Insights for tomorrow

2025 Mining Workforce Plan

Acknowledgement of Country

We acknowledge the Traditional Custodians of the lands on which we live and work. We acknowledge Traditional Custodians of Country throughout Australia and their connections to land, sea and community.

We honour and respect their Elders, past and present, and extend that respect to all First Nations people.

2025 Workforce Plan – Evolving Together
Version 1.0
July 2025

The Mining and Automotive Skills Alliance (AUSMASA) is a Jobs and Skills Council funded by the Australian Government Department of Employment and Workplace Relations.

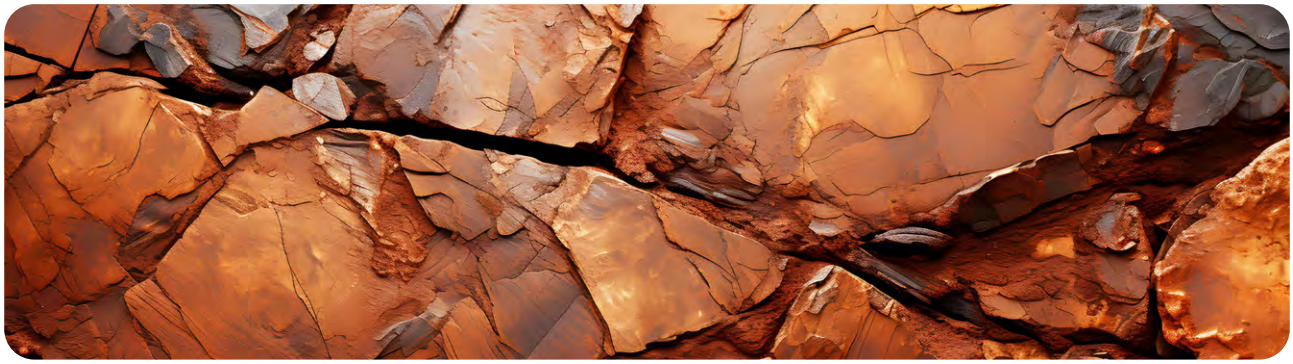
Contents

Mining

Australia's mining industry is a significant contributor to our economy, with revenue of over $400 billion[1] and a total operational workforce of more than 280,000. With approximately 70% of the industry's revenue sourced from exports, it has been affected by commodity price volatility, rising demand for coal, oil, and gas due to global geopolitical events, and reduced demand for iron ore used in steel production due to China's weakening property market.[2] As parts of the industry have responded with higher export volumes, new mines, and existing mine expansions, commodity prices are predicted to continue falling.[3] The coal, oil, and gas extraction workforce has experienced lower growth in recent years, while Exploration and Other Mining Support Services have expanded. Similarly, the Metal Ore Mining workforce has grown, partly in response to higher commodity prices and increasing demand for its broader base of commodities like critical minerals and strategic materials.

> Critical minerals and strategic materials are essential for the development of renewable energy infrastructure and advanced technologies, as illustrated by a range of federal and state initiatives designed to support critical minerals.

Yet iron ore still comprises the single largest source of revenue (30%) for both the sector and the wider industry, followed by coal (24%) and oil and gas (23%).[4] The industry is still working towards greater onshore processing and beneficiation of critical minerals in line with these initiatives. Established sectors for iron ore, coal, and gas will continue to play an important and dominant role in the near term despite recent commodity price falls and longer-term projections of decreased employment in the coal, oil, and gas sectors.[5] Other metal ores, like copper and gold, and critical minerals like nickel, are increasingly essential and represent the fourth largest source of revenue for the sector (16%) – with a range of new mines and mine expansions linked to these commodities.[6]



1 IBISWorld, and Ryan Tan. "Mining." November 2024.
2 Ibid.
3 Ibid.
4 Ibid.
5 Net Zero Australia. "Downscaling - Employment Impacts" 2023.
6 IBISWorld, and Ryan Tan. "Mining." November 2024.

Key strategic and workforce issues in the mining industry

Skills shortage

The mining industry has not seen a decline in job vacancies like other industries.[7] Vacancies remain at record levels, surpassing peaks from the 2011–2012 mining boom. Skills shortages are widespread, particularly in the top 20 occupations in each subdivision. The Mining and Automotive Skills Alliance (AUSMASA) is continuing research and stakeholder engagement to better understand the nature of these shortages and pathways to alleviate them. The subdivision-specific discussions provide further details, and we welcome stakeholder insights into the issue.[8]

Higher education and pathway opportunities

National enrolments in engineering-related degrees have been declining since 2019. Higher apprenticeships combining on-the-job training with formal study, leading to Vocational Education and Training (VET) qualifications, are gaining attention to address skills shortages. These programs allow students to work within the industry while completing higher education courses, potentially attracting more students to the field.[9] AUSMASA plans to work with universities and other industry stakeholders to ensure tertiary degrees continue to meet industry needs, particularly with an eye to emerging and future skills requirements. AUSMASA has developed a project that will research vocational degrees and higher apprenticeships to address skills shortages in various industries. Industry views VET degrees, degree apprenticeships and cadetship models as a way to rapidly build workforce capability and engage early with new workforce entrants.

Vocational Education and Training

The national average completion rate for apprentices and trainees who commenced study in 2018 was 55.8% by 2022.[10] Concerns have been raised about the level of mentoring provided to apprentices. This problem is exacerbated for international students, as they cannot gain industry placement (therefore cannot do an apprenticeship or traineeship) during their study period (because of visa regulations). This leads to international graduates possessing lower skills and work experience than their domestic counterparts. As a result, employers often have to invest in training international students once they are hired. AUSMASA has received stakeholder feedback, calling for better aligned visa regulations that would enable international students to acquire training and education equivalent to that of domestic students.

Community perceptions

AUSMASA research shows that 56% of Generation Z would prefer the mining industry to decrease in size, and only 27% knew about lithium mining and its use in battery storage.[11] The industry must address these perceptions to facilitate workforce growth.

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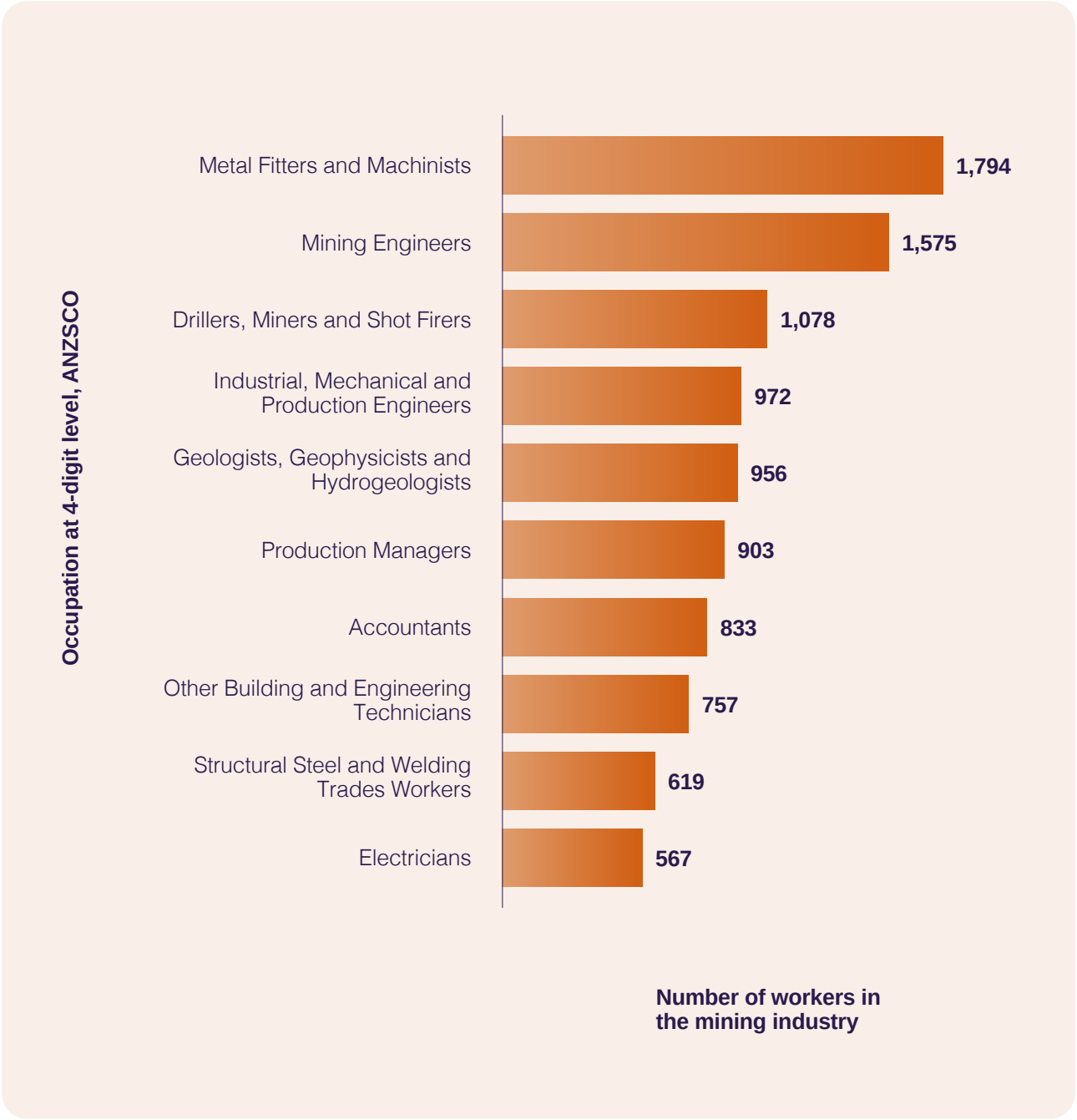
7 Australian Bureau of Statistics, November 2023 – Job Vacancies, Australia (Seasonally adjusted).
8 With the mining industry already providing tailored training outside of the VET system for specific, specialised roles and applications, we will continue to leverage such instances to better inform gaps in training products and further steps for action to alleviate acute skills shortages and empower the workforce to be the workforce of the future, so that the VET sector may become responsive to future skills needs in the industry.
9 Census of Population and Housing (HEAP Level of Highest Educational Attainment), TableBuilder, 2021.
10 NCVER, 'Completion and attrition rates for apprentices and trainees 2022: data tables,' November, 2024.
11 AUSMASA, Gen Z Perceptions of Mining, developed in partnership with Year13.

Skilled migration

The current skilled migration system's high costs and processing times, as well as Australia's housing shortage, are barriers to introducing skilled migrants.[12] The Australian Government aims to revamp the migration system to support national prosperity and security.[13] Skilled migrants are essential to the mining workforce (Figure M1). AUSMASA continues to work with the government to inform the delivery of a migration system that is better aligned with the needs of the mining industry.

Figure M1: Permanent skilled migrants in the mining industry, 2021



Source: Australian Bureau of Statistics, "Australian Census and Migrants, 2021, TableBuilder", 2021

12 For a more detailed discussion on the migration system and the mining industry, please see the AUSMASA February Research Bulletin.
13 Australian Government. Migration Review. 2024.

Table M1: International students in VET[14]

Year	RII enrolments	AUR enrolments
2016	341	3,605
2017	43	5,558
2018	10	7,761
2019	75	12,093
2020	21	15,560
2021	17	15,604
2022	31	15,913
2023	13	17,382

Source: VOCSTATS, 'Total VET students and courses 2023', 2024.

14 There are no international students enrolled in AUM; at the time of writing this, the government is reviewing caps on international students.

Female workforce, enrolments, and gender diversity

Females make up 27% of the overall mining industry workforce. This is below the national average of 48%.[15] Female enrolments in VET qualifications have increased by 29% since 2016, making up 15% of all RII enrolments in 2023. Despite improvements, the mining industry still has significant gender pay gaps, with 95% of employers having pay gaps in favour of men. AUSMASA continues to conduct research on gender diversity in the mining industry and will investigate pathways to improve both awareness of the wide breadth of careers and female participation in the industry.

Workplace cultural reform and mental wellbeing

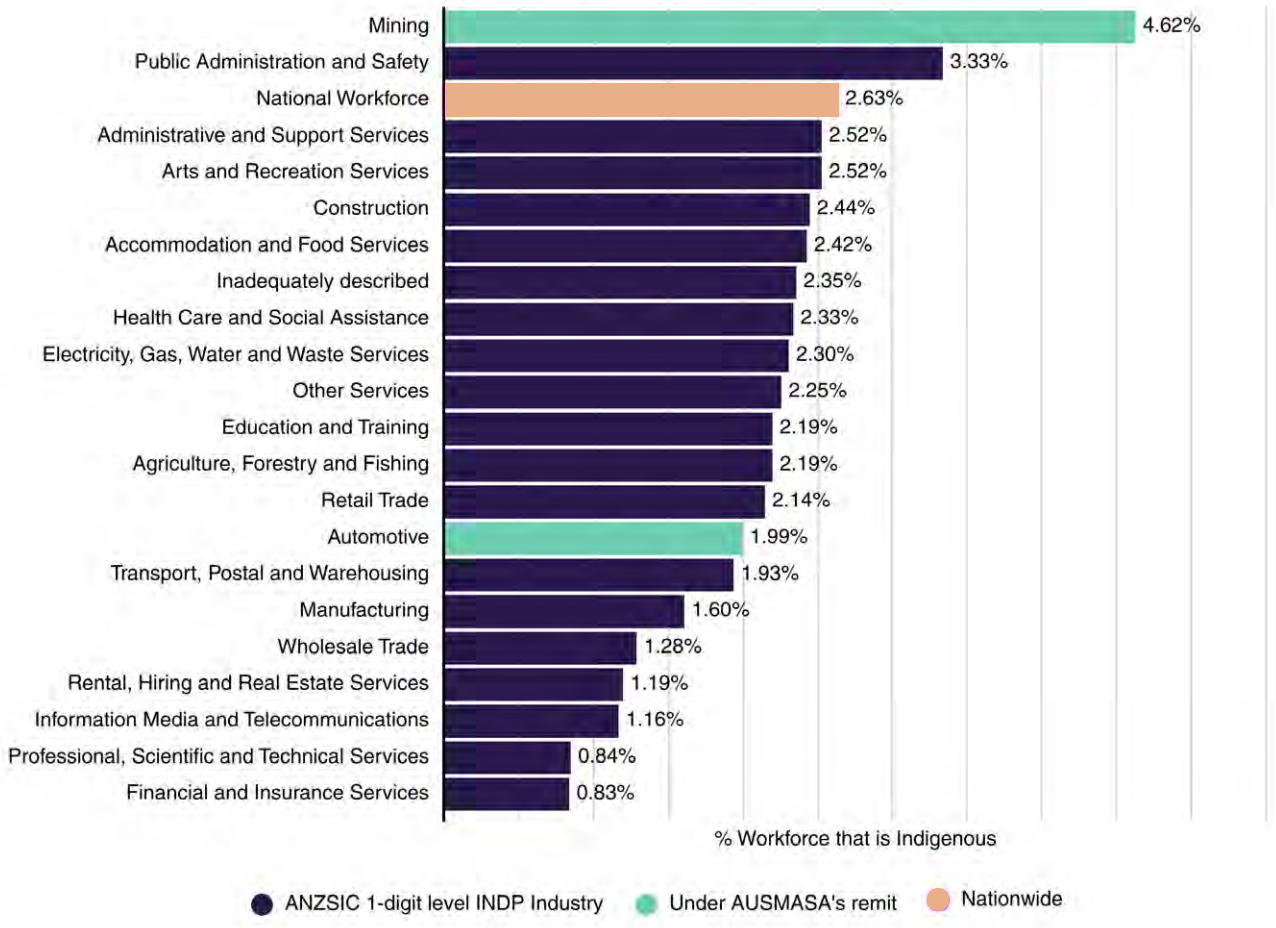
The mining industry has faced issues with workplace culture, including bullying, sexual harassment, and assault. Overall, 52% of stakeholders believe there have been moderate or significant improvements in workplace culture.[16] The Western Australian Government's Mental Awareness, Respect and Safety (MARS) Program addresses mental health, workplace culture, and safety issues. AUSMASA will enable and support the development of accredited training programs for safe and respectful workplaces. The mental health of mining workers is a critical concern due to remote locations, long shifts, and physically demanding work. Further research is needed to understand the impact of mental health issues on productivity and compensation claims. AUSMASA will continue investigating pathways to improve workplace culture and mental wellbeing in the industries we serve.

15 Australian Bureau of Statistics (ABS), Labour Force, Australia, Detailed, Oct 2024, Data trended by AUSMASA.
16 Edith Cowan University. Mental Awareness, Respect and Safety (MARS) Centre. 2024.

First Nations employment and engagement

First Nations people comprise 4.6% of the mining workforce, higher than the 2.6% average for all industries.[17] First Nations Australians represent 12.3% of mining apprentices and trainees, compared to the 6.1% average for all industries (Figure M2).[18] First Nations completion rates for trade apprenticeships are lower than non-indigenous students, indicating a need for additional mentoring and support.

Figure M2: Proportion of Indigenous workforce by industry, 2021



Source: ABS Table Builder 2021 Census - employment, income, and education. Note: the proportion of the Automotive Industry has been calculated by aggregating the 3-digit ANZSIC groups covering the industry and applying the INGP to derive the proportion.

AUSMASA is committed to advancing Indigenous employment by working with industry to support the design and implementation of pre-employment and training programs tailored to First Nations communities. These programs are essential for fostering participation and success in the year ahead. AUSMASA will continue to research this space to better understand the nuances around the opportunity.

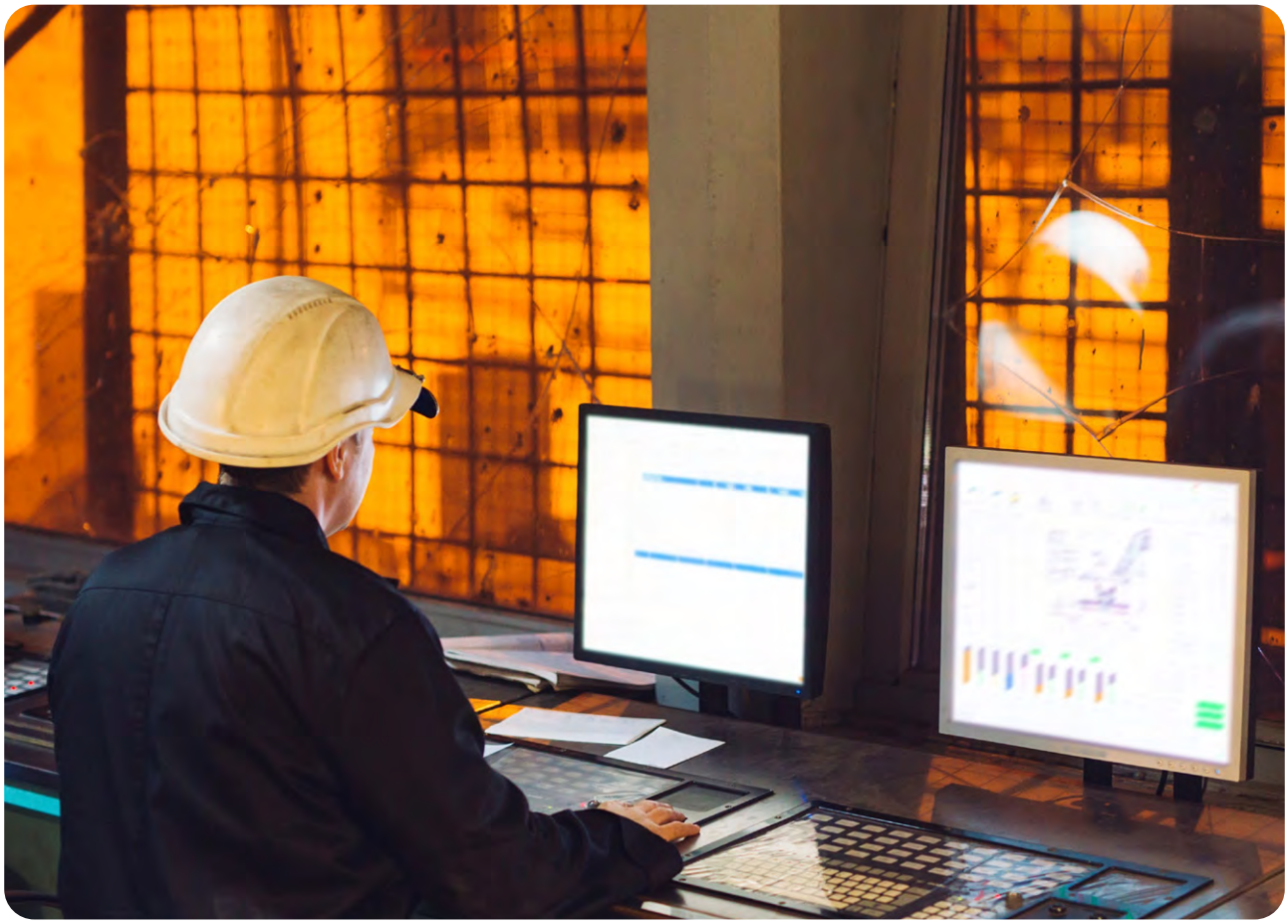
17 Australian Bureau of Statistics, 2021 Census - DataBuilder - Indigenous Employment by Industry, 2023.
18 NCVER, Apprentices and trainees 2023 - March quarter DataBuilder, Contract status, Employer industry 2-digit by Indigenous status, 12, 2023.

Technological advancements in the mining industry

The mining industry continues to implement high-technology solutions and systems into its day-to-day operations. As autonomous and artificial intelligence (AI)-supported technology continues to be deployed and advanced, there is potential for many workers in more traditional roles (for example, Drillers, Miners, Shot Firers, and Mobile Plant Operators) to be displaced. Given the industry's ongoing shortage of workers, however, any roles displaced by technology create opportunities for retraining and redeployment, increasing the retention of experienced employees in the process. With the shift to greater digital skills and literacy, AUSMASA will continue to work closely and collaboratively with the Jobs & Skills Council (JSC) responsible for digital skills – Future Skills Organisation – to support this and other work.

Electrifying the mining industry

Mining is transitioning to electric technology, which many mines can support with the off-grid electricity they already generate in their remote locations – creating synergies between existing infrastructure and the electrification of new vehicles and mobile plant equipment. Mining does, however, face challenges with transitioning its existing workforce of mobile plant technicians (Heavy Diesel Mechanics) to electric alternatives and from diversification. As female students only comprise 4.2% of enrolments in the automotive industry's Certificate III in Heavy Commercial Vehicle Mechanical Technology in 2023.[19] For these and other reasons, the role of mobile plant technicians (Heavy Diesel Mechanics) is being reviewed as part of AUSMASA's Career Mapping project. The results will be made available independently on the AUSMASA website.



19 VOCSTATS, 'Total VET students and courses 2023', 2024.

Drilling

Drillers play an important role in the mining industry, but accurate data on the number of Drillers employed in the industry is hard to access using the Australian and New Zealand Standard Classification of Occupations (ANZSCO). This is because occupation classifications might identify 'Drillers' (ANZSCO 712211) under the occupation classification of 'Drillers, Miners and Shot Firers' (ANZSCO 7122), among others. Drillers support exploration, underground, water well and geotechnical drilling.

Industry data indicates that the mining industry employs over 11,024 Drillers, with employment split across these sectors:[20]

- Exploration 4,775
- Coal 284
- Water well 2,188
- Underground 1,635
- Geo-technical 2,142.

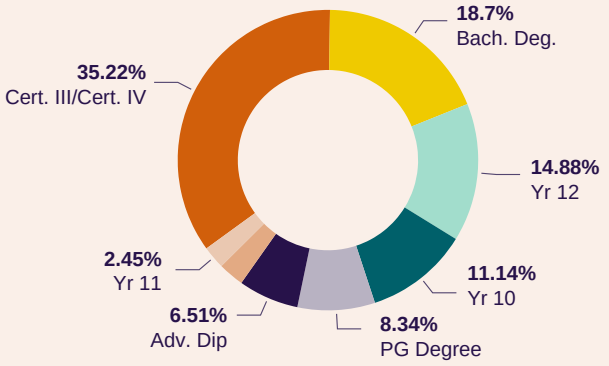
Industry has raised concerns regarding attrition of Drillers from commodity-price driven exploration towards other, more perennial sectors such as geotechnical and water well drilling. Some Drillers are deciding to leave the industry altogether for various reasons. Industry has identified that recognition of prior learning (RPL) could offer a potential solution, helping to ensure more qualified Drillers can obtain their qualification in Certificate III in Drilling Operations or similar. As this would create a training culture from the top down, it would enable the more experienced Drillers to be more actively involved in training future Drillers.

AUSMASA has also heard concerns from industry around water well licensing. Currently, each state and territory has its own water act that intersects with water well licences. Although, there is work being done by the National Uniform Drillers Licensing Committee (NUDLC) towards a harmonised national approach. New South Wales (NSW) retains its 6-class system, whereas all other states and territories have adopted a 3-tier class system. To obtain a water well licence, no qualification is required; applicants need only sit an open-book exam to obtain the licence. This, however, results in a knowledge and skills gap that employers need to fill before allowing Drillers to operate. As new licence holders lack the underpinning knowledge, industry stakeholders have suggested that an accredited training solution tied to the license as a prerequisite could address this.

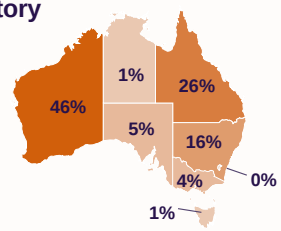
20 ADIA, "Economic Impact: Drilling of Australia 2025", Forthcoming.

Dashboard 1: Mining industry[21, 22]

Education level of the workforce



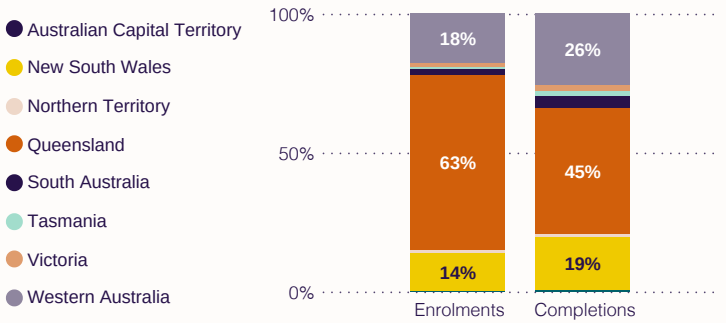
Total workforce by state/ territory



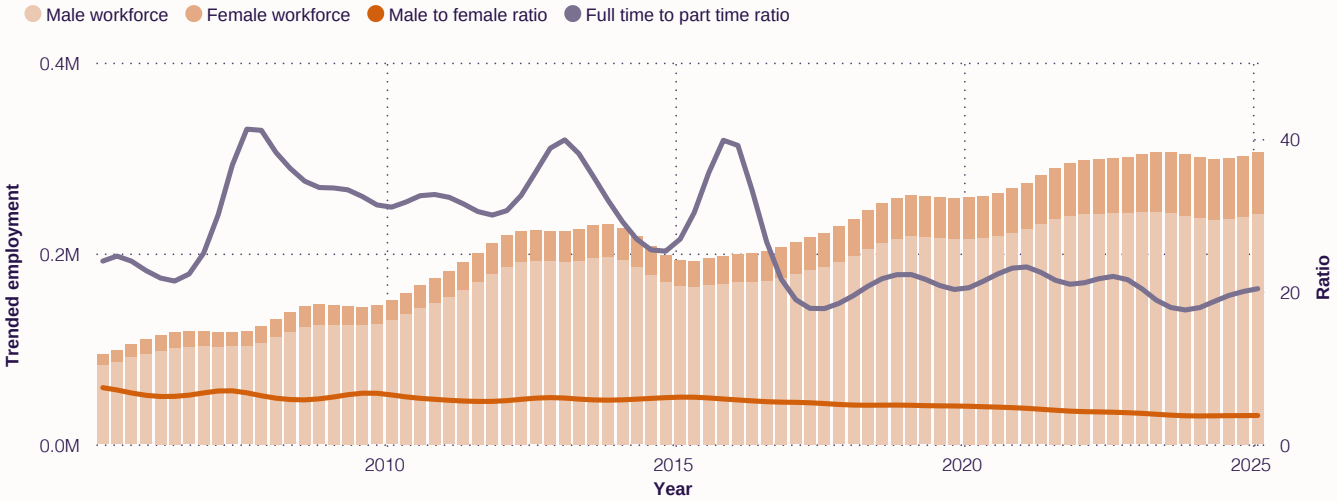
Projected growth over next decade	% female workforce
9%	21%

Median age	% workforce aged 24 or younger	% workforce aged 60 and above
41	6%	8%

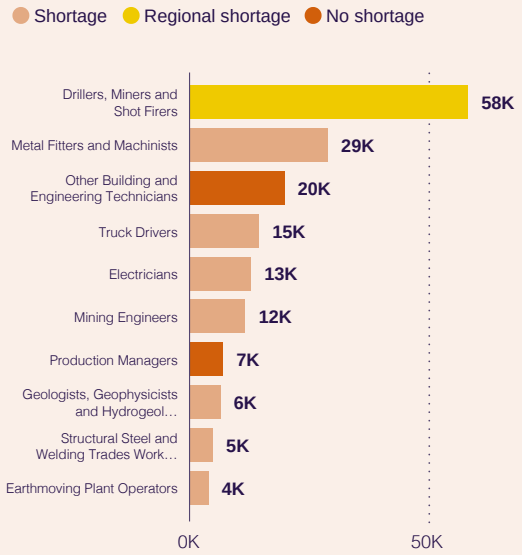
Training package status by state/territory of residence



Trends in employment by gender and work type



Top 10 ANZSCO occupations by workforce number

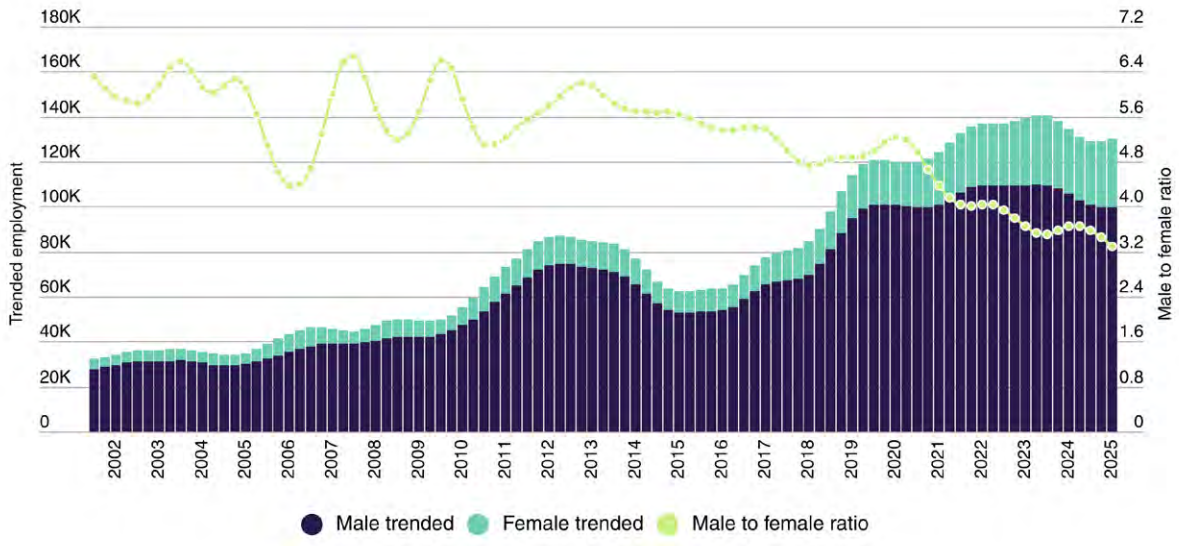


21 List of data source are in the Appendix 'Workforce Data Dashboard'.
22 Data related to the 'Mining nfd' (not further defined) sub-industry have been excluded from this analysis and are not represented in the dashboard.

Metal Ore Mining

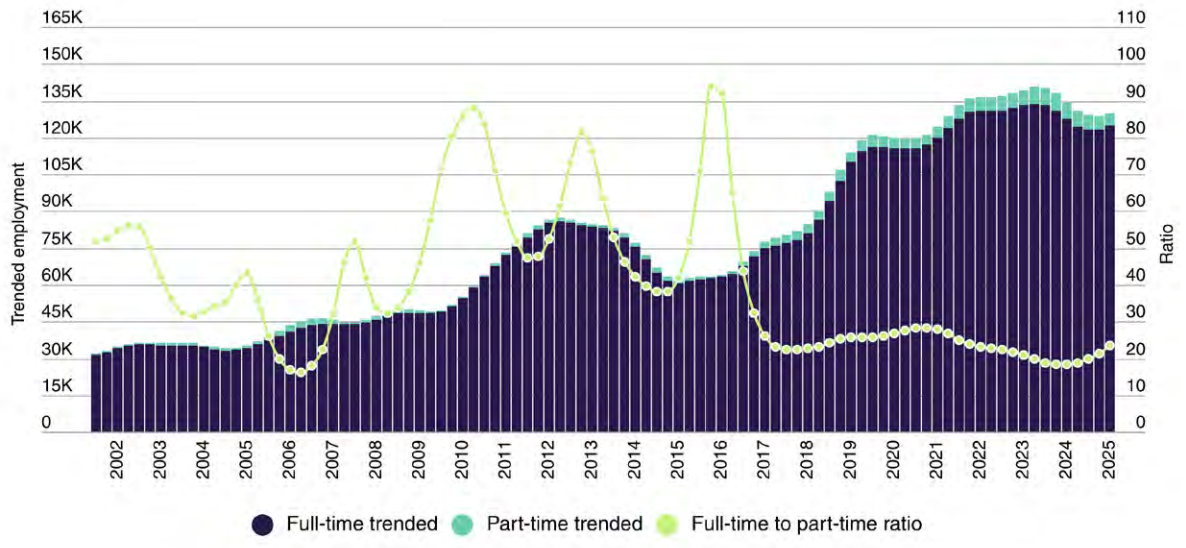
The Metal Ore Mining sector currently employs 130,000 workers,[23] representing an increase of 45,000 (+54%) total workers (Figure M5).[24] Full and part-time employment increased by 43,600 (+54%) and 1,800 (+49%), respectively (Figure M5). Over time, the Metal Ore Mining sector has seen an improvement in the ratio of male-to-female employment. In the early 2000s, the ratio was 6:1 for a decade, before falling to 3:1 in 2025.

Figure M5: Composition and employment trends in Metal Ore Mining, 2001–2025



Source: ABS, Labour Force, Australia, Detailed, Feb 2025*. Data trended by AUSMASA.*

Figure M6: Composition and employment trends by status of the Metal Ore Mining sector, 2001–2025



Source: ABS, Labour Force, Australia, Detailed, Feb 2025*. Data trended by AUSMASA.*

23 16,000 fewer workers than a series high from May 2023.
24 Please refer to our dashboard for Oil and Gas Extraction for an in-depth view on workforce composition and trends, https://ausmasa.org.au/media/scxphb42/07-oil-and-gas.pdf

On the brink of an ageing workforce

The age distribution of the Metal Ore Mining sector's workforce is younger than that of the overall Australian workforce, with a median age of 40 (Table M3) compared to the Australian workforce's median age of 42.[25] The age distribution of the workforce increased by one year between the census years. In total, 25% of the workforce was over 50 years of age or older and 10% over 57 years of age, compared to the average age of retirement for all workers in 2023 of 57.[26] This likely indicates an ageing workforce.

Iron ore's importance, despite recent price decreases linked with economic uncertainties in China and that of critical minerals, means the sector will continue to require a steady stream of new workers.[27] While new entrants into the workforce are generally younger, with a median age of 30, an ageing workforce will present more significant economic and strategic challenges for Australia, given iron ore's importance to the economy. This trend, however, may be temporary, as the Australian Government shifts to support on-shore processing and beneficiation of critical minerals.[28] Nonetheless, a better understanding of the iron ore mining industry, its attraction challenges, its support services, occupation pathways, and the promotion of diverse career options in the sector is needed.

Table M3: Age distribution of the Metal Ore Mining workforce

Percentile	2021 Census	2016 Census	Apprentices and trainees in 2024 Age at the completion
25th	32	31	24
50th (median)	40	39	30
75th	50	49	39

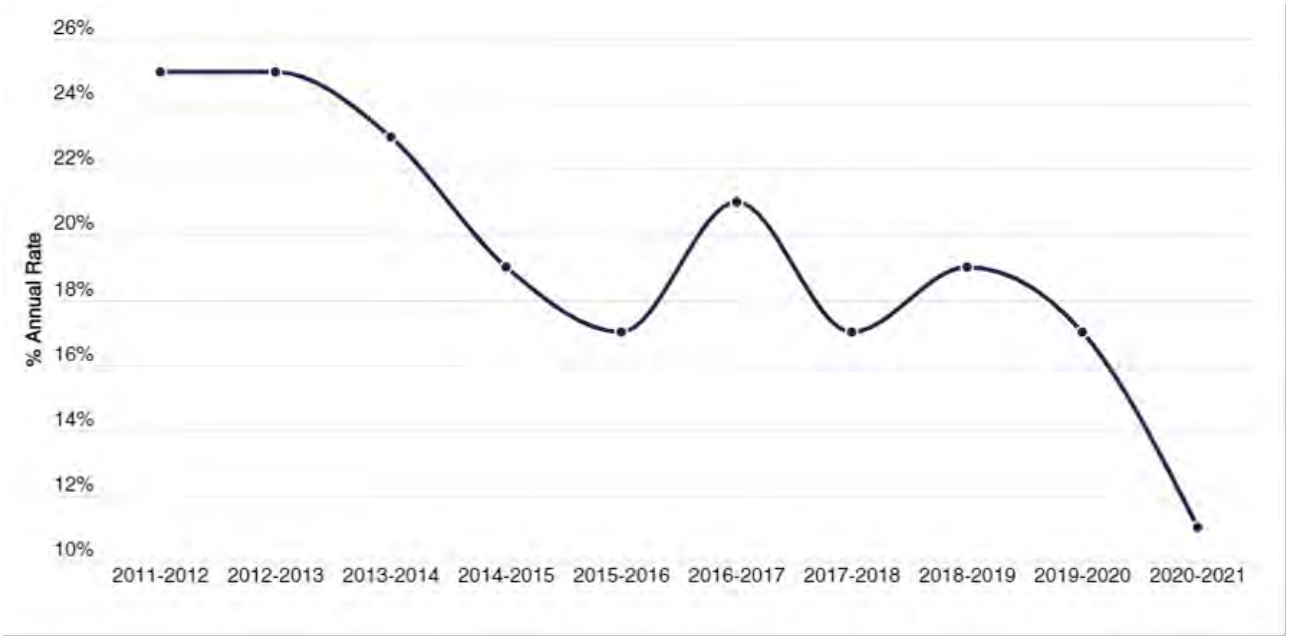
Source: 2021 Census – counting persons,15 years and over; 2016 Census – Counting Employed Persons, Place of Work POW); NCVER VOCSTATS, Apprentices and trainees – June 2024, Age by type of training by reporting period and training contract status.

25 ABS, "Employment in the 2021 Census | Australian Bureau of Statistics", 2022.
26 ABS, "Retirement and Retirement Intentions, Australia", 22 May 2024.
27 Hays, "Mining Industry Report Australia FY24/25", 2024.
28 DISR, "Critical Minerals Strategy 2023–2030", 2023.

Falling labour turnover

Labour turnover in the Metal Ore Mining sector fell to a series low of 11% (-14%) in 2020–21 (Figure M7). This represented the largest fall in turnover by sector for the mining industry. This is positive, as it indicates the workforce is increasingly able to stay in the sector compared to other sectors in the industry. AUSMASA will continue to study this phenomenon and derive lessons for the broader sector and future pathways to further reduce turnover.[29]

Figure M7: Turnover in Metal Ore Mining, 2011–2021



Source: JSA, Data on Occupation Mobility, Jan 2024; Key occupations by sub-industry mapped by AUSMASA.

Job advertisements in the Metal Ore Mining sector have steadily increased following the COVID-19 pandemic, rising by 21,400 (+84%) from January 2021 to March 2023. This trend, however, reversed, with a decrease of 9,300 (-20%) from March 2023 to October 2024.

29 Labour turnover is computed from data and research made available by JSA through their publication on Occupation Mobility – the data only goes up to 2020–21.

Electrifying heavy vehicles

With the largest workforce and number of key occupations in the mining industry, including several electrical-related roles, the Metal Ore Mining sector is at the forefront of electrifying heavy vehicles and other mobile plant equipment. This, however, also poses challenges to those who use, repair and maintain new equipment in electrical and automotive occupations. For example, a conversion of a Liebherr R 9,400 excavator from diesel to electric relied on workers from a factory in France to undertake the conversion in Western Australia.[30]

Industry stakeholders have also suggested that high-voltage electrical work on new and existing heavy vehicles, as well as mobile plant equipment, will likely require new, multi-skilled workers. Work is being undertaken with Curtin University on a block program that allows those with VET qualifications to secure an undergraduate certificate.[31] This means the current workforce can upskill without leaving the industry and risk industry-level productivity.

Similar creative solutions are required to address existing and future workforce challenges and will require coordinated mobilisation of both higher education and VET education providers. The VET workforce also faces challenges in ensuring trainers and assessors have industry currency in emerging technologies. Industry believes collaborations between VET providers and small and medium-sized enterprises (SMEs) can alleviate some of these challenges. VET changes and reforms are straightforward compared to higher education, due to the centralised nature of VET implementation. On the other hand, coordination from universities will require contribution and coordination from various university governing bodies, departments, and accreditation bodies. The benefits, however, from such mobilisation would be significant for the mining sector. AUSMASA will endeavour to work with tertiary education institutes and industry to find and enable such solutions.

Table M4: Top 5 Metal Ore Mining occupations

Occupations	Workforce numbers in 2021 Census	5-yr changes in IVI	Included in Core Skills Occupations List (CSOL)?	Shortage
Drillers, Miners, and Shot Firers	17,500	16.12%	No	RS
Metal Fitters and Machinists	9,100	45.92%	Yes	S
Other Building and Engineering Technicians	5,900	14.76%	Yes	S
Electricians	4,200	49.62%	Yes	S
Production Managers	3,700	64.97%	Yes	NS

Source: Jobs and Skills Australia, Internet Vacancy Index Oct 2024; Key occupations by sub-industry mapped by AUSMASA; Total workforce numbers are based on the Metal Ore Mining snapshot *in the Workforce Plan 2024, including* Core Occupation Skills *and* Occupation Shortage List.

Notes: RS: Regional Shortage; S: Shortage; NS: Not in Shortage. Our conversations with the industry indicate that the Census numbers may be smaller than reality, and we welcome identifying data sources that can paint a more accurate picture.

30 Liebherr, "Groundbreaking", 2023.
31 Thomson, "Fortescue uplifts First Nations employees - Australian Mining", 2024

Enrolments in Metal Ore Mining qualifications

Trends in RII Metal Ore Mining qualifications reflect the role of new VET students and upskilling for mining a range of metals including iron ore, copper, gold, and some critical minerals like nickel. From 2016 to 2019, enrolments and completions fell to 497 (-45%) and 125 (-55%), respectively. However, from 2019 to 2023, enrolments and completions increased to 685 (+38%) and 339 (+171%), respectively. If completions continue to fall, it will reduce the potential supply for the workforce, and greater investigation into this declining trend will be required.[32] Lower rates of full-time study, which can shift completions forward into later years, also suggest fewer completions going forward – as these rates had fallen 16 percentage points to 2% of enrolments by 2023.

While Metal Ore Mining occurs across Australia, Western Australia accounts for 65% of the workforce, which partially differs from where qualifications were delivered. From 2016 to 2020, Western Australia accounted for an average of 45% of student enrolments yearly, followed by New South Wales with 39% and Queensland with 16%, respectively. Western Australia, however, almost doubled this to an annual average of 83% of enrolments from 2021 to 2023, respectively, while the proportions decreased to an average of 11% for New South Wales and 5% for Queensland from 2021 to 2023. Although Western Australia's proportion of completions only averaged 34% from 2016 to 2020 and 45% from 2021 to 2023, Western Australia's recent enrolment increases suggest that it may benefit from more completions in the future, compared to other jurisdictions.

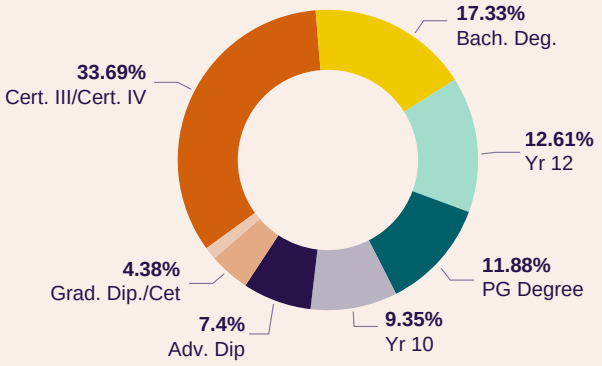
Key issues identified in Metal Ore Mining

The global demand for critical minerals like nickel and lithium presents challenges for Australian miners, particularly against countries like Indonesia, which use carbon-intensive methods. This global competition has led to price volatility, with nickel prices dropping by 51% since early 2022. Due to ongoing challenges in the nickel industry, up to 10,000 workers could be affected.[33] While the broader metal ore industry is expanding, job losses in less concentrated mining areas like Tasmania are more complex to absorb. An in-depth investigation and study of career pathways for workers susceptible to displacement are needed. AUSMASA will continue to work with stakeholders to identify such opportunities and solutions.

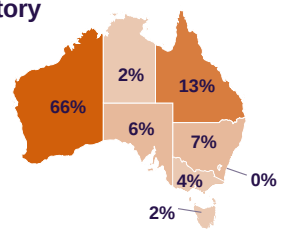
32 Non-completions may also represent instances where a student withdraws upon securing employment, withdraws as they had originally only intended to do some units, or decides to pursue a different career path.
33 Chamber of Minerals and Energy of Western Australia, "A Critical Juncture – Australia's Opportunities and Challenges in Nickel", 2024.

Dashboard 2: Metal Ore Mining[34]

Education level of the workforce



Total workforce by state/ territory



Projected growth over next decade	% female workforce
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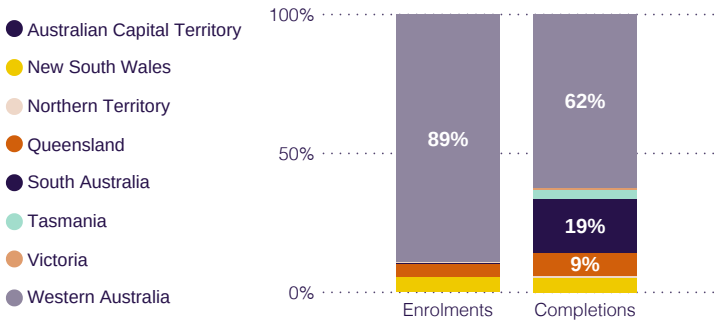
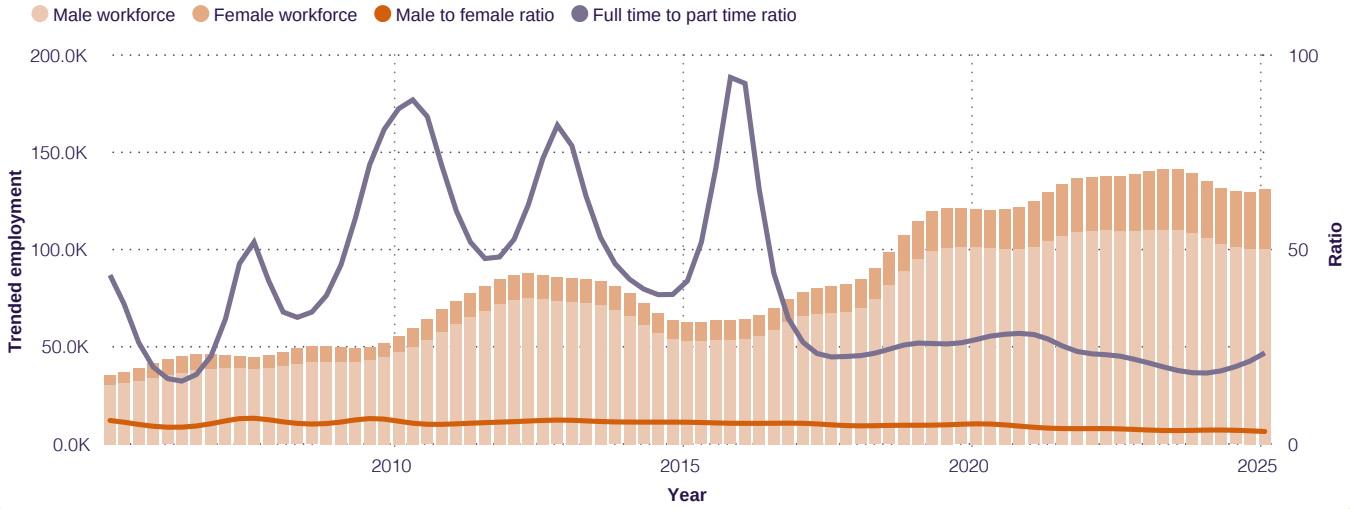
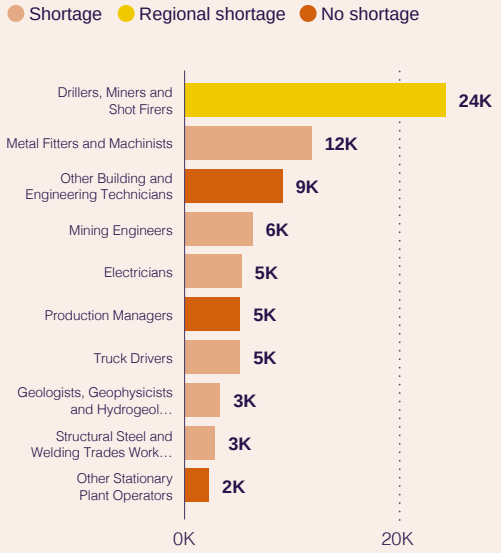
Training package status by state/territory of residence



Trends in employment by gender and work type



Top 10 ANZSCO occupations by workforce number

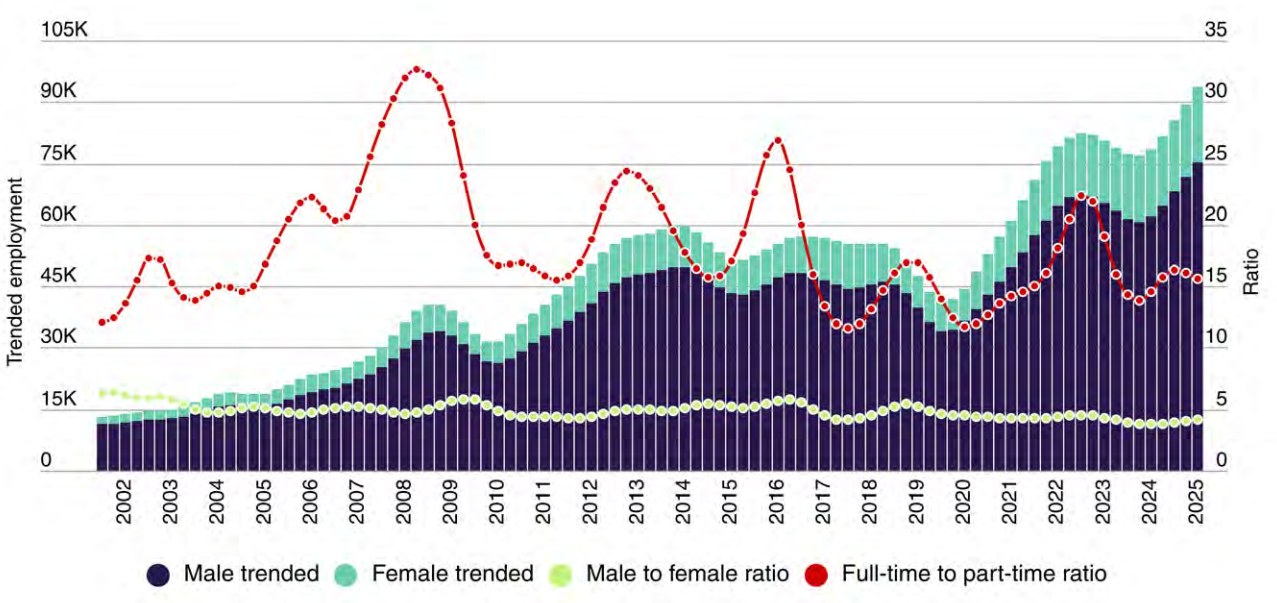


34 List of data source are in the Appendix 'Workforce Data Dashboard'.

Exploration and Other Mining Support Services

The Exploration and Other Mining Support Services' workforce has seen reasonable growth and gains in participation across genders, while the male-to-female ratio improved from around 6:1 to 4:1.[35] The Exploration and Other Mining Support Services sector employs over 93,000 workers, reflecting an increase of 38,300 (+69%) workers (Figure M8). Full and part-time workers have seen an increase of 36,500 (+71%) and 1,700 (+44%), respectively. While increases in full-time roles are positive, as they show the sector continues to perform well with a strong labour market, the relatively smaller increases in employment by females are less positive, as a lack of gender diversity can be associated with current or impending skills shortages.[36] The ratio of male-to-female employment in the sector remained largely consistent at around 6:1 from the early 2000s to 2019, before decreasing to 4:1 in 2025.

Figure M8: Composition and employment trends in Exploration and Other Mining Support Services, 2001–2025



Source: ABS, Labour Force, Australia, Detailed, Feb 2025. Data Trended by AUSMASA.

35 Please refer to our dashboard for Exploration and Other Mining Support Services for an in-depth view on workforce composition and trends, https://ausmasa.org.au/media/yylfj415/10-exploration-and-other-mining-support-services.pdf

36 JSA, "2024 Occupation Shortage List", 14 October 2024.

A younger workforce

Between the census years, the age distribution of the workforce remained largely the same, with the median age being 40 and the oldest 25% of the workforce being above 50 (Table M5). This is slightly younger than the Australian workforce, as the median age of all Australian workers was 42 in Census 2021.[37] Over 10% of the workforce was over 57 years old, noting that the average age of retirement was 57 for all workers in 2023.[38]

While some other parts of the industry are skewed more towards older workers, the sector's key role in bringing onstream new supplies of resources like critical minerals and supporting downstream activities in other sectors means the industry will continue to require a steady stream of new and likely younger workers.[39] As many specialised occupations in the sector require several years of higher education (for example, Geologists, Metallurgists, and Mining Engineers), younger workers may be better placed to commit to this level of training. The median age of new entrants is 28 years – which is positive for the future of the workforce.

Table M5: Age distribution of the Exploration and Other Mining Support Services

Percentile	2021 Census	2016 Census	Apprentices and trainees, 2024 Age at the completion
25th	31	31	25
50th (median)	40	40	28
75th	50	49	33

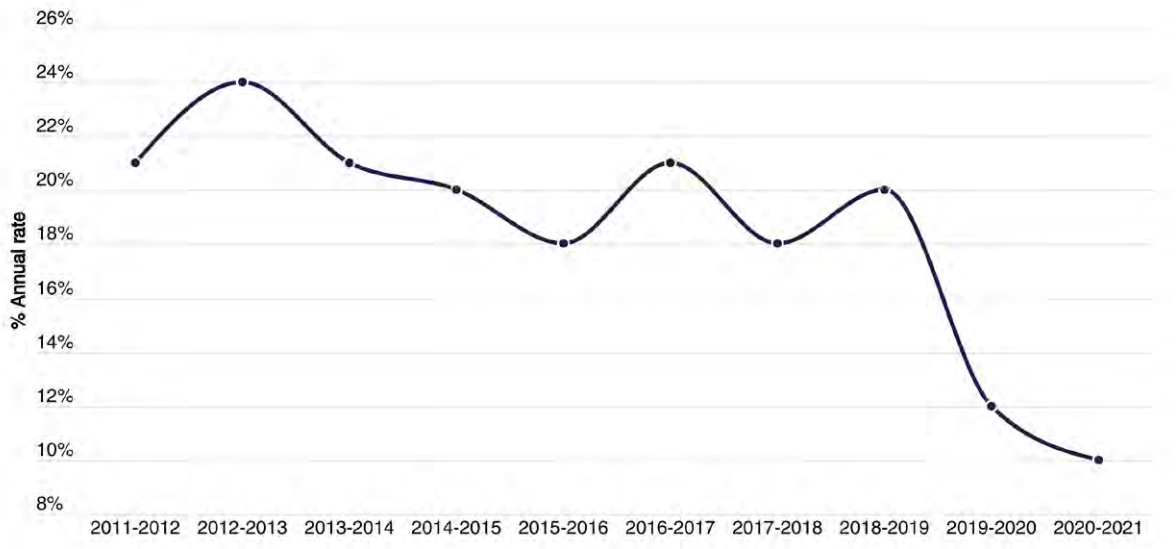
Source: 2021 Census – counting persons, 15 years and over; 2016 Census – Counting Employed Persons, Place of Work (POW); NCVER VOCSTATS, Apprentices and trainees – June 2024, Age by type of training by reporting period and training contract status.

Falling labour turnover

Labour turnover fell to 10% (-14%) in 2020–21 from a series high of 24% in 2012–13 (Figure M9). As the mining industry as a whole performed well, with almost no job losses during the onset of COVID-19, this data suggests that the sector performed even better than the industry overall.[40] Falling turnover indicates that the workforce is increasingly able to remain employed in the sector. AUSMASA will continue to study this trend and derive lessons for the broader industry on improving labour turnover.[41]

37 ABS, "Employment in the 2021 Census", 2021.
38 ABS,"Retirement and Retirement Intentions, Australia." 2023.
39 MCA, "Minerals-Plus", September 2024.
40 AusIMM, "The supply and demand of mining, metallurgical and geotechnical engineers in the Australian resources industry." 2021.
41 Labour turnover is computed from data and research made available by JSA through their publication on Occupation Mobility – the data only goes up to 2020–21.

Figure M9: Turnover in Exploration and Other Mining Support Services, 2011–2021



Source: JSA, Data on Occupation Mobility, Jan 2024; Key Occupations by sub-industry mapped by AUSMASA.

Job advertisements in the Exploration and Other Mining Support Services industry have steadily increased following the COVID-19 pandemic, rising by 7,000 (+81%) from January 2021 to March 2023. This trend reversed, however, with a decrease of 2,700 (-17%) from March 2023 to October 2024.

Table M6: Key Exploration and Other Mining Support Services occupations

Occupations	Workforce numbers in 2021 Census	5-yr changes in IVI	Included in CSOL?	Shortage
Drillers, Miners, and Shot Firers	5,200	16.12%	No	RS
Metal Fitters and Machinists	2,100	45.92%	Yes	S
Geologists and Geophysicists	1,300	15.35%	Yes	S
Other construction and mining labourers	1,200	46.04%	No	NS
Other Building and Engineering Technicians	800	14.76%	Yes	S

Source: Jobs and Skills Australia, Internet Vacancy Index Oct 2024; Key occupations by sub-industry mapped by AUSMASA; Total workforce numbers are based on the Exploration and Other Support Services mining snapshot in the Workforce Plan 2024, including Core Occupation Skills and Occupation Shortage List.

Notes: RS: Regional Shortage; S: Shortage; NS: Not in Shortage. Our conversations with industry indicate that the Census numbers may be smaller than reality, and we welcome the identification of data sources that can paint a more accurate picture.

From 2016 to 2023, more people have been enrolling in and completing mining-related qualifications. Enrolments went up by 198% to 7,210, and completions increased by 83% to 3,335.

Most of this growth, however, comes from students choosing shorter and lower-level courses (Certificate II), while the number taking longer, more advanced courses (Certificate III) has dropped. This shift means students may now have fewer skills and less experience, which could present a problem for the mining industry and its workforce needs.

Queensland accounts for 40% of enrolments and 30% of completions, and Western Australia accounts for 39% and 42%, respectively. This aligns with the distribution of the workforce, as Western Australia and Queensland account for 57% and 22%, respectively.[42]

Distribution is likely influenced by Western Australia's Skills Ready program, launched in 2020,[43] and the Driller's Offsider Job Ready Program, which began in 2022.[44] The program subsidised one skill set (Driller's Offsider Job Ready Skill Set) and several Certificate II-IV qualifications for students to progress in drilling operations – including 3 of the 10 RII qualifications we categorise as Exploration and Other Mining Support Services qualifications.

Key issues identified in Exploration and Other Mining Support Services

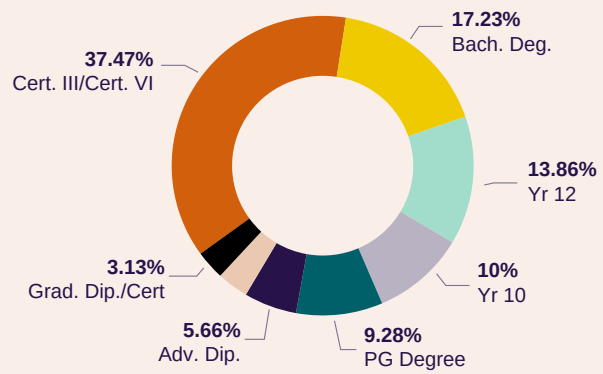
The 2024 Workforce Plan identified that exploration and drilling expenditure fluctuates with commodity prices, leading to high workforce turnover rates. In fact, turnover rates are 2 to 3 times higher than other mining sectors, due to harsh conditions and job transiency. This creates significant workforce planning challenges.[45] Jobs and Skills Australia (JSA) data suggests that labour turnover is falling in the sector, which warrants further investigation. AUSMASA will continue to investigate this trend.

Furthermore, technological advancements, such as drones, unmanned aerial vehicles, and automatic data processing, are changing task performance. These innovations can help achieve more with the existing workforce, attract new entrants, and necessitate upskilling for higher digital skills.[46] Specifically, skill pathways for these higher digital skills need to be developed. AUSMASA will work with stakeholders to identify and enable such pathways.

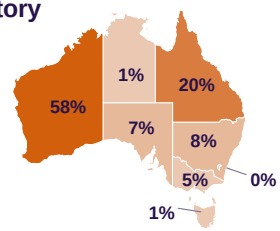
42 VOCSTATS, "Total VET students and courses", August 2024.; ABS, Labour Force, Australia, Detailed, Nov 2023 - Aug 2024 (4 quarter average).
43 JSWA, "Training", 2025.
44 JSWA, "Driller's Offsider Job Ready Program", 2022.
45 D. S. Houghton. Long-distance Commuting: a new Approach to Mining in Australia. The Geographical Journal. 1993.
46 Kazuya Okada. Breakthrough Technologies for Mineral Exploration. Mineral Economics 35. 2022.

Dashboard 3: Exploration and Other Mining Support Services[47]

Education level of the workforce



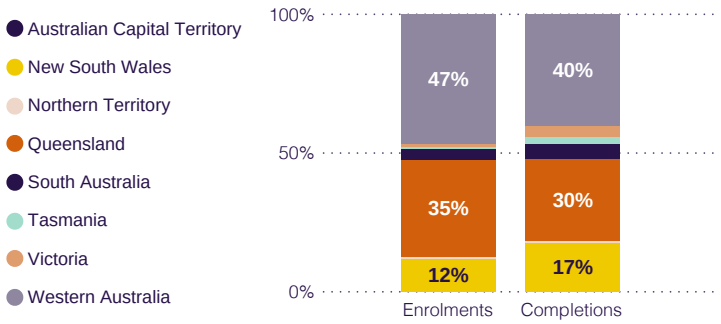
Total workforce by state/ territory



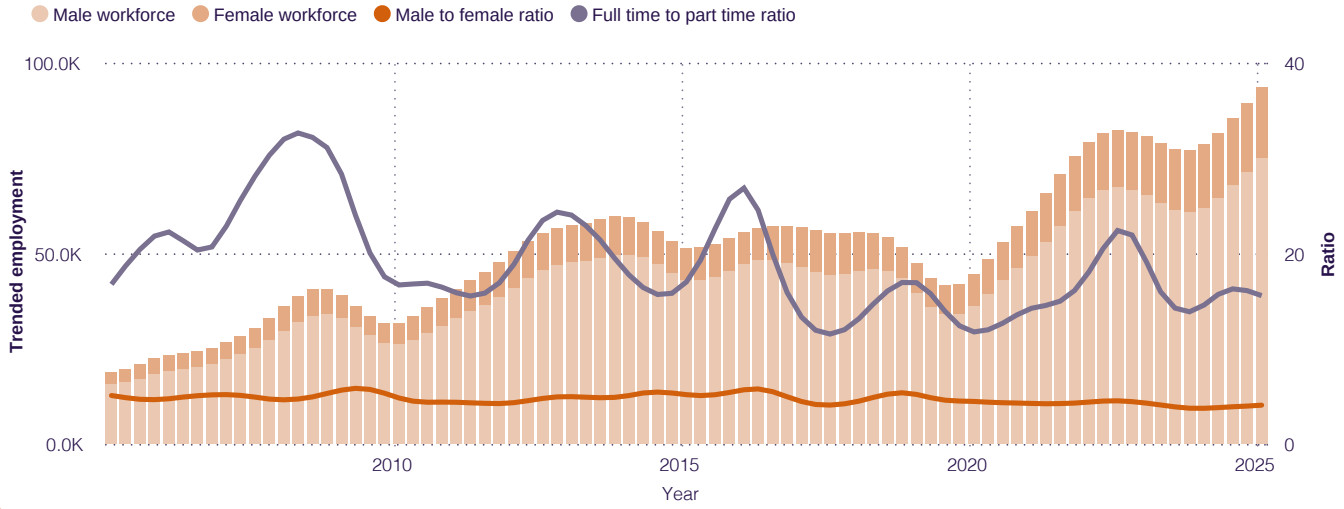
Projected growth over next decade	% female workforce
6%	25%

Median age	% workforce aged 24 or younger	% workforce aged 60 and above
40	8%	9%

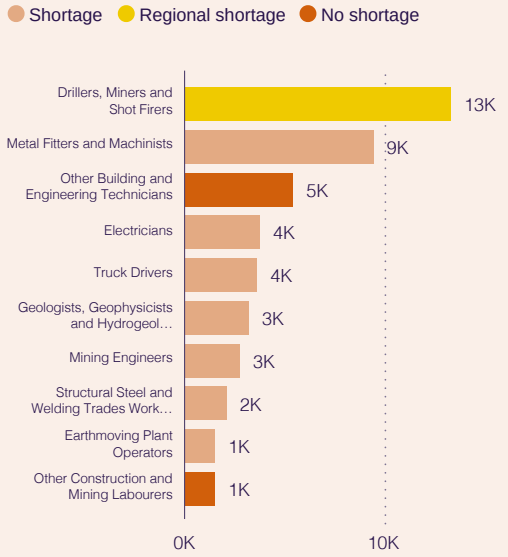
Training package status by state/territory of residence



Trends in employment by gender and work type



Top 10 ANZSCO occupations by workforce number

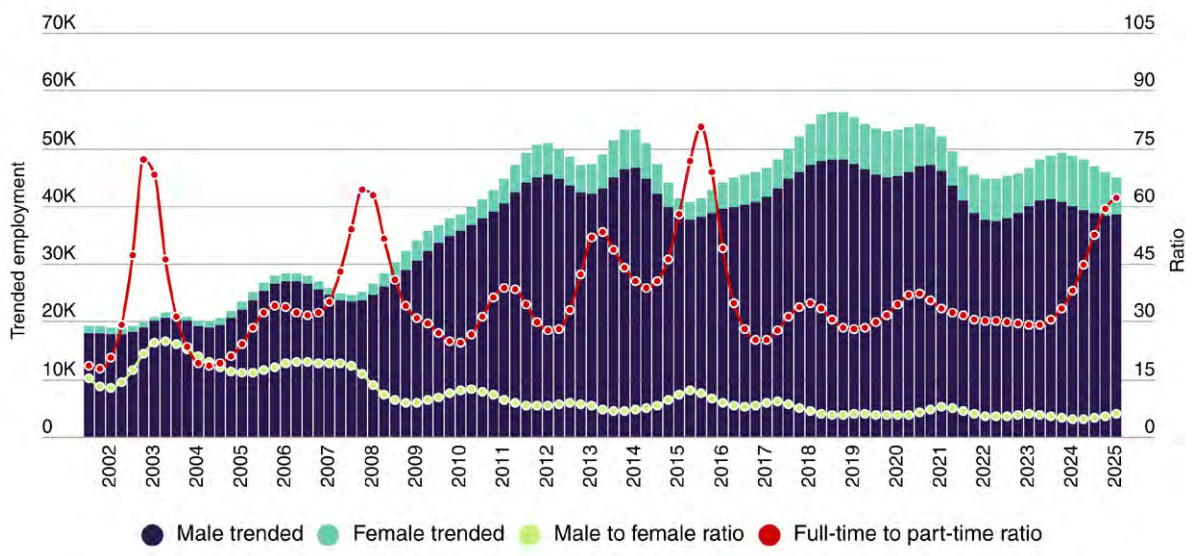


47 List of data source are in the Appendix 'Workforce Data Dashboard'.

Coal Mining

The Coal Mining workforce has seen a notable decline in size since COVID-19, currently employing 45,000 workers (Figure M10).[48] None of the top 10 key occupations in coal mining saw a decrease in size, however, which is largely led by a decline in ancillary and support occupations in the sector. The sector also saw a trend favouring female employment and part-time workers.

Figure M10: Composition and employment trends in Coal Mining, 2001–2025



Source: Australian Bureau of Statistics (ABS), Labour Force, Australia, Detailed, Feb 2025*. Data trended by AUSMASA.*

48 Please refer to our dashboard for Coal Mining for an in-depth view on workforce composition and trends, https://ausmasa.org.au/media/gpnmexev/06-coal-mining.pdf

An ageing workforce

Between the 2016 and 2021 censuses, the age distribution of the Coal Mining workforce remained broadly consistent, only getting a year older for workers (Table M7). This reflects a robust but somewhat waning attraction rate of younger workers, particularly compared to the median Australian workforce age[49].

Indicating entrenched community dependence on the Coal Mining sector, the recruitment trends require further investigation to determine whether coal-dependent communities and towns are driving this trend. Regardless of the source of the trend, it creates the need for significant upskilling and redeployment in the Coal Mining workforce.

> As the country moves towards net zero, the proportion of the workforce needing re-skilling will only increase.

Greater automation and technological change will continue to reduce demand for labour. The shift to automation, however, is creating the need for skills in programming, data management, data communications, and autonomous systems management. These skills currently lack structured pathways, as they are often not tied to formal qualifications and are in short supply.

AUSMASA will continue to leverage the tripartite system to investigate pathways into the industry for such skills and evaluate how these skill gaps can be best serviced. They may result in a natural decrease in labour demand for roles like labour workers and machinery operators in favour of those more specialised or 'skilled'.[50]

49 ABS, "Employment in the 2021 Census,' 30 November 2022.
50 Hays, "Hays Mining Industry Report Australia FY24/25,' 2024.

Better perception needed from younger workers

The 25th percentile shifted up by a year between the census years. While minor, these shifts could also be seen as indicators of an attraction issue. AUSMASA's research on Generation Z found negative perceptions of mining were primarily associated with coal.[51]

Most respondents were less interested in 'traditional' mining occupations and unaware of opportunities in more specialised or 'skilled' areas critical to the sector's future.

More consideration should be given to how to bolster the number of younger workers going forward. Further improvements in turnover and retention could also come from supervisory practice, as various industry stakeholders, particularly in Queensland, call for better implementation of the Brady Review's findings around concerns of appropriate supervision, consistency and relevance to critical control management. AUSMASA has been funded to advance a project that will address mine site supervisor competencies.

Table M7: Age distribution of the Coal Mining workforce

Percentile	2021 Census	2016 Census	Apprentices and trainees, 2024 (age at completion)
25th	33	32	22
50th (median)	41	40	30
75th	50	49	36

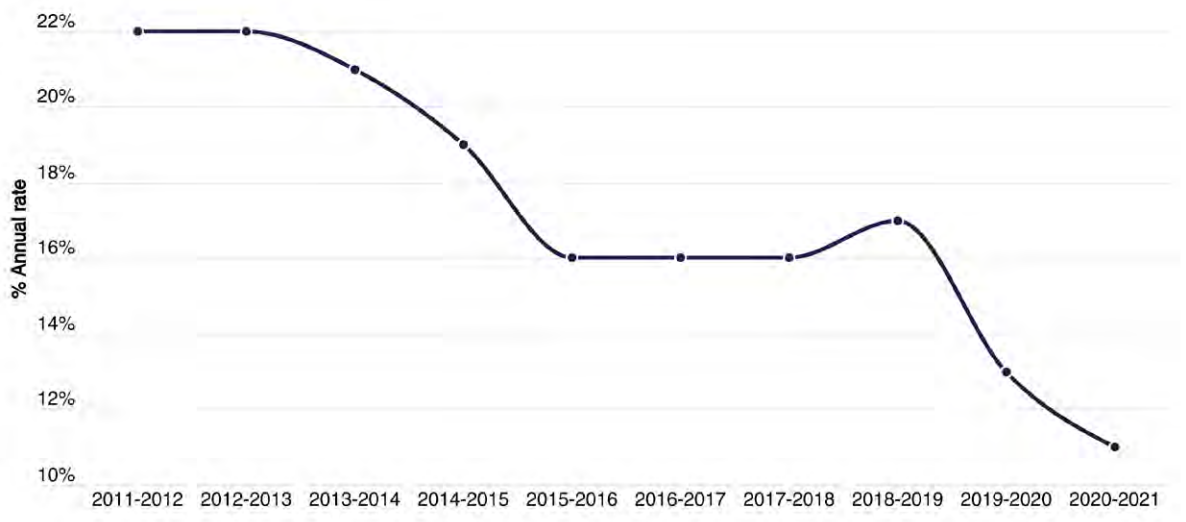
Source: 2021 Census – counting persons, 15 years and over; 2016 Census – Counting Employed Persons, Place of Work (POW); NCVER VOCSTATS, Apprentices and trainees – June 2024, Age by type of training by reporting period and training contract status.

51 Mining and Automotive Skills Alliance (AUSMASA), "Gen Z Perceptions of Mining", 10 April 2024.

Falling labour turnover in Coal Mining

Labour turnover in the Coal Mining sector decreased from a high of 22% in 2011–12 to a low of 11% at the start of COVID-19 in 2020–21 (Figure M11). Falling labour turnover is a positive sign, particularly in a tight job market, as it indicates the workforce increasingly prefers to stay in the sector. With a range of new coal mines set to open,[52] workers will be drawn to the sector to find employment. AUSMASA will continue to research and investigate these trends to understand better how to enhance turnover and retention.[53]

Figure M11: Turnover in Coal Mining, 2011–2021



Source: Jobs and Skills Australia, Data on Occupation Mobility, Jan 2024; Key occupations by industry subdivision mapped by AUSMASA.

52 Hays, "Hays Mining Industry Report Australia FY24/25", 2024.
53 Labour turnover is computed from data and research made available by JSA through their publication on Occupation Mobility – the data only goes up to 2020–21.

Advertisements for key occupations in the Coal Mining sector have steadily increased following the COVID-19 pandemic, rising by 12,900 (+87%) from January 2021 to March 2023 (Table M8). This trend reversed, however, with a decrease of 5,200 (-19%) from March 2023 to October 2024.

Table M8: Top 5 Coal Mining occupations

Occupations	Workforce numbers in 2021 Census	5-yr changes in IVI	Included in CSOL?	Shortage*
Drillers, Miners, and Shot Firers	15,900	16.12%	No	RS
Metal Fitters and Machinists	6,200	45.92%	Yes	S
Other Building and Engineering Technicians	2,900	14.76%	Yes	S
Electricians	2,600	49.62%	Yes	S
Truck Drivers	2,400	75.69%	No	S

Source: Jobs and Skills Australia, Internet Vacancy Index Oct 2024; Key occupations by sub-industry mapped by AUSMASA; Total workforce numbers are based on the Coal Mining snapshot in the Workforce Plan 2024, including Core Occupation Skills List (CSOL) and Occupation Shortage List.

Notes: RS: Regional Shortage; S: Shortage; NS: Not in Shortage. Our conversations with the industry indicate that the Census numbers may be smaller than reality, and we welcome the identification of data sources that can paint a more accurate picture.

Enrolments in Coal Mining RII qualifications

From 2016 to 2021, coal enrolments in RII fell to 2,024 students (-13%) before increasing to 3,361 (+63%) in 2023. Female participation increased as the share of female enrolments rose roughly 12% (+5%) from 2016 to 2023.

These recent increases have not (yet) flowed through to the rise in female completions. Completions increased, however, to 523 (+127%) from 2022 to 2023.

At the jurisdictional level, it should be noted that these national trends were almost entirely driven by Queensland – since the state accounted for 83% of enrolments on average each year between 2016 and 2023 and is home to a larger share of relevant Registered Training Organisations (RTOs). The wider workforce distribution, however, is split between Queensland with 61%, and New South Wales with 33%.[54]

At the same time, this trend was less pronounced in completions, as Queensland accounted for 46% of student completions on average each year from 2016 to 2023, while New South Wales notably accounted for an average of 51% of completions. We consider these differences linked to the Underground Coal Mine Safety Skill Set, which can provide credit towards various Certificate II and III RII qualifications and other Queensland requirements for specific workers.

Key issues for Coal Mining sector

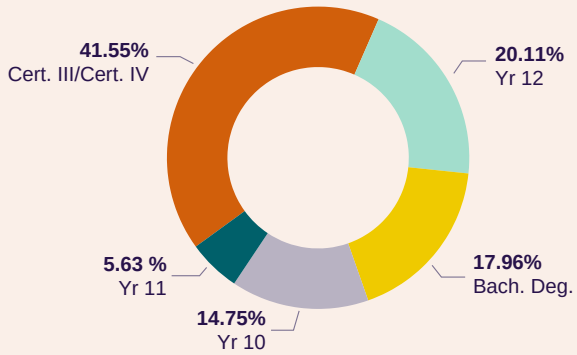
Australia's coal industry faces increasing pressure due to global climate change targets. The International Energy Agency's Net Zero by 2050 Roadmap calls for no new unabated coal plants, phasing out the least efficient coal plants by 2030, and retrofitting remaining plants by 2040.[55]

The transition away from coal-fired power stations will impact nearly all coal mines. Governments are investing in helping affected communities transition to clean energy jobs, requiring large-scale re-skilling with more complex and digital skills.[56] A greater understanding of the nature of skills required in this transition and in enabling the decommission of mines is required. AUSMASA welcomes insight from stakeholders on these issues and will continue to work on identifying such insights to better align today's workforce for tomorrow.

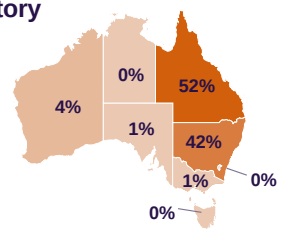
54 ABS Detailed Labour Force Survey (Table EQ06, 4-quarter Average), Reference Period: February 2024
55 International Energy Agency, "Net Zero by 2050 - A Roadmap for the Global Energy Sector", May 2021.
56 The World Bank. For a Just Transition Away from Coal, People Must Be at the Centre', November 2021.

Dashboard 4: Coal Mining[57]

Education level of the workforce



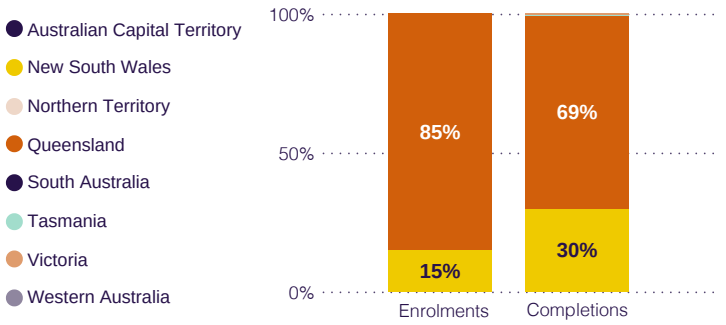
Total workforce by state/ territory



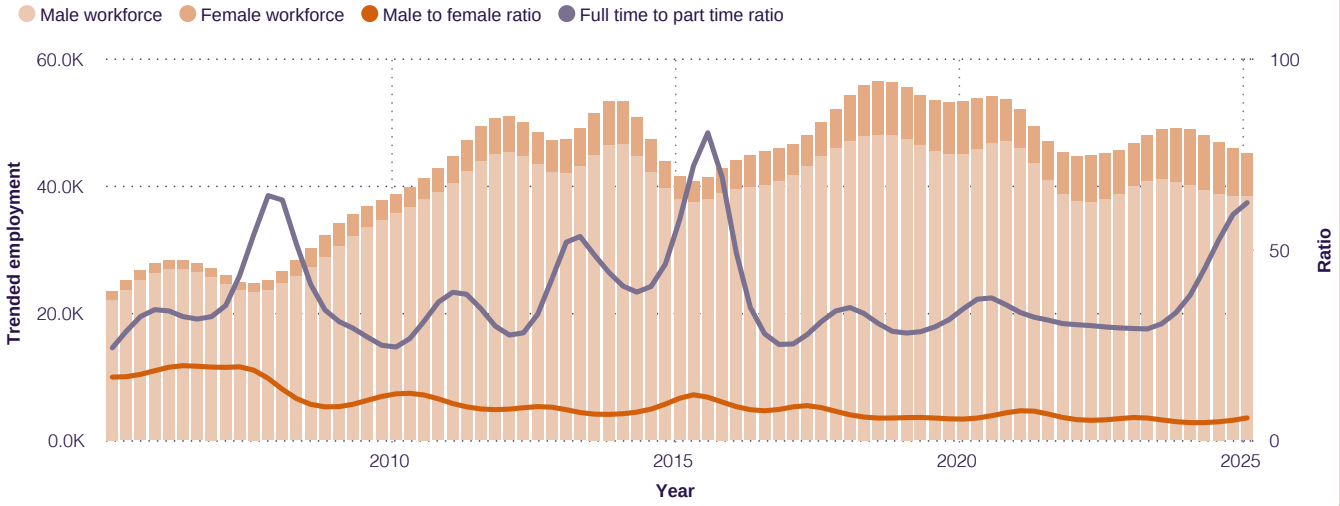
Projected growth over next decade	% female workforce
-1%	17%

Median age	% workforce aged 24 or younger	% workforce aged 60 and above
41	6%	7%

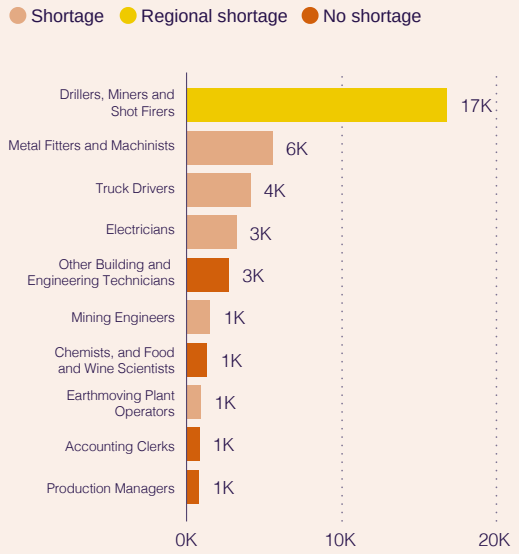
Training package status by state/territory of residence



Trends in employment by gender and work type



Top 10 ANZSCO occupations by workforce number



57 List of data source are in the Appendix 'Workforce Data Dashboard'.

Oil and Gas Extraction

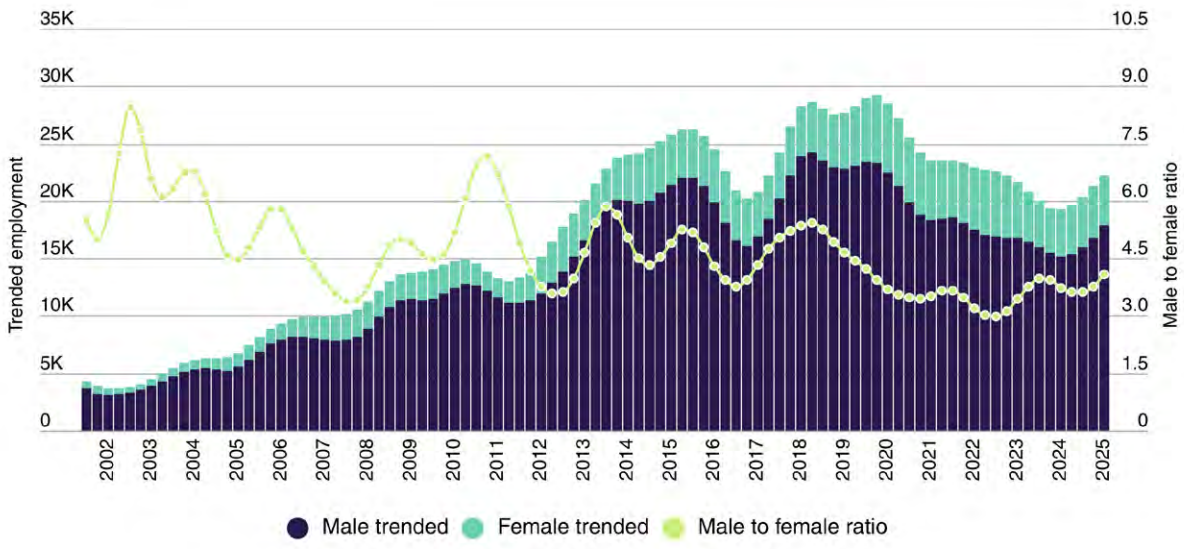
The Oil and Gas Extraction sector currently employs over 22,000 workers, a decrease of 6,000 (-21%) total workers since February 2018 (Figure M12).[58] Both full and part-time workers decreased by 5,600 (-21%) and 460 (-39%), respectively, from February 2018 to February 2025 (Figure M13). This overall decrease may suggest a reduced demand for workers following the peak in 2018 – likely driven by the movement to net zero. The decline in employment was largely spurred by decreases in the size of the chemical, gas, and petroleum generation plant operators and other support occupations. No other key occupation in the sector saw a decrease in employment.

The ratio of male to female employment reached its peak at 8:1 during the 2011–2012 mining boom, before its present 4:1. The decrease was largely driven by the shrinking workforce, maintaining a steady proportion of female workers as male employment fell.

AUSMASA research and stakeholder consultation show that the sector needs to further improve female representation by way of improved employment outcomes, visible and practised career progression, greater work flexibility, and mentoring opportunities.

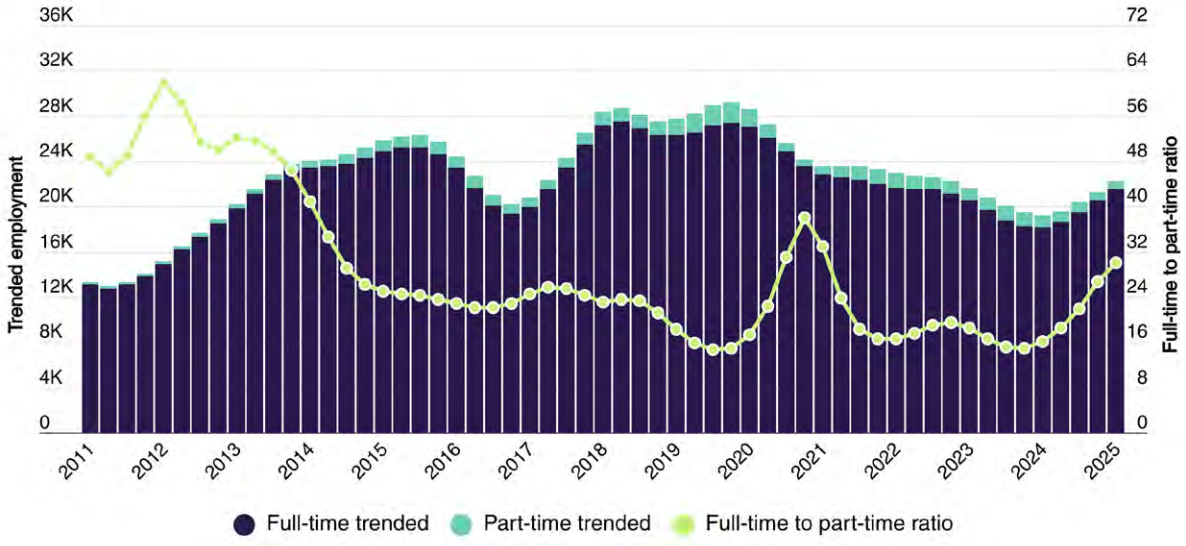
58 Please refer to our dashboard for Oil and Gas Extraction for an in-depth view on workforce composition and trends, https://ausmasa.org.au/media/scxphb42/07-oil-and-gas.pdf

Figure M12: Composition and employment trends in Oil and Gas Extraction, 2001–2025



Source: ABS, Labour Force, Australia, Detailed, Feb 2025*. Data Trended by AUSMASA.*

Figure M13: Composition and employment trends by employment status in Oil and Gas Extraction, 2011–2025



Source: ABS, Labour Force, Australia, Detailed, Feb 2025*. Data Trended by AUSMASA.*

Onset of an ageing workforce

The age distribution of the Oil and Gas Extraction sector is largely similar to the overall Australian workforce, with all Australian workers having a median age of 42 in Census 2021 (Table M9). With only 5% of workers below the age of 26, there is a clear risk of the industry facing an ageing workforce. [59] Over the census years, the median age has increased by 2 years; robust retention typically retains the median age. Additionally, 25% of the sector's workers were 35 years old or younger as of the 2021 census, which is 3 years older than in 2016. This ageing trend is likely a manifestation of underlying workforce attraction issues. Given that the oldest 25% of the incoming workforce (Table M9) is above the age of 30, as older workers retire, the workforce may decline and age.

Table M9: Age distribution of the Oil and Gas Extraction workforce

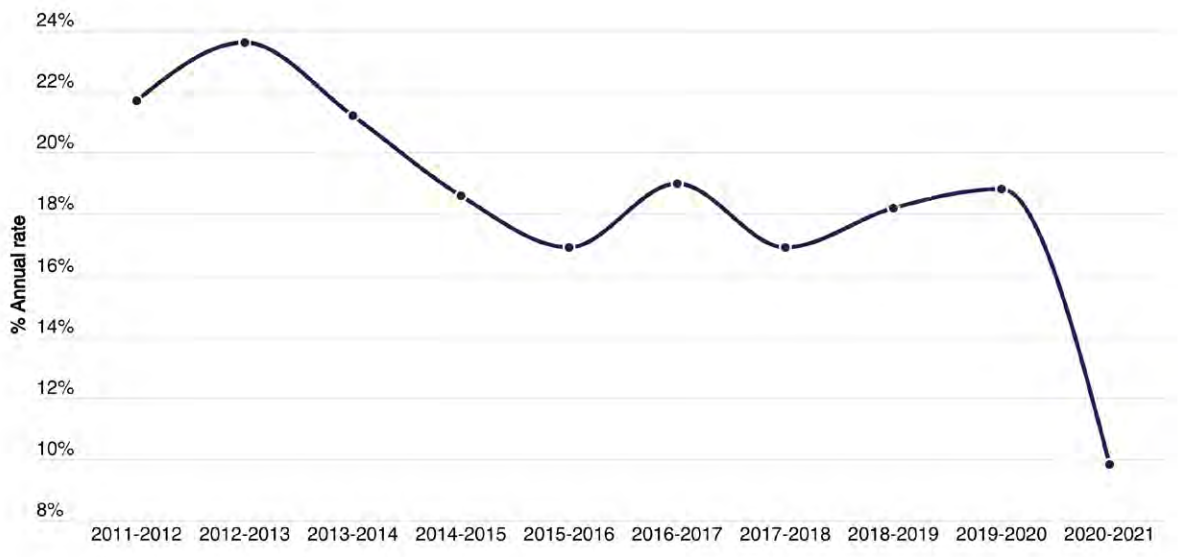
Percentile	2021 Census	2016 Census	Apprentices and trainees in 2024 Age at the completion
25th	35	32	22
50th (Median)	42	40	25
75th	50	48	30

Source: 2021 Census – counting persons, 15 years and over; 2016 Census – Counting Employed Persons, Place of Work (POW); NCVER VOCSTATS, Apprentices and trainees – June 2024, Age by type of training by reporting period and training contract status

59 AUSMASA, "Industry Workforce Plan Moving ahead together 2024", August 2024.

Labour turnover in the Oil and Gas Extraction sector fell to a series low of 9.8% in 2020–21 (-11.8%) (Figure M14). Given the shrinking and ageing of the sector's workforce, the lower turnover is a positive sign, indicating lower attrition and allowing the industry more time to attract younger workers. AUSMASA will continue to research and investigate these trends to better understand how to improve turnover and retention.[60]

Figure M14: Turnover in Oil and Gas Extraction, 2011–2021



Source: JSA, Data on Occupation Mobility, Jan 2024; Key occupations by sub-industry mapped by AUSMASA

Job advertisements in the Oil and Gas Extraction sector have shown a steady increase following the COVID-19 pandemic, rising by 8,400 (+90%) from January 2021 to October 2023 (Table M10). This trend reversed, however, with a decrease of 3,000 (-17%) from October 2023 to October 2024.

Table M10: Top 5 Oil and Gas Extraction occupations

Occupations	Workforce numbers in 2021 Census	5-yr changes in IVI	Included in CSOL?	Shortage*
Chemical, Gas, Petroleum and Power Plant Operators	1,700	-5.00%	Yes	NS
Mining Engineers	1,100	4.72%	Yes	S
Drillers, Miners, and Shot Firers	1,000	16.12%	No	RS
Metal Fitters and Machinists	800	45.92%	Yes	S
Other Building and Engineering Technicians	600	14.76%	Yes	NS

Source: JSA, Internet Vacancy Index Oct 2024; Key occupations by sub-industry mapped by AUSMASA; Total workforce numbers are based on the Oil and Gas mining snapshot in the Workforce Plan 2024, including Core Occupation Skills List (CSOL) and Occupation Shortage List.

Notes: RS: Regional Shortage; S: Shortage; NS: Not in Shortage. Our conversations with industry indicate that the Census numbers may be smaller than reality, we welcome the identification of data sources that can paint a more accurate picture.

60 Labour turnover is computed from data and research made available by JSA through their publication on Occupation Mobility – the data only goes up to 2020-21

Enrolments in RII Oil and Gas qualifications

Enrolments in RII Oil and Gas qualifications have been volatile. From 2016 to 2021, the enrolments fell by 2,402 (-77%), then from 2021 to 2023 enrolments increased 1,149 (+164%). Oil and Gas completions were flat – at about 520 from 2016 to 2019 – before they fell to a low of 327 (-60%) in 2021. They increased to a high of 959 (+174%) in 2023.

Although enrolments and completions for female students followed a similar pattern to the overall figures, their figures were too low for any meaningful analysis. In 2023, there were 23 annual female enrolments and 5 completions. This suggests that the future female workforce will continue to stagnate unless efforts are made to increase diversity in the talent pool. AUSMASA will continue to investigate barriers around female participation in relevant qualifications and pathways to improve female participation.

Queensland's overrepresentation in this data is also a point of interest. While 30% of the entire Oil and Gas workforce is in Queensland, 42% in Western Australia and 14% in Victoria,[61] Queensland represented 97% of onshore RII Oil and Gas enrolments and 78% of completions on average each year from 2016 to 2023.[62] Queensland's large reserves of onshore coal seam gas, its User Choice Program, and its large number of RTOs offering these qualifications may account for these discrepancies. As early as 2017, this employment-based program has subsidised several related traineeships, with Priority 1 qualifications 100% funded and Priority 2 qualifications subsidised by 87.5%.[63] Indigenous students were eligible for a 100% subsidy, with their percentage of enrolments and completions roughly doubling from 3% to 4% in 2016 to 6% to 7% in 2023. It appears that Queensland's program has likely supported and diversified its onshore Oil and Gas sector, which may warrant further investigation to support the training needs of other sectors.

Key issues identified in Oil and Gas Extraction

The Oil and Gas Extraction industry workforce are predominantly middle-aged, with a median age of 42. Only 5% are under 26, and 6% are over 60. This reflects the specialised skills required and the remote, challenging working conditions.[64] These conditions prevent robust recruitment and retention. Further investigation is required to identify possible mitigation strategies.

61 South Australia also accounted for 6% of the wider Oil and Gas workforce, followed by the Northern Territory with 2% and Tasmania and the Australian Capital Territory with 1%. https://ausmasa.org.au/media/5vxngfo2/ausmasa-industry-workforce-plan-2024.pdf#page=92

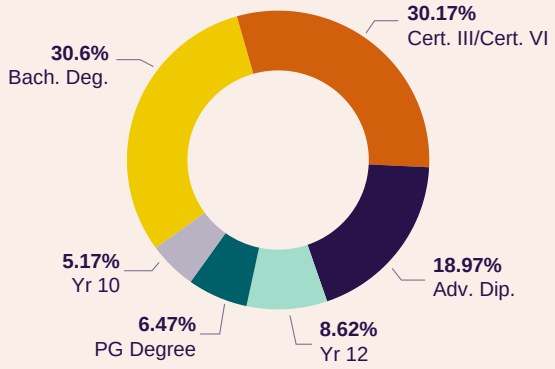
62 NCVER. 2023. TVA program enrolments 2022 (VOCSTATS).

63 Queensland Department of Trade, Employment and Training, VET Funding and pricing, June 2024.

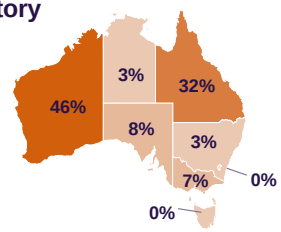
64 Australian Bureau of Statistics. February 2024 - Labour Force, Australia, Detailed - 'Table EQ06

Dashboard 5: Oil and Gas Extraction[65]

Education level of the workforce



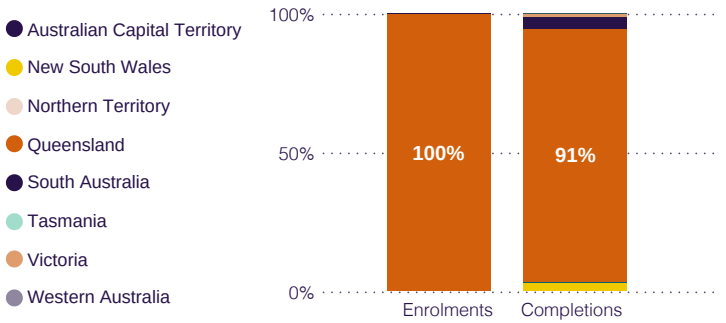
Total workforce by state/ territory



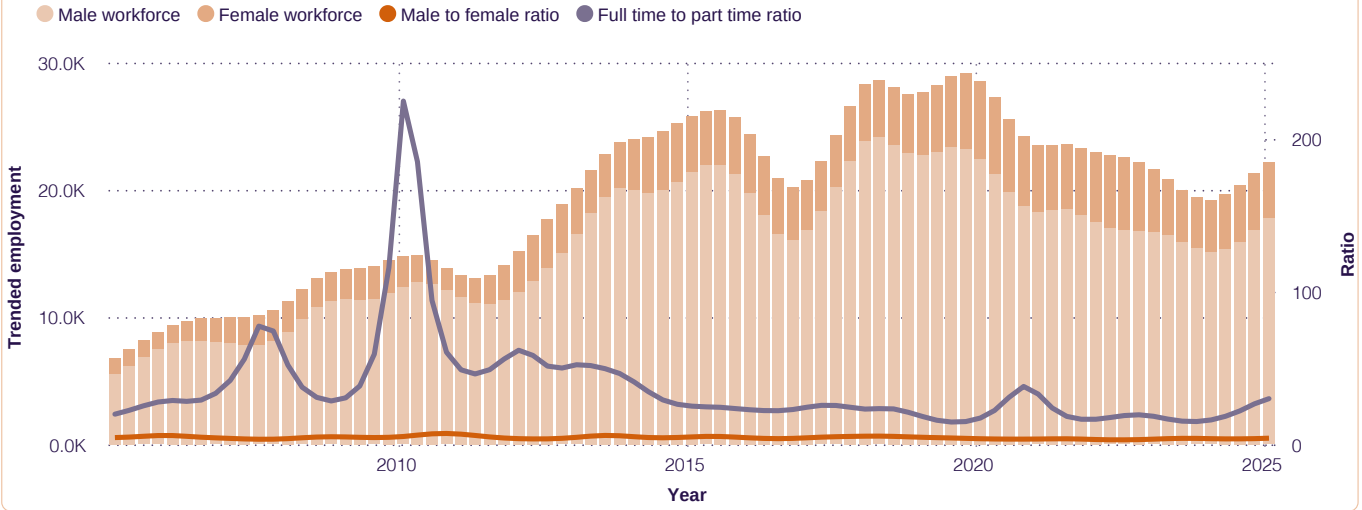
Projected growth over next decade	% female workforce
15%	18%

Median age	% workforce aged 24 or younger	% workforce aged 60 and above
42	3%	6%

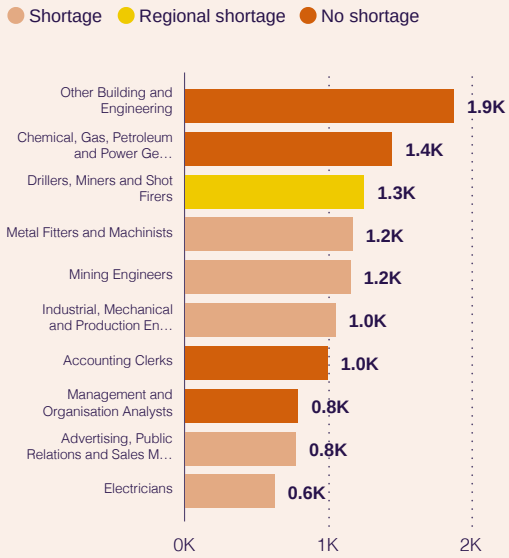
Training package status by state/territory of residence



Trends in employment by gender and work type



Top 10 ANZSCO occupations by workforce number



65 List of data source are in the Appendix 'Workforce Data Dashboard'.

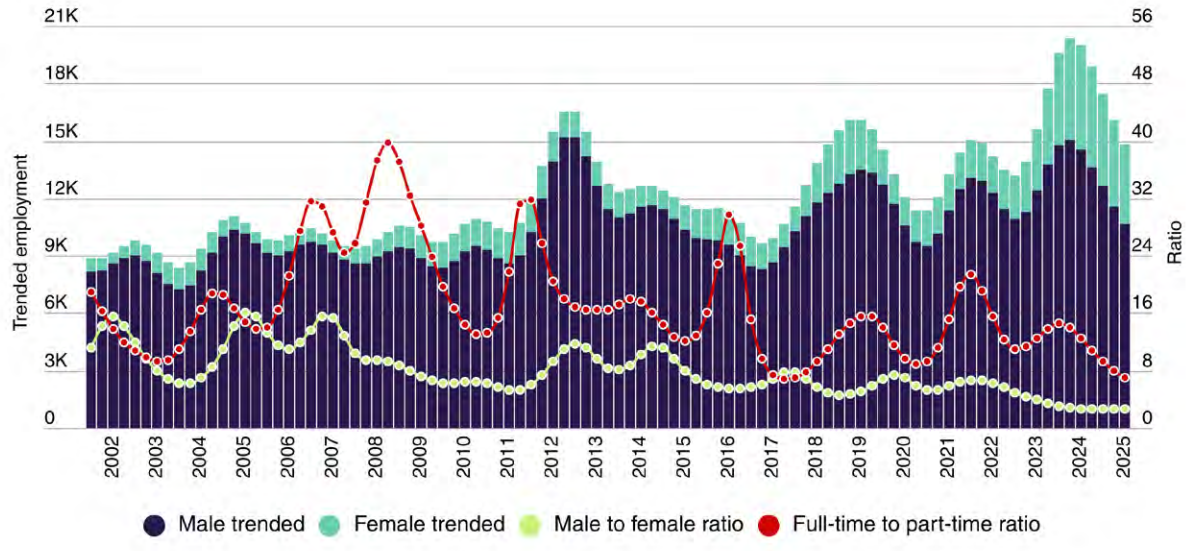
Non-Metallic Mineral Mining and Quarrying

The Non-Metallic Mineral Mining and Quarrying sector currently employs over 14,800 workers, reflecting an increase of 970 (+7%) total workers (Figure M15).[66] Full and part-time workers saw an increase of 460 (+3%) and 520 (+38%), respectively. Trends in favour of full-time employment and participation by females are indicative of a strong and diverse labour market, which is promising for the sector and its workforce.

> Participation by females in the sector has improved, with the ratio of male to female employment going from a series high of 16:1 in the early 2000s to 3:1 in 2025.

There were almost no job losses in mining at the onset of the COVID-19 pandemic in 2020, which, in addition to gains in gender diversity, may explain the resilience of workforce participation by females in the sector.[67]

Figure M15: Composition and employment trends in Non-Metallic Mineral Mining and Quarrying, 2001–2025



Source: ABS, Labour Force, Australia, Detailed, Oct 2024. *Data trended by AUSMASA.*

66 Please refer to our dashboard for Non-Metallic Mineral Mining and Quarrying for an in-depth view on workforce composition and trends, https://ausmasa.org.au/media/ms1do5jm/09-non-metallic-mineral-mining-and-quarrying.pdf

67 AusIMM, "The supply and demand of mining, metallurgical and geotechnical engineers in the Australian resources industry", 2021.

An ageing workforce

Across the census years, the median workforce age remained consistent at 45 – this is higher than the median age of Australian workers of 42 in Census 2021[68].

The oldest 25% of the workforce is above 55 – almost retirement age, with 20% of the workforce above the average age of retirement of 57 in 2023. (Table M11).

It is important to note that the mining workforce typically has some of the lowest intended retirement ages,[69] which poses higher risks to the Non-Metallic Mineral Mining and Quarrying sector, due to its older age distribution. Ageing workforces also experience higher rates of worker compensation claims, while sector issues like mine dust disease[70] may also contribute to worker attrition or early retirement. The sector also has a relatively higher 25th percentile compared to other mining sectors, with the median age of new entrants at 32 – all signs of an ageing workforce.

68 Australian Bureau of Statistics, "Employment in the 2021 Census | Australian Bureau of Statistics," www.abs.gov.au, 30 November 2022.
69 ABS, "Retirement and Retirement Intentions, Australia", 2023.
70 Resources Safety and Health Queensland, "Queensland Mines and Quarries Safety Performance and Health Report", 2020.

According to industry research, a similar trend is also apparent at the tertiary level for the industry, with fewer university entrants in mining-related qualifications and declines in enrolments and graduates since 2015.[71]

This points to a clear sector and industry issue around attracting younger employees, which will need to be overcome if the sector is to contribute to increasing Australia's critical minerals capabilities and workforce needs.[72] Given that any national objectives involving critical minerals, medical technology, renewables, and advanced manufacturing are dependent on mineral mining, research into improving diversity and creating sustainable long-term career pathways for new entrants will be particularly important to ensure a thriving workforce and sector. AUSMASA will continue to investigate these issues and explore pathways to mitigate the effects of an ageing workforce.

Table M11: Age distribution of the Non-Metallic Mineral Mining and Quarrying workforce

Percentile	2021 Census	2016 Census	Apprentices and trainees in 2024 Age at the completion
25th	34	34	25
50th (median)	45	45	32
75th	55	54	42

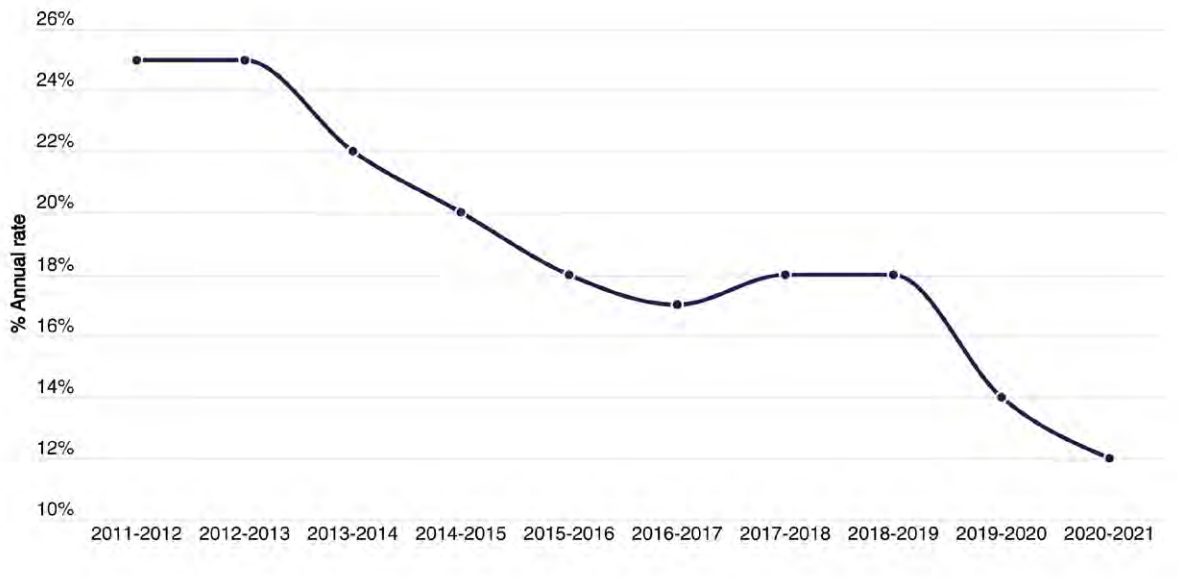
Source: 2021 Census – counting persons, 15 years and over; 2016 Census – Counting Employed Persons, Place of Work (POW); NCVER VOCSTATS, Apprentices and trainees – June 2024, Age by type of training by reporting period and training contract status.

71 AusIMM, "The supply and demand of mining, metallurgical and geotechnical engineers in the Australian resources industry", 2021.
72 Hays, "Mining Industry Report", 2025.

Falling labour turnover

Labour turnover in the non-metallic mineral and quarrying sector fell to a series low of 12% (-13%) in 2020–21 (Figure M16). Falling labour turnover is a positive sign, particularly in a tight job market, as it indicates the workforce increasingly prefers to stay in the sector. This represented the second-largest fall in turnover by sector across the mining industry, also in line with the wider industry's trend. AUSMASA will continue to research and investigate these trends to better understand how to improve turnover and retention.[73]

Figure M16: Turnover in Non-Metallic Mineral Mining and Quarrying, 2011–2021



Source: JSA, Data on Occupation Mobility, Jan 2024; Key occupations by sub-industry mapped by AUSMASA.

73 Labour turnover is computed from data and research made available by JSA through their publication on Occupation Mobility – the data only goes up to 2020-21.

Job adverts in the Non-Metallic Mineral Mining and Quarrying sector have steadily increased following the COVID-19 pandemic, rising by 3,100 (+76%) from January 2021 to March 2023. This trend later reversed, with a decrease of 1,400 (-20%) from March 2023 to October 2024.

Table M12: Top 5 non-metallic mining and quarrying occupations

Occupations	Workforce numbers in 2021 Census	5-yr changes in IVI	Included in CSOL?	Shortage*
Truck Drivers	1,300	75.69%	No	S
Drillers, Miners, and Shot Firers	1,100	16.12%	No	RS
Production Managers	800	64.97%	Yes	NS
Earthmoving Plant Operators	700	31.15%	No	S
Metal Fitters and Machinists	600	45.92%	Yes	S

Source: Jobs and Skills Australia, Internet Vacancy Index Oct 2024; Key occupations by sub-industry mapped by AUSMASA; Total workforce numbers are based on the Non-Metallic Mineral and Quarrying mining snapshot *in the Workforce Plan 2024, including* Core Occupation Skills List (CSOL) *and* Occupation Shortage List.

Notes: RS: Regional Shortage; S: Shortage; NS: Not in Shortage. Our conversations with industry indicate that the Census numbers may be smaller than reality, we welcome the identification of data sources that can paint a more accurate picture.

Enrolments in Non-Metallic Mineral Mining and Quarrying qualifications[74]

From 2016 to 2021 enrolments and completions decreased to 19,201 (-51%) and 2,826 (-73%), respectively. With the decrease in enrolments and completions, coupled together with an ageing workforce and older VET entrants, the sector is going to increasingly face workforce challenges. Enrolments and completions increased to 21,976 (+15%) and 4,309 (+52%), respectively, from 2021 to 2023.

Although positive, these trends only take enrolments back to levels from 2020, while completions sit around 2018 and 2019 levels. Notably, these trends also broadly held for Indigenous students, who had the highest participation rates in Non-Metallic Mineral Mining and Quarrying qualifications – averaging 9% of enrolments and 17% of completions each year from 2016 to 2023. Their higher completions potentially reflect less student attrition or deferrals, which would be positive.

Given the government's focus on onshore processing and beneficiation of critical minerals,[75] further investigation of the sector is required. A separate Australian and New Zealand Standard Industrial Classification (ANZSIC) relevant to critical minerals would aid in the investigation process, cutting across several data sets and providing improved resolution for in-depth analysis. AUSMASA is in the process of making a submission to the Australian Bureau of Statistics (ABS) to identify 'critical minerals' as a separate subdivision.

74 Although many Non-Metallic Mineral Mining and Quarrying qualifications support work in other sectors or industries, making direct comparisons between this qualifications data and the workforce difficult. This data still provides important insights relevant to the sector and the wider industry as they represent the largest group of RII qualifications in our remit.

75 DISR, "Critical Minerals Strategy 2023–2030", 2023.

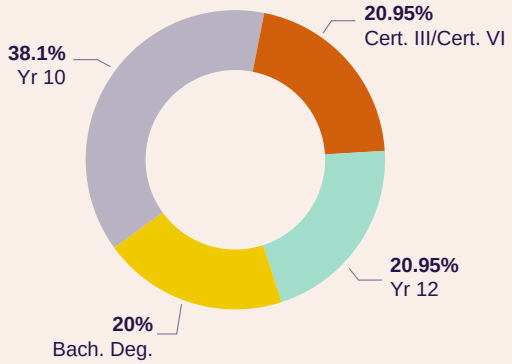
Key issues identified in Non-Metallic Mineral Mining and Quarrying

The quarrying industry faces workforce retention challenges due to potential worker loss to coal, Metal Ore Mining, and construction sectors. While it cannot match the wages of larger mining operations, it should highlight its unique aspects to attract workers. Attracting new workers, especially younger ones, and promoting the sector as a stepping stone to larger opportunities is crucial. Additionally, the industry could appeal to experienced mining workers looking to transition from larger operations, particularly those involving shift work and Fly-In, Fly-Out (FIFO) requirements.[76]

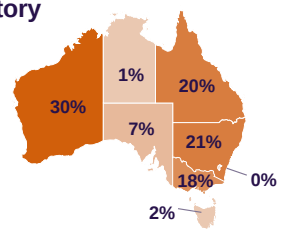
76 Jobs and Skills Australia, 'Employment Projections', 2023.

Dashboard 6: Non-Metallic Mineral Mining and Quarrying[77]

Education level of the workforce



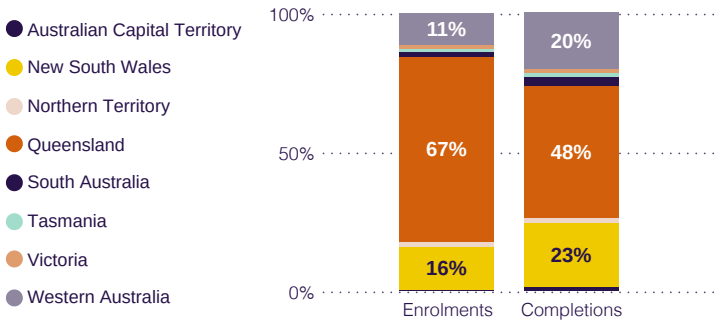
Total workforce by state/ territory



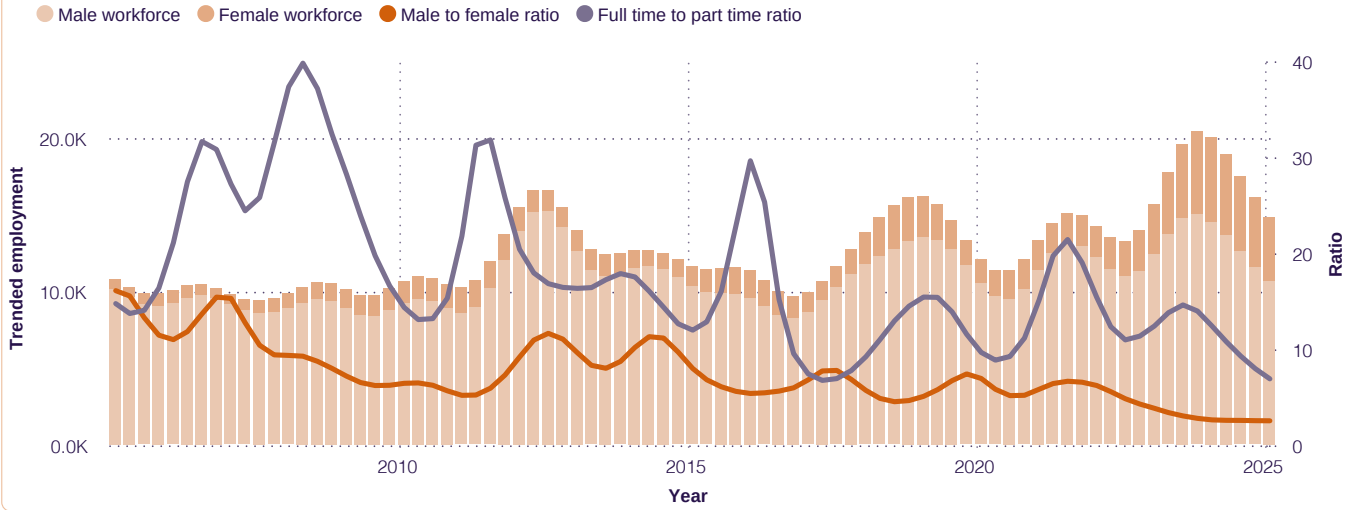
Projected growth over next decade	% female workforce
19%	21%

Median age	% workforce aged 24 or younger	% workforce aged 60 and above
45	6%	15%

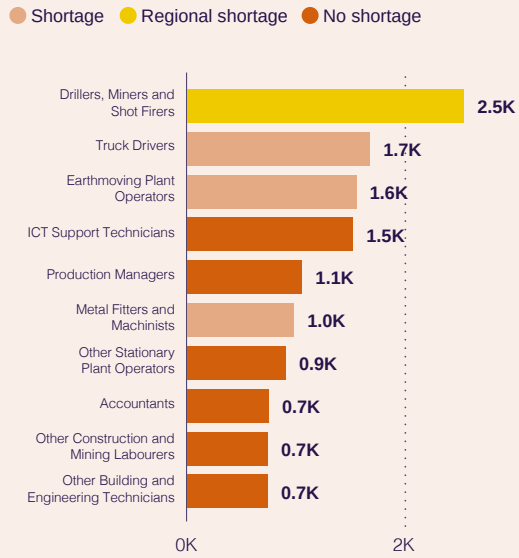
Training package status by state/territory of residence



Trends in employment by gender and work type



Top 10 ANZSCO occupations by workforce number

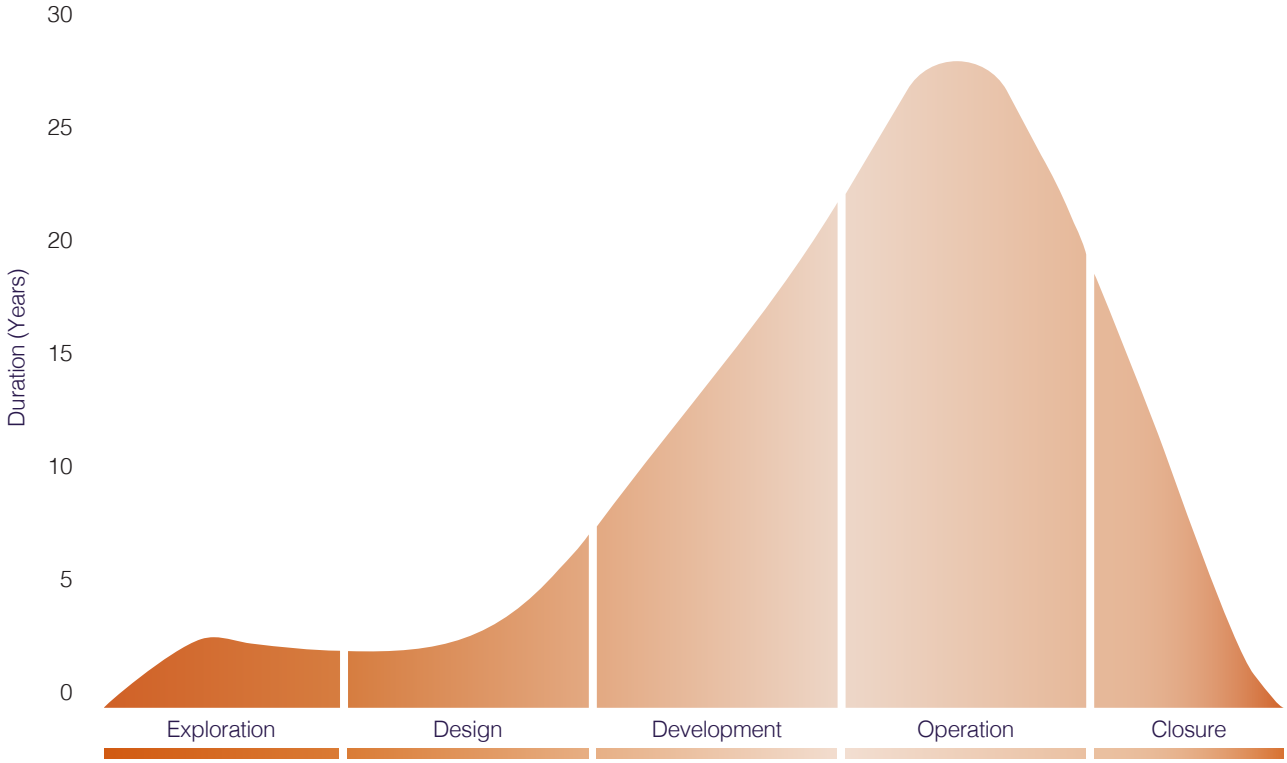


77 List of data source are in the Appendix 'Workforce Data Dashboard'.

Mine life-cycle

The life-cycle of a mine can be broadly divided into 5 stages: exploration, design, development, operations, and closure, with each stage requiring various occupations (Figure M17).
The exploration stage involves identifying and assessing potential mineral deposits, mapping the site, and extracting samples for analysis, which may culminate in an analysis that establishes the economic viability of the mine site.

Figure M17: Key occupations across the mine life-cycle



Exploration	Design	Development	Operation	Closure
Drilling Technician	Mine Designer	Project Manager	Mining Engineer	Environmental Engineer
Assay Laboratory Technician	Mine Planner	Heavy Equipment Operator	Blaster	Hydrologist
Geological Modeler	Geotechnical Engineer	Construction Engineer	Driller	Reclamation Specialist
Mining Engineer	Civil Engineer	Drilling & Blasting Expert	Heavy Equipment Operator	Demolition & Decommissioning Specialist
Environmental Scientist	Mechanical Engineer	Environmental Officer	Metallurgist	Community Liaison Officer
Financial Analyst	Electricla Engineer	Safety Officer	Process Engineer	Waste Management Specialist
Economist	Environmental Engineer	Contractor	Geotechnical Engineer	Soil Scientist
Hydrogeologist	Health & Safety Expert	Skilled Tradespersons	Health & Safety Officer	Water Quality Specialist
Project Coordinator	Permitting & Regulatory Officer	Materials Coordinator	Environmental Specialist	Land Restoration Expert
Regulatory Compliance Officer	Structural Engineer	Supply Chain Manager	Maintenance Technician	Regulatory Affairs Manager

Source: Resources and Engineering Skills Alliance (RESA)

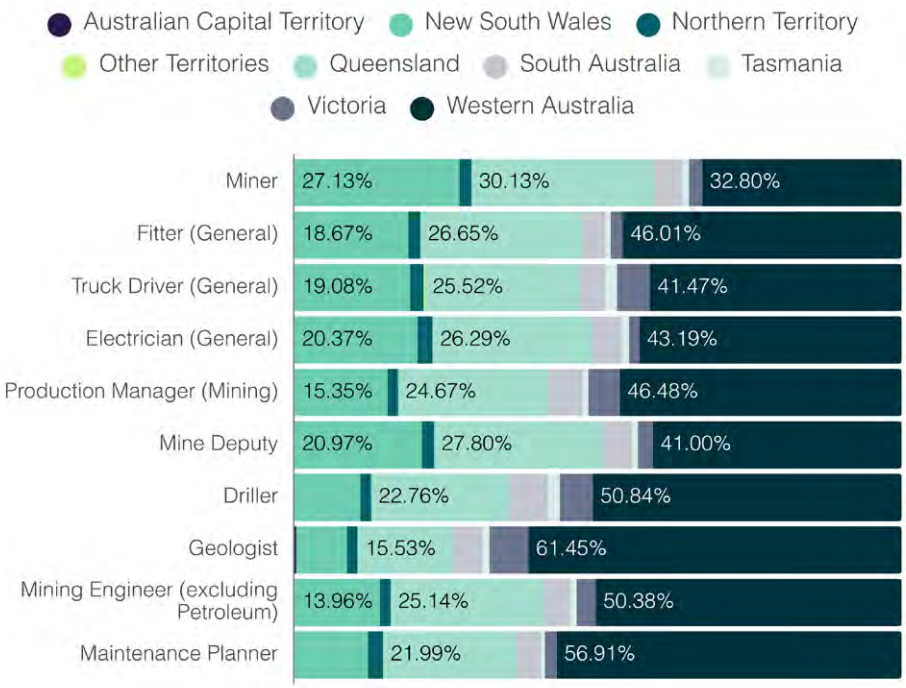
Workforce data by occupation

The number of employees in a mine tends to vary based on the company size, type, and operational phase of the mine. For example, BHP employs around 8,000 workers across 5 of its mines, averaging about 1,600 employees per site.[78] Fortescue employs over 2,200 workers for its 2 mine sites, Kings and Firetail, averaging about 1,100 workers per site.[79] Rio Tinto has 16,000 employees across its 17 mine sites, averaging approximately 940 employees per site.[80]

Large-scale mines, especially ones focused on extensive extraction and processing, may require a varying workforce size to manage different tasks such as extraction, maintenance, logistics, environmental management, and administrative duties. This workforce includes miners, fitters, truck drivers, safety officers, engineers, geologists, and support staff.

The size of the workforce changes based on production needs, automation levels, and mine life-cycle stages, with staffing levels typically higher during the operational and production stages and lower during closure or rehabilitation phases.

Figure M18: Top 10 occupations by state and territory in 2021

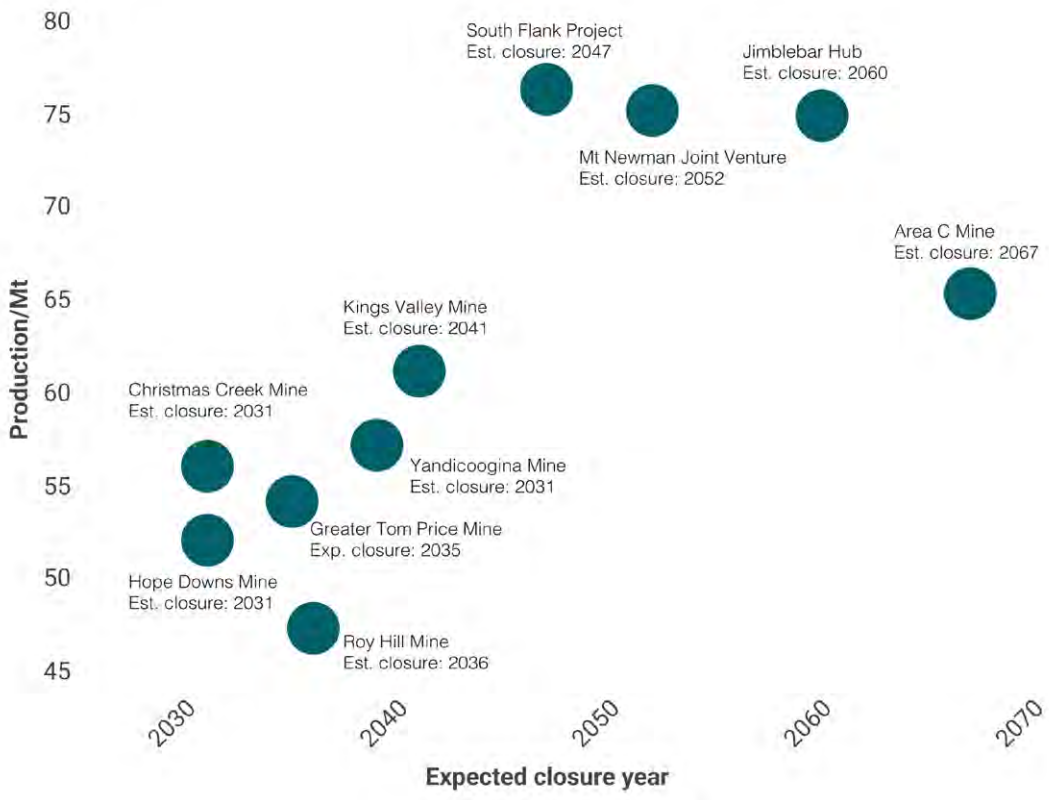


Source: Australian Bureau of Statistics, "Australian Census Population and Housing, 2021, TableBuilder", 2021

In 2021, the top occupations related to a mine's operation stage were miners, fitters, and truck drivers (Figure M18). As the mine transitioned to the closure stage, however, the key roles shifted to fitters, electricians, and maintenance planners. Please see the mine closure section for more information on mine closures.

78 BHP, "Western Australia Iron Ore", 3 October 2022.
79 Fortescue, "Operation Site-Solomon", 2025.
80 Rio Tinto, "Iron Ore Western Australia", 2023.

Figure M19: Top 10 mines and workforce coverage, 2023



Sources: GlobalData, "The ten biggest surface mines in Oceania, 2023", June 2024.

In 2023, the largest iron ore mine sites in Western Australia employed significant numbers of workers. For example, BHP's Mining Area C employed 4,103 people, accounting for 6.8% of the state's iron ore workforce. Fortescue's Solomon Operations followed with 3,840 employees, making up 6.3%. Meanwhile, Roy Hill Operations employed 3,711 people, representing 6.1% of the total iron ore employment in the region.[81]

The expected closure years for the largest mines in Australia may lead to changes in workforce demand over time (Figure M19). The South Flank Project, with operations expected to continue until 2047, shows that workforce demand will remain steady for several years, reflecting the mine's ongoing production needs. Following closely, the Mt Newman Joint Venture, projected to close in 2052, suggests a slightly longer period of workforce demand, due to its extensive infrastructure and ore reserves. The Jimblebar Hub, expected to close in 2060, indicates a prolonged workforce demand driven by continuous investment, resource development, and technological advancements.

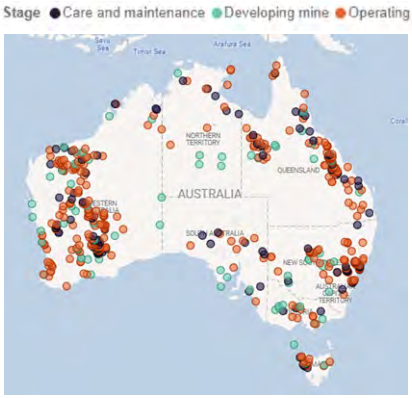
Workforce planning is crucial for anticipating labour demands, allocating resources efficiently, and ensuring the mine is staffed with the right skills throughout its life-cycle. It also helps with addressing community relations, workforce training, and maintaining safety standards. By understanding these workforce distributions, companies can better plan for long-term operational success and sustainability. As mines go through various life stages, career and skills needs require consistent re-evaluation and alignment with the training product system (Figure M20).

81 Department of Jobs, Tourism, Science and Innovation, "Western Australia Iron Ore Profile", May 2024.

Workforce planning is crucial for anticipating labour demands, allocating resources efficiently, and ensuring the mine is staffed with the right skills throughout its life-cycle. It also helps with addressing community relations, workforce training, and maintaining safety standards. By understanding these workforce distributions, companies can better plan for long-term operational success and sustainability. As mines go through various life stages, career and skills needs require consistent re-evaluation and alignment with the training product system (Figure M20).

Figure M20: Mine life-cycle stages and future changes

2021



Source: Geoscience Australia, "Australian Operating Mines Map 2021 Data, March 2022", 2022. Customised by AUSMASA.

2030

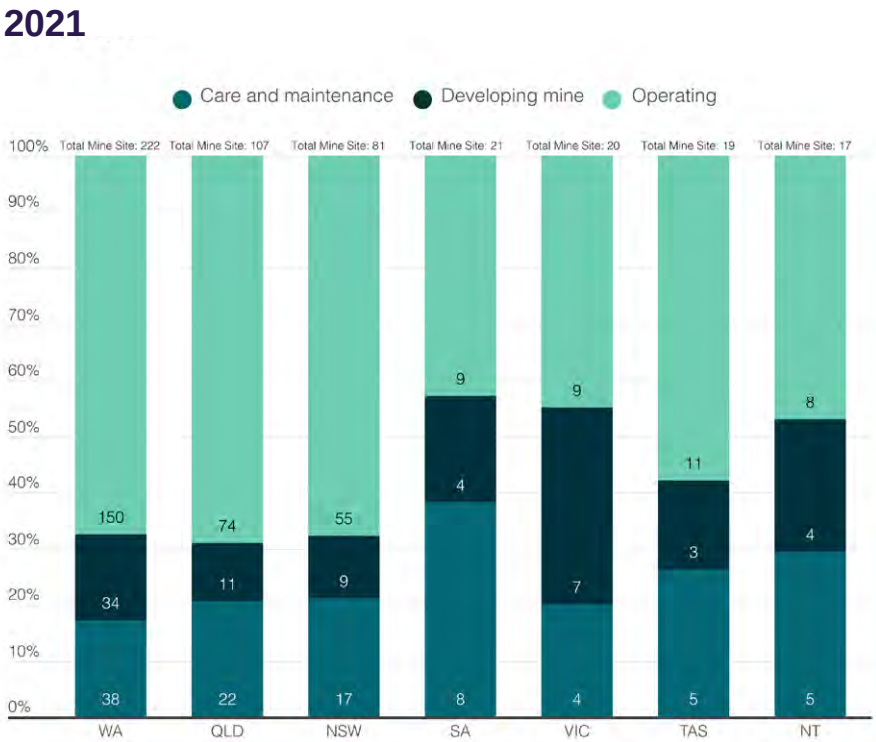
Source: Geoscience Australia, "Australian Operating Mines Map 2021 Data, March 2022", 2022. Customised by AUSMASA.

2040

Source: Geoscience Australia, "Australian Operating Mines Map 2021 Data, March 2022", 2022. Customised by AUSMASA.

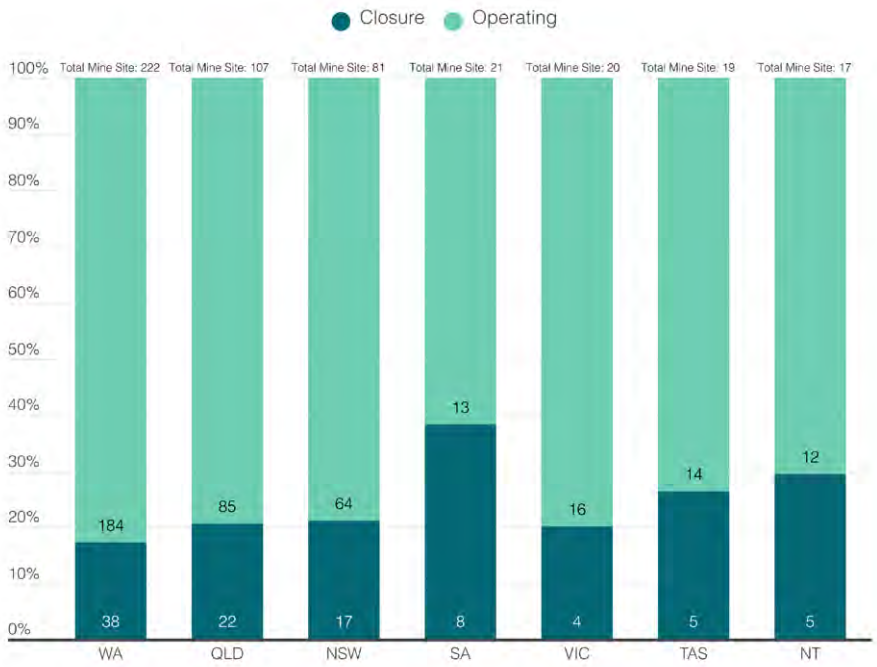
Based on mine life-cycles, we are able to project mine operating status by state by year (Figure M21).

Figure M21: Number of mines by status by state



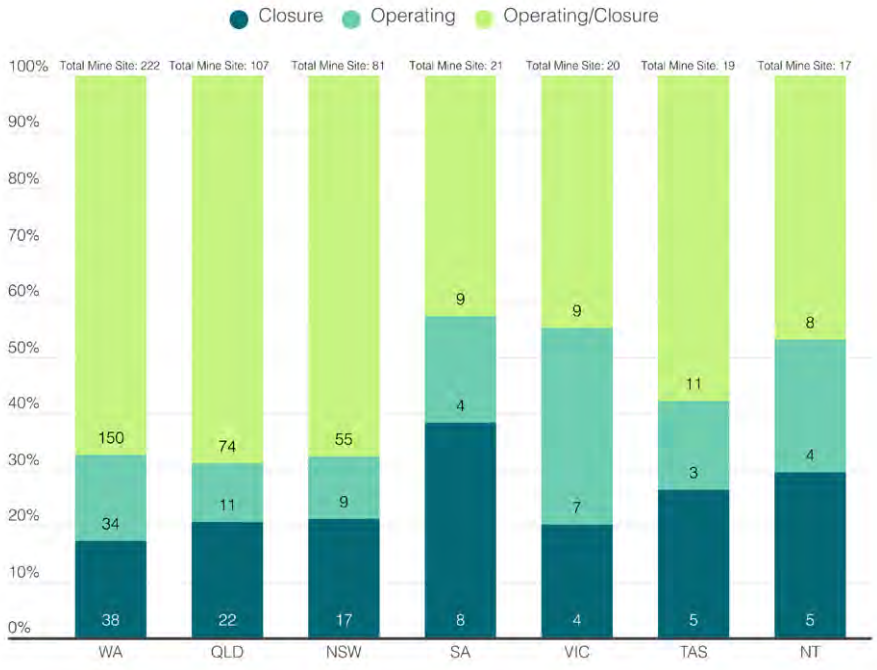
Source: Geoscience Australia, "Australian Operating Mines Map 2021 Data, March 2022", 2022. Customised by AUSMASA.

2030



Source: Geoscience Australia, "Australian Operating Mines Map 2021 Data, March 2022", 2022. Customised by AUSMASA.

2040



Source: Geoscience Australia, "Australian Operating Mines Map 2021 Data, March 2022", 2022. Customised by AUSMASA.

In 2021, there were 150 operating mines in Western Australia, 74 in Queensland, and 55 in New South Wales. By 2030, the number of active mines is expected to grow, with Western Australia adding 34 new operations, Queensland increasing by 11, and New South Wales by 9.

As mines progress through their life-cycle – from exploration to development, production, and eventually closure – many of the currently operating sites will near the end of their productive life by 2040. It is anticipated that around 150 mines in Western Australia may approach closure, leaving only 34 still operational. Similarly, the 74 operating mines in Queensland and 55 in New South Wales from 2021 may also reach the closure stage by this time.

With nearly 300 mines in Australia set to enter the closure stage from 2040, it's crucial for the industry to plan its approach, particularly regarding potential workforce shortages and needs. As mining operations wind down, the focus should shift from what's being phased out to what's being transitioned into.

Table M13: Projected occupation growth

Occupation	May 2024 ('000)	May 2029 ('000)	May 2034 ('000)
Drillers, Miners and Shot Firers	71.0	70.6	73.8
Metal Fitters and Machinists	119.5	120.1	125.9
Other Building and Engineering Technicians	38.5	40.0	42.7
Truck Drivers	185.2	187.2	193.6
Electricians	188.7	201.9	212.9
Production Managers	61.7	65.8	70.8
Mining Engineers	12.9	14.1	15.3
Geologists, Geophysicists and Hydrogeologists	11.8	12.4	13.4
Structural Steel and Welding Trades Workers	77.3	76.3	79.8
Other stationary plant operators	26.6	27.1	28.2

Note: Color-coded with orange to indicate a shortage in the occupation. Source: Jobs and Skills Australia, "Employment Projections", 2025.

Table M13 highlights the top 10 occupations (at the 4-digit ANZSCO level) in demand, based on employment growth over 5-year and 10-year periods. The top occupation – Drillers, Miners and Shot Firers – are projected to decrease by 200 workers by 2029, then increase by 2,400 workers by 2034. This occupation is currently identified as being in shortage. Metal Fitters and Machinists, projected to grow by 200 roles by 2029 and by 1,600 roles by 2034, are also facing a shortage. Other Building and Engineering Technicians are expected to increase by 800 workers in 2029 and by 2,200 workers by 2034.

Several resource sector construction projects that were completed or moved into production in 2023–24 are expected to have a positive impact on employment. For example, Mineral Resources' Onslow Iron project, which shipped its first ore in May 2024, and Liontown Resources' Kathleen Valley Lithium Operation, which began producing spodumene concentrate in July 2024, are both likely to create significant job opportunities. Similarly, Pilbara Minerals' Pilgangoora P680 Expansion Project, which officially opened in August 2024, will likely lead to an increase in employment within the mining and production sectors.

On the other hand, some major projects were suspended or placed under care and maintenance, such as BHP's West Musgrave copper and nickel project, which transitioned to care and maintenance in July 2024, and Albemarle Corporation's halted construction of Trains 3 and 4 at the Kemerton Lithium Hydroxide Plant. These pauses are likely to result in temporary job losses or shifts in workforce requirements.[82]

While 3,000 jobs were 'lost' when BHP closed its Nickel West operations, the company is committed to redeploying around 1,600 frontline nickel miners across its Pilbara iron ore and South Australian copper operations. In addition, a total of 107 mining and energy projects are expected to proceed by 2029, creating demand for around 26,810 new production roles and growing the workforce by 9.4% over 5 years. Of these, 88 mining projects are projected to require around 23,400 workers, with approximately 18,000 needed by the end of 2026.

Coal remains the largest driver of new demand, with 13 projects expected to create 4,836 jobs by 2027. Other key contributors include iron ore (4,495 workers), gold (2,830 workers), critical minerals (3,078 workers), and copper, which has surged to require 2,775 workers across 10 projects by 2026. In contrast, lithium demand has softened, with just 970 workers needed across 6 projects. Diversification is also evident, with 16 'Other Commodity' projects (for example, alumina, graphite, phosphate) expected to require nearly 2,000 workers. Meanwhile, the energy sector's mini-investment boom continues, with 19 projects forecast to create 3,410 new operating phase roles by 2029.[83]

Potential actions:

- Research to better understand occupation and skills needs based on various stages of the mine life-cycle.
- Research to investigate occupation pathways in tandem with other relevant industries to map streams in and out of mining occupations in relevance to mining industry needs.
- Stakeholder engagement to further inform research work, identify skills shortages, and programs and policies to match these needs.
- Training product gap analysis to identify changes to products and anticipate changes needed based on workforce demand driven by mine life-cycles.
- Stakeholder input into our examination and interrogation of the mine life-cycle data and analysis to better align with industry experiences.

82 Department of Energy, mines, Industry Regulation and Safety, "Economic indicators", 25 March 2025.
83 AREEA, "Workforce Forecast 2024–2029", September 2024.

Mine closures and decommissioning

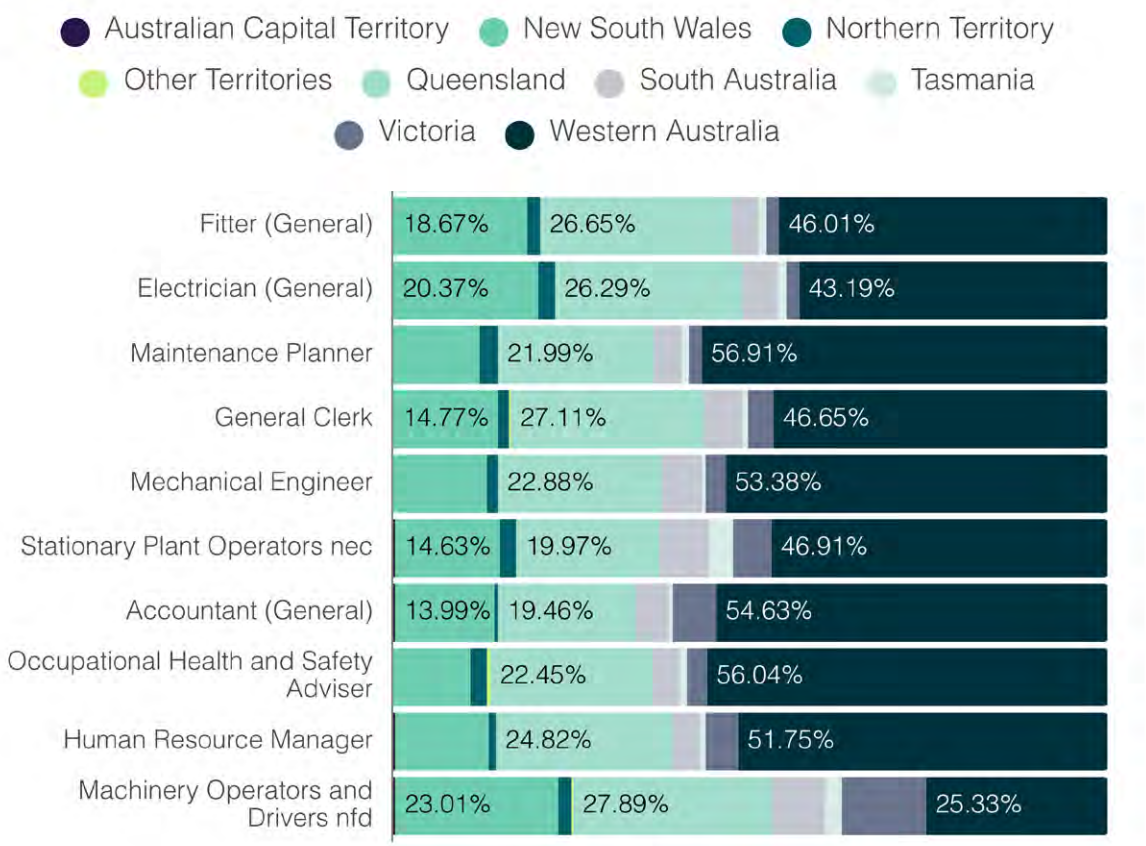
The process of mine closure is complex and resource-intensive and is carried out over an extended period of time.[84] The Commonwealth Scientific and Industrial Research Organisation (CSIRO) estimates suggest that 240 existing Australian mines will close by 2040, generating up to $4 billion in expenditure on mine rehabilitation and closure activities.[85] Mining companies implement closure planning through a dedicated multidisciplinary team, with members contributing either full time or alongside their primary responsibilities.

> While approaches differ, a growing trend among leading mining companies is the inclusion of community relations or social performance specialists within these teams, alongside environmental scientists, engineers, geologists, accountants, and human resources professionals.[86]

Environmental engineers and reclamation specialists play a crucial role in decommissioning and reclamation efforts. Enlisting safety officers and construction teams to dismantle and access mining facilities is essential for ensuring the safe removal of infrastructure, managing hazardous materials and preparing the site for environmental restoration and long-term stability. Environmental officers are responsible for monitoring compliance with regulatory requirements, assessing potential environmental risks, and implementing mitigation strategies to ensure the site is rehabilitated in accordance with best practices and legal standards.[87] Australia is poised to become a global leader in supplying solutions for mine closures, leveraging domestic challenges to fuel international industry growth.[88]

84 Sustainable Minerals Institute, "Mine Closure Overview," 2024.
85 CSIRO, "Enabling Mine Closure and Transitions: Opportunities for Australian Industry," 2023.
86 Sustainable Minerals Institute, "Mine Closure Overview," 2024.
87 Government of Western Australia, "Mine Closure Completion Guideline Available," March 31, 2025.
88 CSIRO, "Enabling Mine Closure and Transitions: Opportunities for Australian Industry," 2023.

Figure M22: Top 10 occupations during mine closures, 2021



Source: Australian Bureau of Statistics, "Australian Census Population and Housing, 2021, TableBuilder", 2021.

As identified in Figure M22, 3 out of the 10 occupations needed to support a mine closure are in shortage. This includes Fitters, Electricians, and mechanical engineers, who are in shortage nationwide and integral to both closure and post-closure processes.

As the mine enters the closure stage, the focus shifts to decommissioning and rehabilitation, with Fitters, Electricians, and Maintenance Planners becoming the key occupations (Figure M23). Fitters continue to play an essential role in dismantling equipment and maintaining machinery during the shutdown process. Electricians are responsible for safely removing and decommissioning electrical systems to ensure the site is safe during and after closure. Maintenance Planners' roles are to develop maintenance strategies, schedule tasks, and coordinate the maintenance of all plant equipment to ensure that operations run smoothly and efficiently.[89] These top occupations are adapted to the changing needs of the mine as it transitions from active production to responsible and sustainable closure.

Figure M23: Occupations involved with mine closures

Source: Resources and Engineering Skills Alliance (RESA), "Jobs: Mine Life Cycle", 2025

89 Jobs and Skills Australia, "Occupations", 2025.

Challenges associated with mine closures and decommissioning

The rehabilitation or closure of large-scale mines that have extensively transformed the natural landscape poses significant technical and economic hurdles. Key challenges include:

- stabilising landforms to mitigate erosion
- preventing the release of contaminants, such as heavy metals and chemicals from mine waste, into local waterways
- restoring native ecosystems on reclaimed land.[90]

Mine closures require many skills, including traditional trades, multiple engineering disciplines, environmental knowledge and First Nations cultural awareness. Training programs delivering such skills tailored to this phase of a mine are essential to meet workforce needs.[91]

Key challenges at each stage of the mine closure process include:[92]

- co-design and partnerships (data management solutions to support transparency, governance, co-design and delivery of mine closure outcomes)
- waste reduction
- repurposing mineral waste
- resource recovery – related to circular economy objectives
- recycling non-mineral waste
- hydrological systems
- pollutant management
- revegetation and biodiversity
- post-closure land use.

90 Sustainable Minerals Institute, "Mine Closure Overview," 2024.
91 AUSMASA "AUSMASA 2025 Consultation papers", 2025.
92 CSIRO, "Enabling Mine Closure and Transitions: Opportunities for Australian Industry," 2023.

Environmental concerns with mine closures

Mine closures have been rated among the top 5 operating risks in mining.[93] Integrated closure planning and implementation can systematically incorporate and balance the perspectives, concerns, efforts, and expertise of both internal and external stakeholders.[94]

One of the main environmental concerns associated with mine closures is acid mine drainage, which contributes to mining-related pollution. This acidic runoff dissolves heavy metals like copper, lead, and mercury, which then leach into groundwater aquifers and surface water sources, posing risks to both human health and wildlife.[95] Runoff from these mines can also impact soil by creating sediment containing heavy metals, which settle into the ground or water and contaminate rivers or other land areas. These metals are not biodegradable, so the soil stays contaminated without corrective action.[96]

Mine closures also often disproportionately impact Indigenous communities, as the Traditional Owners of the land. Therefore, it is important to incorporate their perspectives and knowledge into the planning and closure processes for successful and sustainable outcomes.[97] Local Indigenous groups working alongside mining companies help to increase the Indigenous participants' technical skills, self-confidence and ability to engage in the wider environmental and economic community. Indigenous engagement promotes meaningful work to 'look after Country', maintaining connection to Country and passing on traditional econological knowledge to younger generations.[98]

93 ICMM, "ICMM • Responsible Mine Closures Ensure a Sustainable Environment and Economy," 2019
94 Ibid.
95 Thermo Fisher Scientific, "Mining and the Environment: What Happens When a Mine Closes?," July 10, 2014.
96 Ibid.
97 Sustainable Minerals Institute, "Diavik Traditional Knowledge Panel – Mine Closure Case Study," 2025.
98 UoQ, "Indigenous groups, land rehabilitation and mine closure: exploring the Australian terrain," 2020.

Economic consequences

Mine closure can have various economic consequences, including job losses, reduced economic activity and challenges for local businesses and communities. Involving communities is essential to developing a common framework and vision for the post-mining landscape and process.

Host communities that are dependent on mining operations are especially vulnerable during the closure, and are likely to experience considerable socio-economic impacts.[99] This is often the case for mines in remote areas, where an operation may be the primary local economic driver, impacting job security across the area.[100]

Once a mine reaches the end of its life-cycle, the local economy can develop an inherent vulnerability that affects other industries. Mine companies will often redeploy their workers to another area within the business, give them priority for open positions, or offer retraining opportunities to mitigate the socio-economic impacts of the mine closure.[101]

Effective mine closure planning is essential to ensuring sustainable environmental, social, and economic outcomes. By integrating comprehensive closure strategies, mining companies can proactively address key challenges such as land rehabilitation, pollutant management, and post-closure land use by mitigating the long-term environmental impacts of mining activities.

Additionally, strategic planning helps lessen the economic disruptions caused by mine closures, which in turn supports local communities through workforce redeployment, retraining programs, and economic diversification initiatives. A balanced closure approach would involve the identification and development of training packages and career pathways that equip workers with the necessary skills to manage mine closures efficiently.[102]

Potential actions:

- Stakeholder engagement to better understand the process of mine closures and the skills and occupations that enable appropriate processes around mine closures and rehabilitation.
- Research to understand what skills and occupations are in shortage and anticipate future shortages.
- Research to map career pathways in and out of the mine closure space to better understand workforce demand and supply.
- Training product gap analysis to identify if the VET system is adequately equipped to deliver the skills needed in the mine rehabilitation space.
- Stakeholder engagement to better understand coordination needed from various stakeholder groups, government bodies, and local citizens.

99 ICMM, "The Mine Closure Challenges for Government and Industry," 2021.
100 Ibid.
101 News.com.au, "Aussie Mining Giant Cuts 1000 Jobs," June 19, 2024.
102 ICMM, "Integrated Mine Closure: Good Practice Guide," 2021.

Artificial intelligence

Digitisation and industry transformations can have various implications for relevant industries. Such industry trends and transformations are often disruptors for the industry. These disruptors can bring opportunities for productivity gains and often require industry-level appropriate responses to mitigate any negative effects. Progress and technological change in the digital space have resulted in the ubiquity of cloud-based platforms, the Internet of Things (IoT), and, more recently, generative AI. Digital transformation is crucial for current trends that emphasise broader goals such as corporate environmental, social, and governance (ESG) targets and the transition to net zero emissions. The mining industry is no exception.[103]

> According to a 2024 GlobalData mine-site technology adoption survey, 81% of employees at major global mines believe that AI will significantly impact their operations within the next 10 years (Figure M32).[104]

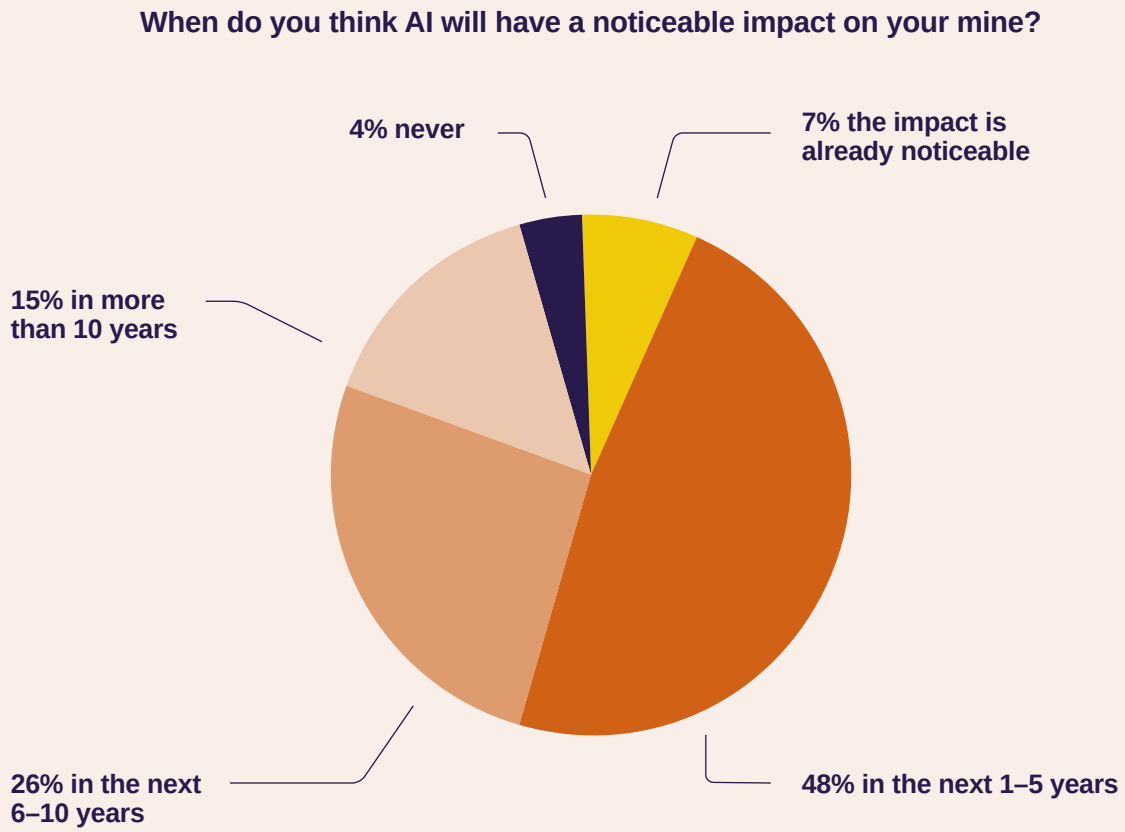
While AI technology is still evolving, it holds great potential for addressing long-standing workforce challenges in the mining industry.

103 Microsoft, "Futureproof the mining industry with AI and digital innovation", June 2024.
104 Mine, "The impact of AI on the mining sector", October 2024 (original data source from HYPERLINK "https://www.globaldata.com/store/report/mine-site-technology-adoption-survey-analysis/"Mine-Site Technology Adoption Survey, 2024 Update

According to a 2024 GlobalData mine-site technology adoption survey, 81% of employees at major global mines believe that AI will significantly impact their operations within the next 10 years (Figure M32).[105] While AI technology is still evolving, it holds great potential for addressing long-standing workforce challenges in the mining industry.

Figure M32: How major mines think AI will impact mine operations

81% of employees at major mines globally think that AI will noticeably impact their mine operations withing the next 10 years



Source: GlobalData mining-technology.com survey conducted from March to May 2024 with a sample of 46 employees working at major mines globally. Major mines were defined as those with over $500 million in revenue.

Source: The impact of AI on the mining sector - Mine | Issue 145 | October 2024*: citing* Mine-Site Technology Adoption Survey, 2024 Update

105 The impact of AI on the mining sector - Mine | Issue 145 | October 2024 (original data source from Mine-Site Technology Adoption Survey, 2024 Update)

AI in addressing safety issues in the mining industry

Mining employs about 1% of the global labour force, but accounts for 8% of fatal accidents.[106] AI can significantly enhance safety in mining by automating the more dangerous tasks. Autonomous trucks, drones, and rock cutters can perform jobs that would otherwise put human workers at risk, thereby reducing accidents.[107] Currently, AI is not widely deployed across some of these applications. As AI becomes ubiquitous, AI will become increasingly integrated into these applications.

Examples of autonomous trucks improving safety

Autonomous trucks can handle loading and haulage, eliminating risks associated with human driver fatigue and fatigue-related judgement lapses. As of July 2024, GlobalData's Mining Intelligence Centre tracked 2,080 autonomous haul trucks operating on surface mines worldwide, which have reduced accidents by 80%.[108] Furthermore, Rio Tinto's autonomous haulage system in the Pilbara region has demonstrated a 15% increase in effective usage, with zero injuries related to haul truck operations since implementation.[109]

Virtual reality in mining safety

Safety remains paramount in mining operations, and virtual reality (VR) emerges as a powerful tool for risk mitigation. By simulating emergency scenarios and complex operational challenges, VR training programs provide workers with realistic, low-risk environments to develop critical skills. Workers can repeatedly practice safety protocols, equipment operation, and emergency response procedures, significantly reducing the potential for real-world accidents.[110]

AI-powered wearable sensors

Mining companies also utilise AI to use sensors, real-time data, and analytics to understand when changes occur in physical factors of mine workers, such as temperature and vibration deviations. AI-powered wearable sensors can continuously monitor mine workers for signs of drowsiness, fatigue, and physical discomfort, enabling proactive measures to help workers at heightened risk of accidents. BHP Billiton started using AI-powered drowsiness caps in its Chilean copper mine in 2022 to monitor drivers' brainwaves for signs of fatigue.[111]

AI in enhancing efficiency

AI algorithms enhance efficiency by enabling companies to make more informed decisions, predict equipment failures, and optimise resource allocation through the analysis of extensive datasets. Mining operations generate data from various sources, such as equipment sensors, geological surveys, and production processes, which were previously underutilised. Rio Tinto utilises automated haul trucks at the Gudai-Darri mine site. They employ a digital replica of the site, which integrates data from actual plants with historical design information to enhance operational efficiency. This 3D model enables teams to comprehend the site's layout and specifications before entering and performing work.[112]

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106 Global Mining Review, "Embracing Generative AI In Mining", February 2024
107 GlobalData, "The impact of AI on the mining sector", October 2024.
108 Ibid.
109 SE Asia Consulting, "AI and Robotics: The Future of Mining in Australia", October 2024
110 Discovery Alert, "Revolutionizing Mining with Virtual Reality: Enhancing Safety and Efficiency", December 2022
111 GlobalData, "The impact of AI on the mining sector," October 2024.
112 Rio Tinto, "Look inside a mine of the future | Global," 2022.

Potential actions:

- Stakeholder engagement to understand skills and occupations that can benefit from AI and AI integration.
- Stakeholder engagement to map occupations relying on AI tools.
- Research to understand industry needs relating to AI.
- Research to identify occupations at risk from AI.
- Training product gap analysis to establish whether AI deployment, diagnosis, and maintenance capabilities are required in training packages in our remit.

Figure M33: Summary of stakeholder comments from national roundtables and potential actions

 **Digital transformation and emerging technologies**	**Keywords:** AI integration, digital skills, remote/ autonomous control, data analytics, VR simulation, drones, electrification, BEVs, rare earths processing, EV hydrogen systems.	Growing need for digital literacy and AI competency in technicians and operators. Emphasis on AI for predictive maintenance, risk management, and ore sorting.	Demand for VR and simulation-based training, especially for safety and skill development. Rise of electric and hydrogen-powered equipment (e.g. Battery Electric Vehicles (BEVs)) requiring new technical skill sets.
 **Skills gaps and workforce transition**	**Keywords:** ageing workforce, declining Science, Technology, Engineering and Mathematics enrolments, succession planning, school placements, upskilling, new qualifications, bite-sized training, shortage of trainers.	The sector is facing a shortage of qualified workers, including mine deputies, Drillers, and trainers. There is an urgent need to attract youth via school programs and pre-vocational pathways.	Succession planning and ageing workforce concerns highlight the need for upskilling and mentoring. Falling automotive workforce in regions is a key risk to talent pipelines.
 **Training system challenges**	**Keywords:** outdated qualifications, micro-credentials, skill set reviews, lack of RTOs, VET lag, certification pathways, industry-RTO collaboration.	Many qualifications (e.g. RII and Construction, Plumbing and Services Training Packages) are outdated and need review. Micro-credentials and bite-sized learning are seen as critical to agile workforce development.	RTO collaboration with Original Equipment Manufacturers (OEMs) and industry is encouraged to improve cost-efficiency and responsiveness. The VET system is not keeping pace with the evolving needs of the mining industry.
 **Safety and regulatory requirements**	**Keywords:** Work Health and Safety, confined space, hydrogen safety, supervisor training, electronic blasting units, psychosocial safety.	A strong need for updated safety training, including hydrogen systems, electronic blasting, and confined space. Supervisor safety skills and psychosocial competencies are becoming a top priority.	Demand for shorter, more flexible safety certifications suited to machine operators and miners.
 **Operational evolution and role changes**	**Keywords:** autonomous operations, mobile mining equipment, light/heavy vehicle technicians, earthmoving, electrification, internal training solutions.	Roles are becoming more complex and tech-heavy, even for historically hands-on jobs. Technicians are being upskilled to operate autonomous and electric machinery.	Companies are often forced to develop internal training solutions due to gaps in formal training offerings.

Figure M33: Summary of stakeholder comments from national roundtables and potential actions

Digital transformation and emerging technologies

Potential actions:

Research to better understand digital, literacy, and AI needs in the mining industry.
Research to investigate skills needs around AI for predictive maintenance, risk management, and ore sorting.
Stakeholder engagement to understand current uses of AI for predictive maintenance, risk management, and ore sorting.
Research to understand utilisation of VR and simulation-based training, especially for safety and skill development.
Gap analysis of training products to understand opportunities for deployment of training solutions around electric and hydrogen-powered equipment (e.g. BEVs) skill sets.

Cross-skilling and convergence of trades

Potential actions:

Research to investigate and better understand ongoing shortage of qualified workers, including mine deputies, Drillers, and trainers.
Stakeholder engagement to identify current approaches in industry to boost youth engagement.
Workforce planning to report and monitor above approaches.
Workforce planning to investigate and report on the success of various industry succession planning and upskilling initiatives.
Stakeholder engagement to identify underlying supply and demand forces around the mining complementary regional automotive workforce and talent pipelines.

Training system challenges

Potential actions:

Gap analysis of training products servicing industry needs around blasting units of competence.
Stakeholder engagement to identify and monitor the success of micro-credentials and bite-sized learning as a pipeline to building an agile workforce.
Workforce planning to report and monitor above approaches.
Workforce planning to investigate and report on the success of various industry succession planning and upskilling initiatives.
Stakeholder engagement to identify underlying supply and demand forces around the mining complementary regional automotive workforce and talent pipelines.

Safety and regulatory requirements

Potential actions:

Gap analysis of training products around safety training, including hydrogen systems, electronic blasting, and confined space.
Research to investigate and inform supervisor safety skills and psychosocial competencies.
Research to investigate and better understand demand for shorter, more flexible safety certifications suited to machine operators and Miners.

Operational evolution and role changes

Potential actions:

Research to better understand industry needs around higher degree technological skills and instreams to such occupations.
Workforce planning to monitor and map out the changing nature of occupations and whether pathways are evolving in tandem.
Stakeholder engagement to better understand the changing nature of technical jobs and how training solutions can better cater to such changes.
Stakeholder engagement to identify gaps in training products, where companies are often forced to develop internal training solutions due to gaps in formal training offerings.

Mining and Automotive Skills Alliance

Jobs and Skills Councils
An Australian Government Initiative

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