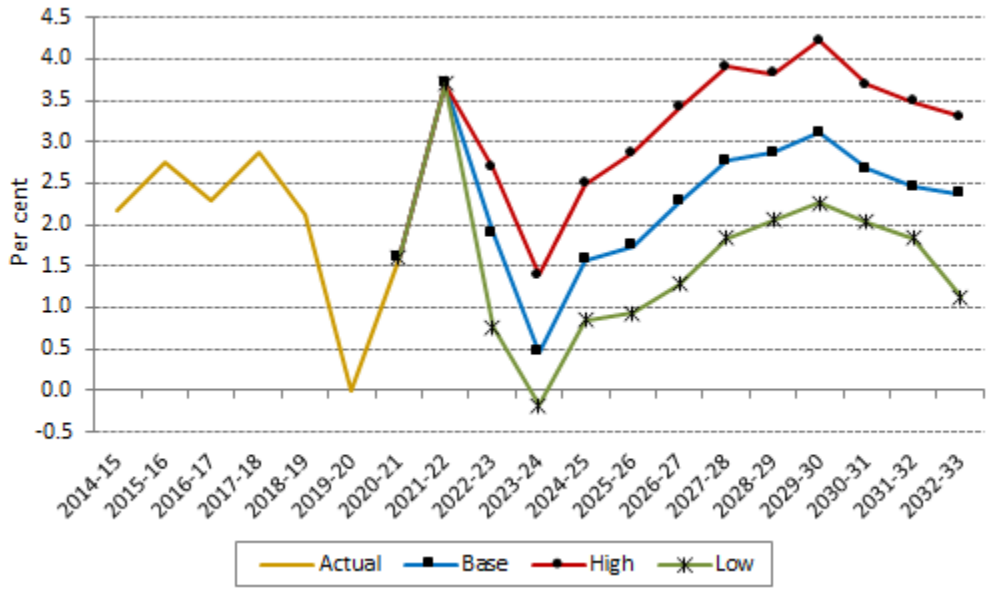
This section provides an outline of the economic outlook for Australia to 2032-33. Figure 2.1 shows the outlook for Australian gross domestic product to 2032-33 by scenario. Table 2.1 shows the projected annual Australian GDP growth rates to 2032-33 for each of the scenarios. These economic forecasts were prepared in May 2022.

Table 2.1 Australian GDP growth under each scenario (per cent)

Financial year	Base	High	Low
2014-15	2.2	2.2	2.2
2015-16	2.7	2.7	2.7
2016-17	2.3	2.3	2.3
2017-18	2.9	2.9	2.9
2018-19	2.1	2.1	2.1
2019-20	0.0	0.0	0.0
2020-21	1.6	1.6	1.6
2021-22	3.7	3.7	3.7
2022-23	1.9	2.7	0.8
2023-24	0.5	1.4	-0.2
2024-25	1.6	2.5	0.8
2025-26	1.7	2.9	0.9
2026-27	2.3	3.4	1.3
2027-28	2.8	3.9	1.8
2028-29	2.9	3.8	2.1
2029-30	3.1	4.2	2.3
2030-31	2.7	3.7	2.0
2031-32	2.5	3.5	1.8
2032-33	2.4	3.3	1.1
Compound average annual change			
2021-22 to 2026-27	1.6	2.6	0.7
2026-27 to 2032-33	2.7	3.7	1.9
2021-22 to 2032-33	2.2	3.2	1.3

Note: Actuals = 2014-15 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2032-33.

Figure 2.1: Australian GDP growth by scenario (annual per cent change)



Notes: Financial years ending June.
Actuals = 2014-15 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2032-33.

2.2 Summary

The key drivers which will determine the outcome for the National and state economies over the next decade will be:

1. the COVID-19 recovery profile and the world interest rate cycle;
2. Australia's net foreign immigration rate and population growth rate;
3. the expansion of the mining sector and the Australian exchange rate;
4. security and defence expenditure; and
5. Net Zero Emissions Target (NZET) and related expenditures.

2.3 The world economy: Post COVID-19

Figure 2.2 profiles the world GDP growth rates to 2033. From Table 2.2, which specifies the medium-term world GDP growth rates, the direct impact of COVID-19 in calendar year 2020 was a fall in world GDP of just under 4.0 per cent. In 2021 the growth rate is projected to be 4.1 per cent. The expectation at the start of 2021 was for a world growth rate for 2021 significantly higher than 4.1 per cent, given the expected vaccine roll out. However, the spread of the Delta variant and its impact on emerging economies, for example India, and the low vaccinated parts of advanced economies, such as the southern states of the United States, lowered what could be achieved in 2021 in terms of the recovery of growth rates.

On balance, for the four years post 2021, world economic growth is expected to be near historical trends, and thereby not allowing for catch-up in lost growth, because of three offsetting factors, namely:

(i) on the positive side, despite the tapering of fiscal stimulus the high excess household savings rates around the world, US$2.3 trillion in the United States in mid-2021 alone, will provide a strong stimulus to growth as household savings ratios fall towards pre COVID-19 levels;

(ii) on the negative side, emerging economies as a whole are not likely to achieve 70 to 80 per cent full vaccination rates until well into 2023, especially in the case where new variants of COVID-19 are likely to require booster vaccinations to maintain effectiveness;

(iii) again, on the negative side, in 2022 and into 2023 inflationary pressures and/or market aversion to the further build-up in excess liquidity, via Central Bank financing of public sector deficits, will force an increase in interest rates. By late 2023 it is expected that nominal interest rates will have returned to the 3.0 to 4.0 per cent range; and

(iv) the rise in interest rates will change the political landscape with a political consensus forming to reduce public sector deficits via reductions in expenditures and increases in taxes.

In terms of the profile in Table 2.2, for the years 2021 and 2022 (i) is the most important constrained by (ii). Over 2022 (iii) emerges constraining growth over 2023 to 2025, with (iv) becoming increasingly important over 2024-2025. The rise in interest rates will result in declines from the recent highs in equity market and housing markets valuations creating negative wealth effects and, thereby, reversing the strong positive wealth effects driving the recovery in the world economy over 2021 and 2022.

The average annual growth rates of the world economy, 2019 to 2025, from Table 2.2, is 2.1 per cent per annum, which will represent its lowest six-year trend rate of growth since the 1930s. The six year average growth rate for the six years from the GFC year 2009 was 2.6 per cent. From the projection profile underlying the calculations in Figure 2.2, it is not until 2029 that the world economy exceeds 3.0 per cent. In short, the economic outlook over the mid-2020 decade will be particularly adverse.

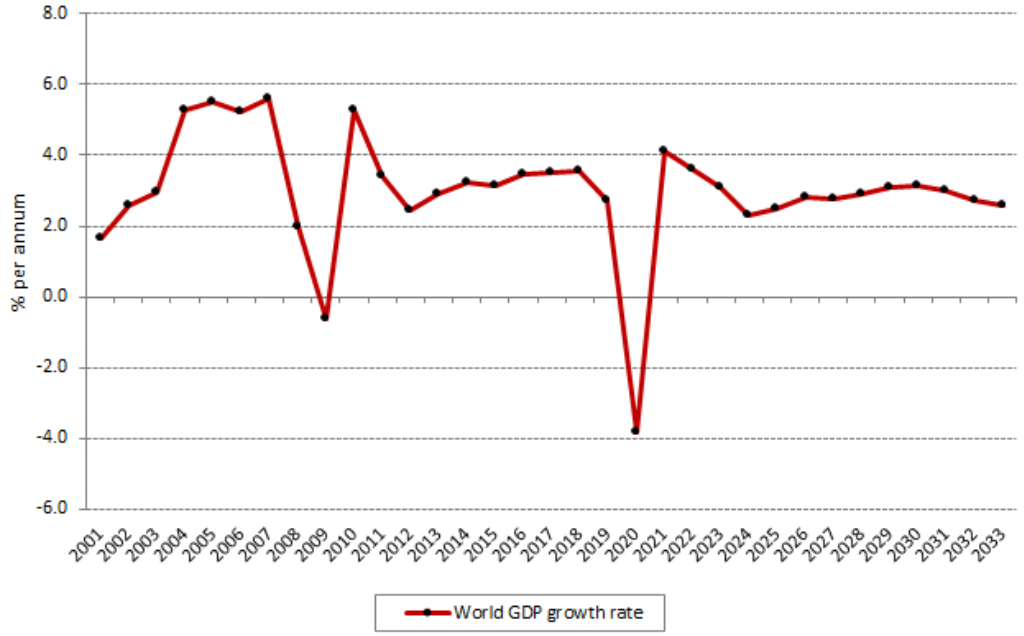
From pre COVID-19 reports, the 2020 decade average world GDP growth rate expectation of 3.0 per cent is obtained. Therefore, from Figure 2.3, COVID-19 will have a permanent scaring impact on the world economy of 6.1 per cent by 2033. This permanent loss can be attributed to the lingering direct impact of COVID-19 well into the 2020s and the intensification of the structural imbalances the world would have otherwise had to overcome in order to re-establish sustainable growth.

Table 2.2 Annual world GDP growth rate – 2020 to 2025 (per cent)

Calendar year	Per cent
2019	2.7
2020	-3.8
2021	4.1
2022	3.6
2023	3.1
2024	2.3
2025	2.4

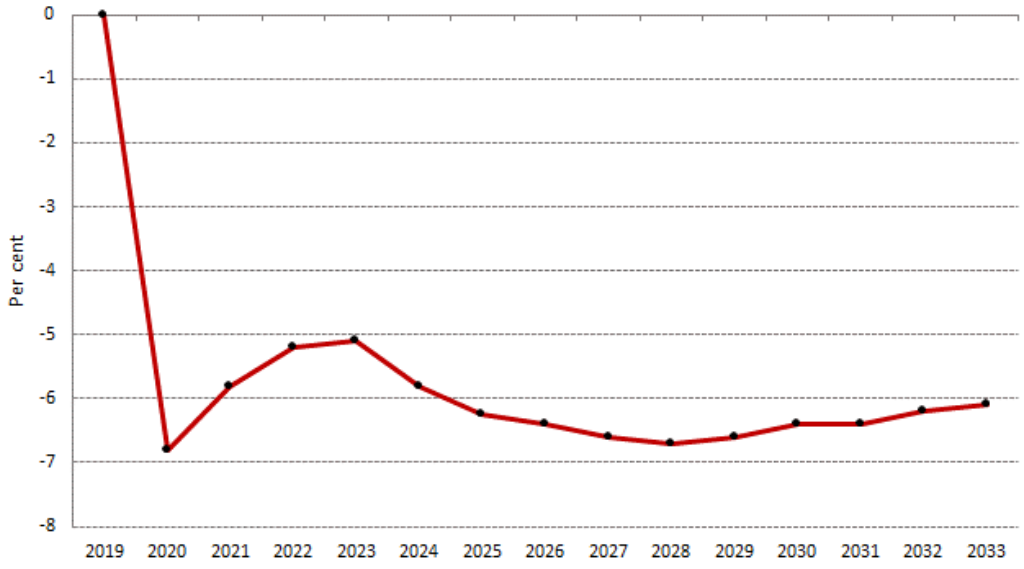
Note: Actuals = 2019 to 2021; Estimate = 2022; Forecasts = 2023 to 2025

Figure 2.2: World GDP growth rate (%)



Note: Actuals = 2001 to 2021; Estimate = 2022; Forecasts = 2023 to 2033.

Figure 2.3: Ratio of post COVID-19 world GDP to pre COVID-19 levels (%)



Note: Actuals = 2019 to 2021; Estimate = 2022; Forecasts = 2023 to 2033.

2.4 COVID-19 outlook

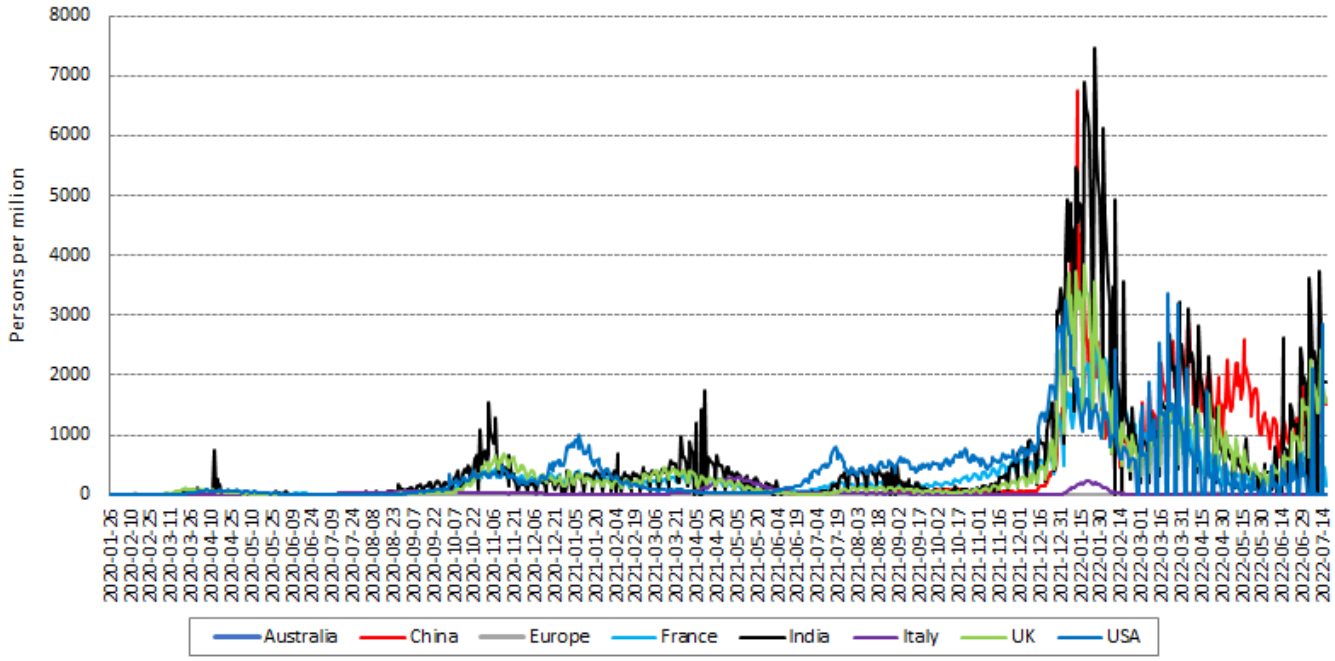
The long-term economic implications of COVID-19 which will extend a decade or more ahead. It is also becoming clearer that there will not be a date anytime soon when Australia and the world will be effectively free of COVID-19 itself.

Figure 2.4 shows new cases of COVID-19 per million population from 26 January 2020 to 16 July 2022 for selected countries around the world. It highlights the rapid spread of Omicron since mid-December 2021. The figure highlights that:

- new cases increased exponentially in January 2022;
- new cases in China, which has a zero case target, reached 20 cases per million in April 2022 compared to nearly zero in December 2021. By July 2022, COVID-19 cases have fallen back to near zero levels;
- increases in new cases in Europe in January 2022 were driven by France and Italy, with cases in Italy nearly double the European average. New cases in France were 150 per cent above the European average. By July 2022, cases in France and Italy were still three times the European average;
- there was an alarming increase in new cases in Australia which reached nearly 7,000 persons per million in early January 2022. While infections have fallen since January in Australia, the infection rate in July 2022 remains high at 1,500 cases per million; and
- new COVID-19 cases per million in the United Kingdom and India have fallen to near zero by July 2022. New cases in Europe per million are about one-third of Australia's infection rate.

China has a zero COVID-19 policy and this has had implications on global economic growth. COVID-19 outbreaks causing factory shutdowns in China and other countries will help fuel inflation. The fast spreading Omicron variant in China does not seem to respond effectively to vaccines. This means a continuing series of restrictions and lockdowns are required in China in 2022 and supply chain weaknesses have emerged.

Figure 2.4: New cases of COVID-19 per million persons, selected countries, January 2020 to July 2022



Source: ourworldindata.org, COVID-19 Data Explorer, COVID-19-data/public.

Figure 2.5: World daily COVID-19 deaths and COVID-19 death rate 26 January 2020 to 16 July 2022

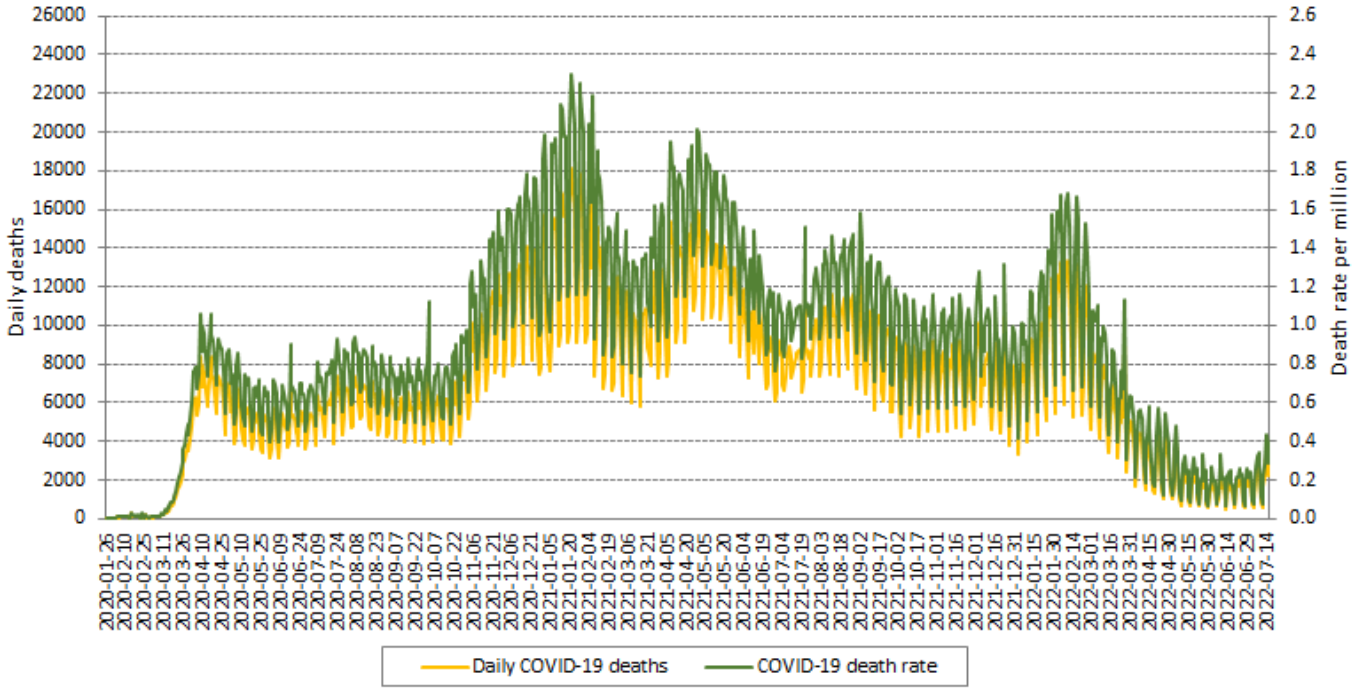
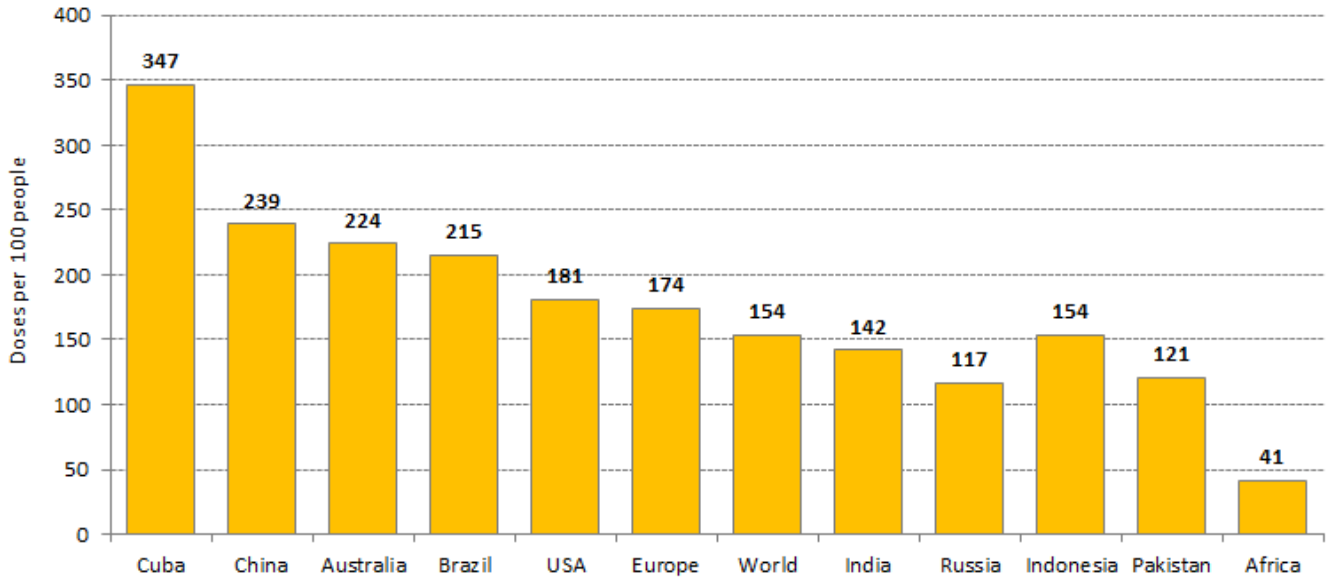


Figure 2.6: COVID-19 vaccine doses administered per 100 people, selected countries, 16 July 2022



Notes: Dates for 16 July 2022. Doses include boosters.
Source: www.ourworldindata.org.

Vaccine supply is and will continue to be a major issue. As of 16 July 2022, the world average doses administered was 154 per 100 people against an ideal of at least 180 doses per 100 people. European countries are generally around 174 doses per 100 people, while the United States is at 181 doses per 100 people. China has administered 239 doses per 100 people.

It is self-evident that emerging economies are well behind the high income economies. In Russia vaccine doses are at 117 per 100 people, while in Pakistan 121 per 100 people. On the African continent, doses administered are only 41 per 100 people. Fully opening up international travel to pre COVID-19 levels will require high vaccinated rates in all countries, along with regular booster shots being widely available. This is some way off, which means that COVID-19 will restrict mobility within and between countries for at last two more years, and longer if new variants emerge in any one country and threaten any other country without adequate international border and domestic restrictions.

Irrespective of the economic constraints, the COVID-19 outlook by itself will be a constraint on economic prospects for some time.

In late 2021 and early 2022, the third main variant of the virus, known as Omicron, spread across the developing and developed countries of the world. Whilst the Omicron variant seems to be leading to less hospitalisations and ICU cases, the rate of infection seems to be more than offsetting this. Omicron is highly contagious and can infect even vaccinated people.

A major concern is the emergence of new variants over the next two years and the effectiveness of booster vaccines to fight these COVID-19 variants. The development of vaccines have a long lead time, much longer than the emergence of COVID-19 variants.

2.5 Australian economic outlook

2.5.1 Summary

Nominal interest rates peak at 3.5 per cent in 2023-24, driving the Australian economy into recession in 2023-24. Real GDP growth is only 0.5 per cent over 2023-24, implying negative growth over two quarters.

There are also medium-term impacts on Australian economic growth as a result of the COVID-19 pandemic. One key impact is Australia's population growth. Australia's population level in 2024 will be 700,000 persons below what would otherwise have been the case, as a result of closing international borders and their slow re-opening. The scaring effect from this will adversely influence the post-2024 rates of economic growth, which will decrease the employment growth rate and thereby the net foreign immigration intake targets, since an important driver of the international immigration targets is the rate of employment growth relative to the non-immigration driven workforce growth rate. It is estimated that from this effect there will be an additional loss in population of 0.7 million between 2024 and 2031, bringing a total loss in population by 2031 from the 2031 pre COVID-19 expected levels of 1.4 million.

Given the return to negative current account deficits by 2023, and high international debt, the result will be that Australia will not be able to escape the consequences of rising world interest rates, especially for the medium to long-term interest rates. Secondly, it is likely that inflation rates will steadily rise under the twin forces of slow workforce growth and modest employment recovery growth rates combining to maintain low unemployment rates after the recovery from the current lockdowns. However, it will not only be the recovery in wages growth that will drive inflation. International supply chain bottlenecks, a falling exchange rate and rising costs from fiscal conditions will also contribute to the recovery in inflation. The expectation is that national GDP will grow at 1.9 per cent in 2022-23, following growth of 3.7 per cent in 2021-22.

After 2022-23, the slowdown in growth in the world economy and rising interest rates will reduce the average annual national GDP growth to 0.5 per cent in 2023-24. For the 2025-26 and 2026-27 fiscal years, the average annual growth rate will be 1.7 and 2.3 per cent per annum. For the remaining years of the projection period (2028 to 2033) Australia's average GDP growth will be 2.7 per cent.

By 2024 the loss in national GDP from pre COVID-19 expected levels will be at least 4.0 per cent of GDP.

2.5.2 The national economy

Figure 2.7 profiles the national GDP growth rate. After growing by 1.6 per cent in 2020-21, the national growth rate for 2021-22 is projected at 3.7 per cent, followed by a 1.9 per cent growth rate in 2022-23. The three following fiscal years produce poor growth outcomes, namely 0.5, 1.6 and 1.7 per cent respectively. For the final seven years of the projection period annual GDP growth is relatively stable at around an average of 2.6 per cent per annum.

The key drivers which will determine the outcome for the national and state economies over the next decade will be:

(1) the COVID-19 recovery profile and the world interest rate cycle;

(2) Australia's net foreign immigration rate and population growth rate;

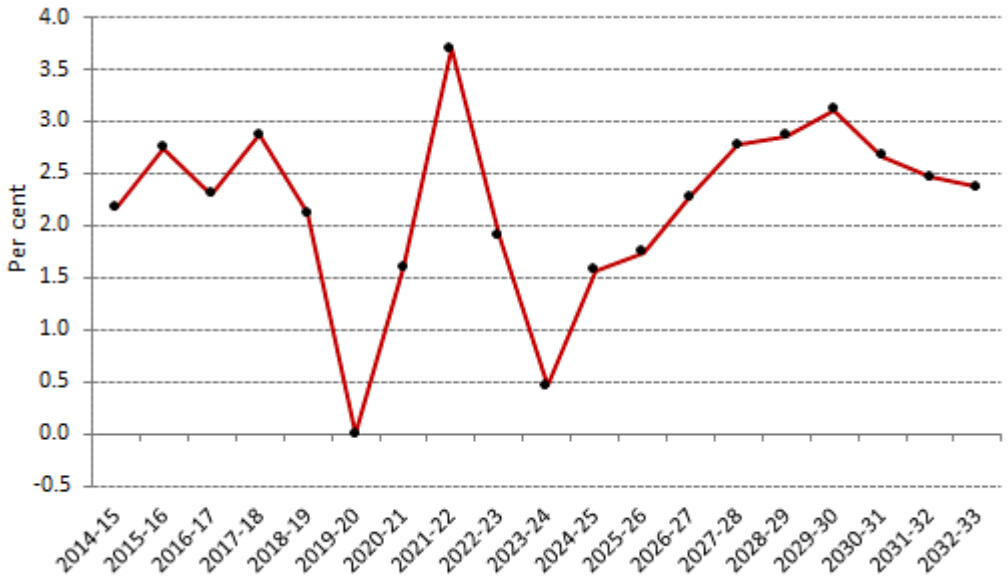
(3) the expansion of the mining sector and the Australian exchange rate;

(4) security and defence expenditure; and

(5) NZET and related expenditures.

Unfortunately, consideration of these issues indicates that they will be major headwinds for the national economy, although there is likely to be considerable opportunities in the national security and climate change expenditure dimensions over the longer term.

Figure 2.7: Australian GDP growth rate (%)



Note: Actuals = 2014-15 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2032-33.

2.5.3 Population

COVID-19 has, and will continue to have, for the next couple of years at least a significant impact on national population growth via its impact on net international immigration.

Table 2.3 outlines the medium-term forecasts for Australian population. The assumption is that Australia will be able to resume near normal immigration intakes, including foreign students and short-term workers by 2022-23. However, the relatively poor economic conditions of the mid-2020s, with rising unemployment rates and sub-trend growth rates, force reductions in foreign immigration in order to stabilise the unemployment rate at around 5.5 per cent. By the end of 2023-24, as the population projection in Table 2.3 implies, compared to the maintenance of the annual average change in national population of 376,000 that occurred between 2008-09 and 2018-19, the Australian population will be less by 700,000. The domestic economy will be subject to the same headwinds to growth as the world economy over the mid-2020s.

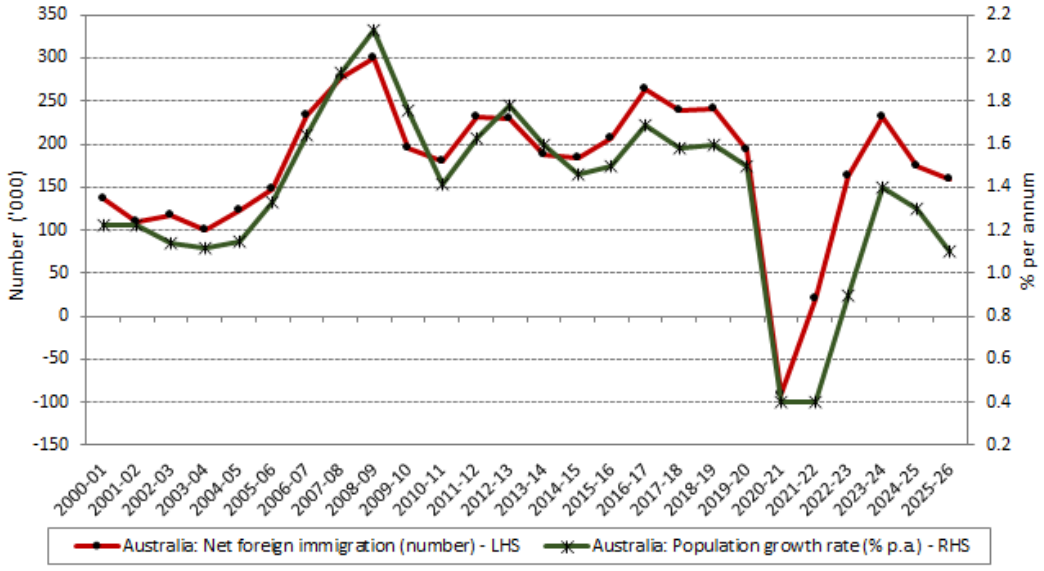
Table 2.3 Australian population trends

	Net international immigration ('000)	Change in population ('000)	Per cent change in population (%)
2018-19	241.3	390.76	1.6
2019-20	192.7	368.09	1.5
2020-21	-89.9	104.20	0.4
2021-22	21.1	93.94	0.4
2022-23	162.3	224.08	0.9
2023-24	232.3	365.84	1.4
2024-25	174.2	333.89	1.3
2025-26	158.3	298.38	1.1

Note: Actuals = 2018-19 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2025-26.

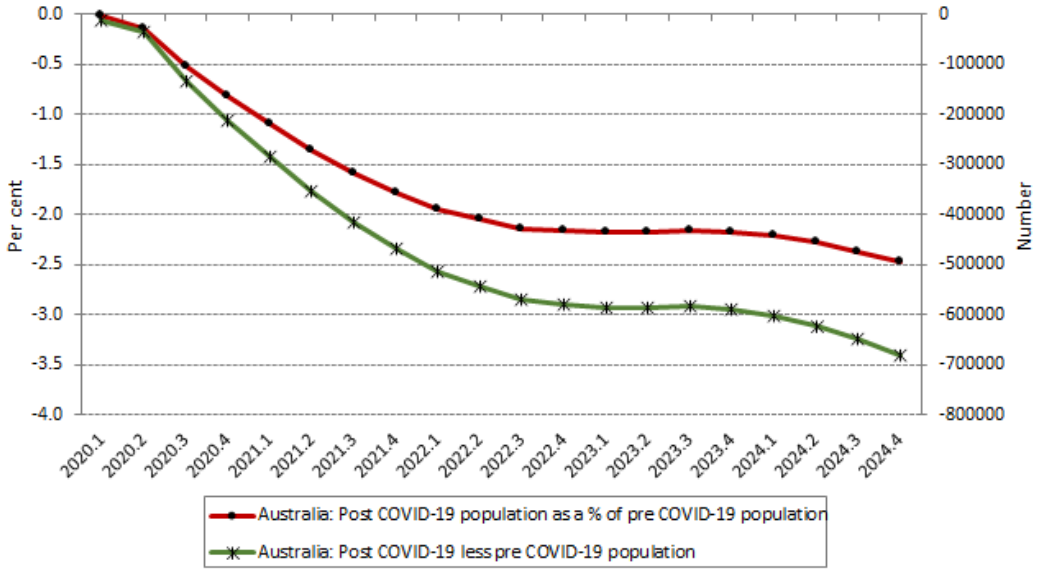
For the forecast projection in Table 2.3 a plausible alternative scenario would be a slower return to the 250,000 intake because of difficulties with the global vaccine roll out and COVID-19 case number suppression. The national population averages 1.1 per cent growth between 2022-23 and 2032-33.

Figure 2.8: Net foreign immigration (no.) and Population growth rates (%)



Note: Actuals = 2000-01 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2025-26.

Figure 2.9: Australia – Post and pre COVID-19 population (percentage and difference from fourth quarter 2024)



2.5.4 The interest rate and inflation cycle

The epicentre will be the United States where fiscal and monetary stimulus measures will be strong and substantially larger than what was required to return to pre COVID-19 economic activity. It is clear that some point over the next 2 to 3 years United States will experience a strong "risk-off" shock where the private sector will be unwilling to hold much additional public and indeed private-sector debt at current interest rates. That is interest rates will rise significantly irrespective of the underlying inflation outlook. However, the risk-off shock is likely to also be reinforced by steady increases in the inflation rate, thereby applying additional upward pressure on interest rates.

The key indicator in this regard is the US 10 year bond rate and from Figure 2.10 is projected to recover to the 5.0 per cent range by 2024 for both the US and Australia. In the United States the rise in nominal interest rates is, therefore, likely to also be reinforced by a recovery in the rate of inflation to at least 3.0 per cent upper boundary by the middle of 2023. This will be due to the likelihood that the current round of stimulus and future planned expenditure programs in physical and social infrastructure together with expansionary monetary policy will reduce capacity utilisation rates and unemployment rates below the levels required for non-accelerating inflation.

One catalyst for triggering the "risk-off" shock may well be if the United States administration persist with its US$3 to US$4 trillion "soft" infrastructure program. The United States needs a program like this. Long-term balanced financing requires tax increases on the high income groups, however, because of the United States extreme inequality in the distribution of income and wealth, these groups have the power to effectively veto government polices by triggering a "risk-off" shock.

Australia's underlying inflation rates will increase from a combination of factors over 2022 ranging from:

- COVID-19 imposed supply bottlenecks;
- lower workforce participation rates from the maintenance of high infection rates;
- wage rate increases from low international migration mobility; and
- conflict in the Ukraine.

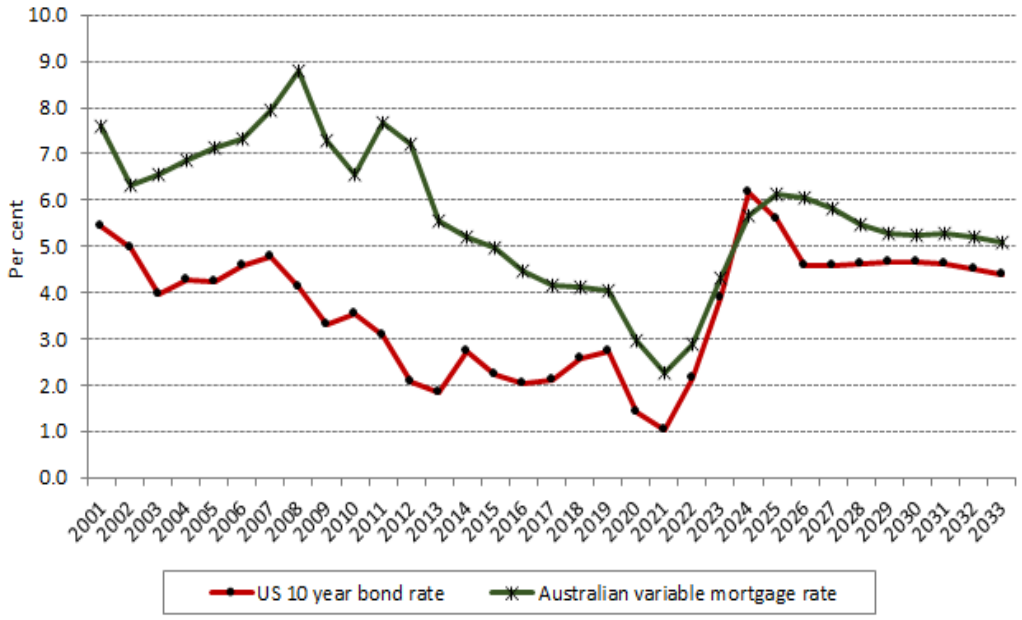
Even if inflation returns to longer term more normal levels of between 2.0 and 3.0 per cent, which seems a minimum expectation given the current economic environment, then nominal interest rates will be approaching the 4.0 per cent threshold. Add in the additional interest rate margins from "risk-off" shocks the potential for a more subdued economic outlook after the immediate short-term recovery would appear to be very high. In Australia a major driver of inflation will be the wage pressure created by labour shortages from a significantly lower population as a result of the COVID-19 imposed constraints on foreign immigration and possible indirect tax increases to control government deficits.

Currently, given Australia's strong balance of payments position and high levels of local funding of the banking system from high domestic savings and low-cost sources of funding from the RBA, Australia has some short-term capacity to set interest rates below world and in particular US benchmarks. However as the iron ore price declines over the next couple of years and impact of the world recovery declines it is likely that Australia's high foreign debt and reliance on the banking system from foreign sources of funding will return as a constraint. The outcome for domestic interest rates being that they will be largely determined by the US long-term rates irrespective of what the RBA may wish to do in regard to short-term rates.

There will be a substantial rise in interest rates in Australia over the next 18 months. The RBA increased the target cash rate in May by 25 points basis and then by 50 points basis in June, July and August. At least two further 50 points basis are expected by the end of the calendar year 2022, with possibly more.

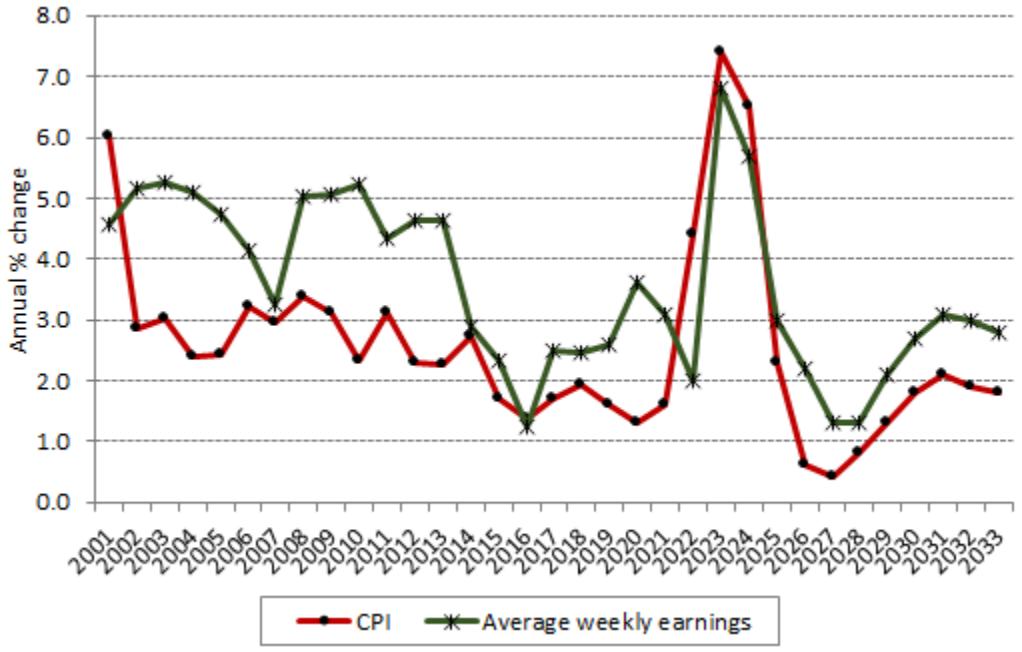
With the increase in public sector debt over the last 15 months in most economies the upswing in the world interest rate cycle will impose significant cost pressures on public-sector budgets. The interest rate increases which will force a regime of fiscal austerity irrespective of the political colours of the governments of the day. In short it is likely to be a rerun of the economic environment that prevailed over the second half of the 1970s and into the early 1980s. The years in the mid-2020 decade are likely to be very difficult economic years for both the Australian and the world economy.

Figure 2.10: US 10 year bond rate and Australian variable mortgage rate (%)



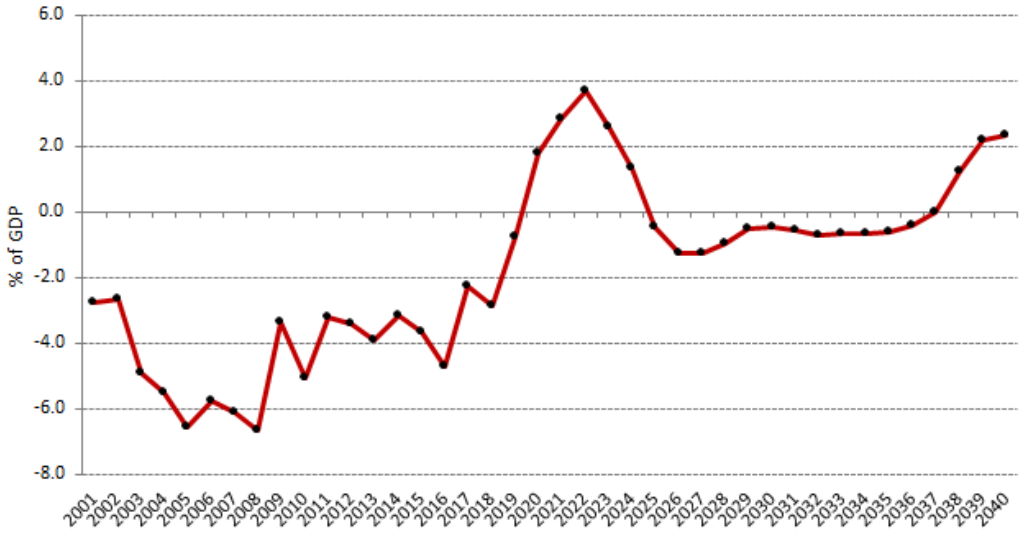
Note: Actuals = 2001 to 2021; Estimate = 2022; Forecasts = 2023 to 2033.

Figure 2.11: CPI and Average weekly earnings (annual % change)



Note: CPI actuals = 2001 to 2022; Average weekly earnings actuals = 2001 to 2021; Average weekly earnings for 2022 is an estimate; Forecasts = 2023 to 2033.

Figure 2.12: Current account balance (% of GDP)



Note: Actuals = 2001 to 2021; Estimate = 2022; Forecasts = 2023 to 2033.

Table 2.4 Formation of Australian GDP (per cent)

	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32	2032-33
Demand															
GDP	2.1	0.0	1.6	3.7	1.9	0.5	1.6	1.7	2.3	2.8	2.9	3.1	2.7	2.5	2.4
Farm GDP ($m)	-11.4	-11.7	22.6	8.6	-4.7	-2.5	0.5	0.9	1.1	1.2	1.2	1.3	1.3	1.3	1.3
Non-farm GDP ($m)	2.4	0.2	1.2	2.9	2.1	0.5	1.5	1.7	2.3	2.8	2.9	3.1	2.7	2.5	2.4
Labour market															
Employment	2.4	0.5	0.6	3.1	1.8	0.9	0.4	0.5	1.1	1.3	1.4	1.3	1.4	1.3	1.3
Unemployment rate (%)	5.1	5.6	6.2	4.3	4.0	4.3	5.2	5.7	5.9	5.7	5.7	5.8	5.8	5.8	5.8
Finance															
90 day bank bill (%)	1.8	0.7	0.0	0.2	2.4	3.3	2.6	2.5	2.6	2.8	2.8	2.8	2.8	2.8	2.8
10 year bond rate (%)	2.2	1.0	1.2	2.1	4.1	4.8	4.3	4.2	4.3	4.4	4.5	4.5	4.5	4.5	4.5
$US/$A	71.5	67.2	74.9	72.3	69.2	67.3	70.5	73.8	73.4	73.2	73.0	72.9	72.9	72.8	72.7
Wages and prices															
Average weekly earnings	2.6	3.6	3.1	2.0	6.8	5.7	3.0	2.2	1.3	1.3	2.1	2.7	3.1	3.0	2.8
CPI	1.6	1.3	1.6	4.4	7.4	6.5	2.3	0.6	0.4	0.8	1.3	1.8	2.1	1.9	1.8
Population growth	1.6	1.5	0.4	0.4	0.9	1.4	1.3	1.1	1.1	1.1	1.0	1.0	1.0	1.0	0.9

Note: Actuals = 2018-19 to 2020-21; Actuals for 2021-22 are employment, unemployment rate, 90 day bank bill, 10 year bond rate, USA exchange rate and CPI. The remainder of 2021-22 are estimates; Forecasts = 2022-23 to 2032-33.

Table 2.5 Selected Australian and Western Australian economic indicators by scenario (per cent)														
	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033
Selected Australian indicators														
Australian GDP														
Base	0.0	1.6	3.7	1.9	0.5	1.6	1.7	2.3	2.8	2.9	3.1	2.7	2.5	2.4
High	0.0	1.6	3.7	2.7	1.4	2.5	2.9	3.4	3.9	3.8	4.2	3.7	3.5	3.3
Low	0.0	1.6	3.7	0.8	-0.2	0.8	0.9	1.3	1.8	2.1	2.3	2.0	1.8	1.1
10 year bond rate (%)														
Base	1.0	1.2	2.1	4.1	4.8	4.3	4.2	4.3	4.4	4.5	4.5	4.5	4.5	4.5
High	1.0	1.2	2.1	5.0	5.5	5.3	5.5	5.5	5.7	5.5	5.7	5.6	5.6	5.5
Low	1.0	1.2	2.1	3.6	3.9	3.7	3.5	3.6	3.7	3.9	3.8	3.9	3.9	3.9
$US/$AUS														
Base	67.2	74.9	72.3	69.2	67.3	70.5	73.8	73.4	73.2	73.0	72.9	72.9	72.8	72.7
High	67.2	74.9	72.3	71.2	70.8	74.5	78.8	78.4	78.2	78.1	78.0	77.9	77.8	77.7
Low	67.2	74.9	72.3	66.2	63.3	66.0	68.9	68.5	68.3	68.2	68.1	68.0	68.0	67.9
Selected Western Australian Indicators														
Western Australian GDP														
Base	1.0	2.6	2.2	2.5	1.2	2.6	1.6	2.3	2.1	3.1	3.2	3.5	2.8	3.2
High	1.0	2.6	2.2	3.7	2.3	3.6	2.3	3.4	3.2	4.3	4.3	4.5	4.0	4.5
Low	1.0	2.6	2.2	1.5	0.4	1.7	0.7	1.6	1.3	2.1	2.4	2.6	1.9	2.5
Western Australian State Final Demand														
Base	1.2	4.5	5.4	3.8	0.8	2.4	0.3	1.1	3.4	2.6	2.6	3.4	2.0	2.5
High	1.2	4.5	5.4	4.7	1.9	3.4	1.5	2.3	4.6	3.7	3.9	4.7	3.0	3.6
Low	1.2	4.5	5.4	2.7	0.1	1.5	-0.6	0.0	2.5	1.6	1.7	2.7	1.3	1.1
Household disposable income (WA)														
Base	3.3	5.8	2.3	2.5	2.0	2.5	2.1	2.4	2.3	2.7	2.7	2.8	2.6	2.7
High	3.3	5.8	2.3	3.6	3.1	3.6	3.1	3.5	3.4	3.8	3.8	3.9	3.7	3.9
Low	3.3	5.8	2.3	1.5	1.0	1.5	1.2	1.5	1.4	1.7	1.8	1.9	1.6	1.9

Note: Actuals = 2020 to 2021; Estimate = 2022; Forecasts = 2023 to 2033.

3. The economic outlook for Western Australia to 2032-33

3.1 Introduction

This section outlines the economic outlook for Western Australia to 2032-33, focusing on the short-term to 2027-28.

3.2 Summary of scenarios

Figure 3.1 shows the outlook for Western Australia GSP growth over the period to 2032-33 by scenario. Between 2021-22 and 2032-33 Western Australia GSP growth is projected to average:

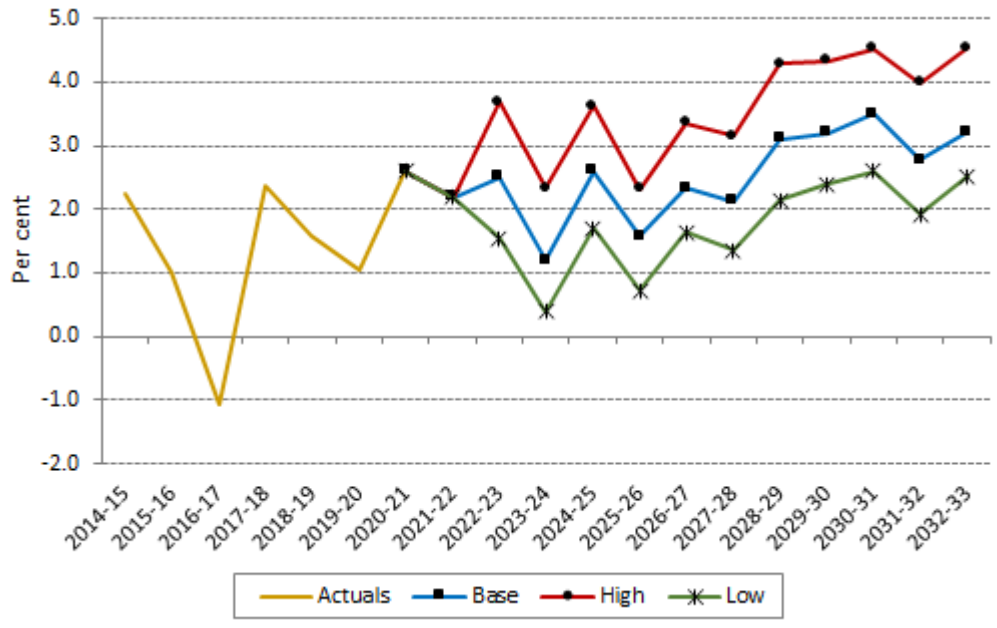
- 2.6 per cent per annum under the Base scenario;
- 3.7 per cent under the High growth scenario; and
- 1.7 per cent under the Low growth scenario.

Table 3.1 shows the projected annual economic growth rates projected for Australia and Western Australia by scenario for the period 2014-15 to 2032-33.

3.3 The Base scenario outlook for Western Australia to 2027-28

Table 3.2 presents selected economic indicators for Western Australia to 2027-28 under the Base scenario.

Figure 3.1: Western Australian GSP growth by scenario – 2014-15 to 2032-33



Note: Actuals = 2014-15 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2032-33.

Table 3.1 Actual and projected Australian and Western Australian GDP growth rate by scenario – 2014-15 to 2032-33						
	Australia			Western Australia		
	Base	High	Low	Base	High	Low
Per cent change						
2014-15	2.2	2.2	2.2	2.2	2.2	2.2
2015-16	2.7	2.7	2.7	1.0	1.0	1.0
2016-17	2.3	2.3	2.3	-1.1	-1.1	-1.1
2017-18	2.9	2.9	2.9	2.4	2.4	2.4
2018-19	2.1	2.1	2.1	1.6	1.6	1.6
2019-20	0.0	0.0	0.0	1.0	1.0	1.0
2020-21	1.6	1.6	1.6	2.6	2.6	2.6
2021-22	3.7	3.7	3.7	2.2	2.2	2.2
2022-23	1.9	2.7	0.8	2.5	3.7	1.5
2023-24	0.5	1.4	-0.2	1.2	2.3	0.4
2024-25	1.6	2.5	0.8	2.6	3.6	1.7
2025-26	1.7	2.9	0.9	1.6	2.3	0.7
2026-27	2.3	3.4	1.3	2.3	3.4	1.6
2027-28	2.8	3.9	1.8	2.1	3.2	1.3
2028-29	2.9	3.8	2.1	3.1	4.3	2.1
2029-30	3.1	4.2	2.3	3.2	4.3	2.4
2030-31	2.7	3.7	2.0	3.5	4.5	2.6
2031-32	2.5	3.5	1.8	2.8	4.0	1.9
2032-33	2.4	3.3	1.1	3.2	4.5	2.5
Compound average annual change						
2021-22 to 2026-27	1.6	2.6	0.7	2.0	3.1	1.2
2026-27 to 2032-33	2.7	3.7	1.9	3.0	4.1	2.2
2021-22 to 2031-32	2.2	3.2	1.3	2.6	3.7	1.7

Note: Actuals = 2014-15 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2032-33.

Table 3.2 Macroeconomic aggregates and selected indicators – Western Australia (per cent change)										
	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	Compound average annual change 2021-22 to 2027-28
Private consumption	-2.4	2.7	5.3	1.5	0.8	2.2	3.4	2.5	2.1	2.1
Private dwelling expenditure	-13.2	2.7	9.2	-5.3	-9.6	7.3	3.0	7.6	1.5	0.7
Business investment	10.0	5.1	2.0	10.2	1.4	2.2	-8.8	-3.7	9.7	1.3
Government consumption	6.4	6.2	4.6	4.6	1.2	2.3	2.0	1.7	1.5	2.2
Government investment	0.5	3.8	17.4	7.2	3.4	2.2	-2.6	-4.3	6.2	2.0
State final demand	1.2	4.5	5.4	3.8	0.8	2.4	0.3	1.1	3.4	1.9
Gross State Product	1.0	2.6	2.2	2.5	1.2	2.6	1.6	2.3	2.1	2.1
Population	2.0	1.4	1.2	1.4	1.7	1.7	1.5	1.4	1.4	1.5
Employment	0.4	1.8	5.4	2.0	1.1	0.8	1.7	2.3	2.1	1.7

Notes: Percentage change unless otherwise specified.
Actuals = 2014-15 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2032-33.
Source: NIEIR.

3.3.1 Gross State Product

After a sustained period of relatively low economic growth, the Western Australian economy has strengthened considerably over the last two years.

Western Australian Gross State Product (GSP) rose by 2.6 per cent in 2020-21 and 2.2 per cent in 2021-22. A sharp turnaround in the labour market saw employment grow rapidly, and there was strong growth in household and housing construction over 2021-22.

Western Australian GSP is forecast to rise by 2.5 per cent in 2022-23 before slowing in 2023-24. The weak growth in 2023-24 reflects the impact of higher nominal interest rates on private consumption expenditure and dwelling construction. Stronger GSP growth resumes over 2024-25.

Western Australian growth is supported by higher levels of mining investment, reflecting high commodity prices, expansions in LNG and various mineral production and processing projects under construction. The resumption of stronger population growth in Western Australia underpins a strong recovery in dwelling construction post 2023-24. Western Australian population growth averages 1.5 per cent between 2021-22 and 2027-28.

Western Australian GSP growth averages 2.6 per cent per annum between 2021-22 and 2032-33, 0.4 percentage points above the forecast national GDP growth rate.

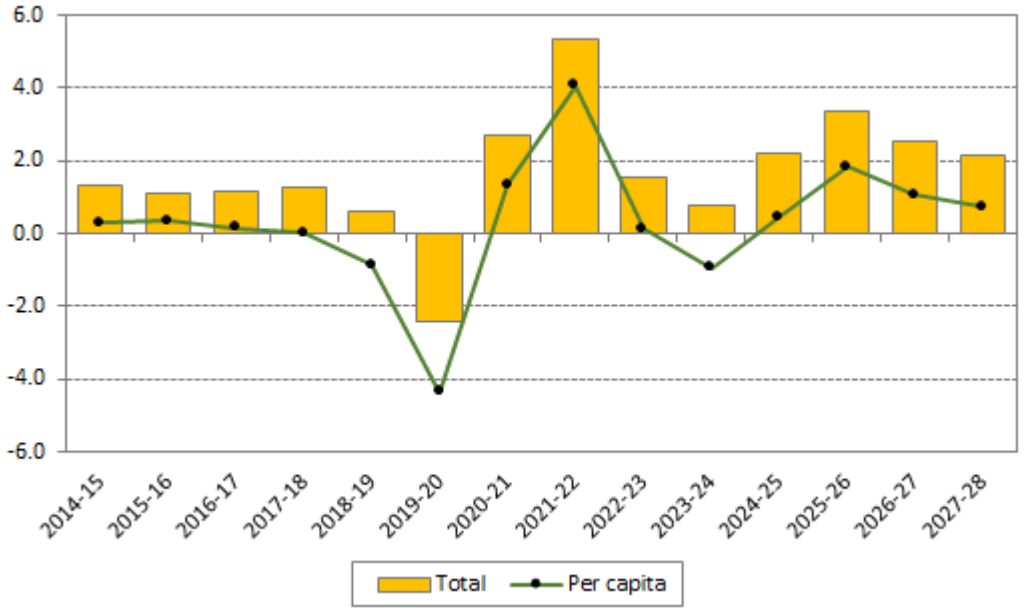
3.3.2 Private consumption expenditure

Western Australian private consumption expenditure rose by 5.3 per cent in 2021-22, reflecting strong household disposable income growth generated by rapid employment growth. Private consumption expenditure actually declined in 2019-20 in Western Australia, so part of the growth in 2021-22 could represent a rebound effect.

Private household expenditure growth is forecast to slow over 2022-23 and 2023-24 as high nominal interest rates impact on expenditure levels, especially household durables and other household equipment.

Stronger growth in private consumption expenditure resumes by 2024-25, with growth of 3.4 per cent projected for 2025-26. Average growth over the 2021-22 to 2027-28 period in Western Australia is 2.1 per cent.

Figure 3.2: Private consumption expenditure growth – Western Australia – Base scenario



Note: Actuals = 2014-15 to 2020-21; Estimate = 2021-22; Forecasts = 2022-23 to 2027-28.

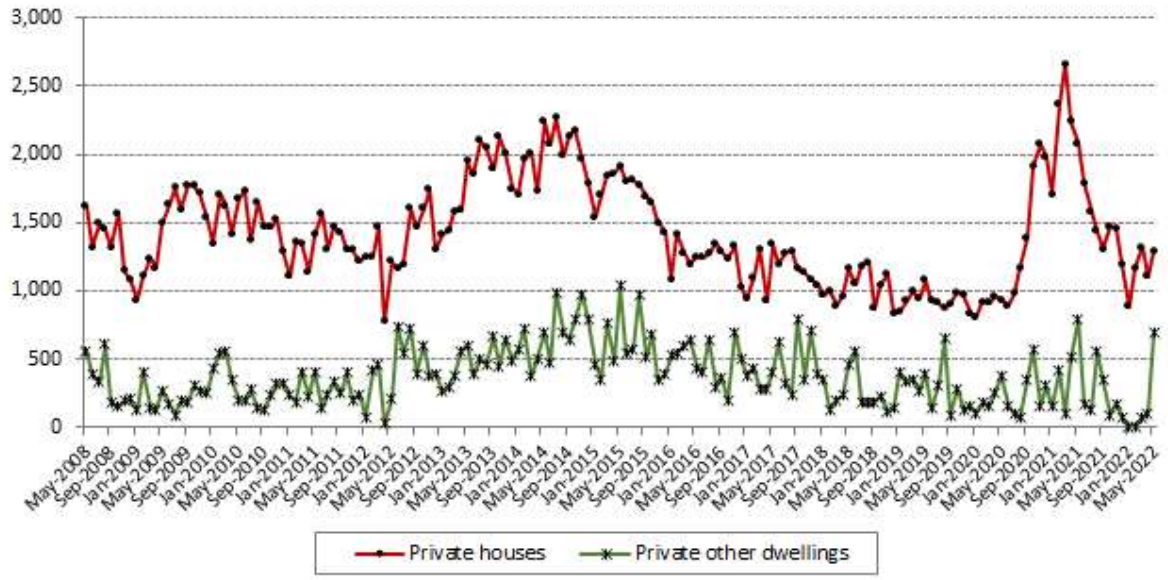
3.3.3 Private dwelling expenditure

Western Australian private dwellings investment rose by 9.2 per cent in 2021-22, following an 18.6 per cent decline in expenditure levels over 2018-19 and 2019-20.

Total private dwelling approvals in Western Australia nearly doubled in 2020-21 to over 26,000 units. Nearly 86 per cent of these approvals, or 22,300 units, were for houses. In 2021-22 total approvals for private dwellings fell by nearly 37 per cent to 16,473 units.

Higher mortgage interest rates and material cost increases in the short-term lead to a decline in Western Australian private housing investment in 2022-23 and 2023-24. Expenditure levels decline by around 15 per cent over these two years. As interest rates stabilise by 2024-25, and steady population growth leads to strong underlying demand growth, dwelling construction in Western Australia recovers. Private dwelling expenditure grows rapidly over the 2024-25 to 2026-27 period.

Figure 3.3: Private new dwelling approvals – Western Australia – Base scenario



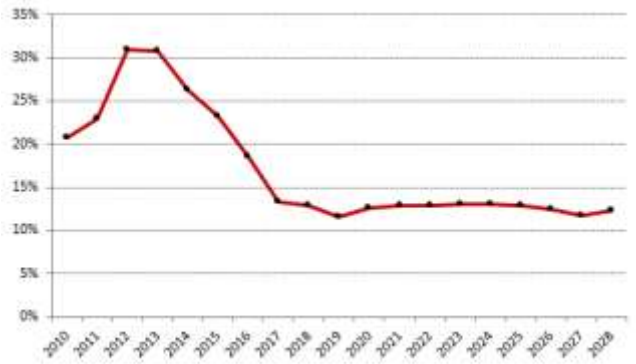
3.3.4 Private business investment

Western Australian private business investment has risen steadily over the last three years, reaching $42.3 billion in 2021-22. The very large expenditures nearly 10 years ago associated with LNG projects and iron ore investments had expenditure levels of over $80 billion.

Private business investment as a percentage of GSP in Western Australia was around 13 per cent in 2021-22. LNG and iron ore expansions support strong growth in private business investment in 2022-23 when expenditure rises by 10.2 per cent.

Private business investment is forecast to increase steadily out to 2024-25 before declining in 2025-26 and 2026-27 by around 7 per cent in total. Further growth to 2032-33 sees expenditure levels rise to $51.6 billion, around 20 per cent above 2021-22 investment expenditure levels.

Figure 3.4: Private business investment as a share of Western Australian GSP – Base scenario



Note: Actuals = 2010 to 2021; Estimate = 2022; Forecasts = 2023 to 2028.

3.3.5 Government expenditures

Public sector expenditures in Western Australia have been increasing rapidly over recent years. Government consumption expenditure growth between 2019-20 and 2021-22 was nearly 6 per cent per annum. Western Australian government investment is expected to rise by 17.4 per cent in 2021-22.

Stronger commodity prices and steady economic growth have resulted in the Western Australian government generating surpluses over recent years. The government has been able to reduce net government debt whilst also increasing expenditure outlays.

Public sector expenditures are forecast to remain strong in 2022-23 before weakening in 2023-24. Public investment expenditure is forecast to fall in 2025-26 and 2026-27. Western Australian public consumption expenditure averages 2.2 per cent growth over the 2021-22 to 2027-28 period.

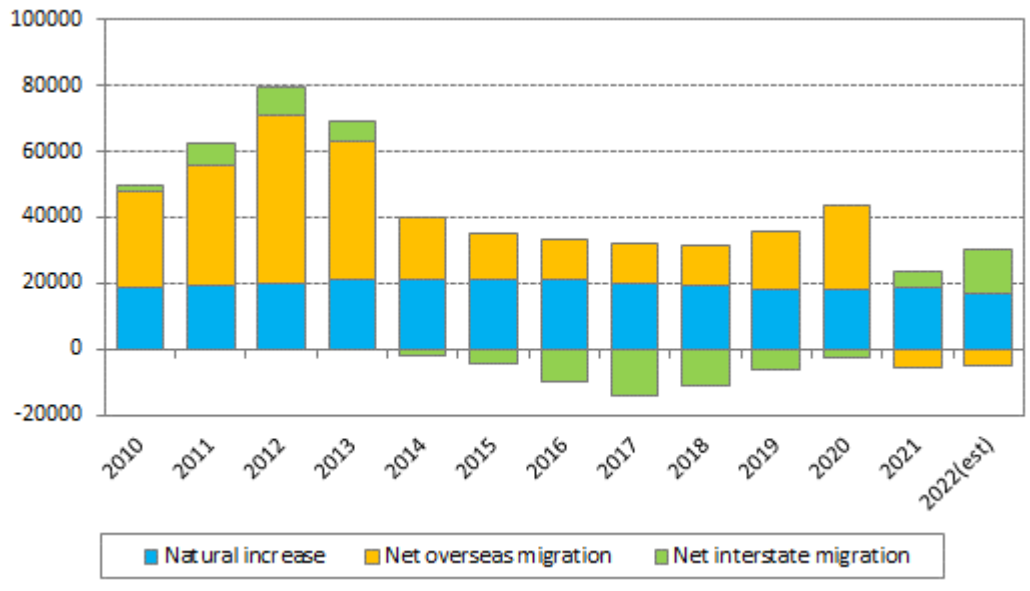
3.3.6 Population and employment

Western Australian population growth was 1.4 per cent in 2020-21 and is expected to be around 1.2 per cent in 2021-22. Whilst population growth slowed with the COVID-19 pandemic, due to restrictions on international travel, Western Australia did not record net population losses as some eastern seaboard States did.

The slowing of Western Australian population growth reflects net overseas migration losses of around 5,000 persons in 2020-21 and 2021-22. Up to the pandemic, Western Australia and other States of Australia recorded net overseas migration gains. One positive aspect of the pandemic, and the ability of Western Australia to remain initially relatively COVID-19 free, was the return of net interstate migration gains. Between 2015 and 2020 net interstate migration losses averaged nearly 9,000 persons per annum from Western Australia. The net interstate gains in 2021-22 is estimated at around 13,000 persons.

Consistent with the national population projection, Western Australian population growth recovers by 2023-24, increasing by 1.7 per cent. Average population growth over the 2021-22 to 2027-28 period is 1.5 per cent.

Figure 3.5: Components of population growth – Western Australia

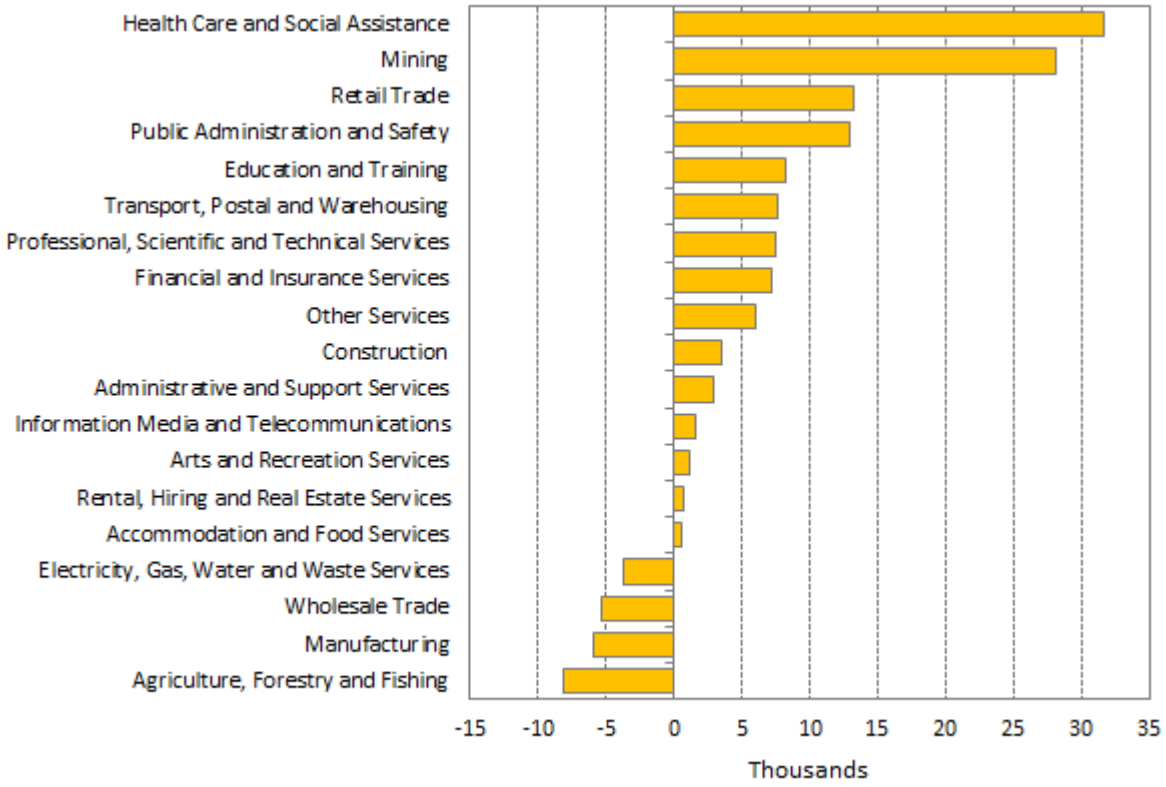


Employment growth in Western Australia is expected to slow over 2022-23 and 2023-24 as higher nominal interest rates impact on consumer and business confidence levels. Employment rose by 5.4 per cent over 2021-22.

The pattern of industry employment change over the last three years is shown below. The change by industry sector represents the change in average industry employment between 2018-19 and 2021-22.

The figure highlights the rapid increase in health care and social assistance, mining, retail and public administration employment. Declines were recorded in manufacturing and agriculture employment.

Figure 3.6: Employment by industry – Western Australia (average annual change in employment from 2018-19 to 2021-22)



Source: ABS Catalogue 6202.0.

4. Mining commodity production in Western Australia – value and quantities mined

Western Australia mining commodity production by type is shown in Table 4.1 for 2015-16 to 2020-21. These are reported as values in Australian dollars. The table also shows the percentage change in the value of each commodity produced between 2015-16 and 2020-21.

The total value of mining commodities produced declined in 2015-16, mainly reflecting a decline in commodity prices over this period. Rising actual production quantities for some commodities (such as iron ore) and improved prices led total Western Australian commodity production to reach A$211 billion in 2020-21.

Table 4.1 Nominal value of Western Australian mining commodities produced – 2015-16 to 2020-21

	Value by year						Average per cent change 2015-16 to 2020-21 (%)	Per cent share 2020-21 (%)
	2015-16 (A$m)	2016-17 (A$m)	2017-18 (A$m)	2018-19 (A$m)	2019-20 (A$m)	2020-21 (A$m)		
Iron ore	48768	64319	62074	81782	104602	155607	26.1	73.8
Gold	10105	10860	11421	11959	15872	16602	10.4	7.9
LNG	10765	12728	18921	28800	27048	15907	8.1	7.5
Alumina	4937	5074	6597	8212	6350	5506	2.2	2.6
Condensate	2214	2230	3301	6163	5402	4278	14.1	2.0
Nickel	2203	2095	2636	2700	3167	3485	9.6	1.7
Crude oil	3045	2128	2322	1840	2681	1708	-10.9	0.8
Copper metal	1181	1241	1348	1322	1387	1513	5.1	0.7
Domestic gas	1908	1835	1660	1607	1773	1471	-5.1	0.7
Spodumene	261	595	1698	1661	999	1055	32.3	0.5
Other commodities	438	411	813	1078	851	870	14.7	0.4
Mineral sands	572	583	550	715	775	853	8.3	0.4
Salt	336	292	303	299	372	553	10.5	0.3
Coal	336	338	332	319	327	306	-1.9	0.1
Cobalt	175	240	510	332	295	299	11.3	0.1
LPG – butane and propane	249	273	331	328	310	295	3.4	0.1
Zinc metal	195	204	324	263	223	232	3.5	0.1
Silver	105	98	105	85	110	156	8.2	0.1
Construction materials	80	63	72	96	128	124	9.2	0.1
Diamonds	354	268	250	219	281	112	-20.5	0.1
Lead metal	15	10	23	13	7	4	-24.7	0.0
Total	**88241**	**105886**	**115591**	**149793**	**172961**	**210935**	**19.0**	**100.0**

Source: Department of Mines, Industry Regulation and Safety, Western Australia (DMIRS (WA)), 2022, Major Commodities Resources Data, 2021.

Whilst Western Australia's overall mining commodity production is diverse, over 93 per cent of production values were concentrated in five groups in 2020-21. These were:

- iron ore (73.8 per cent);
- LNG (7.5 per cent);
- gold (7.9 per cent);
- alumina (2.6 per cent); and
- condensate (2.0 cent).

In terms of the value of production, the fastest growing commodity production groups in Western Australia between 2015-16 and 2020-21 in terms of average per cent change per annum were:

- LNG (8.1 per cent);
- gold (10.4 per cent);
- iron ore (26.1 per cent);
- condensate (14.1 per cent);
- salt (10.5 per cent);
- spodumene (a Lithium ore mineral) (32.3 per cent);
- cobalt (11.3 per cent); and
- mineral sands (8.3 per cent).

The Australian dollar value of Western Australian mining commodities produced is often significantly impacted by commodity prices and the US$ exchange rate. The data in Table 4.1 does not give an accurate picture of the volume of Western Australian commodity production, which, notwithstanding a fall in crude oil and condensate production, has increased significantly over recent years. In volume terms, crude oil and condensate production in Western Australia peaked in 2010, however has declined since then. The iron ore price peaked in 2011, but fell sharply until 2015. This had a significant impact on Western Australian production values for iron ore over this period.

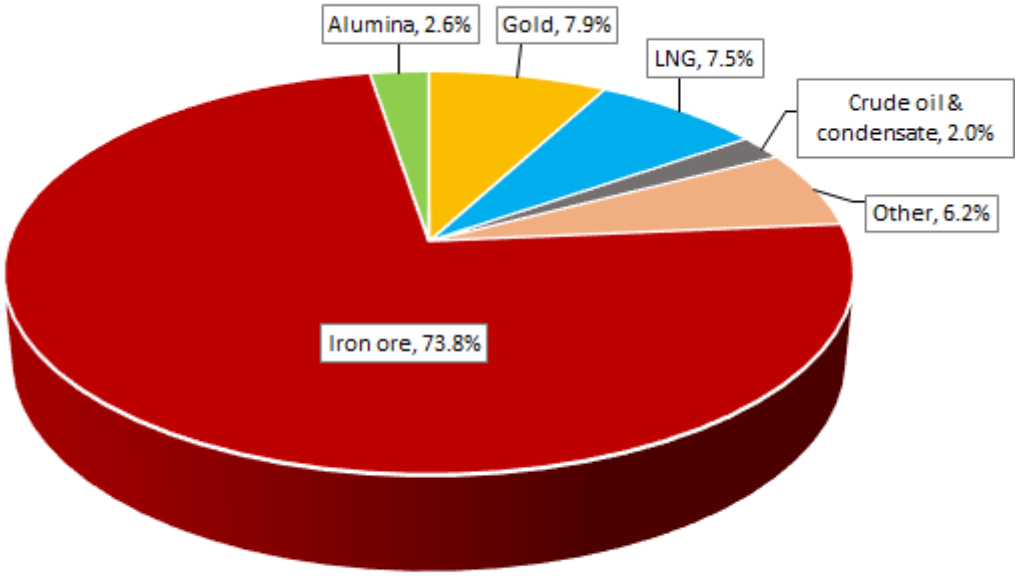
Table 4.2 shows quantities of mining commodities produced in Western Australia by type from 2011-12 to 2020-21. As indicated in Table 4.2, there have been some large production increases over the last nine years in Western Australia. These include the following commodities:

- iron ore (7.1 per cent per annum);
- gold (2.0 per cent per annum)
- LNG (11.7 per cent per annum)
- silica-sand (7.2 per cent per annum); and
- spodumene (15.7 per cent per annum).

Australian metals and other minerals private exploration expenditure over the last 10 years is shown in Table 4.3. During the previous mining boom, exploration expenditure reached nearly A$3 billion in 2011-12. There was a significant fall in expenditure on exploration in Australia between 2011-12 and 2016-17. In 2015-16 exploration expenditure was only $1.2 billion.

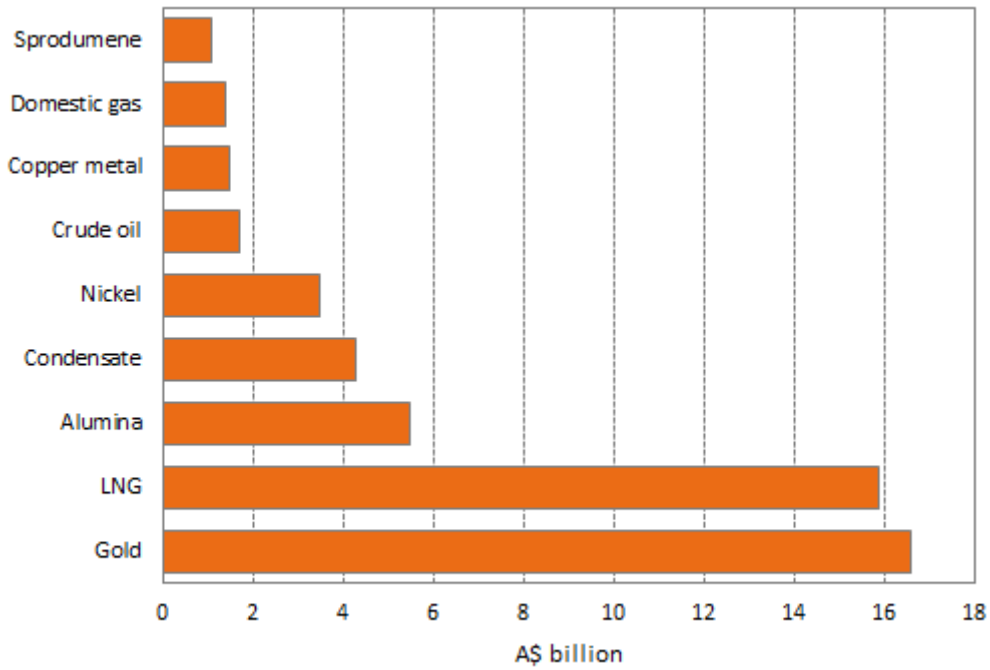
With the increase in base metals prices over recent years, mineral exploration expenditures have risen quite significantly in Australia. Compared to 2016-17, large increases in Australian exploration expenditure occurred for copper, gold, nickel, cobalt, lead, silver, zinc and for mineral sands. Iron ore exploration expenditure has remained relatively flat at around $300 million per year between 2015-16 and 2018-19, but rose to nearly $600 million in 2021-22. Total exploration expenditure in Australia was $3.5 billion in 2020-21. Gold exploration over the last five years has accounted for 47 per cent of total Australian private metals and other mineral exploration expenditure.

Figure 4.1: Value of commodity production, Western Australia, 2020-21 – Main commodities



Source: DMIRS (WA), 2022, Major Commodities Resources Data, 2021.

Figure 4.2: Value of Western Australian mining commodities produced 2020-21 over A$1 billion, excluding Iron ore (A$ billion)



Source: DMIRS (WA), 2022, Major Commodities Resources Data, 2021.

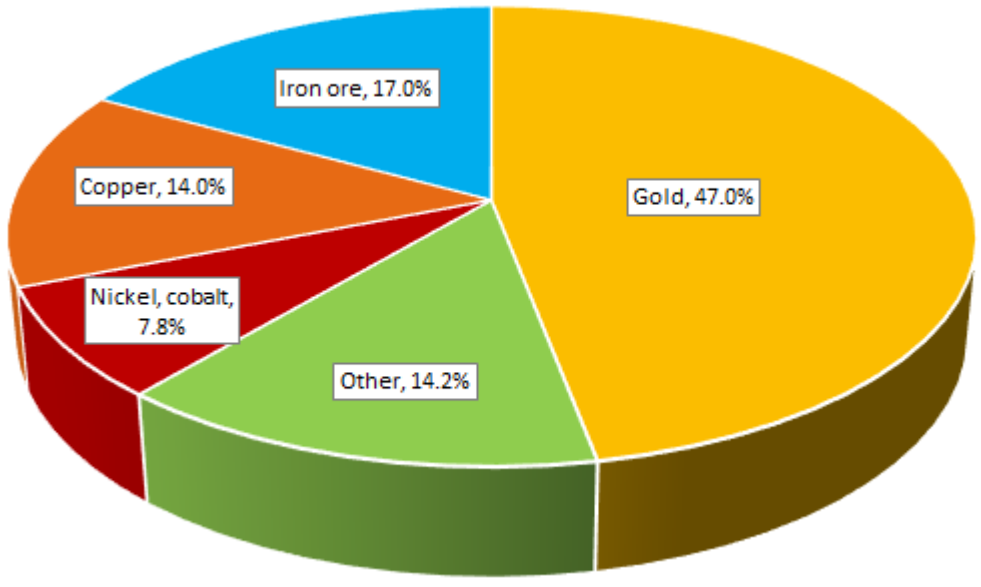
Table 4.2 Quantities of principal mining commodities produced in Western Australia – 2011-12 to 2020-21												
	Unit	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	Average % change 2011-12 to 2020-21
Alumina	kt	12425	13531	13718	13771	13894	13855	13669	13643	14015	14361	1.6
Copper metal	kt	159	209	211	184	190	171	174	162	171	139	-1.5
Lead metal	kt	7	17	79	59	6	4	7	5	3	1	-17.1
Zinc metal	kt	64	56	54	78	83	83	93	71	72	64	0.0
Coal	kt	6986	7494	6275	6553	6891	6806	6680	6275	6196	5272	-3.1
Aggregate	kt	3722	4391	2155	1964	1314	1053	1237	1608	3286	2732	-3.4
Gravel	kt	284	561	52	173	177	261	155	168	162	164	-5.9
Rock	kt	510	1110	403	1747	220	413	267	382	330	494	-0.4
Sand	kt	6287	5416	3797	5659	3435	2579	4120	2017	2459	3007	-7.9
Diamonds	ct '000	8690	9609	11611	10388	13870	12607	15281	11150	17490	8124	-0.7
Gem & semi-precious stones	kt	228	198	310	721	243	335	204	129	268	298	3.0
Gold	kg '000	181	180	196	193	196	203	212	212	212	216	2.0
Gypsum	kt	334	1576	533	577	552	531	896	771	515	833	10.7
Garnet	kt	302	317	357	299	251	566	380	388	324	277	-1.0
Ilmenite	kt	332	271	79	100	175	179	120	234	265	322	-0.3
Leucoxene	kt	22	29	29	17	18	7	14	15	27	20	-1.1
Rutile	kt	39	47	65	30	46	22	21	24	33	54	3.8
Zircon	kt	180	216	212	183	192	185	73	141	172	233	2.9
Iron ore	kt	454385	511760	623507	718806	748100	792985	839424	790547	836758	839087	7.1
Limesand-limestone-dolomite	kt	4158	4092	3117	4903	4446	4178	3943	4305	4010	4733	1.4
Manganese ore	Kt	846	650	712	801	425	237	379	573	554	468	-6.4
Cobalt	T	4950	6200	6236	6036	5479	4759	5200	5222	5796	5426	1.0
Nickel	Kt	209	227	233	183	176	158	163	154	153	158	-3.0
Palladium and platinum by-product	kg	626	658	1015	464	687	783	645	512	482	470	-3.1
Condensate	Kt	5889	6117	4399	6753	6775	6038	7113	11147	12341	11117	7.3
Crude oil	kl '000	11122	8609	6867	7952	7686	5404	4877	3097	5006	4335	-9.9
LNG	kl '000	15611	19805	19826	20448	20956	28685	37894	43635	47113	42393	11.7
LPG – butane and propane	Kt	835	753	390	553	532	527	451	447	583	481	-6.0
Natural gas	million m3	9081	8714	9737	9875	10224	9709	10175	10410	11159	10179	1.3
Salt	Kt	12807	12390	12992	11727	10975	10874	12964	11729	11266	12499	-0.3
Silica – silica sand	Kt	453	498	450	484	582	729	974	992	991	849	7.2
Silver	kg '000	120	124	137	151	155	143	162	129	132	171	4.0
Spodumene	Kt	461	486	342	489	466	914	2138	1697	1460	1711	15.7

Source: DMIRS (WA), 2022, Major Commodities Resources Data, 2021.

Table 4.3	Australian metals and other minerals private exploration expenditure, Australia 2008-09 to 2021-22 ($ million)								
	Copper	Diamonds	Gold	Iron ore	Mineral sands	Nickel, cobalt	Silver, lead and zinc	Other	Total metals and other minerals
2008-09	179	10	438	589	31	260	81	154	1741
2009-10	202	4	575	524	16	204	52	166	1742
2010-11	323	1	652	665	6	271	76	224	2218
2011-12	443	3	768	1151	20	265	88	227	2965
2012-13	319	6	662	1011	38	165	80	161	2442
2013-14	177	8	434	711	21	99	46	170	1666
2014-15	144	5	396	448	27	83	52	131	1286
2015-16	130	4	548	291	20	51	50	115	1209
2016-17	136	2	689	291	20	81	55	150	1423
2017-18	193	8	810	292	27	200	103	176	1810
2018-19	329	9	967	324	36	203	89	194	2151
2019-20	420	5	1162	361	37	203	59	215	2461
2020-21	377	4	1530	473	37	210	65	222	2917
2021-22 (est.)	578	6	1563	589	49	256	87	353	3482
5 year average	309	5	1038	375	32	172	72	204	2208
Per cent share	14.0	0.2	47.0	17.0	1.5	7.8	3.3	9.2	100.0

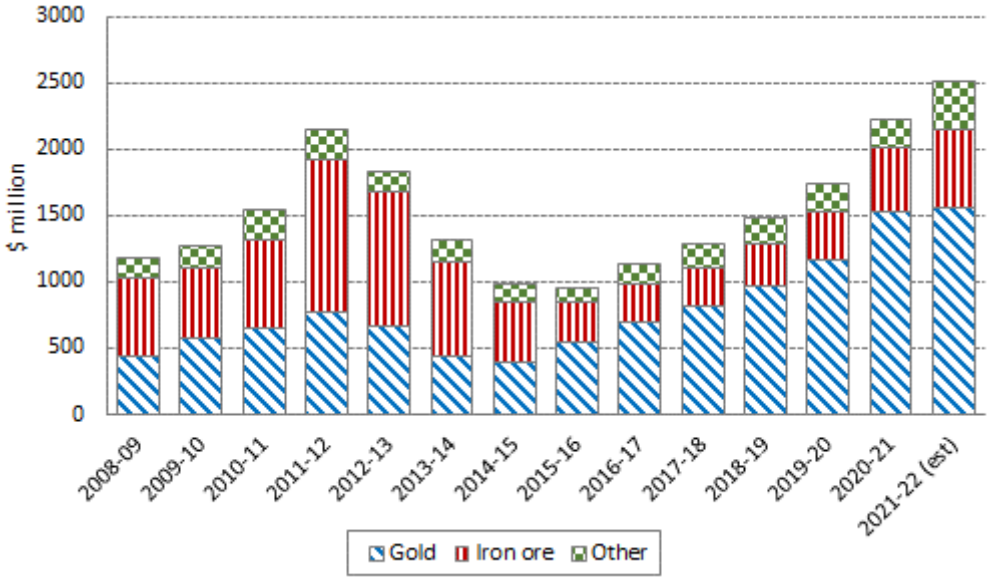
Note: Excludes petroleum exploration and uranium and coal exploration.
Source: Mineral and Petroleum Exploration, Australia, ABS, March 2022.

Figure 4.3: Australian metals and other minerals expenditure – percentage share by group, 2021-22 (%)



Note: Excludes petroleum exploration and uranium and coal exploration.
Source: Mineral and Petroleum Exploration, Australia, ABS, March 2022.

Figure 4.4: Western Australian private exploration expenditure – Selected metals and other minerals ($m)



Note: Excludes uranium and coal.
Source: Mineral and Petroleum Exploration, Australia, ABS, March 2022.

Figure 4.4 shows private mineral and metal exploration expenditure for Western Australia since 2008-09. Exploration expenditure in 2021-22 was a record $2.4 billion. Western Australia accounted for over 65 per cent of total national mineral and metal exploration expenditure in 2021-22. Record exploration levels in Western Australia were recorded for gold, copper, lead, silver and other minerals.

Table 4.4 shows Australia's world ranking of mineral resources in December 2020 in terms of share of world resources and share of world production.

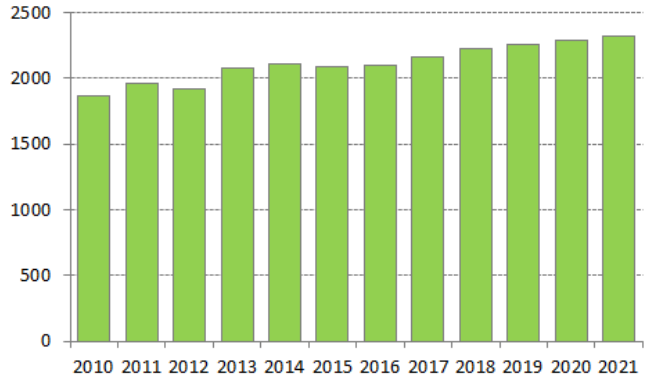
Table 4.4 Australia's world ranking for selected minerals and metals in terms of reserves and share of production, 2020

Mineral	World ranking for resources	Resource as a share of world (%)	Share of world production (%)
Bauxite	2	17	28
Black coal	4	10	7
Cobalt	2	21	4
Copper	2	11	4
Gold	1	20	10
Iron ore	1	29	38
Lead	1	41	11
Lithium	2	27	49
Nickel	1	22	7
Rutile	1	63	26
Zinc	1	26	11
Zircon	1	71	21

Source: Australia's Identified Mineral Resources, 2021, Geoscience Australia, pp. 15.

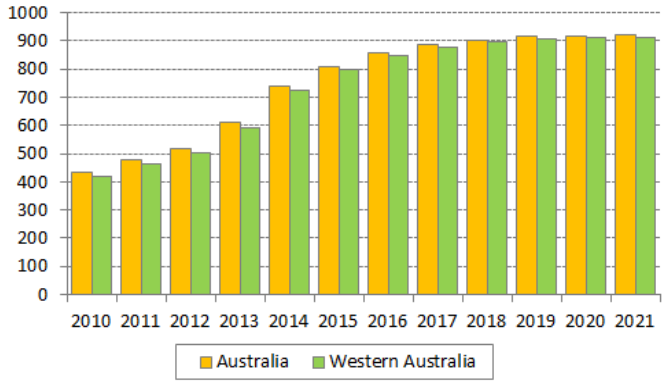
5. Iron ore

Figure 5.1: Iron ore production – World (million tonnes)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Figure 5.2: Iron ore production – Australia and Western Australia (million tonnes)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

World iron ore production in 2021 was 2,321 million tonnes, up 1.5 per cent on production levels in 2020. Australian production of iron ore in 2021 was 922 million tonnes, a similar level to production in calendar years 2019 and 2020. Australia accounted for 46 per cent of global production in 2021.

World production of iron ore in 2022 has been impacted by a number of factors, including:

- reduced imports from China in 2022 impacted by outbreaks of COVID-19 and shutdowns in early 2022;
- Brazil's production (rate) recovery post COVID-19 being impacted by weather events and reduced Chinese demand;
- Russia's invasion of Ukraine impacting on world trade as European steelmakers curtail the use of Russian iron ore; and
- China continues to develop new supply sources in Guinea, on the African continent.

Iron ore is mined in around 50 countries across the world. The four largest iron ore producing countries in 2021 were Australia (35 per cent) Brazil (15 per cent), China (14 per cent) and India (9 per cent).[1]

Iron ore is principally used in the production of crude steel. Around 98 per cent is used in steel production and the remaining 2 per cent in paints, inks and dyes.

Production of crude steel world-wide in 2021 was 1,951 million tonnes. World crude steel production has been growing rapidly, increasing by 27 per cent over the last 10 years.[2] The key applications of steel are in infrastructure and equipment. These include:

- Engineering infrastructure such as railways, bridges, roads and heavy engineering (manufacturing);
- Non-residential building construction such as shopping centres, hotels, sports and entertainment facilities;
- Residential building including apartments, houses and semi-detached dwellings;
- Mechanical equipment (e.g. motors, power tools) and transport equipment (motor vehicles, trains, shipping); and
- Other appliances and equipment.

Australia has massive reserves of iron ore in Western Australia. Australia has 29 per cent of world reserves and is ranked number one in the world. Australia's Economic Demonstrated Resources (EDR) were 27,440 million tonnes in 2020 implying, at current production rates, 30 years of supply.[3] Brazil, Russia and China also have large reserves of iron ore. In 2021-22, exploration for iron ore is estimated to have been A$546 million, or nearly 25 per cent, of total mineral exploration expenditure in Western Australia.

[1] Mineral Commodity Summaries 2022, Iron Ore, US Geological Survey, 2022.

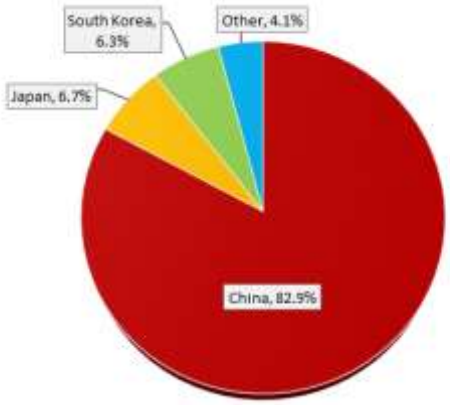
[2] World Steel in Figures, World Steel Association, 2022, www.worldsteel.org.

[3] Australia's Identified Mineral Resources, 2021, Geoscience Australia.

Figure 5.3: Iron ore nominal price (US$/dmtu)

Source: World Bank, July 2022.

Figure 5.4: Percentage share of Australian iron ore exports by destination, 2021 (%)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

China dominates world steel production, producing 1,033 million tonnes in 2021, representing 53 per cent of world crude steel production. Another 20 per cent of world crude steel production is located in India, Japan, the United States and Russia. Australian steel production was only 5.8 million tonnes in 2021, or 0.3 per cent of world production. Australian iron ore production has been directly fuelled by growing crude steel production in China.

Australia's exports of iron ore in calendar 2021 were 871.4 million tonnes, only slightly higher than the 2020 level of 867.2 million tonnes. The total value of Australian iron ore exports in 2021 was A$154.6 billion, up A$37.7 billion or 32 per cent, on 2020 total exports. In 2021, China accounted for 83 per cent of Australian iron ore exports, with Japan and Korea at 6.7 and 6.3 per cent respectively. Figure 5.4 shows Australian export shares by country for calendar 2021 based on volumes.

Iron ore spot prices have remained relatively stable in the six months to June 2022. Over the first six months of 2022 US$ prices have averaged $140.1 per metric tonne. Prices rose steadily over the first half of 2021, partly in response to the COVID-19 pandemic. Prices then fell sharply in the second half of 2021 averaging only US$96 in November 2021. Upward pressure on iron ore prices could stem from:

- COVID-19 developments over the next few years;
- the ongoing war in Eastern Europe; and
- possible supply shocks from adverse weather events in Australia and Brazil.

On balance, however, higher production of iron ore should see prices ease over the 2022 to 2024 period.

Australian production of iron ore has risen substantially over the last decade. Production has nearly doubled over the last 10 years from 477 million tonnes in 2011 to 922 million tonnes in 2021. Nearly all of iron ore mined is exported from Australia.

The major producers of iron ore in Australia are BHP, Rio Tinto and Fortescue Metals Group. All these producers have large mining deposits in Western Australia. In 2021, production by these three companies accounted for over 90 per cent of Australia's total iron ore production of 922 million tonnes.

In 2021, the three major producers commissioned a number of major projects in Western Australia. These included:

- BHP's South Flank project (80,000 kt);
- Rio Tinto's West Angelas project (40,000 kt), Mesa (B, C, H) Robe Valley (25,000 kt), and Western Turner project (32,000 kt); and
- Fortescue Metals Group, Eliwana Western Hub (30,000 kt).

Some of these projects were to replace depleted resources elsewhere, such as BHP's South Flank project.

In 2022 further mining sites are expected to come online, including:

- Rio Tinto's Gudai Darri in June 2022 (43,000 kt); and
- Fortescue's Iron Bridge (22,000 kt).

A number of smaller developments have been completed, such as Atlas Iron's Sanjir Ridge project (4,000 kt).

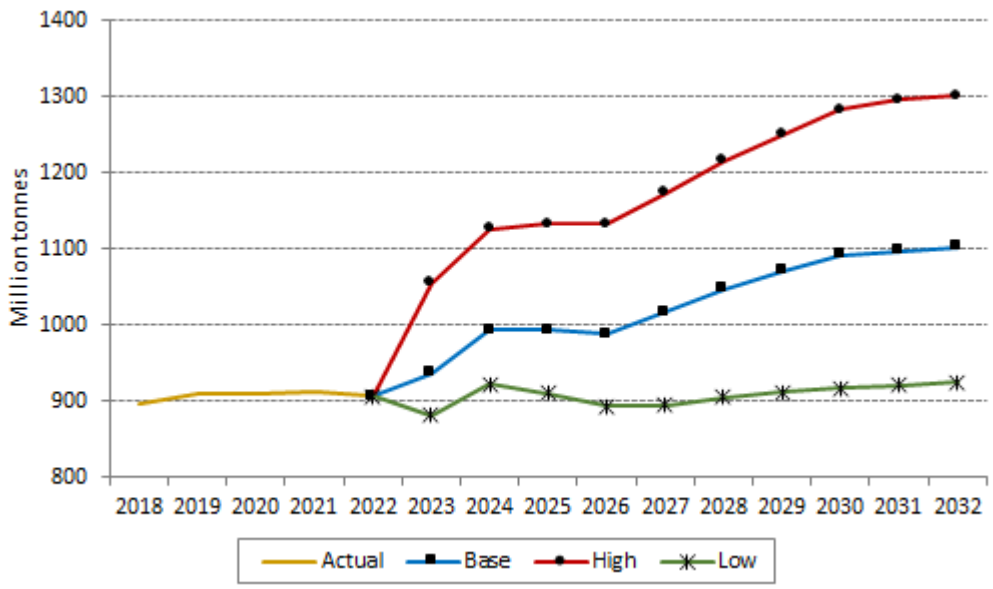
Australian iron ore production is expected to increase steadily over 2023 and 2024. Table 5.1 shows prospective iron ore developments in Western Australia, but focussing on major mine developments.

Figure 5.5 shows the forecasts for iron ore production for Western Australia to 2032 by scenario.

Table 5.1 Prospective major iron ore projects – Western Australia			
Company	**Project**	**Resource (kt)**	**Estimated timing**
Mineral Resources	Ashburton	30,000	2023, 2024
Mineral Resources/Brockman Resources	Marillana and Opthalima	25,000	2024
Hancock Prospecting	Pilbara	14,000	2025-2027
Fortescue Metals Group	Nyidinghu	30,000	Post-2025
BHP/ITOCHU/Mitsui	Western Ridge	20,000	Post-2025
API (Joint Venture)	West Pilbara Iron Ore Project	40,000	Post-2023

Sources: Company websites, reports, ASX company announcements.

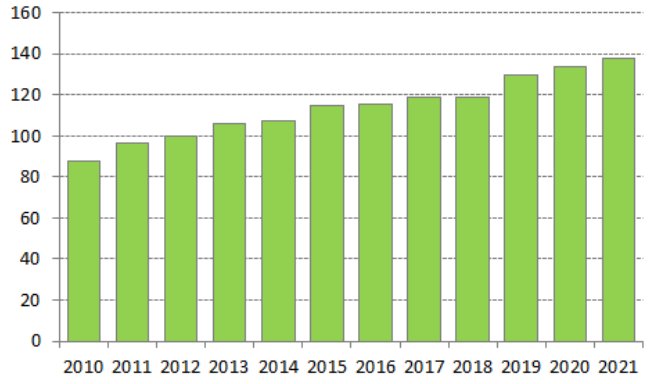
Figure 5.5: Western Australian iron ore production to 2032 by scenario (million tonnes)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

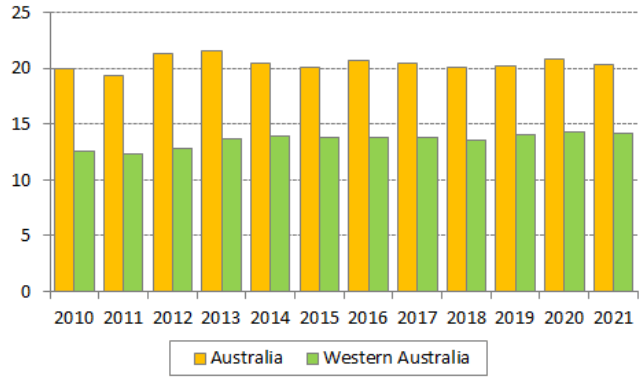
6. Alumina

Figure 6.1: Alumina production – World (million tonnes)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Figure 6.2: Alumina production – Australia and Western Australia (million tonnes)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Global production of alumina was 138 million tonnes in 2021. As indicated in Figure 6.1, world production of alumina has expanded rapidly over the last decade with increased use in road, air and sea transport applications. Global production has increased by 50 million tonnes since 2010, or at an average annual growth rate of 4.2 per cent per annum.

In contrast, Australian production of alumina has remained relatively flat over the last decade, with expansions in Western Australian capacity being offset by plant closures. Rio Tinto closed the Gove Alumina refinery in 2014, however, the bauxite mine is still operating. Bauxite mining operations at Gove are expected to cease in 2030.

World production of bauxite in 2021 was 368.2 million tonnes. Australia produced 103.3 million tonnes, or 28.1 per cent, of total global bauxite production. There are nine operating bauxite mines in Australia. Other major countries producing bauxite are China (23 per cent), Guinea (23 per cent) and Brazil (9 per cent).

Australian bauxite exports were 34.3 per cent of Australian production, or 35.4 million tonnes, in 2021. The export share of bauxite has risen significantly over the last decade, given total alumina smelting capacity has remained relatively flat. The export share of total bauxite production in Australia in 2010 was only 11.6 per cent.

Australia's EDR reserves of bauxite in 2020 were 5,132 million tonnes, 17 per cent of world resources. Australia is ranked second for share of world resources. [4]

Alumina is a white powder, known as alumina oxide. Alumina is usually smelted into aluminium, although there are some direct primary uses of alumina in metallic paint, spark plug insulators and in rocket boosters. Aluminium is extensively used in transport, construction and packaging. Aluminium is a key component in aircraft construction, motor vehicles, boating and shipping. In construction, aluminium is used in doors, windows and fittings. Many consumer durables are cladded in aluminium and drinks are sold in aluminium cans.

Alumina is a manufactured product produced from bauxite mined in Western Australia, Queensland and the Northern Territory. Alumina refineries use the Bayer process to produce alumina from bauxite and caustic soda. Figure 6.3 provides an overview of the process from bauxite to aluminium.

Australian exports of alumina were A$7.8 billion in 2021, up from A$7.0 billion in 2020. The volume of exports was some 18.4 million tonnes of alumina in 2021. Alumina metal is also shipped to aluminium smelters on the eastern seaboard of Australia.

[4] Australia's Identified Mineral Resources, 2021, Geoscience Australia, Digital publication, 2022.

Figure 6.3: From bauxite to aluminium

BAUXITE MINING

Open-cut deposits 4 to 6 metres thick below top soil

↓

ALUMINA REFINING

The refining uses the Bayer Process. Bauxite is heated in a pressure vessel along with caustic soda at a temperature of 150 to 200 degrees Celsius. This process refines bauxite into alumina (alumina oxide), a white powder. This process is very oil or gas intensive.

↓

ALUMINIUM SMELTING

Alumina is converted to aluminium at aluminium smelters. Alumina is dissolved in an electrolytic bath within a large container known as a pot. An electric current is passed through the electrolyte at low voltage but very high current.

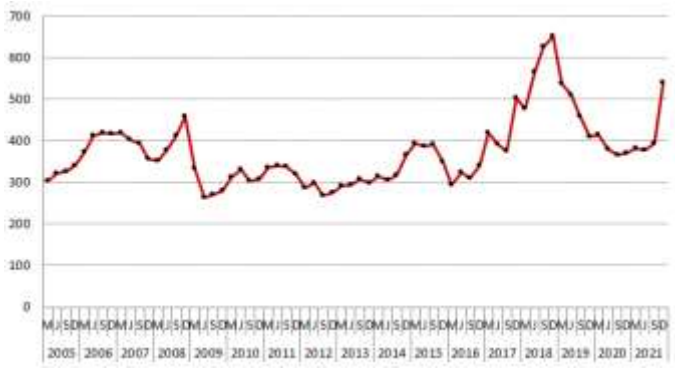
↓

ALUMINIUM RECYCLING

Aluminium is one of the most recycled metals in the world.

Sources: Alumina Limited, Alcoa, company websites.

Figure 6.4: Alumina export value (A$/t)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Australian production of alumina is located at refineries in Western Australia and Queensland. Queensland has two large alumina refineries located in or near Gladstone, the Queensland Alumina Limited (QAL) and the Yarwun refinery (Rio Tinto) at Yarwun. Total alumina refining capacity is some 7.4 million tonnes per annum.

Total alumina refining capacity in Western Australia is some 14.5 million tonnes per annum. Table 6.1 shows the alumina refinery capacity for Western Australia and Queensland. In Western Australia, Alcoa owns three refineries totalling 9.8 million tonnes, while South32 holds a majority interest in Worsley Alumina. In 2021 total production of alumina in Western Australia was 14.2 million tonnes.[5]

The Department of Industry, Science, Energy and Resources[6] recently reported that:

- the operating costs of bauxite mines in Australia were significantly below the world average;
- the operating costs of Australian alumina were significantly below the world average; and
- the operating costs of Australian aluminium smelters were above the world average.

The Russian invasion of Ukraine is likely to impact on alumina and aluminium markets, including prices. World prices initially fell through the COVID-19 pandemic, however, rose over late 2021 and may rise further in 2022. Alumina prices in November 2021 exceeded A$600 per tonne, the highest level since 2018.

Figure 6.6 shows the forecasts for alumina production by calendar year for Western Australia to 2032 by scenario.

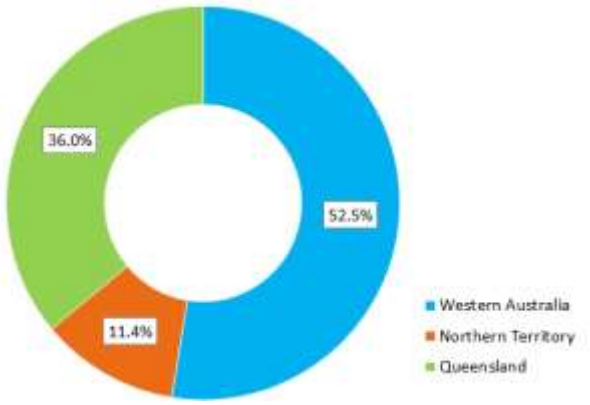
[5] DMIRS (WA) 2022 Major Commodities and Resources, 2021.

[6] Department of Industry, Science, Energy and Resources, Resources and Energy Quarterly, March 2022, pp. 132.

Table 6.1 Australian alumina refining capacity by state and location				
State	**Refinery**	**Location**	**Owner/Operator**	**Capacity (Mt/pa)**
Queensland	Queensland Alumina Ltd (QAL)	Gladstone	Rio Tinto Alcan (80%), Rusal (20%)	3.95
Queensland	Yarwun Alumina	Yarwun (near Gladstone)	Rio Tinto Alcan	3.4
Western Australia	Kwinana Alumina Refinery	Kwinana	Alcoa	2.2
Western Australia	Pinjarra Alumina Refinery	Near Pinjarra Peel region	Alcoa	4.7
Western Australia	Wagerup Alumina Refinery	Wagerup	Alcoa	2.9
Western Australia	Worsley Alumina	Boddington	South32 (86%), Japan Alumina (10%), Sojitz Alumina (4%)	4.7

Sources: NIEIR and Alcoa, QAL, Rio Tinto, South32 websites.

Figure 6.5: Share of Australian bauxite production by State, 2021 (%)

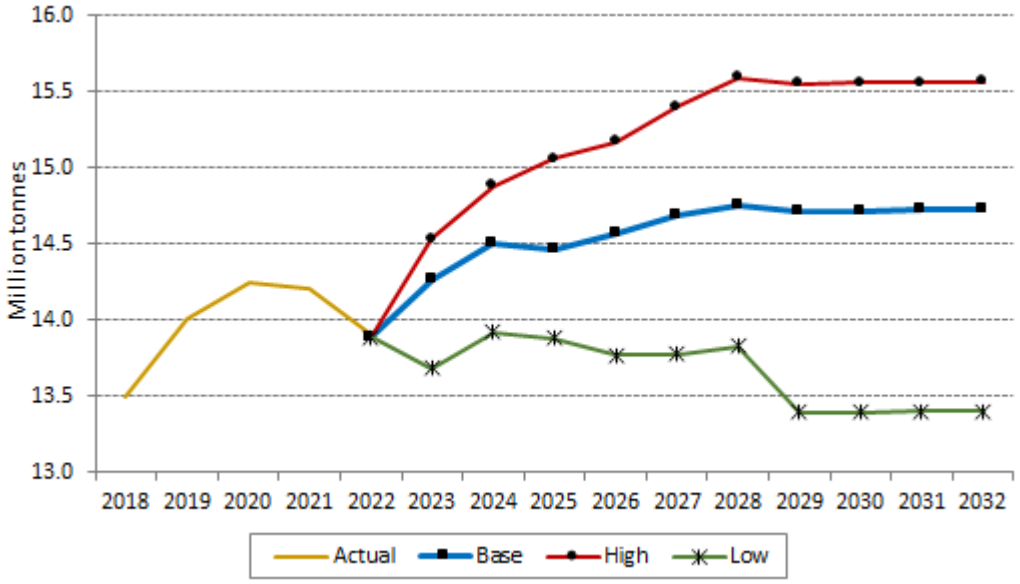


Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Australian production of alumina is expected to rise to just over 21 million tonnes under the base scenario. Western Australian production of alumina will remain at around 14 million tonnes.

Planned expansions at Pinjarra and Wagerup were announced in 2020. Applications were made to Western Australia's Environmental Protection Agency (EPA). Both expansions have been deferred. Alumina Limited also announced expansion plans in 2021, however, these again were deferred. Alcoa and FYI Resources are proposing to build a high purity alumina refining project in Kwinana with a capacity of 900 kt.

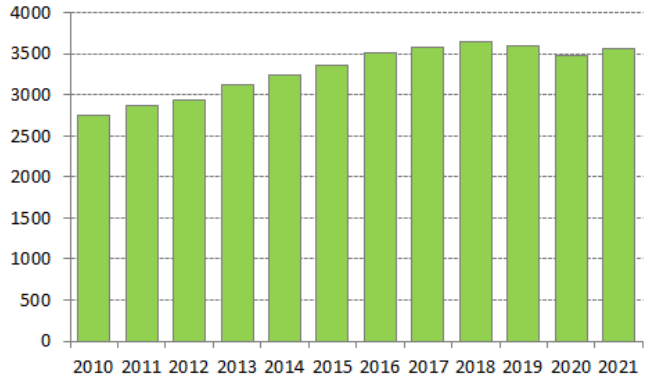
Figure 6.6: Western Australian alumina production to 2032 by scenario (million tonnes)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

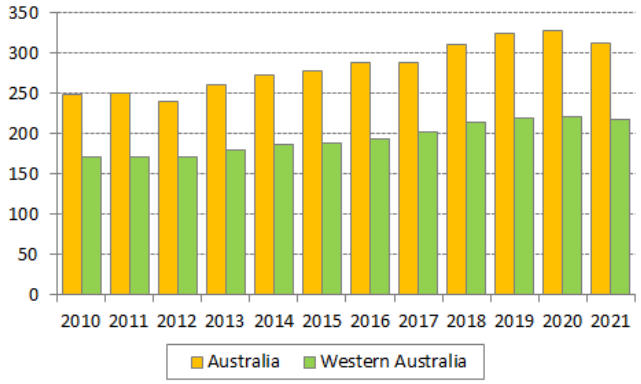
7. Gold

Figure 7.1: Gold production – World (tonnes)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Figure 7.2: Gold production – Australia and Western Australia (tonnes)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

World gold production in 2021 was 3,561 tonnes, up 2.5 per cent on 2020 production levels. Global gold production rose rapidly between 2010 and 2016, by around 750 tonnes or 30 per cent. Since 2016, gold production has fluctuated between 3,500 and 3,600 tonnes per annum. The world's three largest gold producing countries in 2020 were China (11.5 per cent), Australia (10.3 per cent) and Russia (9.7 per cent).[7]

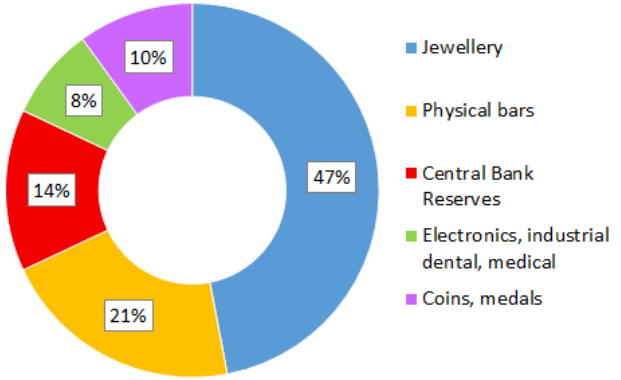
In 2020, Australia's Economic Demonstrated Resource (EDR) of gold was 11,101 tonnes, up 3 per cent compared to 2019.[8] Australia has the largest share of gold resources than any other country in the world (20 per cent). Australia's gold resources are mostly located in three states, Western Australia (45 per cent), New South Wales (16 per cent) and South Australia (26 per cent). Around half of all mineral exploration expenditure in Australia is for gold.

Gold mined in Australia generally comes from open-cut and underground gold mines. The two main types of gold deposits are lode-gold deposits and copper-gold deposits. Lode-gold deposits are when the ore is embedded in a fissure. The Kalgoorlie Super Pit is an example of a lode-gold deposit. Copper-gold deposits are at Telfer, Boddington in Western Australia, and the Cadia mine in New South Wales.

The supply chain process from mine to refined gold bullion may involve a number of different treatments. Mined ore is generally extracted, crushed and ground. Leaching gold with a cyanide solution is commonly used to extract gold from concentrates. Other base metals are also removed. Australia's only gold refiner is located at the Perth Mint in Western Australia. The Mint produces gold bullion from domestic and overseas sources.

Gold is a precious and very rare metal and has been used as a unit of currency since 700 BC. Gold was used well before this in ancient civilisations as jewellery. Global uses of gold are shown in Figure 7.3.

Figure 7.3: Global end-uses of gold metal



Sources: Mineral Commodity Summaries 2022, US Geological Survey.

As indicated in Figure 7.3, the main end-uses of global gold are in jewellery (47 per cent), physical bars (21 per cent) and Central Bank Reserves (14 per cent).

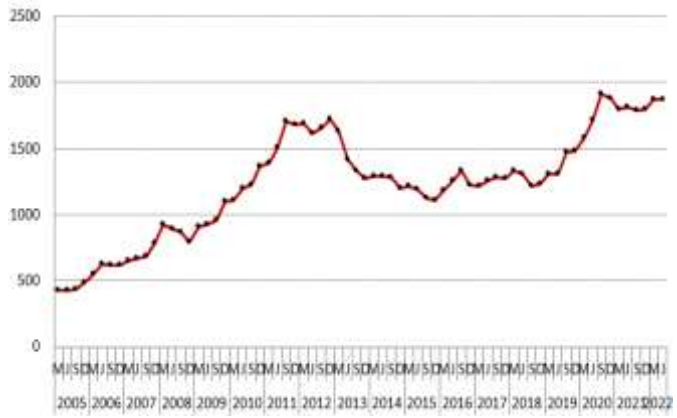
[7] World Mineral Products, 2016-2020, British Geological Survey, 2022.

[8] Australia's Identified Mineral Resources, Geoscience Australia, 2022.

With the onset of the war in Ukraine, gold prices soared from around US$1,800 per ounce in December 2021 to nearly US$1,950 per ounce in March 2022. Since March 2022, gold prices have eased somewhat to average around US$1,840 in the month of June 2022. Gold prices still remain 20 to 30 per cent higher than the levels in late 2019 of US$1,500 per ounce. The raising of short-term and long-term bond yields over 2022 and 2023 should see gold prices fall gradually.

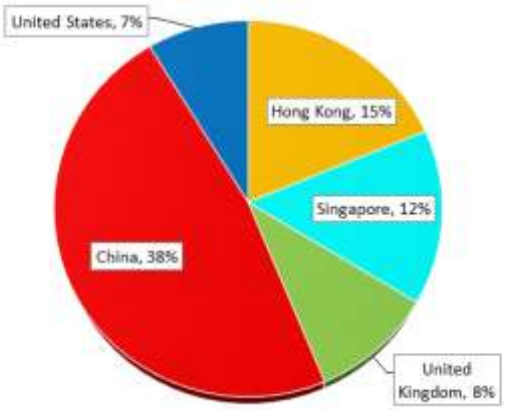
Australian exports of refined and unrefined bullion was 257.1 tonnes in 2021. The total value of exports was A$23.3 billion. Imports of gold by Australia were A$6.5 billion, giving a net trade surplus in 2021 of A$16.8 billion. The main markets for Australian gold in 2021 were China (38 per cent) and Hong Kong (15 per cent), as shown in Figure 7.5.

Figure 7.4: Gold nominal price (US$/troy oz)



Source: World Bank, June 2021.

Figure 7.5: Percentage share of Australian gold exports by destination, 2021 (%)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Gold production in Australia was 312 tonnes in 2021, down from 328 tonnes in 2020. Western Australian production was 218 tonnes in 2021, or 70 per cent of the Australian total. The next largest gold mine producing states in 2021 were New South Wales (10.2 per cent) and Victoria (9.9 per cent). Gold production in Western Australia in 2021 is running nearly 50 tonnes higher than 10 years ago. This represents an increase of 27 per cent over 2011 production levels.

Gold mines in Western Australia are located around Kalgoorlie, in the Pilbara and also South of Perth. Major gold mining activities in Western Australia include:

- Kalgoorlie Consolidated Gold Mines (KCGM – Super Pit) and other Kalgoorlie Operations, operated by Northern Star;
- Newcrest's Telfer mine in the Pilbara;
- Tropicana gold mine located north-east of Kalgoorlie; and
- Newmont's Boddington mine, a copper-gold mine south of Perth.

These four mines operated by Northern Star, Newcrest, Tropicana and Newmont represented 38 per cent of total gold production in Western Australia in 2021.[9]

Outside Western Australia, the Cadia mine in New South Wales near Orange is Australia's largest gold mine producing 600,000 ounces in 2021. BHP's Olympic Dam mine in South Australia produced 149,000 ounces of refined gold in 2021.

Gold production will expand over 2023 and 2024. A falling gold price by 2023-24 is expected to lead to production falls by 2025 and 2026.

The high gold prices over 2021 and into 2022 have stimulated a large number of new, committed and prospective projects. Table 7.1 shows recently completed and prospective projects in Western Australia. This list is not intended to be comprehensive, as it excludes many small to medium sized gold mining operations.

There are many other committed gold projects in Western Australia due to come online over the 2024 and 2025 period. The largest project outside Western Australia is

[9] Company websites and Quarterly Production Reports ASX.

the Newmont Tanami Expansion 2 in the Northern Territory of 580,000 ounces.

Gold exploration has been expanding in the East Pilbara region of Western Australia. A number of discoveries have been made in the region. These include the De Grey mining discovery at Hemi, Rio Tinto's discovery of the Winu copper-gold deposit and Greatland Gold's discovery of the Havieron deposit. Newcrest has teamed up with Greatland Gold to develop Havieron, near the Telfer mine.

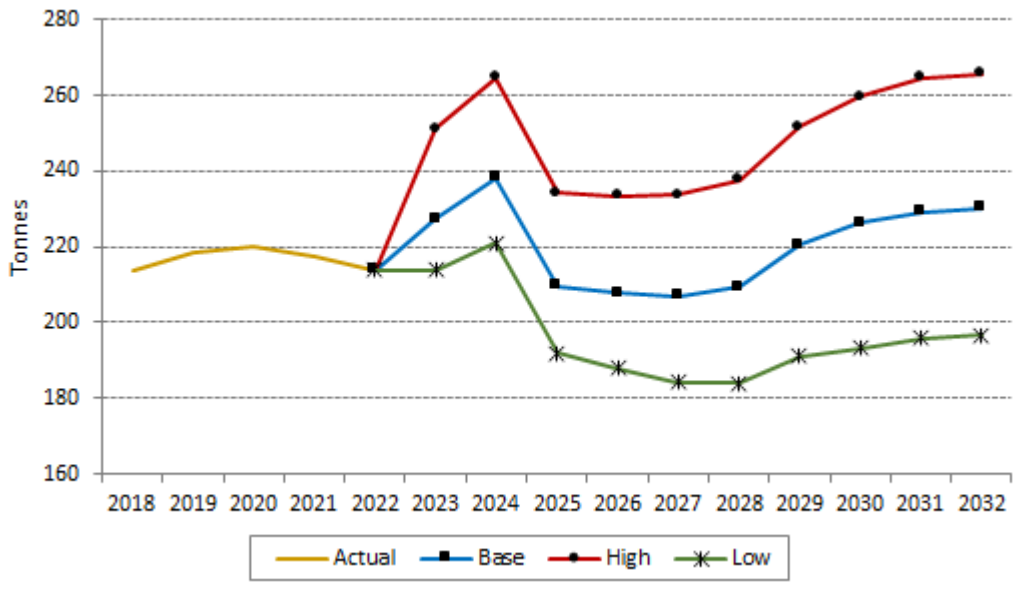
Figure 7.6 shows the forecasts for gold production on a calendar year basis for Western Australia to 2032 by scenario.

Table 7.1 Major gold projects – Western Australia

Company	Project	New capacity (oz)	Estimated timing
Recently completed			
Red 5 Ltd	King of the Hills	72,000	2022
Norseman and Pantoro	Norseman	108,000	2022
Zijin Mining	Paddington Mill Upgrade	193,000	2021
Ramelius Resources	Tampia	104,000	2021
Newcrest Mining	Telfer West Dome (Stage 5)	390,000	2022
Northern Star Resources	Thunderbox Mill Expansion	3 Mtpa (hard rock)	2022
Calidus Resources	Warrawoona Gold Project	130,000	2022
Wiluna Mining	Wiluna Gold Project (Stage 1)	120,000	2022-2023
Prospective and probable			
St Barbara[1]	Bardoc Gold Project	150,000	2024, 2025
Bellevue Gold	Bellevue Gold Project	200,000	2023 H2
Zijin Mining Group[2]	Bullabulling (expansion)	175,000	2023-2024
Greatland Gold and Newcrest Mining	Havieron Gold-Copper	160,000	2024 H1
Northern Star Resources	Kalgoorlie Super Pit	200,000	2025
De Grey Mining Ltd	Mallina	300,000	2026
Wiluna Mining	Wiluna Gold Project Stage 2 (underground)	215,000	2026

Notes: 1. Previously Bardoc Gold Limited. 2. Previously Norton Gold Fields Ltd.
Sources: St Barbara, Bellevue Gold, De Grey Mining, Zijin Mining, Newcrest Red 5 Ltd and Ramelius Resources websites.

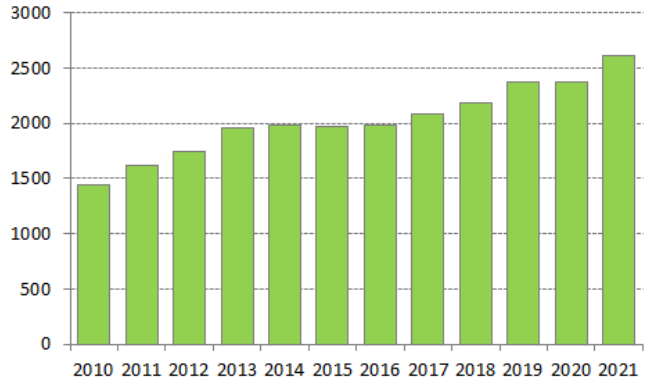
Figure 7.6: Western Australian gold production to 2032 by scenario (tonnes)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

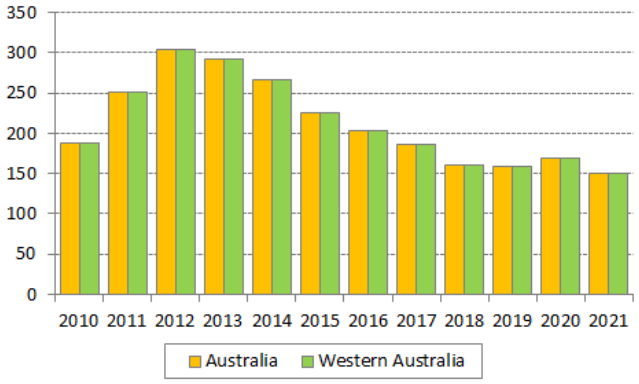
8. Nickel

Figure 8.1: Nickel production – World (kt)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Figure 8.2: Nickel production – Australia and Western Australia (kt)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

World production of nickel rose to 2.6 million tonnes in 2021, up 10 per cent on 2020 levels. Production of nickel in 2020 was adversely affected by COVID-19 containment measures in some countries. Global production of nickel is expected to increase further in the medium term, driven by demand for stainless steel products and batteries for electric vehicles.

Australian production of nickel was 151 kt in 2021, representing nearly 6 per cent of total global production of nickel. Australia is ranked the 6th largest producer of nickel in 2020.[10] The three largest nickel producing countries in the world in 2020 were Indonesia (33 per cent), Vietnam (13 per cent) and Russia (9 per cent).

Nickel production in Australia has been dominated by Western Australia, accounting for 100 per cent of Australian production for nearly 15 years. In May 2022 it was announced that Tasmania's Avebury Nickel Mine was out of care and maintenance. The owner of the mine is Mallee Resources and production has recommenced at this site.

Australian EDR of nickel were 21.4 million tonnes in 2020.[11] Australia is ranked number one in terms of nickel mineral resources, accounting for 22 per cent of world nickel resources. Nickel West, owned by BHP, is a major producer of nickel in Western Australia. Production was 82.1 kt in calendar 2021, a lower than usual level of production due to planned maintenance at the Kwinana refinery and across the supply chain.[12]

Exports of nickel from Australia in 2021 were A$5.9 billion, up A$3.2 billion on exports in 2020. Over 90 per cent of the value of Australian exports were in refined and intermediate nickel. Figure 8.5 shows the value of Australian nickel exports over the last 10 years.

Nickel is a silver metal that resists corrosion. Nickel is primarily used in making alloys such as stainless steel. Because nickel resists corrosion it is commonly used to plate other metals. It is commonly used in consumer durables such as toasters and electric ovens. Nickel is used in sinks, cooking utensils, cutlery and coinage. Nickel alloys are used in boat propeller shafts and turbine blades.

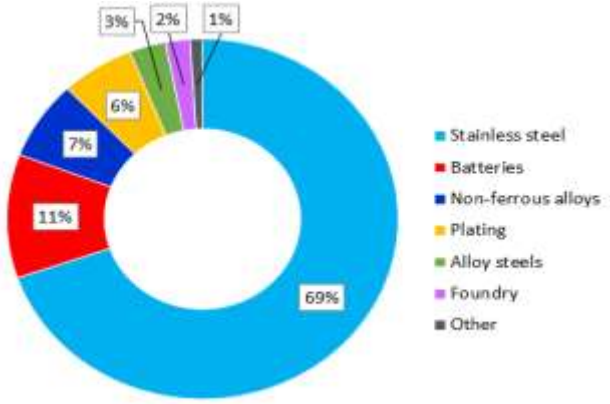
Nickel is used in batteries, including rechargeable nickel-cadmium batteries and nickel metal hydride batteries.

[10] World Mineral Production, 2016-2020, British Geological Survey, pp. 50.

[11] Australia's Identified Mineral Resource, 2021, Geoscience Australia, Digital publication.

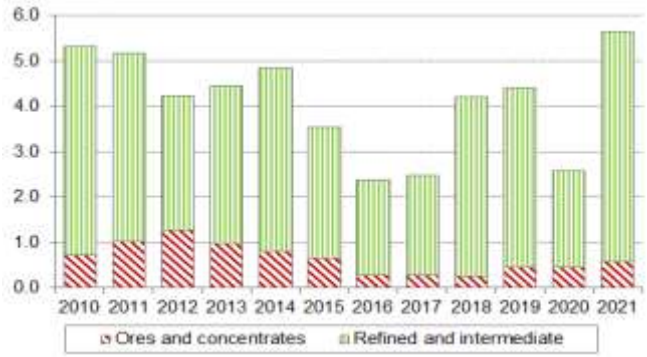
[12] Quarterly Activities Reports, BHP.

Figure 8.3: The main end-uses of nickel



Source: Nickel Institute, https://nickelinstitute.org.

Figure 8.5: Australian nickel exports by class (A$ billion)



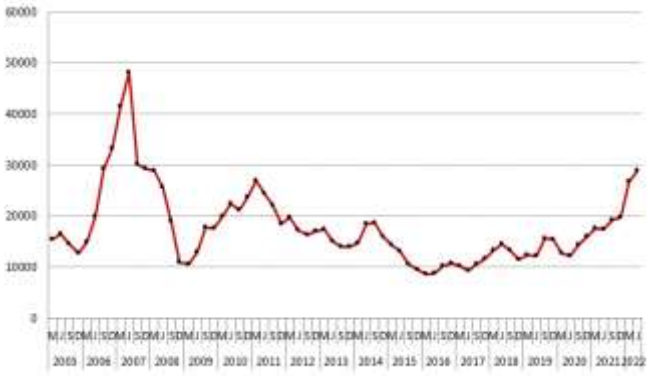
Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

World nickel prices have surged over the first half of 2022, reaching US$30,600 in the June quarter 2022. This is the highest US$ nickel price since 2007. Nickel prices initially fell over 2020 with the COVID-19 pandemic, but then rose steadily over 2021. The sharp price increase partly reflects the impact of Russia's invasion of Ukraine, low nickel inventories and positive sentiment around electric vehicles. Average monthly nickel prices have fallen by 24 per cent between March and June 2022.

The largest producer of nickel in Australia is BHP's Nickel West. Nickel West's operations in Western Australia encompasses the following:

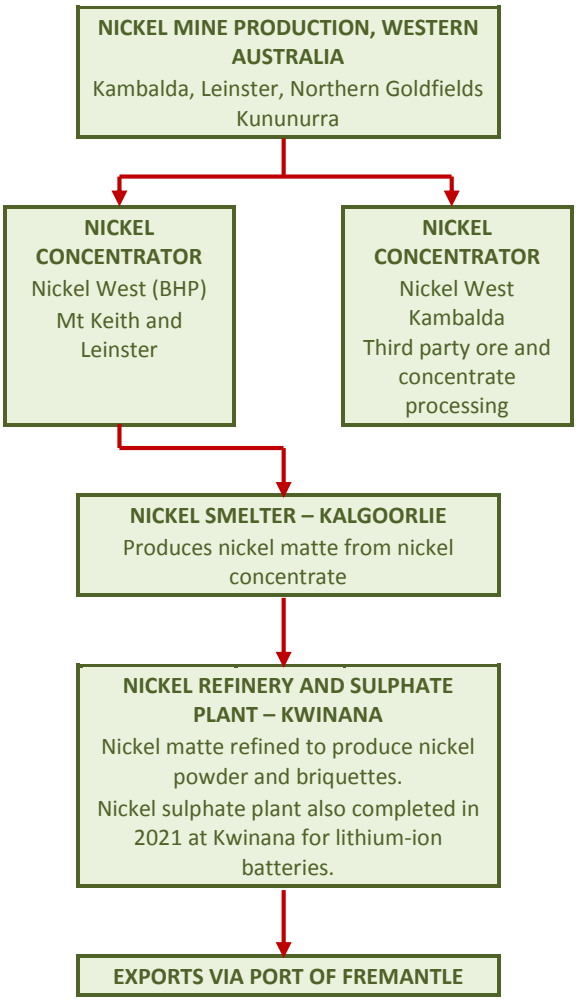
- ore mine at Mt Keith open cut and ore from the underground Cliffs and Leinster mines;
- a concentrator and dryer at Leinster and Mt Keith, as well as a concentrator at Kambalda, which processes ore from third parties;
- a smelter at Kalgoorlie which converts nickel concentrate to nickel matte; and
- a nickel refinery in Kwinana which converts nickel matte into premium grade nickel powder and briquettes.

Figure 8.4: Nickel nominal price (US$/tonne)



Source: World Bank, June 2022.

Figure 8.6: The Nickel West (BHP) supply chain



Source: BHP website.

Western Australian nickel production is expected to increase, driven by high prices and increased electric vehicle manufacturing. Recently completed and prospective nickel projects for Western Australia are shown in Table 8.1. The Ardea Kalgoorlie nickel project at Goongarrie represents one of the largest nickel-cobalt resources in the world. The Kalgoorlie nickel project has a resource estimate of 830 mt at 0.71 per cent nickel and 0.046 per cent cobalt (5.9 mt nickel and 380 kt cobalt).[13] The Cannon Resources project at Fisher East, which is located in the North-Eastern Goldfields region, has an estimated total nickel resource of 116.3 kt.

The Greenstone Resources Mt Thirsty project is a cobalt-nickel project. The project is expected to produce 19.1 kt of cobalt and 24.8 kt of nickel.

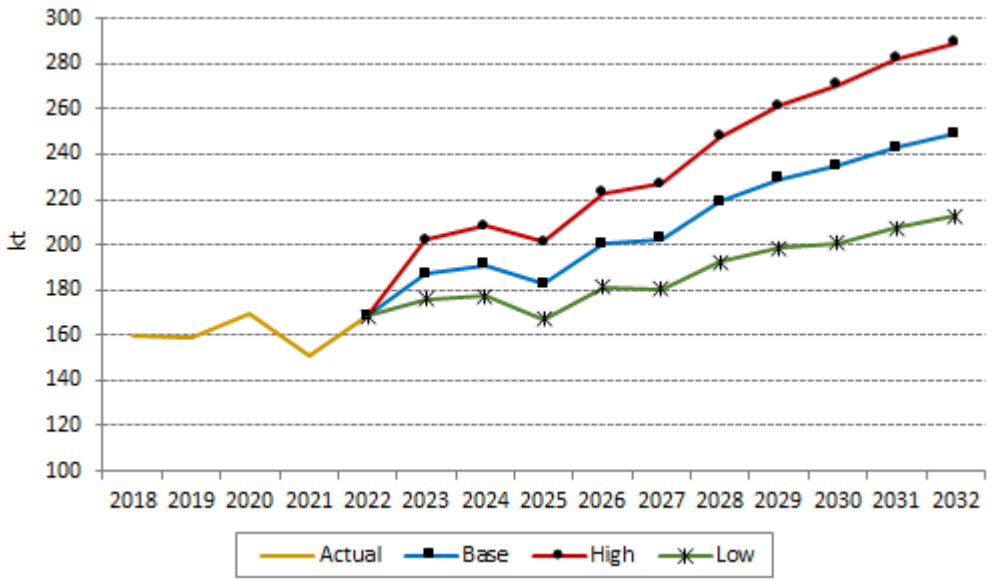
Figure 8.7 shows the forecasts for nickel production on a calendar year basis for Western Australia to 2032 by scenario.

Table 8.1 Western Australian nickel projects

Company	Project	Nickel kt (annual)	Timing
Recently commissioned			
Mincor Resources	Kambalda Nickel Operations (Cassini, Long and Durkin North Mines)	16	March 2022
Western Areas	Odysseus (mine and concentrator)	13	December 2022
BHP	Leinster B11 Block Care (expansion)	10	2021
Prospective projects			
Cannon Resources	Fisher East	7.3	2025
Ardea	Goongarrie (nickel-cobalt project)	18	2025
Greenstone Resources (formerly Barra Resources)	Mt Thirsty (cobalt-nickel)	2.1	2024

Sources: Mincor Resources, Western Area, BHP, Ardea Resources, Cannon Resources, Greenstone Resources websites.

Figure 8.7: Western Australian nickel production to 2032 by scenario (kt)

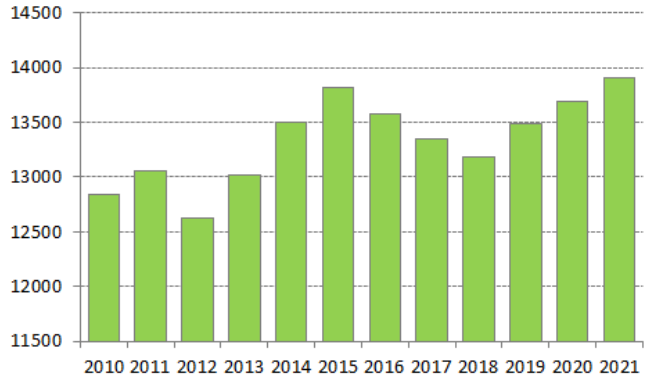


Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

[13] Ardea Resources website, www.ardearesources.com.au, Kalgoorlie Nickel Project-Feasibility Study Update, 14-06-2022.

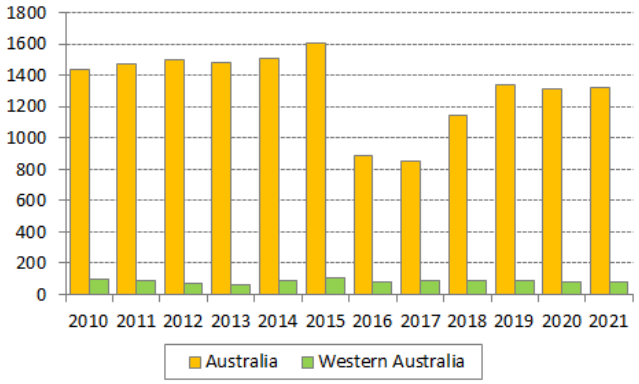
9. Zinc

Figure 9.1: Zinc production – World (kt)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Figure 9.2: Zinc production – Australia and Western Australia (kt)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

World zinc production was 13.9 million tonnes in 2021, up slightly from 13.7 million tonnes in 2020. Australia is one of the world's dominant producers of zinc, accounting for 10 per cent of world production in 2021. China accounted for around 46 per cent of global zinc production in 2021.

Australia's EDR of zinc in 2020 were 66.4 million tonnes, the largest reserves of any country in the world. There are large deposits of zinc resources at Mt Isa in North-West Queensland, at McArthur River in the Northern Territory and at Admiral Bay in Western Australia. Smaller zinc resources are scattered across other states of Australia. In Western Australia, other significant zinc deposits are at Golden Grove and Abra.

Australian zinc metal production in 2021 was 1,323 kt. While this level of production is significantly higher than production levels in 2016 and 2017, it is still short of the 1,610 kt produced in 2015. Queensland and the Northern Territory accounted for 78 per cent of total Australian zinc metal production in 2021, while Western Australia accounted for 6 per cent.

It should be acknowledged that zinc, lead and silver are often found together in mineral deposits. Mining activity at these sites may often involve extracting two or three of these ores from the same mine. In 2021, Glencore operations at Mount Isa and McArthur River produced 609 kt of zinc concentrate, or 46 per cent of total Australian production.[14]

The main end-uses for zinc are in galvanising steel, diecasting and making brass and bronze alloys. Zinc is also used in many other applications. In the manufacturing sector, zinc can be used for coatings, plating and also in chemical and mining applications. Zinc metal is also used in various battery applications.

Table 9.1 Zinc usage by sector

End-use	Sector/Commodity	Per cent
Galvanising	Automobiles and construction	50
Diecasting	Door hardware, motor housings, toys	17
Brass and bronze	Plumbing fittings – taps, pipes	17
Rolled zinc	Roofing, guttering, coffins, batteries	6
Chemicals	Tyres, cosmetics (zinc cream)	6
Miscellaneous		4

Source: International Lead and Zinc Study Group, ilzsg.org/statistics/enduses.

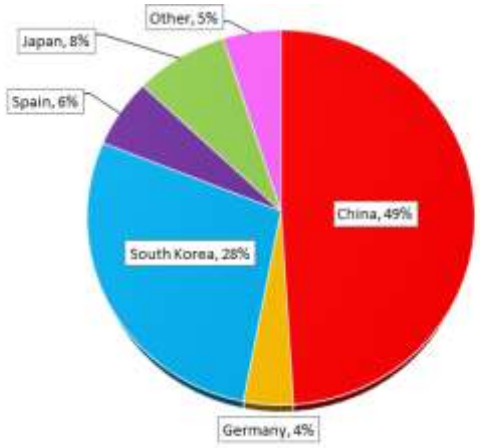
Around 40 per cent of zinc comes from reclaimed zinc sources. The most common recycling of zinc is from galvanised steel using Electric Arc Furnaces. Given zinc ore deposits are not renewable, recycling must become a growing viable source of this metal.

[14] Glencore company website.

Figure 9.3: Zinc nominal price (US$/tonne)

Source: World Bank, July 2022.

Figure 9.4: Percentage share of Australian zinc concentrate exports by destination, 2021 (%)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

World zinc metal prices rose rapidly through the COVID-19 pandemic. By the June quarter 2021, zinc prices reached over US$2,900 per tonne, compared to only US$1,968 in June 2020. By June 2022, prices had risen to over US$4,000 per tonne, the highest realised price since the December quarter 2006. The price increases largely reflect supply shortages caused by labour shortages, border restrictions and some zinc smelters rebuilding stocks.

Australian exports of zinc concentrate and refined zinc were $3.5 billion in 2021. China imported nearly 50 per cent of Australian zinc concentrates in 2021, followed by South Korea (28 per cent), Japan (8 per cent) and Spain (6 per cent).

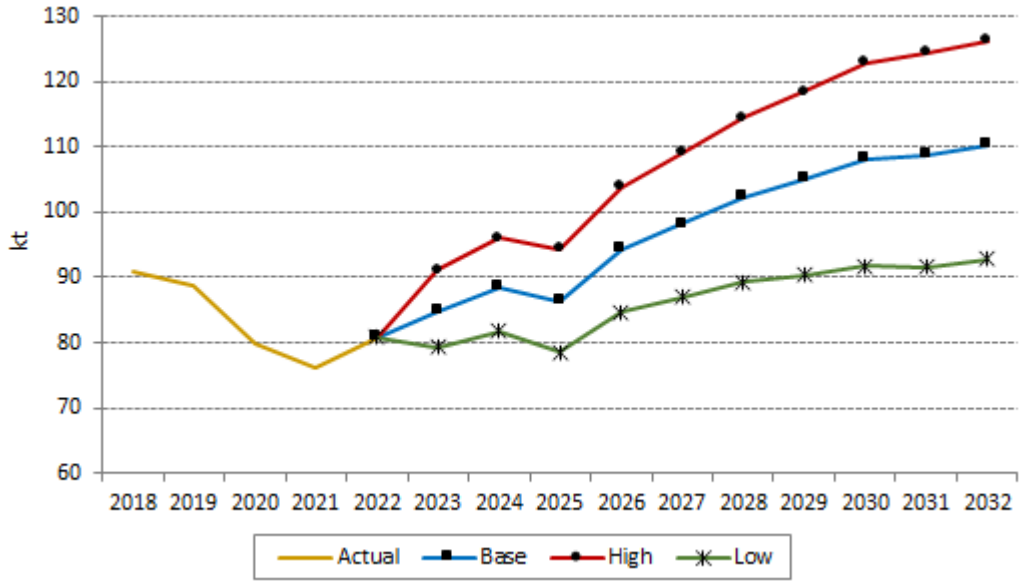
Australian production of refined zinc was 466 kt in 2021. Refined zinc products from Australia are generally exported to Asia, including China, Chinese Taipei, Indonesia, Malaysia and India. In Australia, refined zinc is produced at Sun Metals in Townsville, Queensland and by Nyrstar at Risdon in Hobart, Tasmania. The processing of zinc requires roasting, leaching and electrolysis plant. The refining process is electrically intensive.

There is a reasonably positive outlook for zinc production in Australia over the next few years. Production increases will be driven by increases at McArthur River in the Northern Territory, the Century mine in Queensland and increases at the Golden Grove operation in Western Australia. Exploration expenditures for base metals, such as zinc, have also increased significantly.

Zinc mining operations in Western Australia include Golden Grove operated by 29 Metals and Round Oak Minerals, which has the Jaguar operation near Leonora. Golden Grove is a high grade copper, zinc and precious metals mine. Mining commenced in 1989 at the Scuddles underground mine and Gosman Hill, both underground and later open pit. The Golden Grove operation produced nearly 64 per cent of Western Australia's zinc concentrate production in 2021.

Figure 9.5 shows the forecasts for zinc production for calendar years for Western Australia to 2032 by scenario.

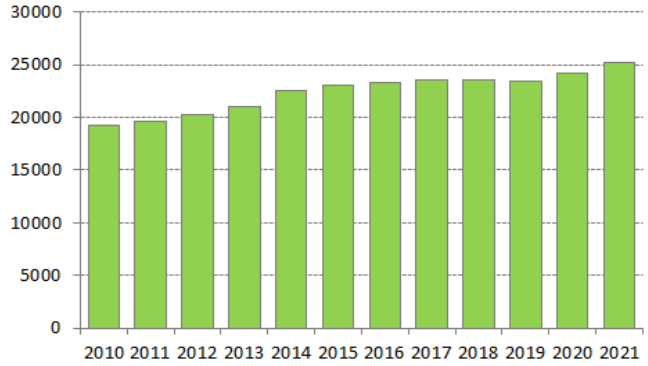
Figure 9.5: Western Australian zinc production to 2032 by scenario (kt)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

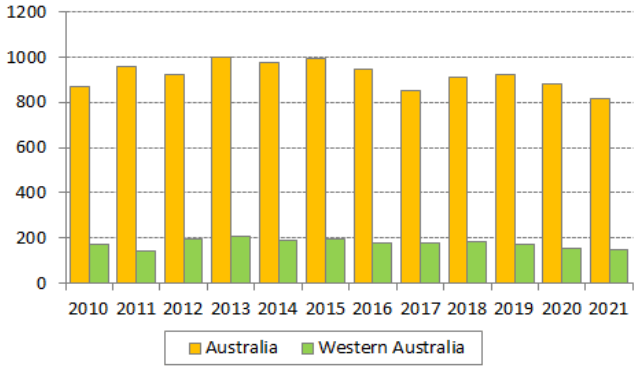
10. Copper

Figure 10.1: Copper production – World (kt)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Figure 10.2: Copper production – Australia and Western Australia (kt)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

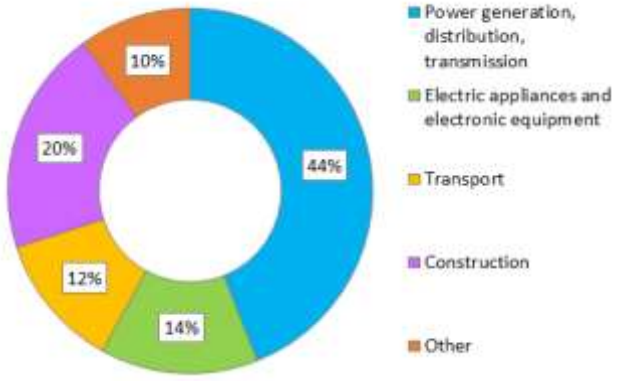
World copper production rose strongly in 2021 to 25.2 million tonnes, up 4.4 per cent on 2020 production levels. World copper production remained flat in 2017 and 2018, and then fell slightly in 2019 and 2020. Overall, growth in world copper production over the last 10 years averaged 2.5 per cent per annum.

Supply disruptions due to the COVID-19 pandemic in 2020 were experienced in South American countries such as Chile and Peru. These two countries accounted for nearly 40 per cent of world copper production in 2020. Other major copper producing nations in 2020 were China (8 per cent), the United States (6 per cent), Russia (5 per cent) and Australia (4 per cent).[15] Australia was ranked the 5th largest producer of copper in 2020.

Geoscience Australia estimates Australia's EDR in 2020 were 96.7 million tonnes, an increase of 4 per cent over 2019 reserves.[16] Australia is ranked second in terms of world reserves of copper. There were 38 operating mines in Australia in 2020. The majority of Australian copper reserves are in South Australia at Olympic Dam, Prominent Hill and Carrapateena accounting for 67 per cent of reserves in 2019. There are also significant copper reserves in New South Wales (14 per cent), Queensland (11 per cent) and Western Australia (6 per cent).[17]

Due to the high electrical conductivity of copper, its main end-use is in electricity generation (e.g. wind farms), transmission and distribution. In wind farms copper is used in the rotor portion of the generator and in cabling and transformers. In photovoltaics copper is used in cabling, inverters and transformers. As indicated in Figure 10.3, copper is used extensively in electrical appliances and equipment (14 per cent). The construction sector uses copper in plumbing, cooling, roofing and cladding. The transport sector uses copper in wiring and motors, providing power to multiple electronic applications in all types of vehicles. Copper is also used by the telecommunications sector. Other end-uses of copper include coinage, sculptures, musical instruments, cookware and other consumer goods.

Figure 10.3: End-uses of copper



Source: Copper Alliance, www.copperalliance.org/resource/copper-recycling.

[15] World Mineral Production, 2016-2020, British Geological Survey, 2022, pp. 18.

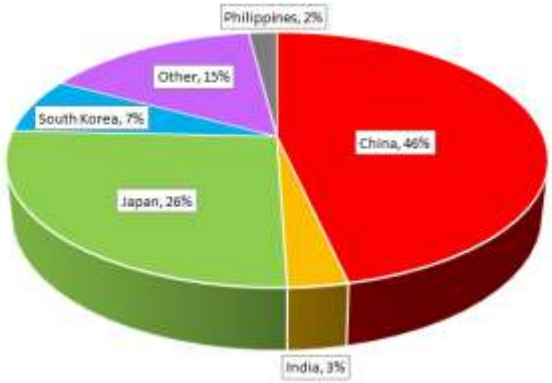
[16] Australia's Identified Mineral Resources 2021, Geoscience Australia.

[17] Australia's Identified Mineral Resources 2020, Geoscience Australia.

Figure 10.4: Copper nominal price (US$/tonne)

Source: World Bank, June 2022.

Figure 10.5: Percentage share of Australian copper ore and concentrate exports by destination, 2020 (%)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2021.

Copper is extensively recycled, both globally and in Australia. Around 32 per cent of world copper usage is sourced from recycled scrap.[18]

Australian production of copper in 2021 fell by 8 per cent to 813 kt. Mine closures and planned maintenance at BHP's Olympic Dam facility contributed to this decline in Australian copper production. High copper prices, however, will encourage new mines to be developed and restarts at existing mines over 2023 and 2024 in Australia.

In 2021, Australian copper production was spread mainly across four states – South Australia (33 per cent), Queensland (25 per cent), New South Wales (24 per cent) and Western Australia (18 per cent). A small amount of copper is produced in Tasmania. In South Australia, BHP's Olympic Dam has significant reserves and could expand further in the future. Queensland's copper mines are mainly located in the Mt Isa region. In New South Wales, copper mines are located at North Parkes, Cobar, Cadia East and Marsden.

Refined copper in Australia is produced at two locations, Townsville and Olympic Dam in South Australia. Olympic Dam is a fully integrated metals processing complex and incorporates mining, a copper smelter, a copper refinery and a recovery circuit for precious metals. Glencore's copper refinery in Townsville, Queensland, has a capacity of 300 kt producing pure copper cathode. Glencore's operations involve mines at Mt Isa and Ernest Henry, to smelting at Mt Isa, then transport and refining in Townsville. Smelter and refinery production in Australia in 2021 was 1,635 kt.

World copper prices rose sharply since the June quarter 2020. In US$ terms, the price of copper metal has nearly doubled. The average price of copper in the June quarter 2022 was US$9,770.00. These high prices partly reflect production falls in China, COVID-19 disruptions and stock rebuilding. Prices are expected to fall over 2023 and 2024 as new supply comes online.

The value of Australian copper ore and refined copper exports was A$12.1 billion in calendar 2021. Australia's major export markets for copper ore and concentrates are China and Japan. For refined copper, the major export markets are China, Malaysia and Taiwan.

Most of Western Australia's copper mines are copper-gold mines. The major existing mines in Western Australia are DeGrussa, Nifty (under care and maintenance), Telfer, Boddington and Golden Grove.

The DeGrussa copper-gold mine operated by Sandfire Resources consists of two mines, DeGrussa and Monty. In 2021, copper production was nearly 70 kt, or nearly 50 per cent, of Western Australian copper production. The mine has an on-site concentrator with a capacity of 1.6 mtpa. Newcrest produces around 14 to 15 kt of copper at its Telfer mine. 29 Metals, which operates the Golden Grove mine, produced 16 kt of copper in 2021.[19]

There are a number of prospective copper mining projects in Western Australia. These are summarised in Table 10.1.

Cyprium Metals, that purchased the Nifty copper mine in 2021, are working towards recommissioning in the second half of 2023. Stage one of the Caravel Minerals project may proceed by 2023. These projects will both help increase copper ore and concentrate production in Western Australia.

Figure 10.6 shows the forecasts for copper production on a calendar year basis for Western Australia to 2032 by scenario.

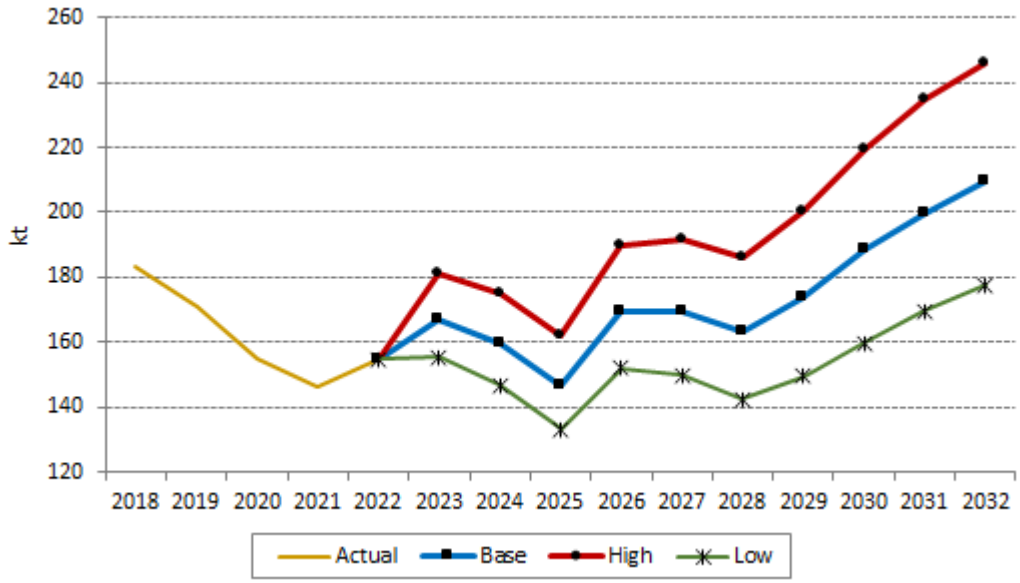
[18] Copper Alliance, www.copperalliance.org/resource/copper-recycling.

[19] Company websites, Quarterly Production Reports.

Table 10.1 Prospective major copper projects – Western Australia			
Company	**Project**	**Production (kt/a)**	**Possible timing**
Caravel Minerals	Caravel Copper	35 (Y1 – Y5)	2023
Caravel Minerals	Caravel Copper expansion	55 (Y6 – Y28)	2028
Cyprium Metals	Nifty (re-commissioning)	260	2023
DEVELOP	Sulphur Springs (copper, zinc, gold)	35	2025
OZ Minerals	West Musgrave	32	2025
Rio Tinto	Winv (copper-gold)	300	2024

Source: Caravel Minerals, Cyprium Metals, OZ Minerals, Rio Tinto, and DEVELOP websites.

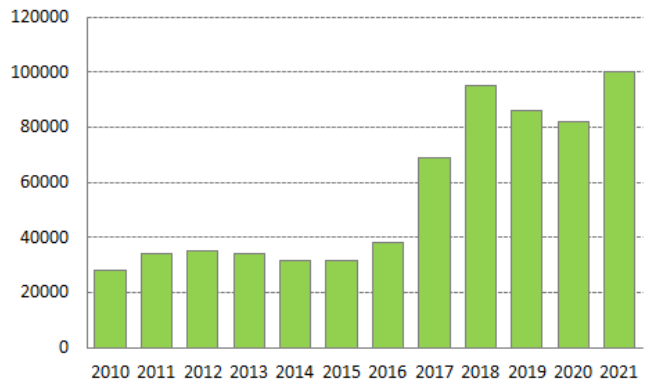
Figure 10.6: Western Australian copper production to 2032 by scenario (kt)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

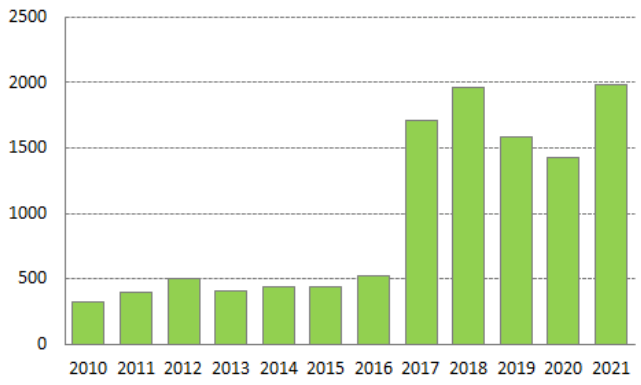
11. Lithium

Figure 11.1: Global lithium mine production (metric tonnes)



Source: Statista, February 2022.

Figure 11.2: Lithium spodumene concentrate production – Western Australia (kt)



Source: DMIRS (WA), 2021, Major Commodities Resources Data.

World production of lithium in 2021 rose to 100,000 tonnes, compared to 82,500 tonnes in 2020. Production in 2021 exceeded the previous record peak of 95,000 metric tonnes in 2018.

There are differences in the reporting of lithium minerals, this partly reflects the extraction processes. Australia reports spodumene concentrate, while others report lepidolite, Li content and carbonate.

The market for lithium has increased enormously over the last five years, however, global production exceeded demand in 2018 and may possibly again post-2022. Australia is the largest producer of lithium in the world, accounting for nearly 50 per cent of world production. The other major producers are Chile and Argentina.

Lithium is a light metal, which is silvery-white, and has a low melting point. The main lithium compound is lithium hydroxide, although processing technologies can produce lithium carbonate, lithium fluoride, lithium chloride and other lithium compounds.

Australia's EDR reserves of lithium were 6,174 kt in 2020, up from 5,702 kt in 2019.[20] Australia has 27 per cent of world lithium resources and is ranked second. Australia's lithium reserves are located in Western Australia and the Northern Territory. In the Northern Territory the main deposit is the Grants Deposit, south of Darwin. The largest lithium resources in Western Australia are located at Greenbushes, Wodgina, Pilgangoora and Earl Grey.

Additional resources are at Mount Cattin, Mount Marion, Bald Hill and Kathleen Valley.

In Australia, lithium occurs in hard rock spodumene deposits. In Chile and Argentina, lithium comes from salt deserts, known as salars. The most important end-use for lithium is in rechargeable batteries for mobile phones, laptops, digital cameras and electric vehicles. Lithium is also used in ceramics, glass and primary aluminium production. Other major end-uses include the manufacture of lubricants and greases, pharmaceuticals and synthetic rubber.

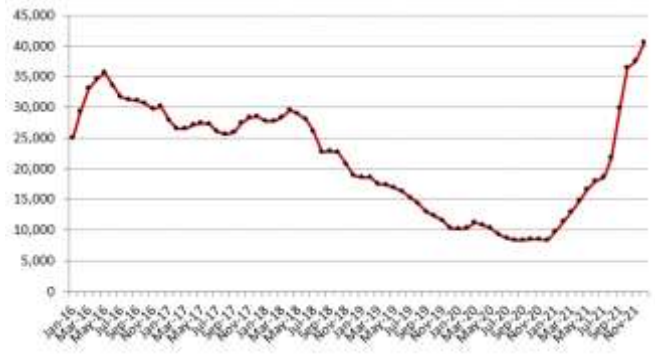
Lithium prices have been volatile over recent years. Lithium prices peaked in 2016 and 2017, however, excess supply led prices to fall over the 2018 to 2020 period. In Australia mine production was cut and mines closed.

Lithium prices surged over 2021 and into early 2022. The price of spodumene jumped by 45 per cent to US$2,400 per tonne in January 2022 alone from $1,650 in December 2021. The price for lithium hydroxide and lithium carbonate followed this trend.

In June 2022, Goldman Sachs released a prediction that lithium prices would fall sharply over the next two years. They suggested the spot price would fall from $60,000 to $54,000 in 2022 and then back to $16,000 in 2023. Some market analysts have questioned the basis of this assessment.

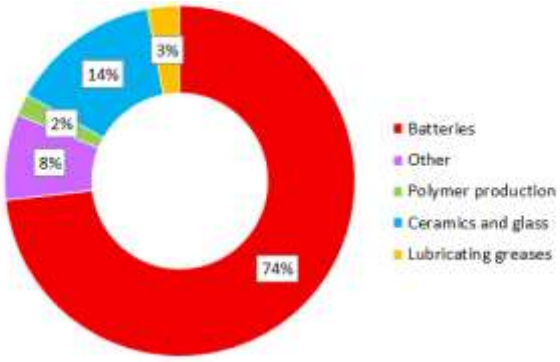
[20] Australia's Identified Mineral Resources, Geoscience Australia, 2022, Digital publication.

Figure 11.3: Lithium carbonate nominal price – (A$/tonne)



Source: DMIRS (WA), 2022, Major Commodities Resources Data, 2021.

Figure 11.4: Main end-uses of lithium



Source: US Geological Survey, Mineral Commodity Summaries, Lithium, January 2022.

If predictions regarding the world-wide take-up of electric vehicles are correct, then the lithium mining and processing industries may need to grow tenfold. For this to happen a period of sustained high prices may be necessary.

Spodumene concentrate exports in calendar 2021 were valued at A$1.6 billion.[21] Around 95 per cent of these spodumene exports went to China.

In Western Australia, spodumene concentrate production was 1,985.7 kt in 2021, up from 1,477.2 kt in 2020.[21] Spodumene concentrate production in 2021 was the highest on record. The total value of spodumene concentrate production was A$2.6 billion in 2021.

The Greenbushes mine in Western Australia is the world's largest lithium mine. The mine is owned by Albemarle and Tianqi Lithium Corporation and operated by Talison Lithium. The Greenbushes mine contains the highest grade hard rock lithium in the world. The mine was expanded by 600 kt per annum in 2021 (CEPZ). Two additional expansions of 500 kt per annum each are planned, as well as Tailings Retreatment Plant with a capacity of 280 kt per annum. Table 11.1 shows prospective lithium mines and processing plant recently completed, under construction and under consideration.

Mineral Resources operates two hard rock lithium mines, one at Mt Marion in the goldfields and one at Wodgina in the Pilbara region. The Mt Marion mine is currently expanding from 206 kt per annum to 900 kt per annum, due for completion in December 2022. The Wodgina mine produces 750 kt per annum.

Pilbara Minerals has also been active in expanding its mining operations over 2022 and has medium-term plans of expanding a further 420 kt of spodumene concentrate. Pilbara Minerals is also active in exploration for lithium resources. Pilbara Minerals and Calix together are undertaking to build a demonstration plant at the Pilgangoora site to produce lithium salts for global distribution.

There are three lithium hydroxide plants under construction at Kwinana, Western Australia. These include Tianqi Lithium's train 1 and train 2, and Covalent Lithium's plant for processing ore from Mt Holland. As indicated in Table 11.1, Liontown Resources also has mine and refinery proposals in Western Australia.

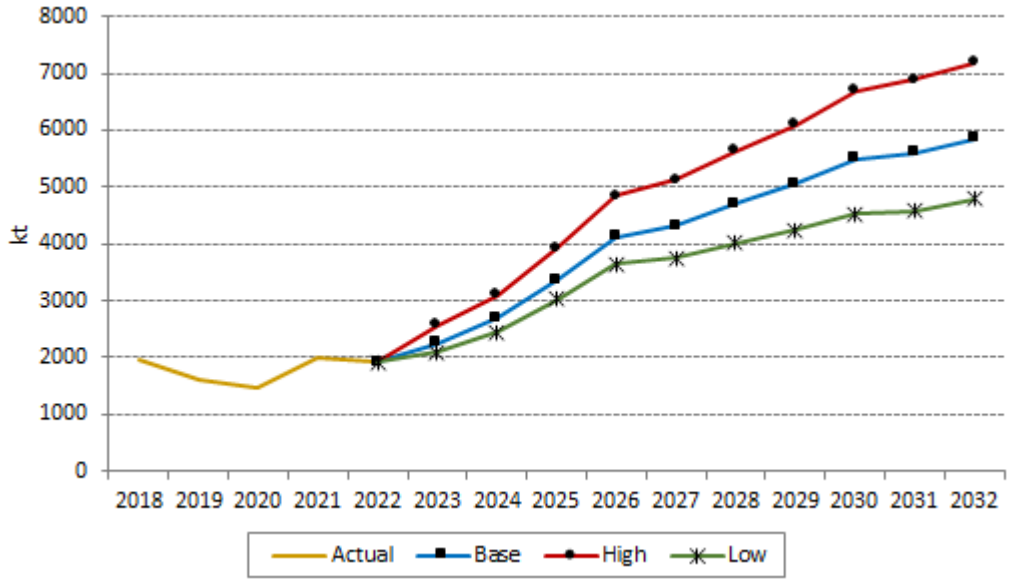
Figure 11.5 shows the forecasts for lithium production by calendar year for Western Australia to 2032 by scenario.

[21] DMIRS, 2022 Major Commodities – Resources data, 2021.

Table 11.1 Western Australian spodumene projects			
Company	**Operation**	**Annual capacity (kt)**	**Timing**
Recently completed/Under construction			
Spodumene concentrate			
Talison Lithium	Greenbushes Expansion (CGP2)	600	2021
Talison Lithium	Greenbushes Expansion (CGP3)	500	2024
Talison Lithium	Greenbushes Tailings Treatment Plant	280	2023
Pilbara Minerals	Pigan Plant Improvements	30 – 50	2022
Pilbara Minerals	Ngungali Plant Restart	180 – 200	September 2022
Mineral Resources	Mt Marion Expansion	700	December 2022
Lithium Hydroxide Plant			
Albemarle	Kemerton Processing Plant	100 tpa	Mid-2022
Tianqi Lithium Corporation	Kwinana Lithium Hydroxide Plant – Train 1	24 tpa	2022
Tianqi Lithium Corporation	Kwinana Lithium Hydroxide Plant – Train 2	24 tpa	2024
Covalent Lithium (Wesfarmers and SQM)	Kwinana Lithium Hydroxide	50	2024
Prospective			
Spodumene concentrate			
Talison Lithium	Greenbushes Expansion (CGP4)	500	2026-2028
Liontown Resources	Kathleen Valley	350	2024
Pilbara Minerals	Pilgangoora Expansion (P680)	100	2023-2024
Pilbara Minerals	Pilgangoora Expansion (P1000)	320	2025-2026
Lithium hydroxide			
Liontown Resources	Lithium Hydroxide Plant	58	2026-2027

Sources: Company websites.

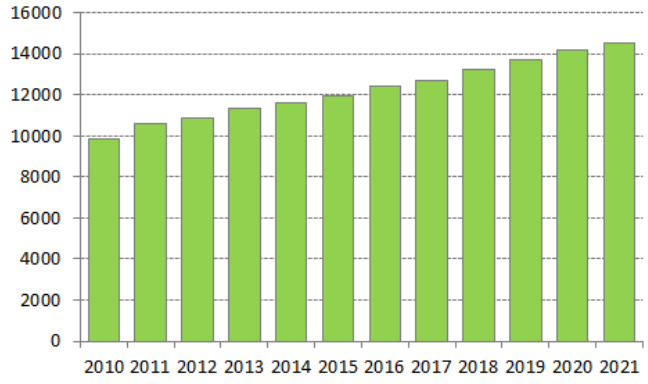
Figure 11.5: Western Australian lithium spodumene concentrate production to 2032 by scenario (kt)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

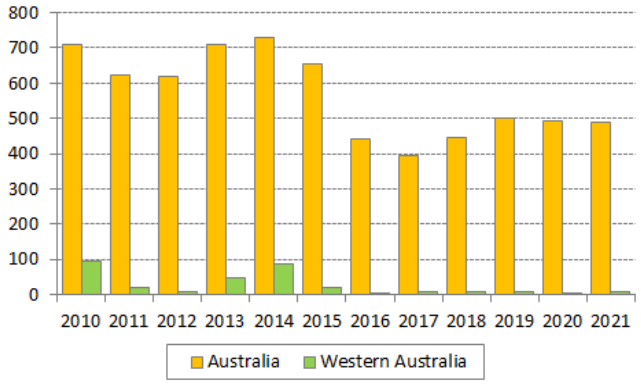
12. Lead

Figure 12.1: Lead production – World (kt)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Figure 12.2: Lead production – Australia and Western Australia (kt)



Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

Global lead production in 2021 rose to 14.5 million tonnes, reflecting steadily increasing production over the last 10 years. Average growth in world lead production over the last 10 years has been 3.2 per cent per annum.

Australian production of lead in 2021 was 488 kt. Since 2014, Australian production of lead has fallen by nearly 32 per cent. Queensland is the dominant state producing lead, accounting for 62 per cent of Australian production in 2021. The other major producers of lead were New South Wales (19 per cent), Northern Territory (10 per cent) and Tasmania (8 per cent). Western Australian production of lead was 6.0 kt, accounting for only 1 per cent of total Australian lead production.

Australia's EDR of lead was 35.7 million tonnes in 2020. Australia has the largest lead resource reserves, accounting for 41 per cent of world resources.[22] There were 20 operating mines in Australia in 2020 and these would typically be lead-silver mines or lead-silver-zinc mines.

Lead is a dull grey metal and is easily worked to alternative applications. Lead's main end-uses is in lead-acid batteries for motor vehicles, including heavy machinery and trucks. Lead is also used in construction, pigments, ammunition, weights, diving bells, glass and some solders. Lead has been banned from use in petrol, hair dyes and insecticides.

Lead is one of the most recycled materials in the world. This partly reflects the fact that nearly 100 per cent of lead is recovered from lead batteries. Lead can be re-melted and recycled indefinitely without losing its quality.

Table 12.1 Principal end-uses for lead

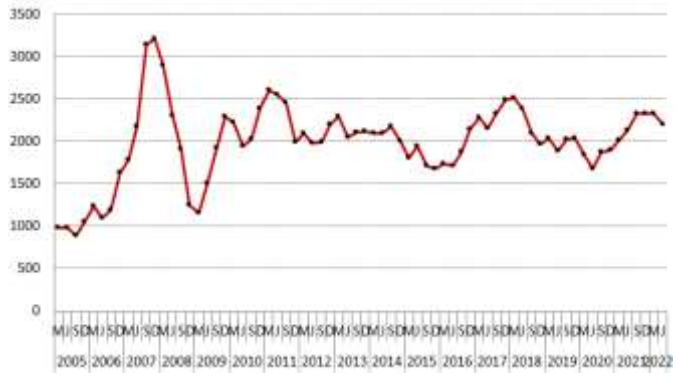
End-use	Industry/Sector	Per cent
Batteries	Lead-acid batteries for vehicles, industrial batteries	80
Cable	Cable sheathing	1
Pigments and compounds	Glass and plastics industries	5
Rolled and extruded products	Construction, manufacturing	6
Alloys	Manufacturing	2
Shot	Ammunition, military, policing	3
Other	Various	3

Source: International Lead and Zinc Study Group, ilzsg.org/statistics/enduses.

Australian lead exports in 2021 totalled A$1.9 billion. Lead concentrate exports represented nearly 50 per cent of the total value of Australian lead exports in 2021. The main export destinations for lead concentrate from Australia in 2021 were South Korea (56 per cent), China (29 per cent), Japan (11 per cent) and the European Union (3 per cent).

[22] Australia's Identified Mineral Resources, Geoscience Australia 2021, Digital publication.

Figure 12.3: Lead nominal price (US$/mt)



Source: World Bank, July 2022.

Figure 12.4: Percentage share of Australian lead exports by type, 2021 (%)

Source: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022.

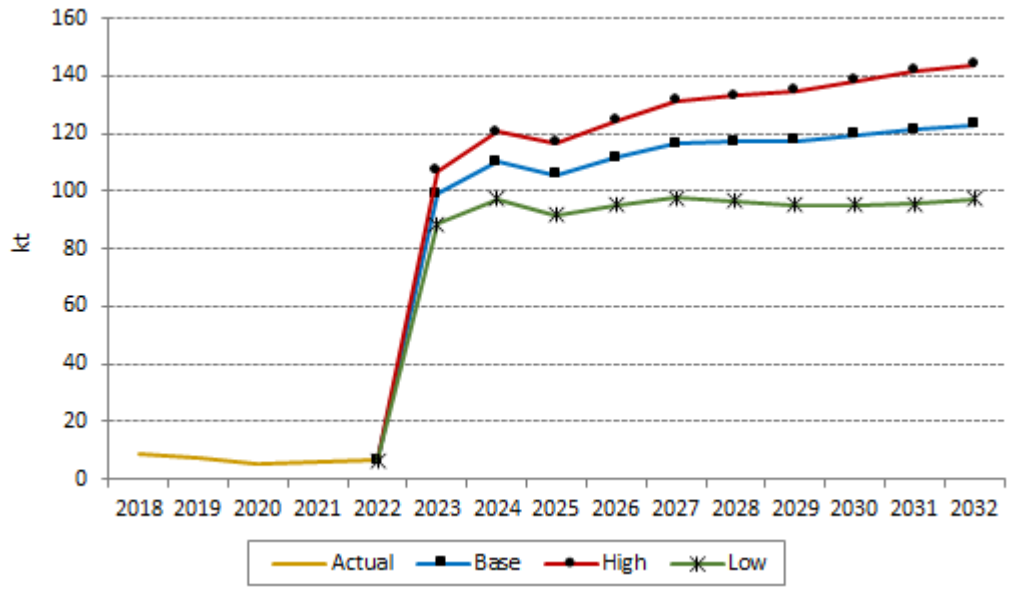
World lead prices on average rose by around 17 per cent over the course of 2021-22. Like some other base metal prices, world lead prices fell initially with the outbreak of COVID-19, falling to US$1,676 in the June 2020 quarter. Although lead prices have risen to around US$2,311 over 2021-22, they still remain below the previous peak of US$2,518 in the March quarter 2018.

In 2021, the Golden Grove mine produced around 2.4 kt of lead concentrate. Higher production levels are expected in 2022. The Paroo Station lead mine, operated by Rosslyn Hill Mining, is a lead carbonate mine, but has been under care and maintenance since 2015.

In Western Australia, the Abra lead-silver mine is currently under construction and is expected to be commissioned in 2023. It is located in the Gascoyne region of Western Australia. The lead resource has been estimated at 1,520 kt with a mine life of 16 years. The commissioning of the Abr mine is reflected in Figure 12.5 below. Another prospective project is the Sorby Hills project being developed by Boab Metals. The Sorby Hills project is again a lead-silver mine and could be developed by 2024.

Figure 12.5 shows the forecasts for lead production by calendar year for Western Australia to 2032 by scenario.

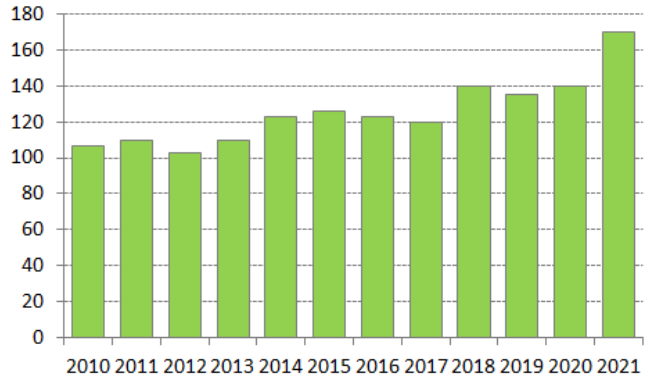
Figure 12.5: Western Australian lead production to 2032 by scenario (kt)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

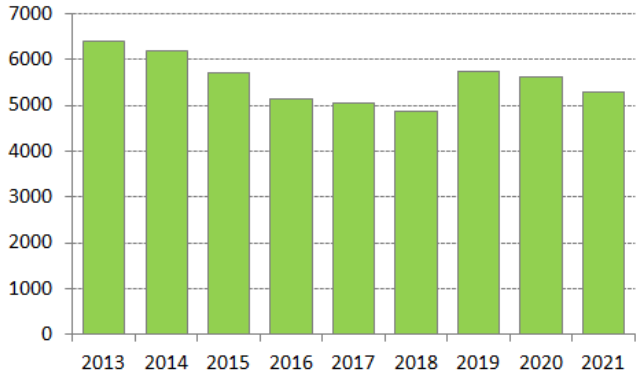
13. Cobalt

Figure 13.1: Cobalt production – World (metric tonnes '000)



Source: Statista, 2022.

Figure 13.2: Cobalt production – Western Australia (metric tonnes)



Source: DMIRS (WA), Major Commodities Resources Data, April 2022.

World production of cobalt in 2021 was 170 kt, up from 140 kt in 2020. World production levels have increased significantly over the last decade from just over 100 kt in 2012 to 140 kt in 2018 to 170 kt in 2021.

Cobalt is mined at copper-cobalt mines in Africa. Glencore is a major producer of cobalt, producing 27.4 kt in 2020. The world's largest producer of cobalt is the Democratic Republic of Congo, which accounted for 68 per cent of mine production in 2020. Another 25 per cent is produced currently by five countries – Russia, Canada, Cuba, the Philippines and Australia, accounting for just under 5 per cent of world production each. Australia typically has nickel-cobalt mine deposits, primarily located in Western Australia.

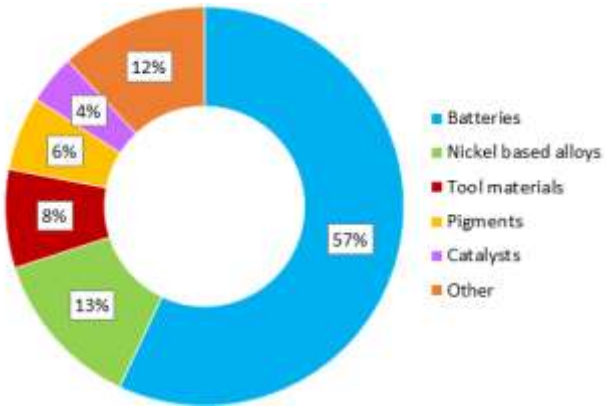
Australian production of cobalt in 2020 was 5,600 metric tonnes, nearly all of it sourced from Western Australia. As indicated in Figure 13.2, Western Australian cobalt production has been relatively stable at between 5,000 and 6,000 metric tonnes over the last eight years. The value of Western Australian cobalt mine production in 2021 was A$380 million.[23]

Australia has EDR of 2 per cent of world resources of cobalt and is ranked second in terms of its world share of resources. Total Australian cobalt EDR reserves were 1,495 kt in 2020.[24] Cobalt EDR have been increasing over recent years.

Western Australia has almost 70 per cent of Australia's cobalt reserves. Queensland has 16 per cent of cobalt reserves while New South Wales has 13 per cent.[25]

Australia's largest cobalt mine is the Murrin Murrin nickel-cobalt mine operated by Glencore. The mine is located in the North-Eastern Goldfields near Leonora. In 2021, production of cobalt at Murrin Murrin was 2.5 kt, or nearly 50 per cent, of total Western Australian production.

Figure 13.3: Consumption of cobalt by application, 2020



Source: www.cobaltinstitute.org, Cobalt Institute Market Report, 2020.

[23] DMIRS (WA), 2022 Major Commodities and Resources, 2021.

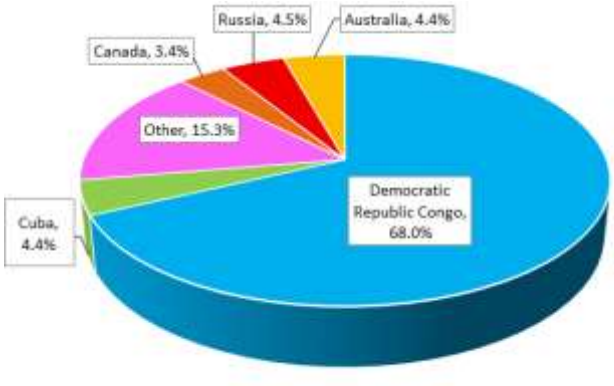
[24] Australia's Identified Mineral Resources, 2021, Digital publication.

[25] Australia's Identified Mineral Resources, 2020, pp. 39.

Figure 13.4: Cobalt nominal price (US$/mt)

Source: DMIRS (WA), 2020, Major Commodities Resources Data.

Figure 13.5: Percentage share of cobalt production by major country, 2020 (%)



Source: World Mineral Production, 2015-2020, British Geological Survey, 2022.

Cobalt's main end-use is in rechargeable batteries which are used in:

- electric vehicles and other transport equipment (e.g. forklifts, farm machinery);
- portable electronic devices (phones, laptops, tablets); and
- home battery storage and distribution storage solutions.

Cobalt has many other uses, such as a superalloy in engines, in tools, paints, magnets and tyres. In electric vehicles the batteries use lithium-ions, with nickel, manganese and cobalt in the cathode, a key part of the battery. Some cathodes can contain up to 0–15 kg of cobalt, 0–40 kg of nickel and 30–50 kg of lithium. Some electric car manufacturers are transitioning away from cobalt in batteries.

As indicated in Figure 13.4, which shows the cobalt price in US$ and A$, there has been considerable speculative activity in cobalt markets over recent years. Unrealistic expectations regarding the uptake of electric vehicles were a major driver of this between 2015 and 2020. The price of cobalt rose from US$25,000 per tonne in 2015 to US$87,700 by the June quarter 2018. By 2020, the US$ cobalt price had fallen to around US$33,000 per tonne. Prices surged again over 2021 reaching nearly US$65,000 by December 2021.

Russia's invasion of Ukraine in early 2022 will place additional upward pressure on cobalt prices. With high oil prices being sustained over the first half of 2022, and possibly well beyond June 2022, there are additional incentives to switch to electric vehicles.

A number of potential cobalt projects have emerged in New South Wales, Queensland and Western Australia. These include:

- Cobalt Blue's Broken Hill Cobalt project, which has an expected annual capacity of 3.6 kt per annum;
- Australian Mines Sconi project in Queensland, a nickel-cobalt sulphate mine with expected annual cobalt production of 7 kt per annum; and
- Australian Mines also has the Flemington project, a nickel-cobalt-scandium project which could be developed by 2026.

Western Australia also has a number of prospective cobalt mine developments, including:

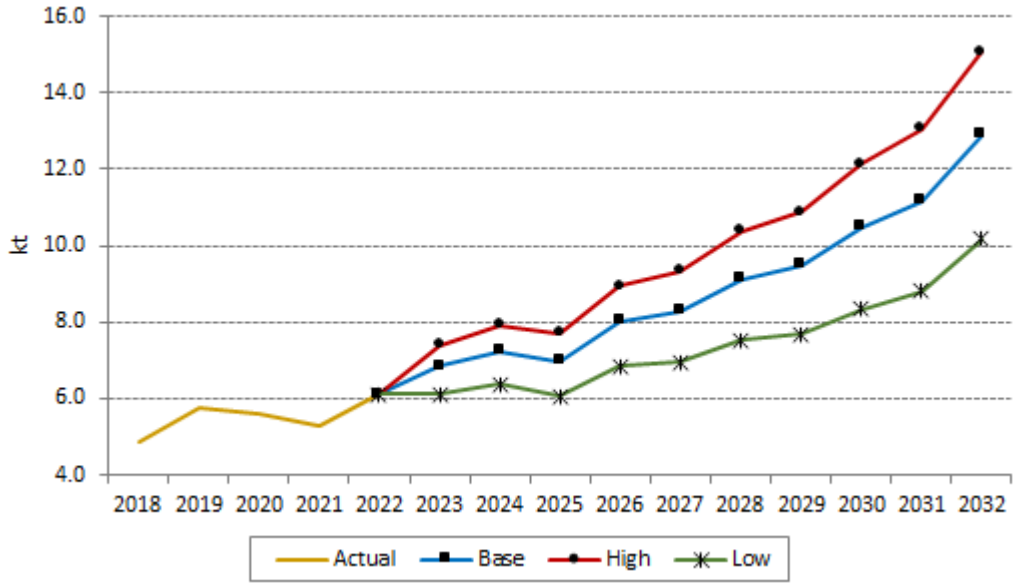
- the Barra Resources nickel-cobalt mine at Mt Thirsty with an annual production estimate of 1.6 kt per annum;
- the NiWest Nickel-Cobalt project near Leonora which could add 1.4 kt of cobalt per annum; and
- a restart at Kambalda by Mincor Resources. The Kambalda region is primarily a high grade nickel resource.

The rate of development of prospective new mines and new resources from exploration activities partly depends on the uptake of electric vehicles.

A number of publicly announced projects are unlikely to proceed until post-2025. A more rapid take-up of electric vehicles and battery storage by the household sector should lead to a more positive outlook for cobalt post-2025. Battery storage costs need to fall significantly in order for a mass market take-up to proceed.

Figure 13.6 shows the forecasts for cobalt production by calendar year in Western Australia to 2032 by scenario.

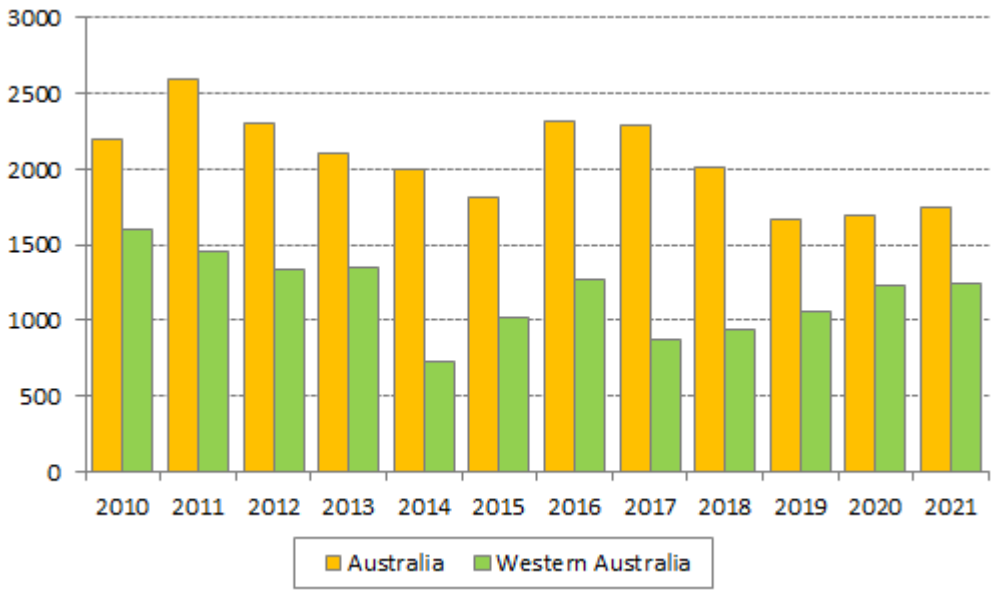
Figure 13.6: Western Australian cobalt production to 2032 by scenario (kt)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Source: DMIRS (WA), 2021, Major Commodities Resources Data and NIEIR.

14. Mineral sands

Figure 14.1: Mineral sands production – Australia and Western Australia (kt)



Source: DMIRS (WA), 2021, Major Commodities Resources Data, April 2022 and NIEIR estimates.

The mineral sands industry involves the mining of zircon and titanium dioxide products, ilmenite, rutile and other upgraded titanium dioxide products.

The product zircon is an opaque, hard-wearing material that is mainly used in the ceramic tile industry. Zircon is also used in high tolerance casting/foundry applications. Lower quality zircon can also be used in digital printing, lower quality ceramics, zirconium chemicals and air and water purification systems.

The product titanium dioxide is mined as ilmenite or rutile. Both of these mineral sands are dark coloured, although turn white after processing. Titanium dioxide pigment is primarily used on paints, plastics, paper and other applications. These other applications include, for example, catalysts, ceramics, coated fabrics, floor coverings and printing ink. Titanium metal is used in aerospace applications, armour, marine equipment, chemicals, medical implants, consumer and power generation.

In the majority of mineral sands deposits zircon is produced in smaller quantities than titanium dioxide. The ratio of zircon to titanium dioxide is typically 1:4. World production of titanium dioxide in 2021 was 9.0 million tonnes.[26] Global production of zircon in 2018 was 1.2 million tonnes.

In 2020, Australia's EDR reserves of mineral sands were as follows:

- 274.0 million tonnes of ilmenite;
- 35.3 million tonnes of rutile; and
- 79.3 million tonnes of zircon.

In terms of global resources in 2020, Australia had 22 per cent of the world's ilmenite, 63 per cent of the world's rutile and 71 per cent of the world's zircon. Australia has large reserves of these critical minerals. China had one-third of the world's reserves of ilmenite in 2021.

The majority of mineral sands reserves in Australia are located in Victoria and New South Wales in the Murray Basin, in the Eucla Basin in South Australia, and in various locations in Queensland and Western Australia. In Western Australia, resources are located in the Perth Basin, at Coburn, McLaren West and Mindarra Springs.

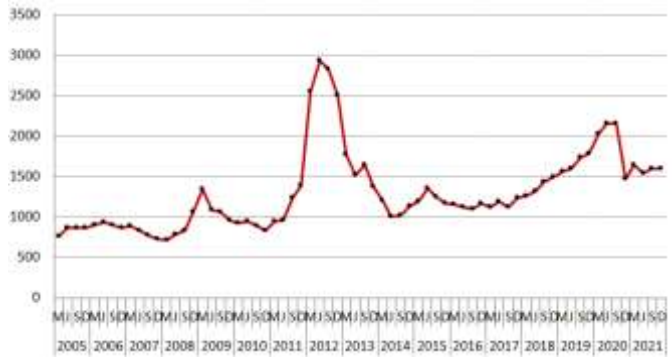
In 2021, Australian mineral sands production was 1,750 kt, a similar production level to 2020. Australian production of mineral sands has fallen by 30 per cent over the last 10 years.

[26] Mineral Commodity Summaries, 2022, US Geological Survey.

Western Australian production of mineral sands was 1,243 kt in 2021.[27] This represented around 71 per cent of total Australian mineral sands production in 2021. Many of the reserves in eastern states of Australia remain undeveloped.

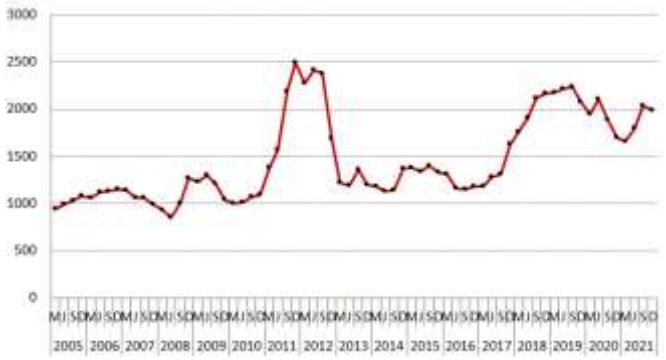
Australian production of ilmenite in 2020 was 1,100 kt from 11 mines, 10 per cent higher than in 2019. Production of rutile was 200 kt from 8 mines and zircon 400 kt from 10 mines.[28]

Figure 14.2: Rutile nominal price (A$/t)



Source: DMIRS (WA), 2021, Major Commodities Resources Data, April 2022.

Figure 14.3: Zircon nominal price (A$/t)



Source: DMIRS (WA), 2021, Major Commodities Resources Data, April 2022.

In Western Australia the following mineral sands and downstream processing operations are in place.

- Iluka Resources has four establishments operating, the Cataby mine, the Narngulu mineral separation plant, Capel Operation and Eneabba:
  - the Cataby mine, north of Perth, is a large ilmenite deposit and has associated zircon and rutile;
  - the Narngulu mineral separation plant is near Geraldton. The plant produces zircon, rutile and ilmenite products for export;
  - the Capel Operation has two synthetic rutile kilns. One has been operational and the other will start at the end of 2022; and
  - the Eneabba is a large stockpile of high grade monazite. Iluka Resources is looking to commission a rare earths refinery at this site with a capacity of 17.5 kt per annum by 2025.
- Tronox Operations in Western Australia is an integrated titanium dioxide project which has been in operation since 1988. Its Northern operations consist of the Coolgarloo mine and the Chandala mineral separation plant. Southern operations consist of the Wonnerup mine and a mineral separation plant at Bunbury. Titanium dioxide pigment plants are located at Kwinana with a total capacity of 260,000 tonnes per annum.
- Image Resources operates a high grade zircon rich mine at Boonanarring, north of Perth, commissioned in late 2018.
- Doval Mineral Sands operates its Keysbrook mine located south-west near Brusselton. The Keysbrook mine produces 90 kt of heavy mineral concentrate (HMC) per annum. The HMC is processed at Picton at a mineral separation plant (MSP) and leucoxene and zircon are then exported. Mines at Yoongarillup and Dardanup are closed and are being rehabilitated.

Exports of mineral sands from Western Australia were A$1.9 billion in 2021. The major markets for mineral sands in 2020 were China (46 per cent), Saudi Arabia (10 per cent), the United States (8 per cent), and India and Spain (around 5 per cent).

Table 14.1 shows prospective mineral sands developments for Western Australia.

In the eastern states of Australia a number of other large mineral sands developments have been proposed. These include:

- the Balranald Project in New South Wales by Iluka Resources;

[27] DMIRS, 2022, Major Commodities Resource Data 2021.

[28] Australia's Identified Mineral Reserves, 2021, Digital publication.

- the Donald Mineral Sands Project in Victoria (Astron Ltd);
- the Fingerboards Project in Victoria (Kalbar Operations); and
- the Wimmera Project in Victoria by Iluka Resources.

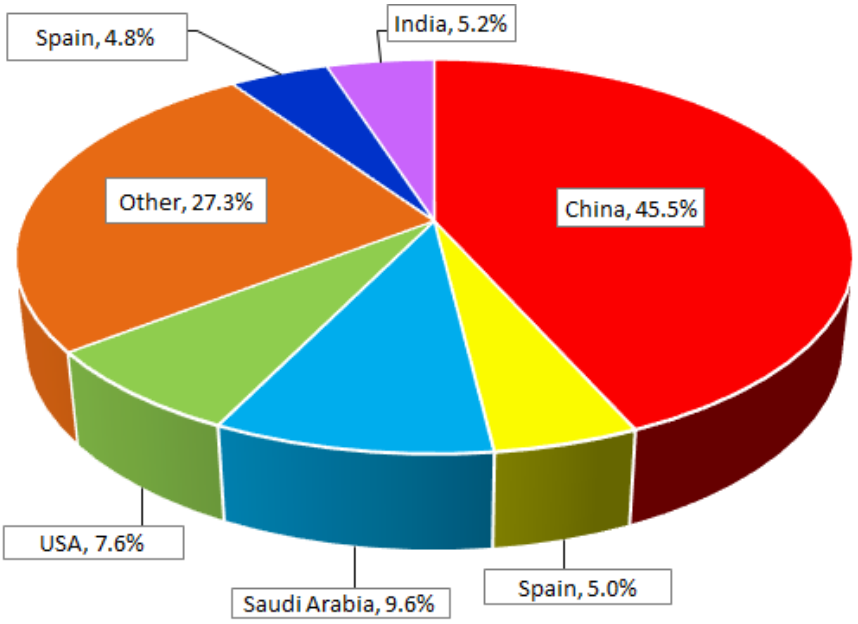
Figure 14.4 shows the forecasts for mineral sands production on a calendar year basis for Western Australia to 2032 by scenario.

Table 14.1 Prospective mineral sands projects – Western Australia

Company	Project	Capacity (kt)	Estimated timing
Doral Minerals	Yalyalup Mine	100 (HMC)	2022
Strandline Resources	Coburn Project	34 zircon 10 ilmenite 24 rutile	2023
Iluka Resources	Eneabba Rare Earths Refinery	17.5	2023
Diatreme Resources	Cyclone Zircon Project (Eucla Basin)	65 zircon	Post-2025
Tronox	Cerrantes Expansion	Under feasibility	Post-2025

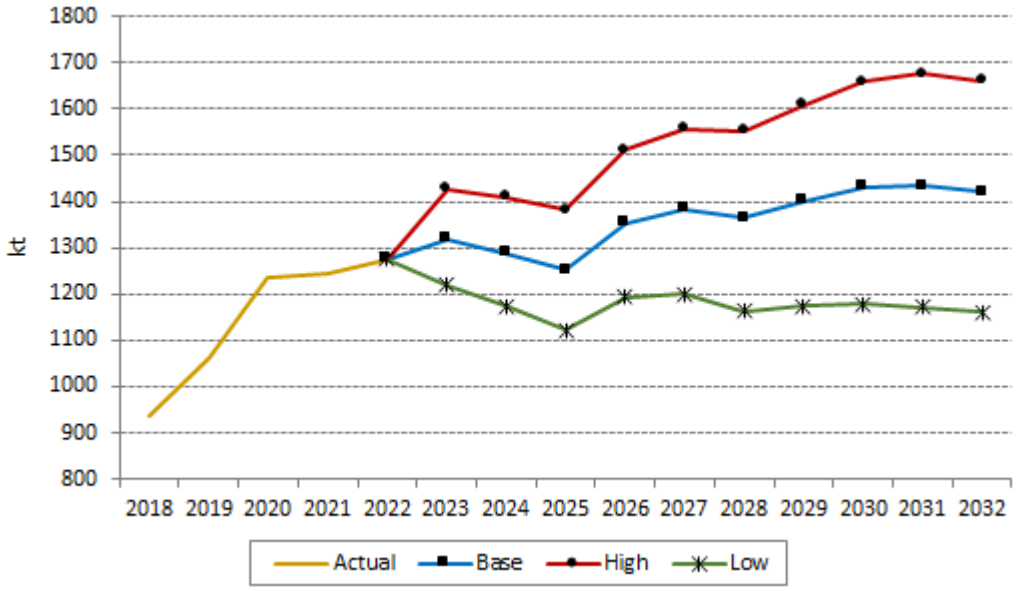
Note: HMC refers to Heavy Mineral Concentrate.
Sources: Company websites, ASX announcements.

Figure 14.4: Percentage share of the value of Western Australian mineral sands exports, 2021 (%)



Source: DMIRS (WA), 2022, Major Commodities Resources Data, 2021.

Figure 14.5: Western Australian mineral sands production to 2032 by scenario (kt)



Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032.
Source: DMIRS (WA), 2021, Major Commodities Resources Data and NIEIR, April 2022.

15. Commodity production forecasts

Tables 15.1 to 15.3 summarise the production outlooks for the Base, High and Low scenarios, respectively, for Western Australia on a calendar year basis. The key drivers of the high and low growth scenarios for commodity production are different assumptions regarding world and Australian economic growth. This would also be reflected in different commodity price outlooks for the high and low growth scenarios. Australian production of mineral resources is primarily driven by the demands from overseas countries for these commodities, as well as commodity prices and movements in the exchange rate.

Table 15.1 Western Australian commodity production forecasts for the Base scenario

Calendar	Alumina (Mt)	Copper (kt)	Gold (t)	Iron ore (Mt)	Nickel (kt)	Zinc (kt)	Lithium (kt)	Lead (kt)	Cobalt (kt)	Mineral sands (kt)
2018	13.5	183.6	213.5	896.5	160.0	90.8	1965.9	8.6	4.9	936.6
2019	14.0	171.2	218.3	909.0	158.8	88.7	1616.8	7.2	5.7	1063.3
2020	14.2	155.1	220.0	909.8	169.3	79.8	1477.2	5.4	5.6	1237.1
2021	14.2	146.0	217.6	911.1	150.9	76.1	1985.7	6.0	5.3	1243.2
2022	13.9	154.8	213.9	906.8	168.6	80.9	1907.2	6.4	6.1	1275.4
2023	14.3	166.9	227.3	936.1	187.0	84.8	2253.6	98.9	6.8	1318.5
2024	14.5	159.4	238.1	993.3	191.0	88.6	2686.4	110.2	7.2	1289.4
2025	14.5	146.5	209.6	993.2	182.6	86.4	3367.5	105.8	7.0	1251.7
2026	14.6	169.5	207.9	988.0	200.5	94.4	4121.2	111.7	8.0	1354.5
2027	14.7	169.6	206.8	1016.6	202.6	98.2	4318.9	116.5	8.3	1383.2
2028	14.7	163.2	209.4	1047.3	219.0	102.4	4708.9	117.0	9.1	1364.8
2029	14.7	173.8	220.6	1070.9	229.0	105.0	5051.2	117.6	9.5	1401.8
2030	14.7	188.3	226.2	1092.1	235.0	108.1	5494.8	119.6	10.5	1431.0
2031	14.7	199.9	229.2	1097.1	243.0	108.8	5598.4	121.4	11.2	1434.2
2032	14.7	209.5	230.2	1102.0	249.0	110.3	5852.0	123.2	12.9	1421.3

Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032-31.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

Table 15.2 Western Australian commodity production forecasts for the High scenario

Calendar	Alumina (Mt)	Copper (kt)	Gold (t)	Iron ore (Mt)	Nickel (kt)	Zinc (kt)	Lithium (kt)	Lead (kt)	Cobalt (kt)	Mineral sands (kt)
2018	13.5	183.6	213.5	896.5	160.0	90.8	1965.9	8.6	4.9	936.6
2019	14.0	171.2	218.3	909.0	158.8	88.7	1616.8	7.2	5.7	1063.3
2020	14.2	155.1	220.0	909.8	169.3	79.8	1477.2	5.4	5.6	1237.1
2021	14.2	146.0	217.6	911.1	150.9	76.1	1985.7	6.0	5.3	1243.2
2022	13.9	154.8	213.9	906.8	168.6	80.9	1907.2	6.4	6.1	1275.4
2023	14.5	181.0	251.1	1054.9	202.1	91.2	2576.1	107.2	7.4	1428.1
2024	14.9	174.7	264.5	1125.9	208.3	96.0	3099.8	120.5	7.9	1410.4
2025	15.1	162.3	234.2	1132.6	201.0	94.3	3922.0	116.9	7.7	1382.7
2026	15.2	189.6	233.5	1133.2	222.7	103.9	4844.2	124.6	8.9	1510.9
2027	15.4	191.7	233.6	1172.9	227.1	109.0	5123.1	131.2	9.3	1557.7
2028	15.6	186.2	237.8	1215.3	247.6	114.5	5636.5	133.0	10.4	1551.7
2029	15.6	200.3	251.8	1249.9	261.3	118.4	6100.7	135.0	10.9	1609.0
2030	15.6	219.2	259.6	1282.0	270.5	122.9	6695.6	138.5	12.1	1657.9
2031	15.6	234.9	264.5	1295.2	282.2	124.5	6882.2	142.0	13.1	1677.0
2032	15.6	246.1	265.6	1301.0	289.1	126.2	7194.0	144.1	15.1	1661.9

Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032-31.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

Table 15.3 Western Australian commodity production forecasts for the Low scenario										
Calendar	Alumina (Mt)	Copper (kt)	Gold (t)	Iron ore (Mt)	Nickel (kt)	Zinc (kt)	Lithium (kt)	Lead (kt)	Cobalt (kt)	Mineral sands (kt)
2018	13.5	183.6	213.5	896.5	160.0	90.8	1965.9	8.6	4.9	936.6
2019	14.0	171.2	218.3	909.0	158.8	88.7	1616.8	7.2	5.7	1063.3
2020	14.2	155.1	220.0	909.8	169.3	79.8	1477.2	5.4	5.6	1237.1
2021	14.2	146.0	217.6	911.1	150.9	76.1	1985.7	6.0	5.3	1243.2
2022	13.9	154.8	213.9	906.8	168.6	80.9	1907.2	6.4	6.1	1275.4
2023	13.7	155.5	213.8	880.5	175.9	79.3	2085.0	88.7	6.1	1218.6
2024	13.9	146.6	221.0	922.0	177.3	81.7	2445.4	97.3	6.4	1173.4
2025	13.9	133.1	192.0	909.7	167.3	78.6	3018.2	91.8	6.1	1120.9
2026	13.8	151.9	187.8	892.6	181.2	84.7	3634.8	95.3	6.8	1193.4
2027	13.8	150.0	184.3	894.0	180.5	86.9	3747.0	97.8	7.0	1198.8
2028	13.8	142.3	184.0	904.3	192.4	89.3	4017.2	96.5	7.5	1163.1
2029	13.4	149.5	191.1	911.9	198.4	90.3	4236.8	95.3	7.7	1174.5
2030	13.4	159.7	193.2	916.8	200.7	91.7	4529.4	95.1	8.3	1178.4
2031	13.4	169.5	195.8	921.0	207.5	91.5	4575.0	95.7	8.8	1172.0
2032	13.4	177.6	196.6	925.2	212.6	92.8	4782.2	97.2	10.2	1161.5

Note: Actuals = 2018 to 2021; Estimate = 2022; Forecasts = 2023 to 2032-31.
Sources: Department of Industry, Science, Energy and Resources, Commonwealth of Australia, Resources and Energy Quarterly, June 2022 and NIEIR.

16. Commodity price forecasts

NIEIR conducted a survey of public world commodity price forecasts from major economic institutions. The survey presented in Table 16.1 was completed in July 2022, and was used to inform the commodity production outlook. The price forecasts are influenced by the timing, in terms of when they were prepared.

Table 16.2 also contains price forecasts for lithium hydroxide out to 2024. These were prepared by NIEIR and the Office of the Chief Economist based on supply and demand characteristics of the forecast lithium market.

As indicated in Table 16.1, the short-term outlook for major commodities is mixed. With the exception of iron ore, commodity prices for gold, copper, nickel, zinc and alumina are expected to peak in 2022. Prices are then expected to weaken over 2023 and 2024. The sharpest expected declines in prices between 2022 and 2024 are for iron ore (-20 per cent), nickel (-19 per cent) and zinc (-18 per cent). Gold prices are expected to fall by 10 per cent.

Table 16.1 Survey of world commodity price forecasts, July 2022

	Iron ore (US$ per tonne)			Gold (US$ per ounce)			Copper (US$ per tonne)		
	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
2021	143	143	143	1800	1800	1800	9315	9315	9315
2022	96	113	125	1838	1862	1901	8963	9609	10100
2023	71	90	106	1700	1748	1800	9146	9511	9909
2024	66	81	95	1608	1668	1750	8347	8949	9450

	Nickel (US$ per tonne)			Zinc (US$ per tonne)			Alumina (Fob Australia) (US$ per tonne)		
	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum
2021	18468	18468	18468	3005	3005	3005	0	328	0
2022	18875	25301	28133	2525	3498	3757	0	390	0
2023	21250	22016	22750	3196	3305	3536	0	370	0
2024	19417	20417	21000	2614	2854	3150	0	358	0

Note: Forecast prices are from 2022 to calendar year 2024.
Sources: Office of the Chief Economist (June 2022), the World Bank (April 2022), Westpac (June 2022), Scotia Bank (April 2022) and WA Treasury Budget Paper No. 3, 2022-23.

Table 16.2 World Lithium price forecast (US$ per tonne) – Lithium hydroxide LME

	2021	2022	2023	2024
Office of Chief Economist	17,370	35,570	40,100	28,810
NIEIR	17,370	31,500	30,200	25,600

Note: 2022 prices, fiscal years.
Source: Office of Chief Economist, June 2022.