MINERALS COUNCIL OF AUSTRALIA

SUBMISSION TO THE AUSTRALIAN UNIVERSITIES ACCORD PANEL DISCUSSION PAPER

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1. EXECUTIVE SUMMARY

The mining industry is committed to working the Australian Universities Accord, across the tertiary sector, with government and the broader industry to ensure there is a steady, skilled and confident talent pipeline.

Given the broad scope of the discussion paper, the Minerals Council of Australia focused on minerals related tertiary education, skills and training, with particular attention to:

- Skills shortages and improving outcomes and alignment with industry needs
- The impact of new and emerging technologies, the raw material challenge and sustainability
- Meeting Australia's skills needs now and into the future
- Collaboration with industry, focused on innovation, research and development.

This submission includes key recommendations and actions for both the Australian Universities Accord and the Australian Government in refining the role of higher education in Australia's future stressing the importance of relevant collaborations and partnerships.

The skills, knowledge and learning gained through quality education are building blocks for healthy and prosperous lives. This in turn supports productive, equitable and inclusive societies. Quality education also equips people with the tools necessary for innovative solutions to the challenging and complex problems facing the world today.

The connection between high skill jobs and educational attainment is evident, with nearly 66 per cent of Australia's mining workforce (aged between 15 and 74 years of age) holding a Certificate III level qualification or higher, which is above the national average for all industries.[1] Importantly more than one in every four people employed in Australia's mining industry holds a Bachelor degree qualification or higher.[2]

In this context, the MCA has a strong interest in maximising alignment between the tertiary education landscape (both higher education and vocational education and training systems) and industry need.

Delivering a flexible, functional and fluid tertiary education system at the vocational education and training, and higher education level is critical to meeting the skills needs of the sector, especially as specialist skills associated with innovation and technology adoption increase.

STEM skills remain important to many professional occupations and trades across the mining industry. With anticipated increases in STEM occupations, reversing and diversifying the narrowing pipeline to STEM careers is a priority.

For more than twenty years, the mining industry (through the MCAs Minerals Tertiary Education Council) has been building provider capacity in core minerals related disciplines, and enhancing collaborative partnerships across the tertiary education landscape.

Industry investment (in excess of $65 million) and collaboration delivered modernised curriculum (bachelor and associate degrees in engineering), innovative courses and new learning pathways (foundational skillsets and micro-credentials).

Despite industry investment and collaboration, skills shortages and an unstable pipeline persist. The industry has grown by 90,000 jobs since 2011 and projections indicate up to 16,000 jobs are to be added by November 2026.[3]

[1] Australian Bureau of Statistics, *Education and Work, Australia, May 2022*, ABS, Canberra, 10 November 2022, table 31.
[2] ibid.
[3] Australian Bureau of Statistics, *Labour Force, Australia, Detailed, Quarterly: February 2023,* 23 March 2023, table 6; and National Skills Commission, *Employment Outlook: Industry and occupation trends: five years to November 2026*, 2022, p. 7.

Recommendations

The Australian Universities Accord should:

- Work with Jobs and Skills Australia (JSA) in translating outcomes of Jobs and Skills Australia's Clean energy capacity study to the tertiary education sector – to ensure the sector is able to identify, plan and facilitate the right offerings, infrastructure and tertiary workforce needed to secure the talent pipeline for the clean energy workforce
- Undertake a scoping study with JSA for establishing 'green skills' qualifications (including determination of skills level, types of offerings for specialist and upskilling options) to create a benchmark for national consistency in the development and application of 'green skills' across industries and occupations.

The Australia Government should:

- Safeguard critical, but lower-demand courses from negative effects of any changes to funding models (federal or state) – for example, those courses that will help Australia's workforces secure the talent pipeline required to achieve net zero
- Offer further rounds of the Women in STEM and Entrepreneurship to encourage participation of girls and women in science, technology, engineering and mathematics leading to STEM education and careers
- Prioritise implementation of recommendations from the Review of the Australian Qualifications Framework (AQF) Final Report 2019, by establishing a governance body, accountable to the relevant Council of Australian Governments (COAG) councils, with representation from government, schools, VET, higher education, industry and professional bodies, to implement agreed reforms to the AQF[4]
- Establish a cohesive tertiary education system that accommodates the unique requirements of both the higher education and VET sector, is easy to navigate and provides a modern mix of education, training and skills pathways, to provide knowledge and skills needed in the redesigned workplaces of the future
- Support next generation university-industry R&D collaboration initiatives such as the Trailblazer Universities Program, which better integrates research between universities and industry
- Maintain support for industry-oriented research initiatives such as university-led institutes, CRCs and CSIRO-led initiatives.

[4] Peter Noonan et al., *Review of the Australian Qualifications Framework Final Report 2019*, Australian Government, 30 September 2019, p.p. 11 and 15.

2. TERTIARY EDUCATION IN THE MINERALS INDUSTRY

Australian governments should:

- Safeguard critical, but lower-demand courses from negative effects of any changes to funding models (federal or state) – for example, those courses that will help Australia's workforces secure the talent pipeline required to achieve net zero.

Higher education

Australia's mining industry covers a range of scientific fields and professional occupations and is the largest total employer of:

- Mining engineers (10,078)
- Geologists and geophysicists (11,250)
- Industrial, mechanical and production engineers (10,400)
- Production managers (6,600)
- Metallurgists (678).[5]

Mining is also the second-largest employer of production managers (employing more than 10,570 directly and indirectly); third-largest employer of industrial, mechanical and production engineers (employing more than 16,360 directly and indirectly); and fourth-largest employer of environmental engineers and environmental consultants (employing more than 3,500 directly and indirectly).[6]

The MCA advocates for a higher education system which produces job-ready graduates, who have well rounded capabilities allowing them to confidently step into employment and be resilient in managing their future careers through continued technological, economic and social change.

Through the MCAs Minerals Tertiary Education Council (MTEC), the industry established and fosters robust relationships with Australian universities to deliver a stream of graduates equipped with skills necessary to sustain a career in the minerals industry now and into the future.

Box 1: Minerals Tertiary Education Council (MTEC)

In the late 1990's, from a minerals industry perspective, Australia's higher education system was characterised by unsustainable low student numbers across minerals-related programs, which threatened a future pipeline of professionals for the industry.[7]

In 1998, the MCA's *Back from the Brink* report:

- Identified delivery of education in Australia's universities needed to change if the minerals industry was to maintain and build upon its international competitiveness
- Explored Australia becoming a world leader in minerals education at a time when university education was becoming more market oriented
- Confirmed the opportunity to develop a true partnership between industry, government, and academia to reshape minerals education in Australia, thereby securing the supply of future specialist professionals.

In late 1999, MTEC was established to address the supply of graduates into the minerals industry and in partnership with universities, create world class minerals education in Australia.

This was driven by:

[5] Australian Government, *Labour Market Insights: Occupation profiles*, MCA calculations, 7 March 2023. These figures are estimates of the total number of workers directly and indirectly employed by the resources sector.
[6] ibid.
[7] Minerals Council of Australia: National Tertiary Education Taskforce, *Back from the brink: reshaping minerals tertiary education*, discussion paper, Canberra, February 1998, p. 3.

- The MCA acting as intermediary to drive closer, deeper engagement between universities and industry
- Building collaboration between universities in program development and provision.

Since MTEC's establishment, MCA funding of more than $65 million has supported specialist minerals related programs in mining engineering, extractive metallurgy and minerals geoscience across 17 Australian universities – benefitting over 6,000 graduates.

This support and investment, however, did not translate into universities defining a sustainable way of maintaining these programs without the need for recurrent industry investment.

A recalibration of the university/industry relationship was required that focussed on modernising course content and delivery to equip graduates with the skills needed in modern re-designed workplaces of the future.

From 2020, the MTEC strategy changed in response to industry needs and circumstance, with combined investment in a number of highly successful long-standing programs, alongside support of innovative pilot programs to test new approaches to curriculum updates, improved work integrated learning and diversified skills and learning pathways.

A comprehensive breakdown of MTEC funded programs and initiatives is listed on the MCA website.[8]

According to the QS World University Rankings by Subject 2023 (QS Ranking), a number of Australia's universities rank amongst the top in the world for minerals and mining engineering.[9] Curtin University's Kalgoorlie outpost, the Western Australian School of Mines (for the seventh consecutive year) secured the school the top ranking in Australia and second in the world.[10]

University of New South Wales and University of Queensland placed fourth and fifth. Rounding out Australia's top 50 representation were University of Western Australia, coming in at 7, University of Adelaide at 19, Monash University at 20, The University of Melbourne at 22, The University of Newcastle at 31, Queensland University of Technology at 42, and University of Wollongong at 46.

Whilst Australian universities ranked within the top 50 in geology and geophysics, they all fell outside the top ten, with the Australian National University placing eleventh for both subjects.

Vocational Education and Training

Vocational Education and Training (VET) provides a stable source of talent for the mining industry through apprentices and trainees, who make up more than 4.5 per cent of the workforce.[11]

Approximately 10 per cent of apprentices and trainees identify as Aboriginal and Torres Strait Islander and more than 21 per cent are women.[12] VET also provides opportunities for existing workers to upskill, re-skill, cross-skill and supports transitions from adjacent industries.

Over the last 10 years, the mining industry has been one of the strongest users of the VET system to skill and train its workforce. With an average of 60 per cent of employers using the system to meet their workforce needs, the industry was among the top five users nationally.[13]

During the same period, an average of 46.8 per cent of mining employers had jobs requiring vocational qualifications, higher than the all-industry average of 36.3 per cent.[14] Mining was the second greatest user of nationally recognised training, after construction.[15]

Relationships with Australia's VET system were cemented through the Mining Skills Organisation Pilot (MSOP).

[8] Minerals Council of Australia, *Minerals Tertiary Education Council*, Workforce, Innovation and Skills policy web page, Canberra, 2023.
[9] QS Top Universities, *QS World University Rankings for Engineering - Mineral and Mining 2023*, University rankings by subject web page, QS Quacquarelli Symonds Limited, 2023.
[10] Timothy Bond, *WA home to world-class mining university*, Australian Mining, Melbourne, 27 March 2023.
[11] National Centre for Vocational Education Research, *Apprentice and trainees 2022 September quarter*, released 28 March 2023.
[12] ibid.
[13] National Centre for Vocational Education Research, *Employers' use and views of the VET system: 2021: data tables*, table 3, MCA calculations 10-year average: 2011-21.
[14] ibid.
[15] ibid.

Through MSOP the MCA was developing strategic partnerships and pathways to facilitate access to, and inspire VET students and graduates to pursue opportunities in Australia's minerals industry.

Box 2: Mining Skills Organisation Pilot[16]

The Mining Skills Organisation Pilot (MSOP) was announced as part of the Australian Government's $585.3 million reform of the VET system, and formally launched on 7 May 2020 with the vision that VET become the pathway of choice for jobs in the minerals industry.

The $9.7 million investment for the MSOP over three years from 2019-20, matched with significant industry in-kind and financial support, has seen the MCA lead a program of work to develop a model for a mining skills organisation and improve national arrangements for skilling the workforce.

MSOP established four project hubs to drive training system improvement activities:

- Apprenticeships: understanding how to produce tradespeople faster without losing quality, and ensuring a better fit between skill needs and training programs
- Attraction and retention: focusing on workforce planning, pathways and skillsets for those looking to enter or transition into the mining, resources or energy sector from outside (complementary) industries
- Digital transformation: building speed to market and responsiveness to address issues around the identification and prioritisation of skills needs for the mining, energy and resources sector
- Qualification reform trials: testing new ways of designing qualifications to improve the flexibility and responsiveness of qualifications design, and address transferable and specific skills for the industry now and into the future.

MSOP transitioned into a standalone entity in October 2021 and has now been superseded by AUSMESA – the Australian Government's Mining and Automotive Jobs and Skills Council, with a focus on working to address skills shortages in the mining and automotive industries by improving training packages.[17]

The MCA works in partnership with AUSMESA to build a robust, agile and sustainable workforce for Australia's mining and resources.[18]

Skills shortages and unstable talent pipeline

Addressing skills and labour shortages is a global challenge. As the nation navigates the economic recovery of the COVID-19 pandemic and impacts of low productivity growth, fortifying the integrity and stability of Australia's education, skills and training sectors is an important foundation, and continued priority for the minerals industry.

A substantial growth in workforce size, combined with tightening of the labour market has seen the mining industry experience acute skills shortages that are driving up costs and reducing production.

Since 2011, more than 90,000 jobs have been added to the mining workforce and projections of continued strong growth indicate an additional 16,000 jobs to be added by November 2026.[19] This substantial growth in workforce size, combined with tightening of the labour market has seen the mining industry experience acute skills shortages.

The most critical professional roles for the mining industry are mining engineers, geotechnical engineers, metallurgists and geologists.[20]

The National Skills Priority List 2022 reported the number of occupations in shortage grew by nearly 50 per cent from the previous year, underlying the severe constraints in the current labour market.[21]

[16] Minerals Council of Australia, MCA facilitates next steps for mining skills, MCA Annual Report, Canberra, 2020, p. 17.
[17] AUSMESA, *Welcome to AUSMESA, web page,* 2023.
[18] ibid.
[19] Australian Bureau of Statistics, *Labour Force, Australia, Detailed, Quarterly: February 2023,* 23 March 2023, table 6; and National Skills Commission, *Employment Outlook: Industry and occupation trends: five years to November 2026*, 2022, p. 7.
[20] Minerals Council of Australia, *Submission to the Employment white paper consultation*, 5 December 2022, p. 14.
[21] National Skills Commission, *2022 Skills Priority List* and *Key Findings Report,* Australian Government 2022.

Newly listed occupations relevant to the mining industry include miners, drillers, engineers (chemical, materials and electronics) and technicians (metallurgical, materials and mechanical).[22]

In addition to professional roles, some of the critical skills required for mining include technicians (earth sciences, electrical engineering, and metallurgical and materials), trade workers (electricians, diesel fitters and automotive mechanics) and machine operators (drillers, miners and train drivers).[23]

A more detailed breakdown of skills shortages, including reporting from member companies and internet vacancy data is outlined in MCAs submission to the Employment white paper consultation.[24]

Advancements in technology and their application across industries will not only shape the future needs of Australia's workforces, they will contribute to the fight for skills across industries. For example, the strong overall growth in Australian technology workers is expected to continue, with forecasts of over 1 million technology workers by 2024, growing to 1.2 million by 2027.[25]

These workers will be spread across multiple industries, including mining, METS and advanced manufacturing. However, this will require growing the skills pipeline for technology talent, including digital skills.

Improving student engagement and outcomes aligned with industry need

Ensuring students take up the right courses, delivery modes and pathways requires innovation and lateral thinking across all parts of the pipeline, to encourage and facilitate study options, skills development activities and employment pathways in a holistic, lifelong learning model.

Industry has made significant investment in supporting education and training initiatives and pathways to employment. Individual company commitments to investing in skills and education have been substantial – from school education programs to internships, apprenticeships and scholarships, as well as undergraduate and postgraduate sponsorships and programs.

Despite significant and ongoing industry investment and collaboration, the industry is experiencing sustained skills and labour shortages and universities continue to report fluctuating student enrolments across disciplines. As the technically-driven, minerals related courses tend to have smaller enrolments, there is increasing pressure to increase student numbers, amalgamate with larger courses, or shutdown.

The Productivity Commission recommended reverting to a demand-driven model of funding, should this model be considered, it is vital to ensure that mechanisms are put in place to safeguard:[26]

- Courses that will secure the workforce needed for Australia to achieve net zero and deliver a cohesive clean energy sector and supporting supply chain
- The ability for Australia institutions to deliver these courses and retain the associated core knowledge and intellectual property.

Australian governments should:

Safeguard critical, but lower-demand courses from negative effects of any changes to funding models (federal or state) – for example, those courses that will help Australia's workforces secure the talent pipeline required to achieve net zero.

[22] ibid
[23] Minerals Council of Australia, *Submission to the Jobs and Skills Australia 2023 National Skills Priority List Survey,* 31 January 2023, p. 2.
[24] Minerals Council of Australia, 5 December 2022, p.p.14-15.
[25] Australian Computer Society, *ACS Australia's Digital Pulse Unlocking the tech sector: beyond one million,* Deloitte Access Economics, 2022, p. 1.
[26] The Productivity Commission, *5-year productivity inquiry: advancing prosperity – From learning to growth, Inquiry report – volume 8*, report no.100, Australian Government, Canberra, 7 February 2023, p. 51.

3. CHALLENGES AND OPPORTUNITIES FOR AUSTRALIA

The Australian Universities Accord should:

- Work with Jobs and Skills Australia in translating outcomes of Jobs and Skills Australia's Clean energy capacity study to the tertiary education sector – to ensure the sector is able to identify, plan and facilitate the right offerings, infrastructure and tertiary workforce needed to secure the talent pipeline for the clean energy workforce
- Undertake a scoping study with Jobs and Skills Australia for establishing tertiary 'green skills' qualifications (including determination of skills level, types of offerings for specialist and upskilling options) to create a benchmark for national consistency in the development and application of 'green skills' across industries and occupations.

Impact of new and emerging technologies

Clean energy workforce

As highlighted in the Discussion Paper, the transformation of Australia's energy system creates huge demand for skills, knowledge and technological solutions.[27]

Jobs and Skills Australia is conducting a Clean energy capacity study to understand the Australian workforce needed to transition to a clean energy economy.[28] The study will build on existing research and deepen understanding of the [emerging] clean energy sector, the skills of existing workforces, levels of skills transferability across industries and jobs, as well as forecasts of future supply and demand for clean energy-related roles.[29]

This approach will enable the clean energy workforce to be considered across the full supply chain of clean energy production – from mining of raw materials, through to any waste management requirements – to ensure all workforce constraints are considered. This will reflect a broad set of skills from the high-skill traditional occupations, through to traditional trades, as well as emerging roles, and roles which will be augmented through the changed lens of clean energy and/or the application of technology. For example, an electric vehicle mechanic requires skills more aligned to an IT professional or software engineer than a traditional mechanic, such as coding and reprogramming vehicle software and diagnosing and repairing high voltage rechargeable energy storage systems.[30]

The higher education sector, as well as the broader tertiary eco-system need to be equipped with the right offerings, infrastructure and workforce to cultivate the talent pipeline for clean-energy related roles; both new and emerging roles, as well as those that support the full supply chain of clean energy production.

The Australian Universities Accord should:

- Work with Jobs and Skills Australia (JSA) in translating outcomes of Jobs and Skills Australia's Clean energy capacity study to the tertiary education sector – to ensure the sector is able to identify, plan and facilitate the right offerings, infrastructure and tertiary workforce needed to secure the talent pipeline for the clean energy workforce.

The raw materials challenge

As the world seeks to reduce carbon emissions, demand for renewable and low emissions technologies and their component parts will increase dramatically. The global transition to low emissions technologies – including solar, wind, batteries, gas, advanced coal and nuclear energy – depends on the metals and raw materials provided by the minerals sector.[31]

[27] Department of Education, *Australian Universities Accord Discussion Paper*, Australian Government, February 2023, p. 9.
[28] Jobs and Skills Australia, *Clean Energy Capacity Study: Terms of Reference*, webpage, 2023.
[29] ibid.
[30] Tess Bennett, *An extra 6000 EV mechanics will be needed by 2030*, Financial Review, 12 December 2021.
[31] Minerals Council of Australia, *Energy and climate change*, web page, 2021.

Australia is one of the world's major producers of key mineral commodities (bauxite, coal, copper, lead, gold, ilmenite, iron ore, nickel, rutile, zircon, and zinc) with significant geological reserves of other minerals.[32] Established operations across Australia refine bauxite into alumina; smelt alumina into aluminium; refine and mint gold and silver; process, smelt and refine copper, zinc, nickel and other base metals.

Over the next three decades the world is on track to consume more minerals and metals than the total consumed over the last 70,000 years.[33] This creates a raw material challenge requiring economic, technological and workforce interventions.

Box 3: The raw material challenge

There is broad consensus that demand for metals essential to the clean energy transition will rise substantially in the long-term.[34]

Electrification will drive increased demand for copper, nickel, cobalt, uranium for nuclear power and lithium needed for battery electric vehicles, neodymium for permanent magnets and steel for critical infrastructure.[35]

Leading analysts forecast demand for some raw materials, such as rare earth metals, could increase by a volume of ten times or more the current market size.[36]

- Demand for electricity is projected to triple by 2050 as sectors electrify and hydrogen and hydrogen-based fuels become more available as the economy decarbonises[37]
- A fourfold increase in metals is required to generate the same megawatts from wind and solar energy generation as a coal or gas-fired power station.[38]
- By 2050 the minerals and metals required globally each year to decarbonise the electricity sector could be double to nine times the amount produced in 2015, and three and a half to seven times for the transport sector, depending on the speed of emissions reductions.[39]
- By 2030, global electricity storage alone will require 50 new lithium mines, 60 new nickel mines and 17 new cobalt mines.[40]

With significant resources of these minerals, Australia is well placed to meet this surging demand – to do this will require the mining industry to explore for the metals, find, and develop the deposits that will enable the transition.

Critical to this will be the industry's ability to:

- Attract new investment needed to increase output and meet this demand – the mining industry faces significant competition from emerging mining regions in Africa as well as traditional mining centres in South America and Canada to attract investors[41]
- Access the existing and emerging technologies needed to facilitate and maintain the energy transition – this includes:
  - Transformative technologies such as carbon capture utilisation and storage in which Australia can build competitive advantages to underpin high paying jobs in the clean economy of the future

[32] Minerals Council of Australia, *Submission to Australia's critical minerals strategy: discussion paper*, February 2023, p. 10.
[33] Guillaume Pitron, *The Rare Metals War: the dark side of clean energy and digital technologies*. Scribe Publications, 2020.
[34] Minerals Council of Australia, *Submission to Productivity Commission inquiry into Australia's productivity performance*, 29 March 2022, p. 10.
[35] Minerals Council of Australia, *The Digital Mine: A review of Australia's mining innovation ecosystem*, September 2022, p. 12.
[36] Minerals Council of Australia, September 2022, p. 12; and Marcelo Azevedo et al., *The raw-materials challenge: How the metals and mining sector will be at the core of enabling the energy transition*, McKinsey and Company,10 January 2022.
[37] McKinsey and Company, *Global Energy Perspective: executive summary*, April 2022, p. 23.
[38] op. cit. Marcelo Azevedo et al, January 2022.
[39] T. Watari et al., *Total material requirement for the global energy transition to 2050: A focus on transport and electricity*, Science Direct: Resources, Conservation and Recycling, Volume 148, September 2019, p.p. 91-103.
[40] International Energy Agency, *Global Supply Chains of EV Batteries*, July 2022, p.p. 49-50.
[41] Minerals Council of Australia, 29 March 2022, p. 10.

- Critical technologies such as long duration energy storage, which enable surplus energy to be stored from wind, solar and other clean sources to be available when needed[42]

- Secure technical, specialist and operational workforce needed – this includes emerging occupations as well as those currently in national and global shortage.

Sustainability and environmental challenges

In addition to the technical, specialist and operational skills, there will be increased demand for 'green skills' (at a specialist level and to upskill existing professions) to support the energy transition and tackle climate change. These will be required to ensure competency, application and advancement across:

- Safety and sustainability practices and sustainable development planning
- General environmental knowledge, awareness and understanding
- Regulatory skills related to compliance, licensing and modelling
- Research and adaptive management skills for environmental planning.

Demand for these skills will spread across industries, placing additional pressure on both the education and training system, as well as the already tight skills and labour market.

The Australian Universities Accord should:

- Undertake a scoping study with JSA for establishing 'green skills' qualifications (including determination of skills level, types of offerings for specialist and upskilling options) to create a benchmark for national consistency in the development and application of 'green skills' across industries and occupations
    - The collaboration could be a tripartite arrangement with JSA and VET, or through a broader 'green skills' taskforce (comprised of government, JSA, higher education and VET providers, peak bodies and/or industry representatives, relevant regulators and environmental management experts).

[42] Long Duration Energy Storage Council and McKinsey & Company, *Net zero power: Long duration energy storage for a renewable grid*, LDES Council, November 2021, p. ii.

4. MEETING AUSTRALIA'S SKILLS AND KNOWLEDGE NEEDS NOW AND INTO THE FUTURE

The Australian Government should:

- Offer further rounds of the Women in STEM and Entrepreneurship to encourage participation of girls and women in science, technology, engineering and mathematics leading to STEM education and careers.[43]
- Prioritise implementation of recommendations from the Review of the Australian Qualifications Framework (AQF) Final Report 2019, by establishing a governance body, accountable to the relevant Council of Australian Governments (COAG) councils, with representation from government, schools, VET, higher education, industry and professional bodies, to implement agreed reforms to the AQF[44]
- Establish a cohesive tertiary education system that accommodates the unique requirements of both the higher education and VET sector, is easy to navigate and provides a modern mix of education, training and skills pathways, to provide knowledge and skills needed in the redesigned workplaces of the future – this should be done through co-design with the Australian Universities Accord, and relevant representatives from VET and industry.

The mining workforce

The mining industry's high-tech operations are directly providing 286,000 highly paid, highly skilled and secure jobs across Australia.[45] They are also driving demand for skills and expertise from multiple fields, such as data analytics, robotics and artificial intelligence.

With a significant national supply chain, Deloitte Access Economics estimates one in ten Australian jobs is linked in some way to the mining industry. A key part of the supply chain is delivering innovative drilling, extractive and processing technologies to improve performance.[46]

Evolving skills of the mining workforce

Already digitalisation and technology is transforming mining skills with traditional mining trades increasingly incorporating elements of computing, and new career paths such as mechatronics and virtual reality advancing the digital ambitions of mining companies.

Estimates from EY show adoption of digital and technological innovation has the potential to deliver significate productivity improvements (up to 23 per cent) to the mining industry by 2030.[47]
EY also estimates that to transform the industry in this way requires investment of up to $35.2 billiion in technology and up to $12.8 billion in people.[48]

These jobs are increasingly requiring leading edge skills: advanced engineering and mathematics, digital, artificial intelligence, robotics and communications. This is on top of significant traditional employment in engineering trades, chemical and environmental science.

[43] Australian Government, *Grants to boost participation of girls and women in STEM and entrepreneurship*, Grants and programs web page – business.gov.au, 10 March 2023.
[44] Peter Noonan et al., *Review of the Australian Qualifications Framework Final Report 2019*, Australian Government, 30 September 2019, p.p. 11 and 15.
[45] Australian Bureau of Statistics, *Labour Force, Australia, Detailed, Quarterly – February 2023*, 23 March 2023, table 6.
[46] Deloitte Access Economics, *Economic contribution of the mining and METS sector*, Australia Estimates, 2021.
[47] EY, *The Future of Work – The economic implications of technology and digital mining*, report commissioned by the MCA, Canberra, 2019, p.9.
[48] ibid, p. 50.

Box 4: Science, technology, engineering and mathematic (STEM) skills

A number of challenges exist in securing the STEM pipeline to service the skills required for the mining, METS and advance manufacturing workforces into the future, including:

- Lack of 'work readiness' amongst STEM graduates – due to inadequate problem-solving skills in technology-rich work environments[49]
- The narrowing pipeline to STEM careers – exacerbated by the volume of STEM subject being taught by 'out-of-field' teachers in schools, teacher quality in vocational education and training, and declining enrolments in STEM subjects/courses at all levels.[50]
- The growing complexity of attributes sought by employers – both formal technical qualifications, and broader experiential or employability attributes, in light of shifting technologies and workplace practices[51]
- The lack of diversity in the STEM pipeline – women hold only 15 per cent of STEM roles in Australia (an increase of five percentage points in 10 years), at this rate, equal representation of women in the STEM workforce will take 70 years.[52]

Many of the roles and skills are centred on science, technology, engineering and mathematics (STEM). These skills are critically important to live and work in a globalised world, providing the necessary knowledge to solve real-world challenges and address complex problems.[53]

Government, industry and education providers at all levels, need to work together to ensure a stable supply of STEM qualified professionals. In recognition of the growing role of digital skills in the Australian workforce and that a key objective is to improve diversity in the STEM workforce, sustained investment to support this is required.

The Australian Government should:

- Offer further rounds of the Women in STEM and Entrepreneurship to encourage participation of girls and women in science, technology, engineering and mathematics leading to STEM education and careers.[54]

Skills mix of workers

As the nature of work changes and evolves, workers will need skills and capabilities that are adaptable, transferable, relevant to the needs of the future economy, and which are not easily replicated by technological advances.[55]

In light of shifting technologies and workplace practices, Australia's mining workforce, as well as other workforces (e.g. advanced manufacturing) will increasingly need a complex mix of skills – both formal technical qualifications, and broader experiential or employability attributes:

- Skills needed to leverage technologies: change management, advanced system development and integration, data science and digital literacy, higher level operations and planning, business information systems operations and data analysis

[49] The Productivity Commission, *Digital Disruption: What do governments need to do?*, Australian Government, 2016, as cited in Advanced Manufacturing Growth Centre, *Manufacturing competitiveness plan 2022: transforming Australia from lucky to smart*, 2022, p. 78.
[50] School News Australia, *STEM classes taught by teachers outside of their field of expertise*, May 12 2020; Steph Delaporte, *STEM education in Australia*, 9 June 2020, World Strides Educational Travel & Experiences; Sue Thompson, *Student educational aspirations and attitudes towards STEM*, Article from the Australian Council for Educational Research, Teacher Magazine, 7 June 2021; and Minerals Council of Australia, *The Digital Mine: A review of Australia's mining innovation ecosystem*, September 2022, p. 12.
[51] Tanya Carney and Jim Stanford, *Advanced skills for advanced manufacturing: Rebuilding vocational training in a transforming industry*, Report by The Centre for Future Work at the Australia Institute, June 2018, p. 19.
[52] Barbara Messerle and Steph Ryan, *How to get women in STEM and keep them there*, Australian Financial Review, 5 March 2023.
[53] Department of Education and Training, Support for Science, Technology, Engineering and Mathematics (STEM), Australian Curriculum web page, Australian Government, 6 October 2021.
[54] Australian Government, *Grants to boost participation of girls and women in STEM and entrepreneurship*, web page – business.gov.au, 10 March 2023.
[55] Minerals Council of Australia, *Submission to the Australian Qualifications Review*, 15 March 2019, p. 2.

- Cognitive skills to balance technology enhanced workplaces: critical thinking collaboration, problem solving, communication and complex stakeholder management – with new skills in self-management including active learning, resilience, stress tolerance and flexibility.[56]

These broad ranging skills, competencies and qualifications will be obtained through both accredited and non-accredited offerings across the tertiary landscape. There is an expectation that these skills, competencies and qualifications are:

- Offered through a mix of modern education, training and skills pathways, developed in collaboration with industry – including traditional and nested qualifications, accelerated apprenticeships, micro-credentials and accredited bridging/stackable, short-burst courses
- Portable, affordable and accessible to all Australians regardless of their background
- Increasingly delivered just-in time where appropriate.

To support this, the Australian Government should:

- Prioritise implementation of recommendations from the Review of the Australian Qualifications Framework (AQF) Final Report 2019, by establishing a governance body, accountable to the relevant Council of Australian Governments (COAG) councils, with representation from government, schools, VET, higher education, industry and professional bodies, to implement agreed reforms to the AQF[57]
- Establish a cohesive tertiary education system that accommodates the unique requirements of both the higher education and VET sector, is easy to navigate and provides a modern mix of education, training and skills pathways, to provide knowledge and skills needed in the redesigned workplaces of the future – this should be done through co-design with the Australian Universities Accord, and relevant representatives from VET and industry.

[56] EY, *The future of work: the changing skills landscape for miners*, Report commissioned by the MCA, Canberra 2019, p. 13; and Advanced Manufacturing Growth Centre, 2022, p.35.
[57] Peter Noonan et al., *Review of the Australian Qualifications Framework Final Report 2019*, Australian Government, 30 September 2019, p.p. 11 and 15.

5. COLLABORATION WITH INDUSTRY

The Australia Government should:

- Support next generation university-industry R&D collaboration initiatives such as the Trailblazer Universities Program, which better integrates research between universities and industry
- Maintain support for industry-oriented research initiatives such as university-led institutes, CRCs and CSIRO-led initiatives.

A system that delivers new knowledge, innovation and capability

Australian mining is contributing to research to develop future technologies and industries

Innovation enables Australian mining companies to extract and process ores at competitive cost and to extract deposits that are becoming deeper or more remote. New techniques and technologies allow firms to increase productivity and remain competitive in an increasing globalised industry. Innovation also supports improved safety, social and environmental outcomes by allowing impacts to eliminated or better mitigated or managed.

A global technology leader and one of the most productive industries in the world, innovation occurs across the mining value chain within what can be called the mining innovation 'ecosystem.'[58] It is comprised of mining firms and other stakeholders contributing to mining innovations such as:

- Businesses providing mining equipment, technology and services (METS sector)
- International suppliers of specialised mining equipment
- Publicly-funded universities and research organisations, such as the CSIRO, as well as cooperative research centres (CRCs) and other government-funded agencies
- Investment on behalf of and/or in collaboration with the mining industry by firms in the METS sector, leading technology supplies, and research agencies.[59]

Collaboration – both within industry and between industry and researchers – helps to advance scientific knowledge, solve industry-wide problems, develop new industries and benefit the economy as a whole. Australian mining has invested more than $30 billion in research and development (R&D), since 2005.[60]

The Digital Mine Report – released by the MCA in September 2022 – provides a review of Australia's mining innovation ecosystem – including the evolution, innovators and technologies. Importantly, it provides a breakdown of:

- Mining research led by mining institutions – areas of focus, industry and government partners and related centres and facilities (e.g. Sustainable Minerals Institute (SMI), University of Queensland[61]
- Mining research led by cooperative research centres (CRCs) – areas of focus and industry and University partners (e.g. Transformations in Mining Economies (CRC TiME) [62]

[58] The Productivity Commission, *5-year Productivity Inquiry: Advancing Prosperity Inquiry report,- volume 1,* Report no. 100, 7 February 2023, p. 7; A Daly et. al., *Global Challenges for Innovation in Mining Industries,* Cambridge University Press, 2021; and, The Productivity Commission, *Shifting the Dial: 5 Year Productivity Review: Supporting Paper No. 1: Productivity and Income – The Australian Story*, Canberra, 3 August 2017, 24 October 2017, p.p. 22, 26.
[59] Minerals Council of Australia, September 2022, p. 16.
[60] Australian Bureau of Statistics, *Research and Experimental Development - Businesses, Australia,* published 3 September 2021.
[61] Minerals Council of Australia, September 2022, p. 58.
[62] Minerals Council of Australia, September 2022, p. 63.

- Mining research led by government agencies – areas of focus and industry, University and CRC partners (e.g. Commonwealth Scientific and Industrial Research Organisation (CSIRO).[63]

Box 5: Resources Technology and Critical Minerals Trailblazer hub [64]

Curtin was the first university nationally to receive a share of $242 million in Australian Government funding last year to develop a research commercialisation hub to keep Australia at the forefront of critical mineral supply chains.

The Trailblazer project is a collaboration between Curtin University, The University of Queensland and James Cook University – collectively the university partners have attracted 33 industry partners across Australia who are working in value chains associated with lithium, nickel, cobalt, vanadium and hydrogen resources.

Industry partners have committed over $90 million of investment in the Trailblazer.

Regional benefits include the engagement of local business to provide services across a broad spectrum, including transport and logistics, construction, maintenance, flowing through to other areas of the business community in regional areas.[65]

Through this hub, the collaboration is positioned to, amongst other things:

- Facilitate industry placements and relevant training to help early stage academic career development
- Develop cost effective exploration, extraction and processing technologies across a number of value chains, as well using digital capabilities and automation to increase Australia's global competiveness
- Design and test a digital stack and autonomous system that will equip critical minerals pilot plants and mine equipment with a digital stack (sensors, wifi/networks, artificial intelligence, simulation, decisions) for productivity gains and training
- Partner with industry to design and pilot more education programs.

If Australian mining is to maintain its position as a global innovation leader, a supportive innovation ecosystem is required. As a central vehicle for Australian mining to develop and deploy decarbonisation technologies and other key innovations to support industry's transition to net zero and broader safety, productivity and sustainability, R&D remains a crucial component of this ecosystem.

The Australia Government should:

- Support next generation university-industry R&D collaboration initiatives such as the Trailblazer Universities Program, which better integrates research between universities and industry[40]
- Maintain support for industry-oriented research initiatives such as university-led institutes, CRCs and CSIRO-led initiatives.

[63] Minerals Council of Australia, September 2022, p. 65.
[64] Curtin University, *Industry titan set to lead Curtin's cutting-edge mineral research hub,* News at Curtin, Perth, 9 February 2023; and Alexandra Eastwood, *Curtin employs industry titan for minerals research,* Australian Mining, Melbourne, 14 February 2023.
[65] Department of Education, *Trailblazer Universities Program*, Programs and Initiatives page, Australian Government, Canberra, 15 February 2023.

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    - Data sources for occupations is based on: ANZSCO 4-digit occupations: ABS, Labour Force, Detailed, Jobs and Skills Australia seasonally adjusted February 2023; and ANZSCO 6-digit occupations: ABS, 2016 Census, customised report. ANZSCO 6-digit figures do not sum to match the total for their 4-digit parent, as the figures come from different sources.
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