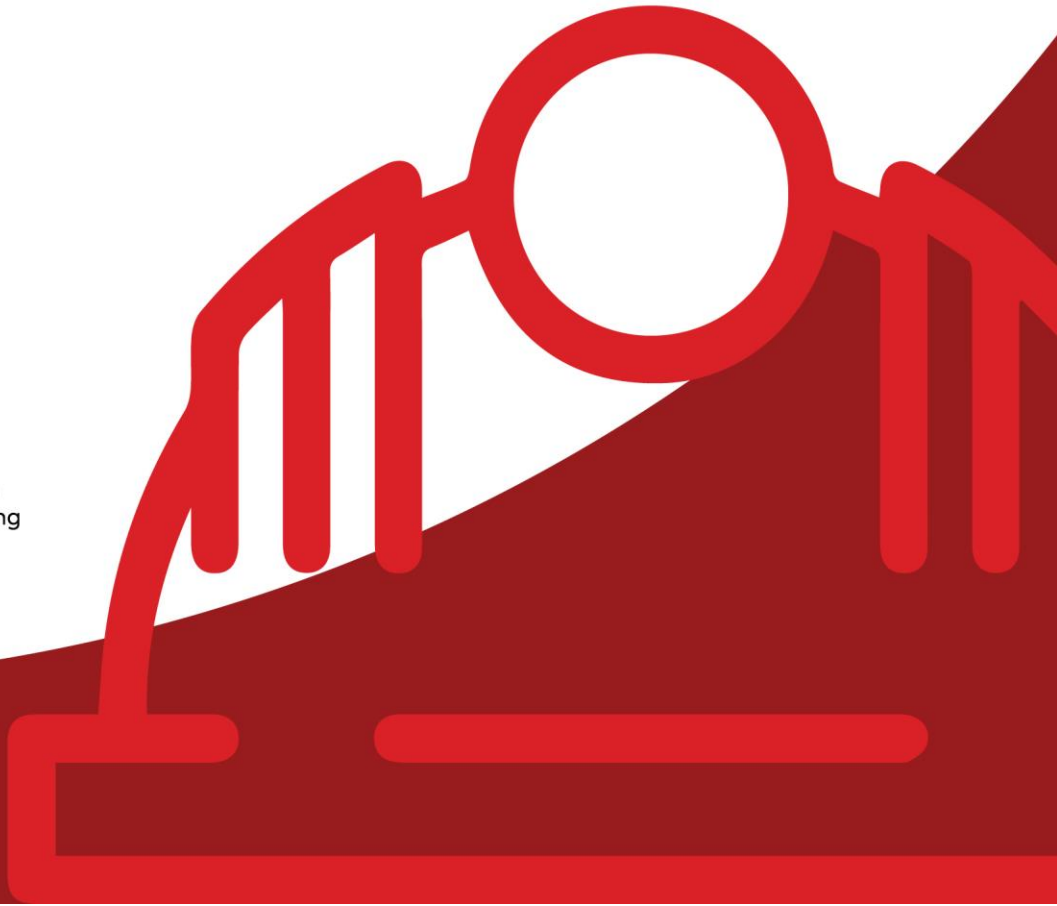
Victorian Skills Authority

Victorian Skills Plan

Mining Industry Insight

October 2022



VICTORIA State Government | Education and Training

Contents

Introduction

This report on the Mining industry forms part of the 2022 Victorian Skills Plan and outlines demand for occupations, education and training directed to meeting the demand and current workforce issues facing the industry.

This report has been prepared by the Victorian Skills Authority (VSA). The VSA was formed in July 2021 in response to the review *Future Skills for Victoria: Driving collaboration and innovation in post-secondary education and training* (known as the Macklin Review). The VSA is charged with preparing an annual Victorian Skills Plan (the Skills Plan) to guide decision-making on skills and training, by the Government, education and training providers, industry, and communities.

The Victorian Skills Plan

The annual Skills Plan sets out Victoria's skills needs for 2022 to 2025 by drawing on data, evidence and insights from a range of system-wide and local sources.

The Government in conjunction with industry, communities and education and training partners brings collaborative action through the Skills Plan which:

- **defines skill needs** with clear statements of required skills and capabilities (current and emerging)
- **sets priorities** for post-school education and training in Victoria
- **communicates to the community** the opportunities education and training can provide to offer careers for individuals that also meet the workforce needs of industry
- **aligns action** across industry and government to support improved outcomes for all Victorians.

The Skills Plan consists of:

- a summary report – the Victorian Skills Plan
- the industry needs of the Victorian economy segmented into 13 insight reports, each comprising like industries – of which this report is one
- profiles of industry and occupations in the regional areas of Victoria which outline priorities for skills development – either as snapshots or Regional Skills Demand Profiles
- current employment and forecast demand to 2025 across Victoria – a user-driven dashboard.

About Industry Insight Reports

Each industry insight is based on robust research, qualitative and quantitative data collection and analysis and extensive consultation with the Government's Industry Advisory Groups, partners and stakeholders over a period of six months. Each report sets out to:

- profile the **industry outlook**, taking into account sector trends and key drivers of demand
- detail the **workforce and skilling implications** of the industry based on forecasting
- set **industry priorities** in responding to current and future workforce challenges
- provide initial guidance for an **education and training response** to these challenges.

The industries reflected in each report are defined according to their classification within *1292.0 - Australian and New Zealand Standard Industrial Classification (ANZSIC) 2006*, prepared by the Australian Bureau of Statistics. Occupations within industries have been defined using the *Australian and New Zealand Standard Classification of Occupations (ANZSCO)*.

Each industry insight contributes to the conclusions and recommendations of the Skills Plan, focusing on actions for implementation over a three-year period.

The VSA acknowledges and extends sincere thanks to the individuals and organisations that participated in the consultations and contributed to these materials.

Using this report

This is a point-in-time report on the Mining industry in Victoria and the associated skills and workforce issues.

This report, along with the Skills Plan, has been prepared for industry and training provider partners as a summary of demand for occupations and workforce issues. In addition to being used by the Victorian Government to consider responses as a public document it is available to industry and education and training partners to form actions and responses.

The report does not represent the full picture of workforce issues in the industry. Opportunities associated with skills and workforce are longstanding. The information in the report, however, provides the basis for ongoing work on skills demand and responses, including by the VSA and through the Industry Advisory Groups.

Feedback

Feedback on this report, and others, is welcome and can be provided to SkillsPlan@education.vic.gov.au. Feedback will contribute to developing insights and actions.

Report coverage

This industry insight focuses on the mining industry as defined under ANZSIC and the occupations relevant to the industry, classified according to ANZSCO. It includes activities such as coal mining, oil and gas extraction, metal ore mining, metallic mineral mining and quarrying, and exploration and other mining support services.

Statistics about an industry and its sub-sectors are collated by the Australian Bureau of Statistics (ABS) from the activity of businesses. Each business is classified to an industry based on their primary activities. Where an individual works for multiple businesses, their main job is used.

Industry classifications rarely encompass the full nature of the work (and therefore skills) associated with a given industry. ABS definitions of industries or sectors may not align with the definitions used by an industry association, while the allocation of businesses on primary activity can result in businesses that perform similar services but with a different emphasis being classified across different industries.

Coverage in this report is limited to employment in the industry and sectors as defined by ABS, noting some occupations are almost exclusively associated with an industry, such as mining engineers in mining, while others, such as accountants and electricians, are associated with many industries. Note, however, that occupational demand for Victoria as reflected in the dashboard is the total of occupational demand for all industries.

Table 1 sets out activities that may occur within the Mining industry but are reported formally under other industries. The relevant Industry Insight report is listed.

Table 1 | Scope of related industry activities and insights related industries

Activities	Industry insight
• Gemstone cutting • Liquefying natural gas • Manufacturing products of mineral origin such as coke or cement • Manufacturing within the same unit, of non-metallic mineral products (such as brick, glass, cement, slate paving, cut and polished ornamental stone) • Operating blast furnaces to produce pig iron from iron ore • Peat briquetting, where the peat is purchased and not mined • Production of alumina • Production of direct reduced iron/hot briquetted iron • Refining or smelting of minerals or ores (other than preliminary smelting of gold) • Refining heavy and light component crude oil, manufacturing and/or blending materials into petroleum fuel, and manufacturing fuel from liquefied petroleum gases • Roasting of sulphide concentrate or in smelting or refining of silver lead or zinc • Refining salt	Manufacturing
• Construction of mining related infrastructure by contractor's whose primary business is construction • Incidental quarrying of earth soil or filling carried out by a contractor at a construction site • Undertaking mine site preparation and removal of overburden done on a contract or fee basis	Construction
• Providing geological or geophysical surveying services on a contract or fee basis	Professional, Scientific and

Activities	Industry insight
• Providing ore testing, assaying or similar laboratory type services on a contract or fee basis	Technical Services

Executive summary

Industry Outlook

The mining industry continues to be important to Victoria's economy. Victoria has the largest known mineral sand resources in Australia, significant gold mining operations, continuing coal, gas and quarrying operations and various exploration projects underway. The industry offers high paying jobs and has flow-on effects to many other industries including manufacturing and construction. The industry employs approximately 15,700 workers in Victoria across coal mining, oil and gas extraction, non-metallic mineral mining and quarrying, exploration, and metal ore mining.[1]

The mining industry in Victoria has remained resilient through the COVID-19 pandemic as the industry was considered an essential service, which allowed operations to continue.

The industry is undergoing a period of change. Key drivers of demand in Victoria include investment in minerals exploration (e.g. gold) and extractive industries (e.g. onshore gas). The retirement of existing energy assets (e.g. coal), fluctuating market conditions and the need to respond to climate change is reducing demand in other mining sub-sectors.

Workforce and skilling implications

On average, across all industries total employment is expected to grow by an additional 211,900 workers to 2025, from 3,538,900 workers in 2022, an annual growth rate of 1.97 per cent[a].[2,3] In comparison between 2017 and 2020 employment grew by 2.68 per cent annually[b].[4]

In the mining industry, employment is expected to grow by an additional 100 workers to 2025, from 15,700 workers in 2022, an annual growth rate of 0.39 per cent[c] which is below the overall Victorian average across all industries.[5,6] In comparison between 2017 and 2020 employment across this industry experienced a decline of 16.58 per cent annually [d].[7]

By 2025, an estimated 500 new workers are needed across all occupations in the industry.[8] This includes 100 employment growth and replacement of 400 retirees.[9,10]

Table 2 identifies the top ten occupations in demand across the industry to 2025. Of these, four occupations (highlighted in table) are expected to experience employment growth at a rate above the overall Victorian average between 2022 and 2025.

Table 2 | Top ten occupations in demand in the mining industry to 2025[e,11,12]

Occupation	Current employment	Employment growth (2022–25)		Retirements (2022–25)	New workers needed (2022–25)
		Number	Per cent		
Drillers, Miners and Shot Firers	800	80	1.3%	90	170
Other Building and Engineering Technicians	720	50	3.2%	20	60
Mining Engineers	690	20	1.8%	20	40
Production Managers	860	20	1.7%	30	40

[a] 3-year compound annual growth rate
[b] Computed for 2017 to 2020 employment growth for pre-COVID comparison
[c] 3-year compound annual growth rate
[d] Computed for 2017 to 2020 employment growth for pre-COVID comparison
[e] Due to rounding, some totals may not correspond with the sum of the separate figures

Metal Fitters and Machinists	1,010	-20	-0.6%	40	20
Human Resource Managers	200	10	1.5%	10	10
Management and Organisation Analysts	170	10	4.6%	Less than 10	10
Database and Systems Administrators, and ICT Security Specialists	20	10	5.5%	Less than 10	10
Electricians	220	Less than 10	-0.04%	10	10
Other Specialist Managers	60	Less than 10	2.0%	Less than 10	10

Legend

Above Victorian employment growth average between 2022 and 2025

Skills in digital technologies and robotics are becoming more important and creating new roles across the industry, including drone pilots and metallurgical or materials technicians. Other roles are increasing in volume, including engineering technicians, resource geologists and metallurgists.

Meeting this demand will be challenging. A total of 13 occupations of specific relevance to the mining industry were identified as in shortage. Industry reports low awareness of the career opportunities available in mining, particularly among school leavers. This is in parallel to few entrants to the industry from diverse cohorts (e.g. females) contributing to this challenge.

Industry also identified changing skills needs. Workers will need to keep up to date with new safety and environmental risks for businesses (e.g. fatigue management) and operation of new technologies such as autonomous drill rigs, satellite drive technologies and other automated vehicles.

Workforce priorities

Three priorities are identified to address workforce and skilling needs for the mining industry:

1. Build an available and appropriately skilled workforce to support the industry
2. Manage the workforce transition in line with the retirement of existing energy assets, market conditions and the need to respond to climate change – forward planning is needed, involving effective partnerships between government, industry, and education and training providers
3. Support training in specialist skills required by industry and explore ways to attract underrepresented cohorts

Mining pipeline and workforce response

Pathways to employment in the mining industry are split across Higher Education and Vocational Education and Training (VET) with 28 per cent of workers holding a degree or above as their highest level of education and 44 per cent holding a VET level qualification as their highest level of education.[13] As an indication of the education pipeline to draw from, there were approximately 6,850 enrolments in relevant VET qualifications in 2020 and 8,770 equivalent full-time study load (EFTSL) in higher education in 2019.[14, 15]

Key entry points to the industry include the Certificate III in Civil Construction Plant Operations, the Certificate III in Civil Construction, and the Certificate III in Surface Extraction Operations.[16] While activity is high in some courses, many courses feature low enrolment numbers and there is opportunity to better respond to identified priorities.

Broadening awareness of the career pathways and roles beyond traditional mining careers is a priority to build the pipeline of workers. There is also an opportunity to expand the availability of in-demand courses to meet industry needs and support training provision in thin but critical markets (e.g. drilling operations). More micro-credentials could be made available to people looking to upskill or transfer from other industries into new areas, such as satellite drive technologies.

Government has a key role in managing the transition to clean energy over the coming decades, specifically the reduction in brown coal-fired power generation supplies. These workers can be transitioned to other areas of mining in Victoria that are experiencing growth such as mineral sands exploration. In addition, consideration of the implications of continuing investment in civil construction projects and the demand for a similar pool of workers is critical to meeting demand. Without consideration of the value proposition for working in mining in Victoria, the industry will continue to face competition with other states/territories in attracting a skilled workforce.

Table 3 highlights actions that can be adopted by education, industry, and government to meet workforce demand.

Table 3 | Actions for consideration for education, industry, and government

- Broaden awareness of the diversity of careers available in mining and provide clear pathways to build the pipeline of workers.
- Review training provision in thin (low enrolment) but critical markets to the Victorian economy.
- Make use of skill sets and micro-credentials to meet the growing demand for specialist and/or higher order skills as the mining industry transitions.
- Assess cross industry impacts from investment that will result in additional employment demand for construction related workers.

Industry outlook

The mining industry is a high productivity sector and plays an important role in regional development within Victoria

Mining of resources has long been important to Victoria's economy, a trend that continues to the present day. The industry extracts naturally occurring mineral solids, such as coal and ores; liquid minerals, such as crude petroleum; and gases, such as natural gas.[17] Activities include underground or open cut mining; dredging; quarrying; well operations or evaporation pans; recovery from ore dumps or tailings as well as beneficiation activities and other preparation work customarily performed at the mine site, or as a part of mining activity.[18] Victoria's mining industry produces a variety of commodities, including brown coal (lignite), gold, antimony, mineral sands and base metals, contributing more than $13 billion to the state's economy.[19]

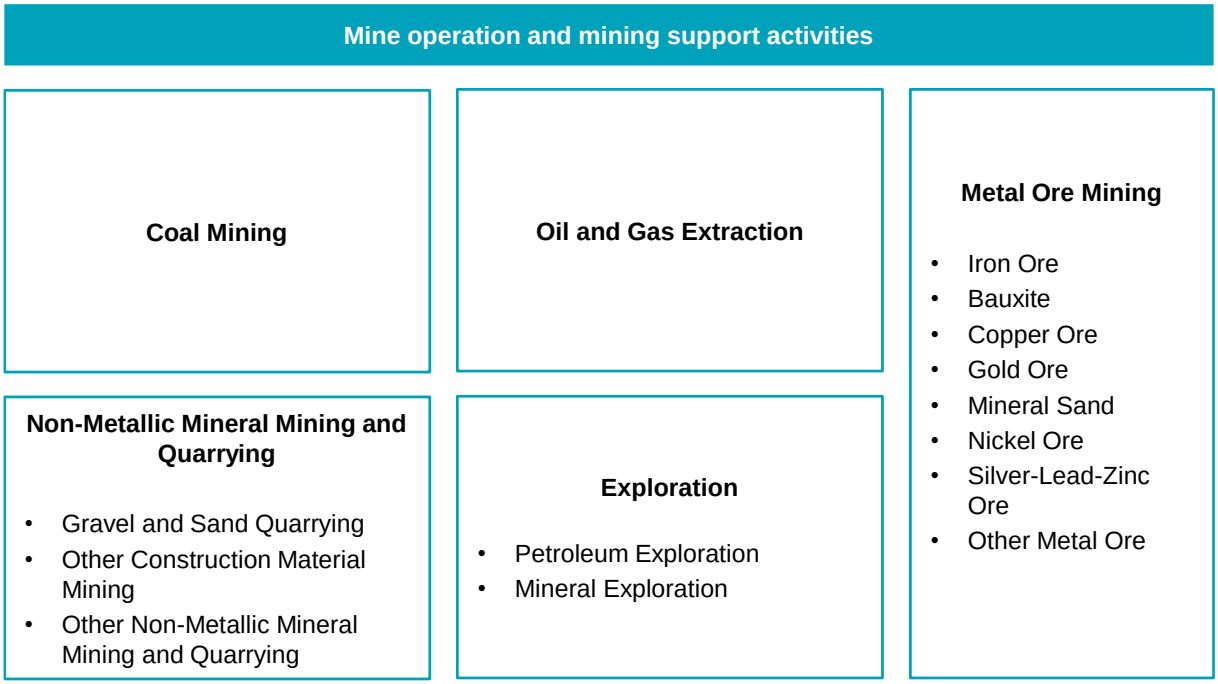
The mining industry plays an important role in regional development within Victoria. It creates high paying jobs for regional Australians and supports a supply chain of small and medium sized businesses. Victoria has significant mineral sand resources in Australia and there are several mineral sands projects at various stages of development.[20] Significant gold mining operations exist in Fosterville, Ballarat, Stawell and Costerfield.[21] The state also produces antimony.[22] Exploration projects across Victoria in gold, lithium and base metals, including copper, are promising and have the potential to develop into new future mine projects.[23] As one of the biggest contributors to export trade, mining activities have a significant impact upon the manufacturing, construction, financial, process engineering, property, and transport sectors.[24]

The mining industry employs 0.4 per cent (15,700 workers) of the total Victorian workforce.[25] Across the industry,16.2 per cent of workers are female (2,574), significantly lower than the Victorian average of 47.2 per cent. Approximately 31.8 per cent of workers in the sector are aged over 50 (2,910), above the Victorian average across all sectors of 29 per cent.[26,27] The national average annual earnings ($140,176) for those employed in mining significantly exceeds that of all other industries due to their high productivity output for the economy.[28] Drillers, miners and shot firers are forecast to be the largest occupations within mining by a significant margin (~20 per cent of employees).[29]

Unemployment rates within industry have fluctuated significantly, in part reflecting changing demand and commodity prices, and competition from other sectors and interstate.[30] Under-employment has also been consistently low in mining (compared to the Victorian average).[31] This has become more pronounced during the COVID-19 recovery and the tight labour market for mining skills with over 2.5 vacancies per unemployed person in mining, as of February 2022.[32] The mining industry in Victoria has remained resilient and shown relatively strong growth through the COVID-19 pandemic as it was deemed an essential service.[33,34]

The industry comprises various sectors and distinguishes between two basic activities: mine operation and mining support activities. In general, there are five sectors: coal mining; oil and gas extraction; metal ore mining; non-metallic mineral mining and quarrying; and exploration and other mining support services.[35] Further segmentation of these sectors relates to the type of processes undertaken. These five sectors are supported by a variety of mining support activities (e.g., draining and pumping), as shown in Figure 1.

Figure 1 | Key sectors within the mining industry



Coal Mining

Coal mining refers to open-cut or underground mining of black or brown coal, including lignite mining and peat cutting (except horticultural).[36] Victoria has brown coal deposits only and is one of the largest brown coal resources in the world, supplying most of Victoria's energy. [37] The sector employs the smallest proportion of workers in Victoria (4 per cent).[38] Most of Victoria's brown coal resource is located in the Gippsland Basin, off the South-East coast of Victoria.[39]

Exploration and other mining support services

Exploration includes natural gas and petroleum exploration while mining support services include integral activities such as cementing oil and gas well casting, directional drilling and redrilling, mining draining and pumping services, and oil and gas field support services.[40] In Victoria, exploration and other mining support services employs the largest proportion of workers in the industry (35 per cent).[41]

Metal Ore Mining

Metal ore mining encompasses iron ore, bauxite, copper ore, gold ore, mineral sands, nickel ore, silver-lead-zinc ore and other metal ore.[42] Non-metallic mineral mining and quarrying includes materials such as barite, diamond, gemstone and graphics.[43] Gold and mineral sands (zircon, rutile and ilmenite) are prevalent in Victoria.[44] There is also significant potential for copper, zinc, silver, antimony and nickel deposits.[45] Minerals such as lithium, nickel, lead and tungsten are less common in Victoria.[46] In Victoria, metal ore mining employs 20 per cent of the mining industry.[47]

Non-Metallic Minerals Mining and Quarrying

Mining and quarrying of gravel, sand and other materials for construction are also included such as clary, marble, granite, limestone and pebbles. In Victoria, non-metallic minerals mining and quarrying employs 30 per cent of the mining industry.[48]

Oil and Gas Extraction

Oil and gas extraction workers are engaged in producing crude oil, natural gas or condensate through the extraction of oil and gas deposits.[49] In Victoria, oil and gas extraction employs 11 per cent of the mining industry.[50]

Exploration spending in gold, lithium and base metals across Victoria is driving demand

Sectors including minerals exploration and extractive industries are predicted to grow significantly, while other sectors such as coal mining are predicted to decline. The industry outlook is driven by a range of factors, set out in Table 4.[51] These factors listed have implications for the mining industry and related mining support activities.

Table 4 | Drivers of demand in the mining industry

Driver		Coal	Exploration	Metal Ore	Non-metallic minerals / quarrying	Oil and gas extraction
Policy	Government investment in priority area is enabling new industries and employment opportunities in regional areas (e.g., quarry projects, gas exploration).	 Low	 High	 Medium	 High	 High
Economic	COVID-19 and subsequent supply shortages have accelerated the push for domestic supply chains and produce materials that are globally recognised (e.g., metal ore used in electronics).	 Low	 Medium	 High	 High	 Low
	Shifting demand and commodity prices, alongside competition from other industries and states can create fluctuating employment rates and may deter people entering the industry.	 High	 Medium	 High	 High	 Medium
Social	Environment, social and governance (ESG) standards are creating significant opportunities for long-term value creation, building community trust and sustainable growth.	 High	 High	 High	 High	 High
	Employee retention may become an issue in mining due to the pandemic shifting people's priorities towards better work-life balance (e.g., the capacity to work from home).	 Medium	 Medium	 Medium	 Medium	 Medium
Technological	The uptake of automation and digital technologies across the industry are demanding advanced digital and cognitive skills, creating new roles and ways of working.	High	High	High	High	High
Environmental	Heightened focus on safety and risk management is demanding increased awareness of and responsibility for business risks.	 High	 High	 High	 High	 High

Driver		Coal	Exploration	Metal Ore	Non-metallic minerals / quarrying	Oil and gas extraction
	Disruptions and benefits of Australia's clean energy transition will be felt differently by different communities. For example, Victoria's coal-fired generators will begin closing from 2029 and will require a re-skilling of traditional coal mining workers.	 High	 Medium	 Medium	 Medium	 Medium

Drivers are impacting each sector differently across the industry over the next three to five years. Further detail is provided in Appendix A.

Coal

There will be a fundamental change in the way brown coal is used in the future in Victoria.[52] This is in response to retirement of existing energy assets, market conditions and climate change.[53] Victoria's coal-fired generators will begin closing from 2029, shifting towards a 50 per cent renewable energy generation target by 2030.[54] However, there is also a shift towards using Victoria's valuable coal resources to make alternative high value, low emission products for domestic and international markets.[55] This will provide new economic development and trade opportunities, bringing high-skilled jobs and investment to the Latrobe Valley and Gippsland.[56]

Exploration

Exploration in Victoria is at record highs with over $200 million spent on exploration in 2021 compared to $16 million in 2016.[57] A $100 million investment in the North Central Victorian Goldfields Ground Release will drive demand for minerals exploration in the region over the coming years.[58] Stakeholders commented on the opportunities for commercial mineral sands projects in the longer-term, with significant deposits in the Wimmera region.[59]

Metal Ore

Due to modern exploration techniques, many goldfields in Victoria offer opportunities to reopen mines or find new deposits leading to investment in regional areas (e.g., Stawell Gold Mine and Agnico Eagle's Fosterville Mine and the North Central Victorian Goldfields Ground Release).[60] At a global scale due to the impact of COVID-19, growing vehicle sales have seen the demand for aluminum increase by 25 per cent.[61] In addition, metal producers have benefitted from growing investor demand for safe-haven assets (e.g., gold).[62]

Non-metallic minerals and quarrying

The quarry sector is expected to grow rapidly, with annual production forecast to increase by 25 per cent from 2020-21 to 2029-30.[63] This growth is expected to be driven by the increased demand for quarry-based construction materials resulting from record investments in the Civil Infrastructure and Residential Construction sectors.[64]

Oil and gas extraction

In Victoria, the CarbonNet Project to establish a commercial scale Carbon Capture and Storage (CCS) network in the Gippsland region will enable new industries and employment opportunities in the area and significant reduction in CO^2 emissions in Victoria.[65] In addition, updated regulations will allow for the continuation of onshore gas exploration and development in Victoria and is predicted to boost jobs in South-West Victoria and the Gippsland region.[66]

Workforce and skilling implications

An estimated 500 new workers are needed to meet projected demand over the next 3 years

On average, across all industries total employment is expected to grow by an additional 211,900 workers to 2025, from 3,538,900 workers in 2022, an annual growth rate of 1.97 per cent[f].[67,68] In comparison between 2017 and 2020 employment grew by 2.68 per cent annually[g].[69]

In the mining industry, employment is expected to grow by an additional 100 workers to 2025, from 15,700 workers in 2022, an annual growth rate of 0.39 per cent[h] which is below the overall Victorian average across all industries.[70,71] In comparison between 2017 and 2020 employment across this industry experienced a decline of 16.58 per cent annually[i].[72]

The demand for mining workers in Victoria is expected to grow by an estimated 500 individuals between 2022 and 2025.[73] This includes 100 related to employment growth and replacement of 400 retirees.[74] The number of retirements does not consider people leaving the industry for other reasons. However, industry noted that this figure is likely to be an understatement given new mines and their associated jobs will be determined by mine approval timeframes, the success of exploration and the uncertain nature of the broader commodity market which influences decisions.[75] It is estimated that each new mine will employ an estimated 200 new jobs each if these projects go ahead.[76]

Table 5 identifies the top ten occupations (4-digit ANZSCO) in demand based on employment growth and replacing retirees by 2025.[77] Of these, four occupations (highlighted in table) are expected to experience employment growth at a rate above the overall Victorian average between 2022 and 2025. These figures are estimates but it is important to note that they may be under-estimated as they do not account for existing vacancies nor take account of changes in the rate of workers leaving the industry.

Table 5 | Occupations in demand in the mining industry to 2025 [j,78,79]

Occupation	Current employment	Employment growth (2022–25)		Retirements (2022–25)	New workers needed (2022–25)
		Number	Per cent		
Drillers, Miners and Shot Firers	800	80	1.3%	90	170
Other Building and Engineering Technicians	720	50	3.2%	20	60
Mining Engineers	690	20	1.8%	20	40
Production Managers	860	20	1.7%	30	40
Metal Fitters and Machinists	1,010	-20	-0.6%	40	20
Human Resource Managers	200	10	1.5%	10	10

[f] 3-year compound annual growth rate
[g] Computed for 2017 to 2020 employment growth for pre-COVID comparison
[h] 3-year compound annual growth rate
[i] Computed for 2017 to 2020 employment growth for pre-COVID comparison
[j] Due to rounding, some totals may not correspond with the sum of the separate figures

Management and Organisation Analysts	170	10	4.6%	Less than 10	10
Database and Systems Administrators, and ICT Security Specialists	20	10	5.5%	Less than 10	10
Electricians	220	Less than 10	-0.04%	10	10
Other Specialist Managers	60	Less than 10	2.0%	Less than 10	10

Legend

Above Victorian employment growth average between 2022 and 2025

Advanced digital and cognitive skills in automation and digital technologies are becoming more important and creating new roles across the industry (see Table 6). Emerging occupations are defined as new, frequently advertised jobs which are substantially different to occupations already defined in ANZSCO.[80] It also includes roles where the number of jobs available has grown significantly in the last five years and is expected to continue.

Table 6 | Emerging occupations in the mining industry[81]

Emerging occupations	
• Chemical engineers	• Drone pilots
• Engineering technicians	• Metallurgical or materials technicians
• Metallurgists	• Resource geologists

Existing occupation shortages are focused mainly on highly skilled roles

The mining industry is currently facing difficulties filling skilled vacancies as the industry increasingly adopts automation technology and robotics systems. This is creating new ways of working and needing workers to upskill to adapt. Other ongoing challenges include low awareness of the career opportunities available in mining, alongside few applicants to the industry from diverse cohorts, specifically females.[82] These challenges will need to be addressed to meet projected demand.

> *"We are short on diesel and mechanic fitters / trades – highly specialised trades that are always in demand"*
>
> *Skills Plan Consultation, Industry Forum, December 2021*

A shortage exists when employers are unable to fill or have considerable difficulty filling vacancies for an occupation at current levels of remuneration and conditions of employment, and in reasonably accessible locations. In some instances, shortages in a specialisation within an occupation will show the occupation in shortage. Emerging skills also often relate to roles in skills shortage due to the lag between demand and workers developing the new skills (see Table 9).[83] This lag comes firstly from the delay in demand becoming widespread enough that the workforce has time to respond, and then in the time taken to train and develop the relevant skills.[84]

VSA consultations indicate further occupations across Victoria can be considered to be in shortage, or soon will be. A list of current occupation shortages related to mining is shown in Table 7.

Table 7 | Occupation shortages in the mining industry

Occupation shortages	
• Diesel fitters and trades[85]	• Earthmoving plant operators[86]
• Geologists[87]	• Geophysicists[88]
• Hydrogeologists[89]	• Metal fitters and machinists[90]
• Metallurgists[91]	• Mining engineers[92]
• Petroleum engineers[93]	• Safety specialists[94]
• Underground diamond drillers[95]	
Additional occupations as part of the National Skills Commission's updated Skills Priority List released on 06 October 2022[96]	
• Driller	• Miner

Some skills are in immediate shortage, while others will increase in demand

Key generic skills to work in the mining industry include planning, communication skills, attention to detail and problem solving. Many roles also require a deep understanding of science, technology, engineering and mathematics associated with the relevant sector.[97] The skills identified in Table 8 are identified as in shortage across the industry. Some of these skills are required immediately while others will be required increasingly in the future (see Table 9).

Table 8 | Skill shortages facing the mining industry

Skill shortages	
• Controlling blast emissions and dust production as well as understanding the mineral recovery benefits of electronic blasting[98]	• Data science and programming skills[99]
• Management and leadership skills[100]	• Skills in onshore and offshore drilling, as well as surface and underground drilling[101]
• Work practices to mitigate health, safety and environmental concerns[102]	

> *"Movement from mining coal to new world energy will require changing of understanding and attitudes of people to staff the operations"*
>
> *Skills Plan Consultation, Industry Advisory Group, December 2021*

It is predicted that the largest impact of robotics on the industry will occur in the following activities: mine planning, the mining process (drilling, blasting, loading and hauling) and comminution (breaking of rocks).[103] This is creating new ways of working and requiring workers to upskill to adapt. Some workers may already have these skills while others may be in shortage (see Table 9).

Table 9 | Emerging skills in the mining industry

Emerging skills	
• Awareness of safety and environmental risk for businesses (e.g., nano-diesel particulate matter (nDPM) control, fatigue management and social license to operate)[104]	• Capability to use key technology tools including project management software; Computer Aided Design (CAD) software; GPS receivers; simulation, design and modelling software, and database user interface and query software[105]
• New competencies using drones and other satellite drive technologies[106]	• Operating and servicing automated vehicles, remote operating centres, remote vehicle operations and automated programming[107]
• Operation, maintenance and programming of new technologies such as sonic drilling, coil tube drilling and cyber-chair drilling[108]	• Skills in activities such as planning and construction for dumps, dust risk management and ground instability control[109]
• Skills in emerging sectors such as critical minerals and hydrogen[110]	• Skills in interpreting data from autonomous drill rigs[111]
• Troubleshooting diagnosis and improving the productivity of machine equipment[112]	• Understanding of environment, social and governance (ESG) criteria and social licence to operate[113]

Education and training pipeline

There were over 6,850 enrolments in mining related VET qualifications in 2020 and 8,770 relevant enrolments in Higher Education in 2019.[114,115] This should translate to more than 7,690[k] graduating students entering the workforce each year with relevant qualifications, although some will seek employment in other industries. For further detail, see the collaborative response toward the end of this report.

The mining industry is a small employer in Victoria, which is reflected in the VET enrolment numbers

VET will continue as the primary channel of education supply to the industry, with 44.1 per cent of the workforce holding a VET level qualification as their highest level of education.[116] VET-level study is required for occupations including chemical, gas, petroleum and power plant operators, drillers and shot firers. Education and training activity also supports endorsed industry requirements (EIR). Three out of the 15 qualifications and courses used by industry on the Victorian Funded Course List (FCL) support these requirements.[117] This requirement is crucial to the provision of heavy earth moving, civil contracting and related civil infrastructure services to the mining industry.

The mining industry also provides employment opportunities for people of all skill and experience levels. Some employers prefer to hire workers with basic skills and upskill them, with 27.8 per cent of the workforce not holding any post-school qualifications (not accounting for tickets and licences).[119] The industry is most popular for younger males looking for well-paid roles relative to other industries. Key occupations include crane, hoist and lift operators, miners and earth moving plant operators.

> In 2020 there were over 6,850 enrolments in mining related VET qualifications in Victoria.[118]

Employees may also be required to obtain additional licences and tickets to attend and perform certain types of work on-site. Other professional development opportunities may involve upskilling in new mining technologies and processes. There is only one skill set on the Victorian Funded Skill Set List (FSSL)[l], that relates to the mining industry delivered in Victoria which is the Course in Civil Construction Pathway.[120] The Course in Civil Construction Pathway aims to support the industry to fill entry-level roles related to civil construction, particularly young people and workers looking to re-skill.

VET Activity

People enrol in VET courses for one of three main reasons:

- to prepare for employment
- to support current employment
- to progress their careers within the industry.

This equates to training categorised as prior to employment; with employment (as an apprenticeship or traineeship) and upskilling once qualified as shown in Table 10. The table shows the enrolments in 2020 VET courses on the Victorian Funded Course List (FCL) and the Victorian Funded Skill Set List (FSSL)[121] related to this industry and against each category. The enrolment numbers are drawn from

[k] This number is determined by taking the total number of VET enrolments in courses undertaken prior to employment, combined with 1/3 of the total number of HE enrolments in AQF 5-8 courses (as these courses are traditionally undertaken prior to employment and the average Bachelor degree is three years, so only those in their final year of study will enter the workforce the following year).
[l] The Victorian Funded Skill Set List was introduced in 2021.

Total VET Activity (TVA) which comprises enrolments supported by public funding or private contribution.

As part of preparing this report, industry representatives have provided their perspectives on the purpose of these qualifications, which is summarised in Figure 2 and helps to read Table 10.

Figure 2 | VET pipeline key

1. 'AT' indicates a classroom-based course is also available as an apprenticeship or traineeship option
2. 'Q' indicates industry values the course as a qualification
3. 'SS' indicates industry values the course as a skill set
4. 'EIR' indicates it is an Endorsed Industry Requirement as noted by industry
5. 'OL' indicates the course leads to an Occupational License as noted by industry

Note: Industry has not provided feedback on all qualifications and where indicated; each value assignment can be reviewed in the future.

Table 10 | VET pipeline for mining in Victoria[m]

Prior to employment	
Qualifications (5,713 TVA enrolments 2020)	
Certificate II	**219**
Certificate II in Civil Construction (Q,SS,EIR)	219
Certificate III	**5,494**
Certificate III in Surface Extraction Operations (SS,AT)	90
Certificate III in Civil Construction (Q,SS,AT,EIR)	2,810
Certificate III in Civil Construction Plant Operations (Q,SS,AT,EIR)	2,594
Skill Set	**-**
Course in Civil Construction Pathway	0
With employment (apprenticeship and traineeship)	
Qualifications (1,030 TVA enrolments 2020)	
Certificate III	**884**
Certificate III in Surface Extraction Operations (SS)	8
Certificate III in Civil Construction (Q,SS,EIR)	830
Certificate III in Civil Construction Plant Operations (Q,SS,EIR)	46
Certificate IV	**146**
Certificate IV in Civil Construction (Q,SS,EIR)	146
Upskilling once qualified	
Qualifications (104 TVA enrolments 2020)	
Certificate IV	**81**
Certificate IV in Surface Extraction Operations (AT)	31
Certificate IV in Civil Construction (Q,SS,AT,EIR)	50

[m] VET courses can support a range of occupations across a range of industries, and occupations can also support a range of industries. To present the likely VET trained employment pipeline by industry, enrolments for a course have been assigned to the most common industry in which people seek employment.

Diploma	**23**
Diploma of Surface Operations Management (AT)	23

Note: Enrolment figures in the table above are as reported by NCVER, Total VET student and courses 2020: program enrolment. There may be instances where program enrolments are not reported by training providers to NCVER and therefore not included in the enrolment figures in the total VET training activity data. Total VET activity for 2021 is expected to be released in August 2022.

Notably, the mining industry identified four civil construction qualifications that contain skill sets valued by the industry. These four qualifications were: Certificate II, III and IV in Civil Construction and Certificate III in Civil Construction Plant Operations.

Strong employment growth is forecast across mining related occupations requiring a higher education qualification

Higher education also supports pathways into the mining industry, with 28 per cent of workers holding a degree or above as their highest level of education.[122] A higher education qualification is required for occupations including mining engineers, chemical and materials engineers, geologists, geophysicists and hydrogeologists. Many mining occupations which rely on a workforce having attained a higher education qualification are projected to grow over the next five years. Due to the deep knowledge of resources, materials and practices required, longer periods of study are required to enter the industry through higher education.

In 2019, there were approximately 8,770 equivalent full-time study load (EFTSL) students across mining related higher education courses in Victoria.[123] There are a high proportion of common skills shared between the different sectors, including coal mining, extractive industries and metalliferous mining.[124] This allows for many higher education pathways into the industry such as chemical science, mechanical and industrial engineering and technology, and the industry is increasingly looking to build knowledge and awareness of the career pathways available to those finishing their education.

The higher education pipeline for the mining industry is shown in Table 11. Only relevant courses are included as examples.

Table 11 | Higher Education pipeline for mining in Victoria[125], [n]

Civil Engineering (4,898 EFTSL, Victoria, 2019)	
AQF 9+ (e.g., Master and above) ***(1,269 enrolments)***	**AQF 5-8 (e.g., Diploma, Bachelor, Hons)** ***(3,629 enrolments)***
Examples include: • Master of Civil Engineering (234) • Master of Geomechanics and Geohydrology (<5)	Examples include: • Bachelor of Engineering (Civil and Infrastructure) (Hons) (1,211) • Bachelor of Civil Engineering (Hons) (949) • Bachelor of Engineering Technology (Civil) (243)
Earth sciences (96 EFTSL, Victoria, 2019)	
AQF 9+ (e.g., Master and above) ***(96 EFTSL)***	**AQF 5-8 (e.g., Diploma, Bachelor, Hons)** ***(0 EFTSL)***
Examples include: • Master of Science (Earth Sciences) (15) • Master of Geoscience (12)	Examples include: • n/a

[n] A course may be allocated to different narrow field of educations by different higher education providers based on the primary purpose of the course. Higher education enrolments reported against a course under a specified narrow field of education reflect only the portion of enrolment allocated to the narrow field of education and are not reflective of the total enrolment for the course.

Mechanical and Industrial Engineering and Technology (2,431 EFTSL, Victoria, 2019)	
AQF 9+ (e.g., Master and above) ***(531 EFTSL)*** Examples include: • Master of Engineering (Mechanical Engineering) (84) • Doctor of Philosophy (76)	**AQF 5-8 (e.g., Diploma, Bachelor, Hons)** ***(1,900 EFTSL)*** Examples include: • Bachelor of Engineering (Mechanical) (1,461) • Bachelor of Engineering Technology (88)
Other Natural and Physical Sciences (17 EFTSL, Victoria, 2019)	
AQF 9+ (e.g., Master and above) ***(0 EFTSL)*** Examples include: • n/a	**AQF 5-8 (e.g., Diploma, Bachelor, Hons)** ***(17 EFTSL)*** Examples include: • Bachelor of Geoscience (17)
Process and resources engineering (1,327 EFTSL, Victoria, 2019)	
AQF 9+ (e.g., Master and above) ***(933 EFTSL)*** Examples include: • Doctor of Philosophy (Engineering) (86) • Doctor of Philosophy (Chemical Engineering) (47) • Master of Mining Engineering (5)	**AQF 5-8 (e.g., Diploma, Bachelor, Hons)** ***(394 EFTSL)*** Examples include: • Bachelor of Engineering (Chemical Engineering) (303) • Graduate Diploma of Mining (28) • Bachelor of Mining Engineering (5)

Workforce priorities

Increasing awareness of the careers available in mining and upskilling the existing workforce are key priorities

Key challenges exist to address the supply and skills of labour in the mining industry. This includes low awareness of the career opportunities in mining among young workers and a shift to new mining technologies and energy production demanding new skills, expertise and knowledge while making other skills redundant.[126] The Skills Plan identifies three key priorities for the mining industry. Responsibility for delivering on these priorities lies with many stakeholders, however education and training has a key role to play.

Build an available and appropriately skilled workforce to support the industry

The ability of employers to attract and retain a sustainable workforce is the biggest barrier to meeting workforce needs. Stakeholders noted a lack of understanding, particularly among younger workers of the broad spectrum of roles available in mining and competition with other states for workers. This is accentuated by a lack of diverse applicants to the industry, particularly women, alongside its perceived volatility as Victoria increasingly shifts to clean energy production (for coal mines), detracting from it as a potential career choice.

Roles in mining extend beyond traditional coal mining to include a variety of careers using new technologies and processes such as robotics, automation, GPS technologies and big data. Recent investment in mineral sands and gold in Victoria is also creating new employment opportunities. There is opportunity to reposition the industry as one that provides meaningful career opportunities into the future. As such, additional pathways and programs can be explored to increase attraction to the industry. Efforts are already underway, for example targeting school students through mining tours. Additional efforts to keep students engaged in the industry through study can also be explored.

Table 12 | Areas of focus to build an available and appropriately skilled workforce

- There is limited awareness of the career opportunities available in the mining industry, particularly among school leavers.
- Competition for workers from other states impacts workforce supply.
- Systematic barriers preventing underrepresented workers (e.g., females) from entering the industry need to be addressed.

Manage the workforce transition in line with the retirement of existing energy assets, market conditions and the need to respond to climate change

A shift towards new mining technologies and processes (e.g., automation) is creating demand for new skills and making some skills redundant. This will require targeted training and upskilling among the existing workforce to meet these shifting requirements, for example as the sector transitions into clean energy production and away from coal and other fossil fuels. Employers highlighted the importance of ensuring skills gained are formally recognised, which can in turn improve employee confidence and retention.

Forward planning is needed, involving effective partnerships between industry and education and training providers to ensure the right skills training is provided at the right time.

Table 13 | Areas of focus to manage the workforce transition

- The retirement of existing energy assets and the need to respond to climate change require new skills.
- Curriculum content is misaligned with contemporary industry needs and the pace of change in new technologies.
- There is a lack of upskilling opportunities for existing workers that are formally recognised.

Support training in specialist skills required by industry and explore ways to attract under-represented cohorts

Industry reported insufficient numbers of courses available to meet their needs, particularly in the VET sector. They also noted limited training available for workers looking to transfer into the mining industry from other sectors or industries. This presents an ongoing challenge in accessing training in thin and/or niche markets given it is not often financially viable for education and training providers to deliver to small cohorts. Re-defining the 'value' of a course to industry is essential to ensure training can be delivered in thin markets. Efforts can then focus on expanding the availability of courses in Victoria, such as drilling operations.

> *"A lack of TAFE courses (in mining) in regional areas…largest drilling company in Bendigo with 200 staff are doing training out of an RTO in Queensland on basic drilling operations"*
>
> *Skills Plan Consultation, Industry Advisory Group, February 2022*

Table 14 | Areas of focus to expand the availability of courses

- There is a lack of specialist training programs, particularly in regional areas.
- There are few training/bridging opportunities for individuals moving from other industries or countries.
- Pathways to deepen technical expertise of workers require strengthening.

Collaborative response

The education and training response can review the volume and availability of pathways into and through the industry

The education and training response has a key role to play in helping to address the three key workforce issues for the industry:

1. Build an available and appropriately skilled workforce
2. Manage the workforce transition in line with the retirement of existing energy assets, market conditions and the need to respond to climate change
3. Support training in specialist skills required by industry and explore ways to attract underrepresented cohorts

To attract more people into the mining industry, the education and training response can seek to broaden awareness of the career pathways and roles available to potential employees. Prior to employment, there is an opportunity to diversify the interests of individuals concerning the variety of occupations available beyond traditional mining careers. This should also involve attracting a more diverse workforce profile (e.g., more female workers). The education and training response can also communicate the increasing need for specialist skills that require an understanding of emerging technologies and processes, such as robotics, automation, GPS technologies and big data. Educating future employees on the career pathways available to them will help build the pipeline of workers needed in the mining industry.

> *"People just aren't aware of the opportunities available – there is much more to the mining industry than working underground."*
>
> *Skills Plan Consultation, Industry Forum, February 2022*

There are several pathways into the mining industry that are highly valued. However, industry pointed to a lack of course availability to build the pipeline of workers, particularly in regional Victoria where mines are located. This is accentuated by low enrolment numbers in some courses given the mining workforce is relatively small, thereby making courses challenging for training providers to run due to cost. There is an opportunity to expand the availability of in-demand courses to meet industry need and support training provision in thin but critical markets. For example, industry noted the opportunity to reopen and/or expand provision in courses such as the Certificate III in Mining Exploration as this is valuable to the sector.[127]

The mining industry continues to innovate and introduce new technologies to operate more efficiently, safely and in a sustainable manner. The existing workforce will be required to upskill in these new technologies such as drones, satellite drive technologies, autonomous drill rigs, and remote vehicle operations. However, there are currently limited opportunities available for people to upskill in these areas, particularly workers looking to transfer into mining from other industries. This presents an opportunity for the education and training response to expand the availability of micro-credentials to enable more people to undertake professional development.

Securing a highly capable workforce that keeps pace with new skills requires appropriate and readily available course offerings. Industry noted that they are in the process of developing a new pathway course into mining in collaboration with education and training providers and government.[128] There were also other qualifications identified by industry that would be valued as **skill sets** to upskill workers more efficiently. These qualifications were the Certificate II, III and IV in Civil Construction and Certificate III in Civil Construction Plant Operations. The education and training response can undertake further review to determine if they can be provided as a skill set or as a mining specific skill

set as part of the FSSL given these qualifications also support the construction industry. This will enable the industry to secure a highly capable workforce that keeps pace with new skills.

Industry and government can drive broader reform in job design and workforce planning

The education and training response will also need support from industry and government to improve how the mining industry attracts, develops and utilises talent. Government and industry need to work together to support the training and skilling requirements necessary to meet future demand. Opportunities for action from industry involve strengthening the value proposition for working in the mining industry, in parallel to government planning for the transition of the mining workforce and timing large projects to manage employee demand across vertically integrated businesses that support mining.

Many workers are attracted to the mining industry for competitive pay relative to other industries. However, industry noted that employers continue to face competition for workers with other industries and other states/territories. This presents an opportunity for mining employers in Victoria to strengthen the value proposition of working in the industry. Industry can lead key reforms focused on job design and retention in the face of changing demand and an increasing need for specialist and/or higher order skills.

> *"We are a high paying industry, so we present competition to other industries, but this is not always enough to attract workers."*
>
> *Skills Plan Consultation, Industry Advisory Group, February 2022*

Meanwhile, government has a key role to play in managing the transition to clean energy. Currently, brown coal-fired power generation supplies most of Victoria's electricity, however this will reduce over the coming decades with the retirement of existing energy assets, market conditions and the need to respond to climate change. This is creating demand for new skills while making other skills redundant. Forward planning is needed, involving effective partnerships between industry, education and training providers and government to ensure existing workers are transitioned at the right time. However, industry reinforced that this transition will not affect Victoria as significantly as other states/territories and there will continue to be demand for traditional mining roles.

As government continues to invest in civil construction projects, consideration can be given to the implications on the mining industry who compete for a similar pool of workers. This includes occupations such earth moving plant operators and tunnellers. How this investment in construction development is managed could have significant implications for the mining industry's ability to operate, particularly in regional areas.

The mining industry is already competing with other states/territories and industries for a shared pool of skilled workers. Without these workers, the mining industry in Victoria will struggle to meet new economic development and trade opportunities, including the transition to high value, low emission products for domestic and international markets and a growing minerals sector across the state.

Actions for consideration for education, industry, and government

- Broaden awareness of the diversity of careers available in mining and provide clear pathways to build the pipeline of workers.
- Review training provision in thin (low enrolment) but critical markets to the Victorian economy.
- Make use of skill sets and micro-credentials to meet the growing demand for specialist and/or higher order skills as the mining industry transitions.
- Assess cross industry impacts from investment that will result in additional employment demand for construction related workers.

Appendix A Drivers of demand

Driver	Industry / Sector
Policy	• Regulatory challenges surrounding the building of new mining sites close to housing and development.[129] • Establishment of the Mining Skills Organisation Pilot in 2021 to shape the national training system to be more responsive to the skills need of employers within the mining sector, including the identification of skills needs and qualifications development. **Metal Ore Mining** • The Victorian Government established the *State of discovery: Mineral resources strategy 2018-2023* to help grow investment and jobs in Victoria's minerals sector.[130] Key priorities for government include investment in pre-competitive geoscience and the reduction of costs and red tape for the minerals sector.[131] **Non-Metallic Mineral Mining and Quarrying** • The Victorian Government has recently developed its Extractive Resources Strategy.[132] The Strategy will be key to supporting Victoria's significant infrastructure development and the sand, rock, gravel and clay required for it.[133] **Oil and Gas Extraction** • Victorian Government's CarbonNet Project to establish a commercial scale Carbon Capture and Storage (CCS) network in the Gippsland region, enabling new industries and employment opportunities in the area, and significant reduction in CO^2 emissions in Victoria.[134] • The Extractive Industry Priority Project List by the Victorian Government which identifies quarry projects that will be given priority as Victoria needs more rock, sand and gravel to enable it to grow.[135] • Updated regulations put in place by the Victorian Government to continue onshore gas exploration and development in Victoria, predicted to boost jobs in South-West Victoria and the Gippsland region.[136]
Economic	• A push to increase domestic supply chains and explore more opportunities to produce materials that are globally recognised (e.g., metal ore used in electronics).[137] • Changing demand and commodity prices, and competition from other sectors and states/territories has resulted in fluctuating employment rates.[138] **Coal** • Closure of Yallourn Power Station by 2028, and further closures of Loy Yang A and Loy Yang B scheduled for 2047 but anticipated as early as 2029-2032.[139,140] **Exploration** • Opportunities for commercial mineral sands projects in the longer-term, with significant deposits in the Wimmera region.[141,142] **Metal Ore** • Increased gold exploration activity in recent years, especially within the goldfield's region highlight the potential for additional gold discoveries and development opportunities within the region.[143] • $100 million investment in North Central Victorian Goldfields Ground Release on minerals exploration in the region over coming years.[144]
Social	• There are increasing community expectations to reduce the industry's impact on the environment.[145] • Awareness of the industry's environmental and social performance and concern over the future of mining has deterred younger workers from entering the industry.[146] • Disruptions and benefits of Australia's clean energy transition will be felt differently by different communities.[147] • Employee retention may become an issue due to working under COVID-19 conditions placing additional burdens on employees, particularly as the pandemic has shifted people's priorities and spending time with family and loved ones has taken on new significance.[148]

Technological	• COVID-19 has compelled mining companies to speed up their modernisation programs, including digitisation and automation, to protect workers through technologies that reduced the number of people onsite.[149] The report cites as an example the announcement by BHP of a US$800m program to add 500 autonomous trucks in iron ore and coal mines in Australia.[150] • Robotics, automation, GPS technologies and big data are being incorporated to increase efficiency, improve environmental management, provide additional job opportunities and improve the health and safety of workers.[151] • Increasing use of drone technology to make mining smart and safer for resources professionals.[152] • Scope for innovation in lithium, battery and other critical minerals produced by the sector as essential commodities for modern technologies.[153]
Environmental	• Victoria has legislated a new target of 50 per cent renewable energy generation by 2030. Victoria's coal-fired generators will begin closing from 2028. This will require a re-skilling of traditional coal mining workers.[154] • Exploring opportunities in waste-reduction for the conversion and re-purposing of putrescible organic waste.[155] • Reducing a site's overall water usage, including recycling and reuse following sequestration remains a key priority for businesses.[156] • Heightened focus on safety and risk management is demanding increased awareness of and responsibility for business risks.[157] Nano-diesel particulate matter (nDPM) control, fatigue management and the increasing importance of a social licence to operate are redefining how and which kinds of businesses firms operate.[158]

Appendix B Data methodology

VSA Employment Model overview

The VSA Employment Model produces estimates of:

- projected employment growth between 2022 and 2025
- projected retirements between 2022 and 2025
- projected total new workers needed between 2022 and 2025.

Table 15 further defines the model outputs and identifies the primary source for each output.

Table 15 | Employment model outputs

	Employment growth 2022-25	Retirements 2022-25	New workers needed 2022-25
Definition	Change in the number of workers employed from 2022 to 2025	Workers expected to permanently leave the workforce from 2022 to 2025	Workers needed from 2022 to 2025 to meet demand from growing employment and to replace retirees
Primary source	Benchmarked to the NSC Employment Projections	Derived from retirement rates from Australian Census Longitudinal Dataset	The sum of employment growth and retirements

All outputs are modelled at the occupation, industry and region level:

- occupations are defined by 4-digit occupation unit groups in the Australian and New Zealand Standard Classification of Occupations (ANZSCO)
- industries are defined by 1-digit industry divisions in the Australian and New Zealand Standard Industrial Classification (ANZSIC)
- regions are defined by the nine Regional Partnerships of Victoria as outlined by the Victorian Department of Jobs, Precincts and Regions.

Benchmark data from the NSC give estimates of projected employment growth. Using an approach called iterative proportional fitting, the detailed occupation, industry and region breakdowns are generated by applying the distribution of employment in ABS Census and other data to the benchmark projections.

The model was developed by the VSA with the support of Nous and Deloitte Access Economics (DAE). The sections further below describe how the key outputs were modelled.

> The VSA Employment Model gives a best estimate of employment by industry, occupation and region. It provides an indication but does not, and cannot, tell the full story of the region's economy.

Employment growth, 2022-25

Source: *VSA and Nous (2022), modelling of NSC (2022) Employment Projections*

This modelling takes the NSC Employment Projections as the benchmark data for 2022-25 and breaks it down into occupation by industry by region tables.

The benchmark data sources provide 'control totals' for occupation, industry and region breakdowns independently. However, they do not provide the interaction between each of the variables. For example, they do not give the breakdown of occupations within industries.

Iterative proportion fitting uses a detailed 'seed' data table with the necessary breakdowns from a representative dataset and scales that distribution to control totals in the new dataset. Over many iterations, the seed data is transformed to sum up to the occupation, industry and region control totals.

The seed data comes from the ABS Census 2016. The control totals for occupation and industry come from the NSC's Employment Projections, and the control totals for region come from the NSC's Small Area Labour Markets data. Table 16 describes the inputs in detail.

The modelling results in:

- industry and occupation projections that align with the NSC Employment Projections
- regional data that matches the distribution across NSC Small Area Labour Markets
- industry by occupation by region data tables that approximate the distribution within the ABS Census 2016.

Table 16 | Data sources used to model employment growth from 2022 to 2025

Type	Data	Source
Seed	Employment x 3-digit industry (ANZSIC3) x 4-digit occupation (ANZSCO4) x Statistical Area Level 2 (SA2)	ABS, *Census of Population and Housing*, place of usual residence data
Control total	Employment x SA2	NSC, *Small Area Labour Markets*, 'SALM smoothed SA2 Datafiles (ASGS 2016) - March quarter 2022'.
Control total	Employment x ANZSIC1	NSC, *Employment Projections,* 2020-25
Control total	Employment x ANZSCO4	NSC, *Employment Projections,* 2021-26

Notes:

1. *Following the modelling, SA2 data is aggregated up to Regional Partnership region. Where an SA2 spans multiple regions, the estimates have been apportioned based on geographic area.*
2. *The NSC industry projection is often not available until some months after the occupation projections. As at May 2022, there were no 2021 to 2026 ANZSIC1 by state forecasts available. The previous release of 2020 to 2025 ANZSIC1 by state forecasts were used and scaled up to match the Australian total employment numbers in the ANZSCO4 forecasts.*

Retirements, 2022-25

Source: *VSA, Deloitte Access Economics (DAE) and Nous (2022), Retirement projections 2022-2025*

Retirements are estimated by applying occupation-specific retirement rates to the employment projections.

Using the Australian Census Longitudinal Dataset, an estimate of the size of the labour force aged 50 and over in 2016 was taken and compared to the size of the labour force aged 45 and over in 2011. After adjusting for migration, the gap is an estimate of retirements between 2011 and 2016. The relative age structures of occupations in the Census 2011 were then used to estimate retirements at the detailed occupation level (ANZSCO4).

The outputs were used to estimate an occupation-specific retirement rate, calculated as:

Retirement rate = retirements between periods t and t+1 / employment at t

The retirement rates were applied to the employment projections to estimate the number of retirements between 2022 and 2025 at the region (Regional Partnerships), industry (ANZSIC1) and occupation (ANZSCO4) level.

New workers needed, 2022-25

New workers needed is the simple sum of employment growth and retirements. It is calculated at the region (Regional Partnerships), industry (ANZSIC1) and occupation (ANZSCO4) level.

New workers needed is an estimate of demand for workers to join an industry, occupation or region. In this model, demand comes from growth in employment (as business, government and other employers expand their operations) and the need to replace retirees who leave the workforce.[o]

New workers needed is not an estimate of skills shortage. In the VSA Employment Model, demand is always met by supply of new workers who enter the work force from study, unemployment, migration, a change in industry or occupation, or other avenues.

This means that the VSA Employment Model is not suitable for identifying current or future skill shortages. The Victorian Skills Plan draws on the National Skills Commission's Skills Priority List and stakeholder feedback to identify skills shortages within industries and across Victoria.

[o] This will generally underestimate demand as it does not account for the need to replace workers who leave a job for other reasons, such as switching occupations or migrating out of Victoria.

Appendix C Victorian VET pipeline methodology

Enrolment numbers

Sources:
National Centre for Vocational Education Research (NCVER) (2021), Total VET students and courses 2020, available here.
Victorian Department of Education and Training (2022), Funded Course List, available here.
Victorian Department of Education and Training (2022), Funded Skill Set List, available here.

The Victorian VET pipeline table estimates the number of enrolments in each qualification and skill set for the 2020 academic year in Victoria. The NCVER total VET students and courses is used as the dataset. Only courses on the Victorian Funded Course List (FCL) and the Victorian Funded Skill Set List (FSSL) are included.

The following steps were taken to develop the table:

1. Each course was reviewed by IAG members and allocated to **only one** of three main reasons for studying: to prepare for employment; to support current employment (apprenticeship or traineeship); and to progress their career. Each course is then listed under their respective allocation.
2. The numbers of students who enrolled in that course in 2020 is then noted in the VET pipeline table.
3. For courses that provide **an apprenticeship and traineeship option and a classroom-based option**, these courses are duplicated twice in the table, with enrolment numbers split across the other two options: the number of apprentice and trainee enrolments are reported under the header 'with employment (apprenticeship and traineeship); the number of classroom-based enrolments is shown under the purpose for completing the classroom-based option (either to prepare for enrolment or to progress their career). An ('AT') is noted next to these duplicated classroom-based courses to indicate they are also delivered as an apprenticeship or traineeship.
4. Where industry has provided feedback on the value of qualification or skill set, a ('Q') indicates it is valued as a qualification, while a ('SS') indicates it is valued as a skill set. A ('EIR') indicates it is an Endorsed Industry Requirement and ('OL') indicates it is an Occupational License. Industry has not provided feedback on all qualifications and where indicated; and each value assignment can be reviewed in the future.
5. Numbers are then totaled in their respective headers above. For the Skills Plan, the number of enrolments 'prior to employment' is a key focus for industry as it indicates how many enrolments are being trained but are not yet employed.

The 2020 enrolment figures are a best estimate of the pipeline of workers for industry to draw on. The 2020 figures were the latest dataset available from the NCVER at the time of developing the Skills Plan and will be updated in future iterations of this document. They intend to provide an indication of the pipeline but do not and cannot tell the full story of workforce supply. Factors such as completion rates and the COVID-19 pandemic during 2020 are also likely to impact the availability of the future workforce.

Appendix D Stakeholder engagement process

Stakeholder engagements allowed VSA to test, update and validate the content of the mining industry insight report. Stakeholders from organisations in government, education and industry were engaged to provide input to the report and the Skills Plan more broadly. Specifically, stakeholders provided insight on economic outlook, workforce and skilling challenges and an education and training response across three rounds of consultations. Engagements guided initial thinking and research, as well as opportunities to test and revise the insights. We would like to thank the following organisations for their participation in the stakeholder engagement process. Table 17 lists the organisations involved.

Table 17 | Consultation participants

Organisation
Bendigo Kangan Institute
Construction, Forestry, Maritime, Mining and Energy Union
Department of Jobs, Precincts and Regions
Department of Environment, Land, Water and Planning
Federation University
Gippsland Institute of TAFE
Minerals Council of Australia – Victorian Division
Resources Industry Advisory Group

References

[1] Victorian Skills Authority and Nous, 2022, modelling based on Australian Bureau of Statistics (ABS) (February 2022), Labour Force Quarterly, Employment by industry, available here.
[2] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[3] VSA and Nous (2022), modelling based on Australian Bureau of Statistics, Labour Force, February 2022.
[4] ABS (February 2022), Labour Force Quarterly, Employment by industry (Victoria), available here.
[5] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[6] VSA and Nous (2022), modelling based on Australian Bureau of Statistics, Labour Force, February 2022.
[7] ABS (February 2022), Labour Force Quarterly, Employment by industry (Victoria), available here.
[8] Victorian Skills Authority (VSA) and Nous (2022), modelling of NSC (2022) Employment Projections.
[9] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[10] VSA, Deloitte Access Economics and Nous (2022), Retirement projections 2022-2025.
[11] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[12] VSA and Nous (2022), modelling based on Australian Bureau of Statistics, Labour Force, February 2022.
[13] ABS Census (2016), Education attainment by industry (Victoria).
[14] NCVER (2021), Total VET students and courses 2020, available here.
[15] Australian Government, Department of Education, Skills and Employment, (2021), Selected Higher Education Statistics – 2019 Student Data, available here.
[16] NCVER (2021), Total VET students and courses 2020, available here.
[17] ABS (2013), Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) Division B – Mining, available here.
[18] ABS (2013), Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) Division B – Mining, available here.
[19] Australasian Institute of Mining and Metallurgy (AusIMM) (2021), Australia's Mining Industry, available here.
[20] Mineral Councils of Australia (2021), MCA Victoria, available here.
[21] Mineral Councils of Australia (2021), MCA Victoria, available here.
[22] Mineral Councils of Australia (2021), MCA Victoria, available here.
[23] Mineral Councils of Australia (2021), MCA Victoria, available here.
[24] Myfuture (2021), Mining, available here.
[25] Victorian Skills Authority and Nous, 2022, modelling based on Australian Bureau of Statistics (ABS) (February 2022), Labour Force Quarterly, Employment by industry, available here.
[26] ABS (February 2022), Labour Force Quarterly, Employment by industry by sex (Victoria), available here.
[27] ABS Census (2016), Employment by industry by age group (Victoria).
[28] ABS (November 2021), Average Weekly Earnings by industry, Australia, available here.
[29] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[30] ABS (February 2022), Labour Force Quarterly, Employment by industry (Victoria), available here.
[31] ABS (February 2022), Labour Force Quarterly, Employment by industry (Victoria), available here.
[32] ABS (February 2022), Labour Force Quarterly, Employment by industry (Victoria), available here.
[33] Australian Industry and Skills Committee (AISC) (2021), Mining, Drilling and Civil Infrastructure, available here.
[34] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[35] ABS (2013), Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) Division B – Mining, available here.
[36] ABS (2013), Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) Division B – Mining, available here.
[37] Department of Jobs, Precincts and Regions (2021), Coal, available here.
[38] ABS (February 20220, Labour Force Quarterly, Employment by sub-industry, available here.
[39] Department of Jobs, Precincts and Regions (2021), Coal, available here.
[40] ABS (2013), Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) Division B – Mining, available here.
[41] ABS (February 2022), Labour Force Quarterly, Employment by sub-industry, available here.
[42] ABS (2013), Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) Division B – Mining, available here.
[43] ABS (2013), Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) Division B – Mining, available here.
[44] Victorian Department of Jobs, Precincts and Regions (DJPR) (2022), Minerals, available here.
[45] DJPR (2022), Minerals, available here.
[46] DJPR (2022), Minerals, available here.
[47] ABS (February 2022), Labour Force Quarterly, Employment by sub-industry (Victoria), available here.
[48] ABS (February 2022), Labour Force Quarterly, Employment by sub-industry (Victoria), available here.
[49] ABS (2013), Australian and New Zealand Standard Industrial Classification (ANZSIC), 2006 (Revision 2.0) Division B – Mining, available here.
[50] ABS (February 2022), Labour Force Quarterly, Employment by sub-industry (Victoria), available here.
[51] PESTLE ANALYSIS (2022), The PESTEL Framework Explained: 6 Important Factors, available here.
[52] DJPR (2021), Coal, available here.
[53] DJPR (2021), Coal, available here.
[54] Engage Victoria (2021), Victoria's Draft 30-Year Infrastructure Strategy, available here.
[55] DJPR (2021), Statement on future uses of brown coal, available here.
[56] DJPR (2021), Statement on future uses of brown coal, available here.
[57] ABS (2022), Mineral and Petroleum Exploration, Australia, available here.
[58] Department of Jobs, Precincts and Regions (2021), North Central Victorian Goldfields Ground Release, available here.
[59] Mineral Council of Australia (2021), Victoria's mineral industry supports more resources for regional industry and communities, available here.
[60] Mineral Council of Australia (2021), Victoria's mineral industry supports more resources for regional industry and communities, available here.
[61] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[62] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[63] Skills Plan Consultation (2022), Victorian Department of Jobs, Precincts and Regions, received May 2022.
[64] Skills Plan Consultation (2022), Victorian Department of Jobs, Precincts and Regions, received May 2022.
[65] DJPR (2022), The CarbonNet Project, available here.
[66] DJPR (2021), Restart of onshore conventional gas industry in Victoria, available here.
[67] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[68] VSA and Nous (2022), modelling based on Australian Bureau of Statistics, Labour Force, February 2022.
[69] ABS (February 2022), Labour Force Quarterly, Employment by industry (Victoria), available here.
[70] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[71] VSA and Nous (2022), modelling based on Australian Bureau of Statistics, Labour Force, February 2022.
[72] ABS (February 2022), Labour Force Quarterly, Employment by industry (Victoria), available here.
[73] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[74] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.

[75] Skills Plan Consultation (2022), Feedback from Minerals Council of Australia – Victorian Division, received May 2022.
[76] Skills Plan Consultation (2022), Feedback from Minerals Council of Australia – Victorian Division, received May 2022.
[77] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[78] VSA and Nous (2022), modelling of NSC (2022) Employment Projections.
[79] VSA and Nous (2022), modelling based on Australian Bureau of Statistics, Labour Force, February 2022.
[80] National Skills Commission (NSC) (2022), What are emerging occupations?, available here.
[81] Mining Technology (2019), The changing face of mining jobs in Australia, available here.
[82] AusTIMM (2021), Young People and the Victorian Resources Sector research report, available here.
[83] Infrastructure Australia (2021), Infrastructure workforce and skills supply, available here.
[84] Infrastructure Australia (2021), Infrastructure workforce and skills supply, available here.
[85] Consultation notes from Resources, Forestry and Pulp IAG held 16 December 2021.
[86] NSC (2021), Skills Priority List, available here.
[87] Australian Resources and Investment (2021), How mining can adapt to the skills shortage, available here.
[88] NSC (2021), Skills Priority List, available here.
[89] NSC (2021), Skills Priority List, available here.
[90] NSC (2021), Skills Priority List, available here.
[91] Australian Resources and Investment (2021), How mining can adapt to the skills shortage, available here.
[92] NSC (2021), Skills Priority List, available here.
[93] NSC (2021), Skills Priority List, available here.
[94] Consultation notes from Resources, Forestry and Pulp IAG held 16 December 2021.
[95] Consultation notes from Resources, Forestry and Pulp IAG held 16 December 2021.
[96] National Skills Commission (2022), Skills Priority List 2022, available here.
[97] AISC (2021), Resources and Infrastructure Cross Sector, available here.
[98] AISC (2021), Resources and Infrastructure Cross Sector, available here.
[99] Australian Resources and Investment (2021), How mining can adapt to the skills shortage, available here.
[100] Victorian Department of Education and Training (2022), Victorian employer skills survey, available here.
[101] Consultation notes from Resources, Forestry and Pulp IAG held 16 December 2021.
[102] AISC (2021), Extractive Industries (Quarrying), available here.
[103] Myfuture (2021), Mining, available here.
[104] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[105] VSA (2021), Mining sector insights prepared for Resources, Forestry and Pulp IAG held 16 December 2021.
[106] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[107] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[108] AISC (2021), Drilling, available here.
[109] AISC (2021), Extractive Industries (Quarrying), available here.
[110] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[111] AISC (2021), Drilling, available here.
[112] Mining Technology (2019), The changing face of mining jobs in Australia, available here.
[113] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[114] NCVER (2021), Total VET students and courses 2020, available here.
[115] Department of Education, Skills and Employment (2021), Selected Higher Education Statistics – 2019 Student data, available here.
[116] ABS Census (2016), Education attainment by industry (Victoria).
[117] Victorian Department of Education and Training (2022), Funded course list, available here.
[118] NCVER (2021), Total VET students and courses 2020, available here.
[119] ABS Census (2016), Education attainment by industry (Victoria).
[120] Victorian Department of Education and Training (DET) (2022), Funded Skill Set List, available here.
[121] DET (2022), Funded course list, available here.
[122] ABS Census (2016), Education attainment by industry (Victoria).
[123] Department of Education, Skills and Employment (2021), Selected Higher Education Statistics – 2019 Student data, available here.
[124] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[125] Department of Education, Skills and Employment (2021), Selected Higher Education Statistics – 2019 Student data, available here.
[126] AusTIMM (2021), Young People and the Victorian Resources Sector research report, available here.
[127] Skills Plan Consultation (2022), Feedback from Minerals Council of Australia – Victorian Division, received May 2022.
[128] Skills Plan Consultation (2022), Feedback from Minerals Council of Australia – Victorian Division, received May 2022.
[129] AusIMM (2020), Closing the skills gap in Australian Mining, available here.
[130] DJPR (2021), Mineral resources strategy, available here.
[131] DJPR (2021), Mineral resources strategy, available here.
[132] DJPR (2021), Helping Victoria Grow: Extractive Resources Strategy, available here.
[133] DJPR (2021), Helping Victoria Grow: Extractive Resources Strategy, available here.
[134] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[135] DJPR (2022), Projects, available here.
[136] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[137] Consultation notes from Resources, Forestry and Pulp IAG held 16 December 2021.
[138] VSA (2021), Mining sector insights prepared for Resources, Forestry and Pulp IAG held 16 December 2021.
[139] Engage Victoria (2020), Clean energy future, available here.
[140] AusIMM (2022), Mining technology and innovation, available here.
[141] VSA (2021), Mining sector insights prepared for Resources, Forestry and Pulp IAG held 16 December 2021.
[142] AusIMM (2020), Closing the skills gap in Australian Mining, available here.
[143] DJPR (2022), Projects, available here.
[144] DJPR (2022), Projects, available here.
[145] Transgrid (2021), Energy Vision A clean energy future for Australia, available here.
[146] AusIMM (2020), Closing the skills gap in Australian Mining, available here.
[147] Transgrid (2021), Energy Vision A clean energy future for Australia, available here.
[148] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[149] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[150] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[151] Australian Department of Industry, Science, Energy and Resources (2021), Australia's National Resources Workforce Strategy, available here.
[152] AusIMM (2022), Mining technology and innovation, available here.
[153] AusIMM (2022), Mining technology and innovation, available here.
[154] Engage Victoria (2020), Clean energy future, available here.
[155] AusIMM (2022), Mining technology and innovation, available here.
[156] AusIMM (2022), Mining technology and innovation, available here.
[157] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.
[158] AISC (2021), Mining, Drilling and Civil Infrastructure, available here.