

Mining **Future Skills**



MINING QUALIFICATIONS AUTHORITY

Final Report

**TITLE: DETERMINING THE REQUIREMENT FOR SKILLS AND
UPSKILLING OF MMS WORKFORCES IN THE SUPPORT OF JET, IN
LINE WITH AN ESG FRAMEWORK**

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Acronyms and Abbreviations

B-BBEE:	Broad-Based Black Economic Empowerment
CEDEFOP:	European Centre for the Development of Vocational Training
CSR:	Corporate Social Responsibility
DHET:	Department of Higher Education and Training
ESG:	Environmental, Social and Governance
JET:	Just Energy Transition
JSE:	Johannesburg Stock Exchange
ILO:	International Labour Office
MCSA:	Minerals Council South Africa
MHSA:	Mine Health and Safety Act (29 of 1996)
MHSC:	Mine Health and Safety Council
MMS:	Minerals and Mining Sector
MPRDA:	Mineral and Petroleum Resource Development Act
MQA:	Mining Qualifications Authority
NBI:	National Business Initiative
NEMA:	National Environmental Management Act
NEMLA:	National Environmental Management Laws Amendment Act
NEMWA:	National Environmental Management: Waste Act
OEM:	Original Equipment Manufacturers
PGM:	Platinum Group Metals
SANEA:	South African National Energy Association
SLP:	Social and Labour Plan
SSP:	Sectoral Skills Plan

STEM: Science, Technology, Engineering & Mathematics

TVET: Technical and Vocational Education and Training

EXECUTIVE SUMMARY

This study aimed to determine the extent to which Environmental, Social, and Governance (ESG) principles have been adopted in the Minerals and Mining Sector (MMS). It also sought to understand the state of Just Energy Transition (JET) skills within the Minerals and Mining Sector (MMS), skills frameworks, skills availability, and the effectiveness of policy and legislation related to achieving JET in the MMS.

It was determined to undertake a mixed-methods research study, combining quantitative and qualitative research instruments to gather data from stakeholders on the topics under discussion.

The study is significant to the MMS as ESG is essential to mining operations, particularly from a legislative perspective. JET is a significant factor within the MMS due to its reduction in climate harm and the reduction in the use of fossil fuels. The various impacts of JET fall within all aspects of ESG.

The limitations inherent in this research study were primarily characterised by a constrained timeframe, which encompassed clearly defined start and end dates. This constraint significantly reduced the opportunity for engagement with mining operations and subject matter experts. Furthermore, challenges were encountered concerning the availability of participants during the data collection phase of the study. Potential explanations for this phenomenon may include participant fatigue, particularly due to the presence of concurrent studies within the MMS.

The literature review indicated that there are presently no established JET skills frameworks applicable to the MMS, both in a local and global context. A predominant emphasis is placed on technical skills, while soft skills, although necessary, are frequently overlooked. Skills are often articulated in vague terms, lacking the specificity required for effective training planning; for example, engineering skills may be mentioned without indicating any particular specialisation. Furthermore, there exists a necessity to examine skills from a cross-sectoral

perspective, given the inherently cross-sectoral nature of JET. This entails the identification of skills that span multiple sectors. Additionally, it was deemed essential to expand the stakeholder mapping to encompass a broader spectrum beyond mere operational considerations.

Regarding the identification of skill needs, a model was developed by the Mining Qualifications Authority (MQA), while a separate model was created by the National Business Initiative (NBI). Integrating these models may yield a more comprehensive methodology for skill assessments, ultimately leading to a more precise identification of skill gaps.

Regarding ESG considerations, numerous frameworks have been established; however, none have been specifically mandated for the MMS. The Johannesburg Stock Exchange (JSE) has formulated a framework that is obligatory for listed companies, some of which are stakeholders within the MMS. This framework may also be tailored for application by other stakeholders.

Engagements with stakeholders indicated that slightly over 50% utilise an ESG framework. However, ESG is also perceived, to a certain degree, as a begrudging activity compelled by legislative requirements, which is occasionally challenging to implement in practice.

Responses from stakeholders concerning the JET data gathering are consistent with the literature review on several aspects. Notably, there are currently no existing skills frameworks, and the emphasis primarily lies on technical skills, with minimal consideration given to the necessary soft skills. Furthermore, it is imperative to enhance the understanding of skills requirements across various sectors. It has also been observed that there is a scarcity of available information pertaining to JET, particularly in relation to ESG, prompting stakeholders to request that information be disseminated within the MMS. The involvement of stakeholders, including training providers and community representatives, in the development of skills is of utmost importance.

The primary findings consist of a model illustrating JET as a subset of ESG, thereby indicating the potential for monitoring and evaluation of JET through ESG frameworks. A skills needs

analysis model, which incorporates the contributions made by the MQA, the NBI, and recommendations for broadening stakeholder engagement, is presented herein. Furthermore, it is imperative to disseminate information regarding JET and ESG within the MMS to enable the MMS to address these concepts appropriately.

The recommendations underscored a notable deficiency in awareness within the MMS regarding JET skills and their integration with ESG principles. The development of informational materials and the provision of awareness sessions would serve to mitigate this knowledge gap. The second recommendation pertains to the establishment of a relevant ESG Framework for the mining sector that encompasses the dimensions of JET. This includes initiatives to raise awareness about such models and emphasise the associated benefits. The third recommendation advocates for the execution of a comprehensive skills needs analysis that incorporates a broader range of stakeholders, with particular attention to timelines and geographic areas. A cross-sectoral approach is essential; this could manifest as a cohesive support structure, potentially including the Department of Higher Education and Training (DHET), which would oversee detailed multi-sectoral skills needs analysis initiatives that would complement each other. Such a supportive framework would facilitate the necessary alignment among stakeholders. The fourth and final recommendation is to assess training and development institutions' curriculum, infrastructure, and equipment requirements, ensuring they are aligned with the detailed skills needs and sectoral timelines.

In conclusion, it is imperative that JET be recognised as a subset of ESG frameworks, owing to its extensive impact. A model that illustrates the integration of JET within ESG, which is adaptable to various operational, social, and governance needs, has been presented. The skills associated with JET in the MMS currently lack a clearly defined framework, thereby necessitating further research and active stakeholder engagement to identify pertinent skills. An adapted skills needs analysis model emphasises the cross-sectoral nature of JET. This model encompasses components such as the involvement of employers, training institutions, and communities, focusing on aligning skills with precise timelines and enhancing the quality of education. Such an approach could empower entities, such as DHET, to lead in bridging skills gaps, uniting stakeholders, and potentially instigating policy changes that would benefit the MMS.

1. INTRODUCTION

The pressures induced by climate change have necessitated organisations to adopt a more environmentally sustainable approach to their operations. A significant aspect of this transformation relates to the energy sources employed in operational processes. The global landscape is shifting from a heavy reliance on fossil fuels for energy requirements towards a framework that incorporates alternative energy sources and the adaptation of operations to become less energy intensive.

This development significantly influences numerous industries, particularly the mining sector, which relies on fossil fuels as a primary commodity. Additionally, it necessitates the potential adoption of innovative technologies to harness alternative energy sources and enhance the operational longevity of mining sites. Such transformations carry implications for social structures and governance frameworks, ultimately guiding us toward the concept of JET. JET aims to facilitate the necessary environmental adjustments while mitigating negative social consequences.

This, in turn, leads us to the considerations surrounding ESG factors. Given that JET is focused on energy, it is directly related to the *environmental* aspect within the ESG framework. Furthermore, changes in skills resulting from JET pertain to the *social* considerations of ESG, as well as *governance* issues, which involve overseeing the ethical application of environmental and social matters within the MMS. This concept is not novel and has existed in various forms for several decades.

Taking the factors mentioned above into account, this research endeavoured to evaluate the implementation of ESG frameworks and to identify the prerequisites for skill development and enhancement within the MMS workforce, with the objective of achieving a just energy transition.

1.1 Scope of Study

The study was intended to yield valuable insights, for determining the requirement for skills, and upskilling of the MMS workforce; in the support of JET, in line with an ESG framework, as such:

- Understanding the state of the adoption of ESG principles in the MMS.
- Assessing the skills required to achieve JET.
- Interrogating how existing skills meet the requirements needed for JET in the MMS.
- Analysing the effectiveness of the existing legislative, and policy framework for the achievement of JET in the MMS.
- Determining the extent and nature of JET skills supply in the MMS.
- Specifying the potential impact of adopting ESG principles on the current workforce.
- Formulating interventions that the MQA can enact to support skills development related to the achievement of JET in the MMS.

1.2 Problem Statement

There is currently limited understanding of the skills required for a JET transition with the MMS. This is highlighted by the roundtable report undertaken by the African Climate Foundation in 2023, one of the findings of which was that a national skills mapping was needed (African Climate Foundation, 2023).

There does not appear to be a single identified framework for ESG in South Africa. The exception is the ESG framework developed by the JSE (JSE a, 2022), which applies to listed companies but may also be used by any organisation.

Additionally, a clear connection between the necessary JET skills in the MMS and ESG frameworks seems lacking, as well as how these aspects may either complement or conflict with one another. Consequently, the problem statement for this study has been articulated as follows:

The need for JET incorporation and ESG stipulations, in the mining sector, has brought about skills requirements which have not been clearly identified, which could impact negatively, on accurate skills planning, within the near future.

1.3 Significance of Study

This study has significance in several areas. In terms of ESG, it allows for the understanding of an ESG framework, that may be utilised within the MMS, to address the matters that may be outstanding, and not currently addressed by policy or framework. This allows for a proactive approach, to following international standards and potentially remaining ahead of the curve, should legislation or policy come into place. The focus on environmental and social aspects, impacts the communities and economy, through the health and well-being of community members, and the sustainability of communities.

Partnering ESG considerations with JET skills is a natural pairing that has common benefits. JET seeks to minimise the impact on jobs by upskilling and/or reskilling the existing workforce to meet the changing energy requirements that impact the environment, health, and welfare of communities. Understanding the skills required in this regard and their availability creates an opportunity to focus funding and skills development initiatives on targeted training interventions with maximum impact.

In conclusion, comprehending the degree to which existing policies and legislation support ESG and JET initiatives, in a feasible manner, establishes a conducive environment for these frameworks to flourish and empower the sector. There is frequently a tendency to regard JET and ESG as distinct frameworks, evaluated within isolated contexts of activities, consequently resulting in fragmented skills initiatives.

2. RESEARCH METHODOLOGY

This study sought to develop an understanding of JET, within the MMS, from a skills perspective. Further, was the need to identify if there are any existing JET skills frameworks, that are relevant to the MMS. If there are applicable frameworks, to determine what extent these skills are available, to arrive at recommendations, for closing gaps that may exist. Complementary to this, is the matter of understanding ESG frameworks, and determining if they are in use within the MMS. It was also necessary, to determine if ESG frameworks may serve as a monitoring, and evaluation tool for JET skills improvement.

2.1 Research Questions

Based on the conceptual framework, briefly highlighted above; the research questions for this study were defined as the following:

1. To what extent is there existing policy, and legislative frameworks, regarding ESG in the MMS?
2. How effective have the existing policies, and legislative frameworks been, in implementing JET in the MMS?
3. What are the skills required to achieve JET?
4. What is the availability of these JET related skills, in the MMS?
5. What interventions can be undertaken to support JET skills development in the MMS?
6. What is the potential overlap of impact, and skills requirements between JET and ESG?

These research questions informed the development of the research objectives, and the relevant data collection instruments.

2.2 Research Objectives

To address the above-mentioned research questions, and alignment to the problem statement, the following research objectives were developed:

- Primary Objective: Determine the state of adoption of ESG principles in the MMS.
 - Secondary Objective: Determine an ESG framework.

- Secondary Objective: Determine the extent to which this ESG framework is supported by legislation, or policy within the MMS of South Africa.
- Secondary Objective: Determine the extent to which ESG principles are applied, within sample operations, of the MMS.
- Primary Objective: Determine the skills required to achieve JET in the MMS.
 - Secondary Objective: Determine what the JET skills are in the MMS.
 - Secondary Objective: Determine to what extent JET skills are present in the MMS workforce.
 - Determine the effectiveness of policy, and legislation on JET in the MMS.
 - Secondary Objective: Determine the extent to which JET skills may flow over into other industries.
 - Secondary Objective: Determine the skills development interventions, that may be undertaken to support JET in the MMS.
- Primary Objective: Determine the impact of ESG principles and JET skills on one another.

2.3 Research Design

The research design deemed most appropriate for this study was descriptive. A descriptive research design aims to elucidate the characteristics or functions of a population or phenomenon. In this study, the researcher aimed to comprehend the availability of JET skills within the MMS and the impact of ESG considerations.

2.4 Research Methodology

This study employed a mixed methods approach, integrating both qualitative and quantitative methodologies. This strategy effectively gathered information about skills and provided insights into stakeholders' experiences. Qualitative tools such as interviews and focus groups facilitated deeper engagement with stakeholders, enhancing the understanding of existing practices. Additionally, this approach enabled the creation of a list of JET skills for consideration, alongside possible ESG frameworks for operational use.

The quantitative methodology of an online survey research instrument provided an opportunity to gather data from a larger number of stakeholders related to particular skills, skills analysis methods, and gap closure potential.

2.4.1 Data Collection

Several data collection techniques were utilised in the study, to allow for as much data to be collected as possible. This section details the methods used, but the results are consolidated in section 4 of this report.

2.4.1.1 Online survey

An online questionnaire was shared with a wide array of stakeholders, allowing data to be gathered from multiple participants. The use of a survey promoted higher levels of engagement, thus increasing the data collected. The survey was shared through various methods, including directly from the survey platform and through a link distributed via the larger research team, which provided wider access to participants.

The participant database was developed through the combination of multiple MQA stakeholder databases. The participant database consisted of operations across the various sub-sectors and training providers. The final database, for distributing the survey via the online platform, consisted of 1448 participants.

The result of the distribution of the survey link was as follows:

- 10 recipients opted out (0.8%).
- 198 bounced (15.8%).
- 1250 invitations were successfully delivered.
- 79 recipients participated using the online survey.
- A further 23 respondents participated through the distribution of the survey link, via the larger research team and the MQA.
- The total number of participants = 102.

Participants were not compelled to respond to any inquiries and were permitted to continue with the questionnaire, regardless of whether a question had been omitted. This led to varying response rates among the different questions in the survey. The categorisation of participants by stakeholder group exhibited a distribution across all stakeholder types.

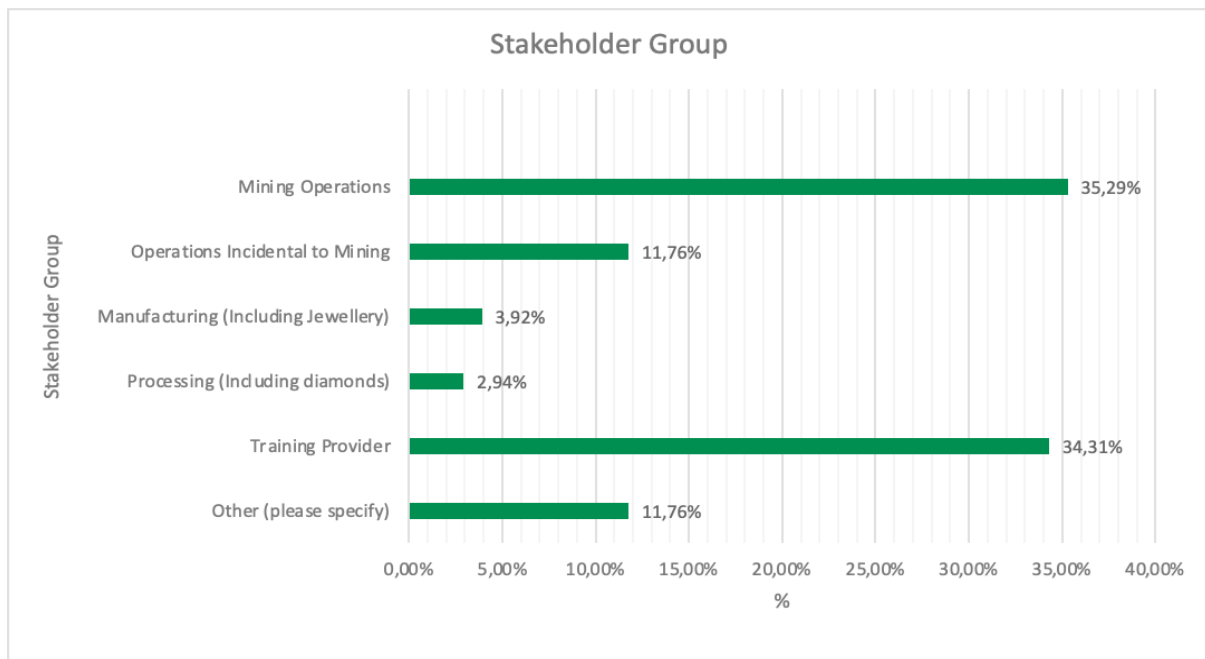


Figure 1: Stakeholder Group

The 'Other' category - was inclusive of government and employer representatives.

It was also found that there was some representation across all sub-sectors.

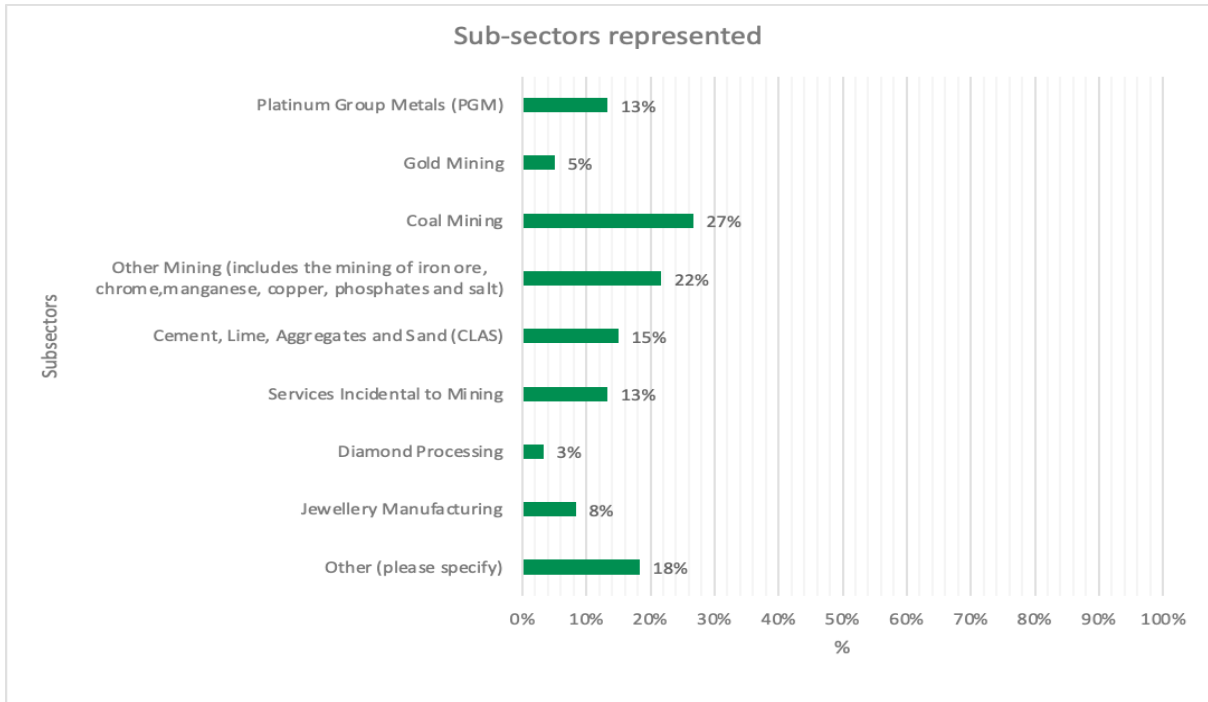


Figure 2: Sub-sector representation

There was also representation across the three organisation size categories.

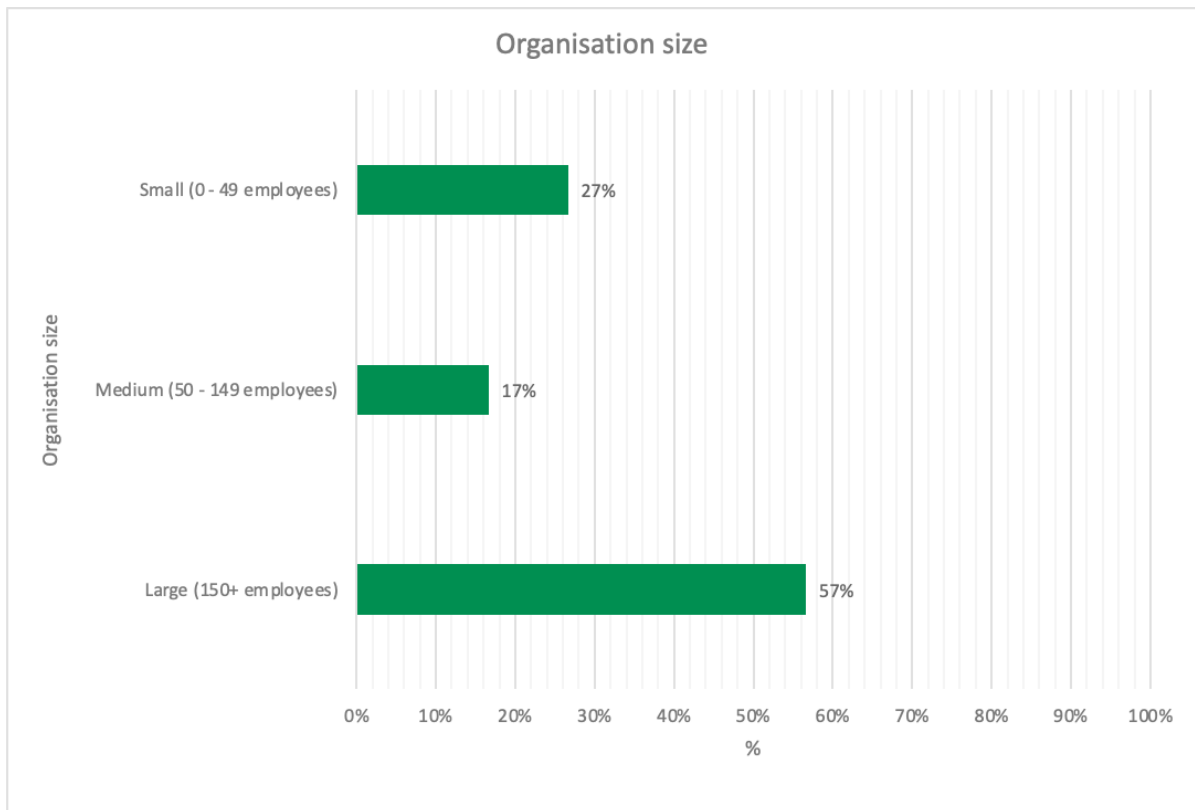


Figure 3: Organisation size

Annexure A provides the questionnaire. It was designed using logic branching based on the type of stakeholder. As such, one questionnaire was for the training providers and another for all other stakeholders.

2.4.1.2 Interviews

This data collection method was utilised with selected stakeholders to gain insights into their experiences, related to the areas that are the focus of the study. The interviews were predominantly semi-structured, with attention given to the primary research questions. The interviews focused on engagement with subject matter experts, and persons who could contribute value to the findings through their experience and knowledge.

Six interviews were conducted with mining operations. The majority of participants were found to have limited engagement with the topics of JET and ESG. While some data was gathered, the interviewer noted hesitancy regarding the linkages between JET and ESG.

2.4.1.3 Focus Groups

A qualitative research method involves a small group of participants, usually between 6 to 12, who take part in a moderated discussion about a specific topic or research question. This approach captures a range of perspectives, opinions, and insights in an interactive environment. One major benefit of focus groups is their capacity to delve into complex ideas through group dynamics, as participants often expand on each other's responses, uncovering insights that might not arise in one-on-one discussions. Moreover, focus groups can yield rich, detailed data in a relatively short timeframe and enable researchers to observe non-verbal cues and interactions, enhancing understanding of the topic at hand.

A total of 4 focus groups were held for this study:

- 3 sessions with mining operations
- 1 session with mining operations and training providers

2.4.2 Data Analysis Methods

The qualitative data gathered through interviews and focus groups was analysed using thematic analysis to identify common themes. The quantitative data gathered using an online survey were analysed using descriptive statistics.

2.4.3 Sampling Procedures

Within this study, it was necessary to ensure that there was representation from mining houses, that mine the following commodities:

- Gold
- Platinum Group Metals (PGM)
- Coal

The commodities listed above were chosen because of the different mining methods used in their operations. Moreover, the scale of these operations ranges from small to large. This diversity in size offers the MQA more precise data, allowing for further insights into other commodities. Both qualitative and quantitative methods were applied to the listed commodities. The sample comprised representatives from the following areas:

- Management
- Training and Development Practitioners (on-site)
- Subject Matter Experts (if applicable)
- Governing and advisory bodies (i.e. MHSC, MCSA, Mandela Mining Precinct)
- Training/Academic institutions

As such, quota sampling was the most appropriate sampling methodology to use, as it allowed for the selection of the sample based on the particular characteristics of varied operational sizes, and mining methodologies to ensure representativeness.

Thereafter, the sample was further refined, using convenience sampling, which allowed the researchers to engage with mining houses that are accessible and willing to participate in the study.

However, as indicated in section 2.4.1.1. there was representation across all sub-sectors.

2.5 Ethical Considerations

In a study examining the skill requirements for mining workers in alignment with JET and the ESG framework, researchers prioritised ethical principles that emphasised participants' well-being and dignity. Obtaining informed consent was crucial; participants received comprehensive information about the research's aim, any potential risks—which were non-existent—and the expected outcomes. They retained the right to withdraw at any time without repercussions. Moreover, the confidentiality and privacy of participants were safeguarded, particularly given the sensitive nature of employment-related data. Measures included anonymising personal information and ensuring that the study's findings were presented in a manner that protected individuals and groups from harm or discrimination.

From a broader perspective, the research sought to be conducted in a manner that promoted equity and inclusivity, reflecting the "just" aspect of the energy transition. The skills required for mining employees to adapt to new energy technologies often vary across different roles and demographics, so the study sought to avoid perpetuating any form of inequality, or bias by providing an opportunity to participate on a larger scale. Ethical research also means; acknowledging the socio-economic implications of transitioning to cleaner energy, particularly how it might affect vulnerable groups, such as low-skilled workers, or communities heavily dependent on traditional mining activities. Researchers aimed for transparency in how findings were used to shape policy and workforce development, ensuring that these do not exacerbate existing disparities, but rather support sustainable, fair outcomes for all stakeholders. The study did not measure or interpret any psychological factors of individuals or groups.

2.6 Limitations and Delimitations

Limitations within this research study include:

- Time. The study had a very limited timeframe, with defined start and end dates. This limited the level of interaction from mining operations and subject matter experts. The research team distributed the engagements as broadly as possible.
- Participants. There were limited challenges in terms of participants availing themselves to participate in the data gathering phase of the study. Causes of this may include study fatigue, as there are ongoing studies within the MMS. The research team attempted to mitigate this through the gathering of data on multiple studies at once.

Delimitations:

- The study was focused on the mining sector. JET spans across various industries and sectors, yet those sectors were excluded from the study.

3. LITERATURE REVIEW

South Africa heavily relies on fossil fuels for energy, with 83% of its electricity generated from these sources, and aims to reduce its environmental footprint by increasing renewable energy to 33% by 2030 (Ember, 2024) and achieving net zero carbon emissions by 2050 (Eskom, ND). This change allows for the diversification of energy sources, reducing the impact of the current volatile supply of energy and the negative impact felt by the economy (Ramsarup, Hepplethwaite, Poulton & Jenkin, 2024).

The JET concept aims to prioritise the transition to lower carbon technologies, minimising negative social impacts and improving workers' lives, reflecting the 'Just Transition' methodology (Eskom, ND). Understanding the socio-economic benefits of JET, allows for the improvement of citizens' lives through decent work, improved environments, and the reduction of energy poverty (Hunkin, 2023), which involves citizens having access to clean, safe and affordable sources of power (Koomson, 2024).

To allow for a successful transition, the impact of changing technologies on skills must be understood, not only for existing occupations but also for new occupations that evolve from greening the economy. As these needs emerge, it is becoming clear that there is an inter-sectoral aspect that requires analysis and potentially consideration of other methodologies for determining skills needs (Ramsarup, Hepplethwaite, Poulton & Jenkin, 2024).

In this report, reference was made to skills being defined as: “the ability to perform a task adeptly, using experience, and professional knowledge” (DHET, 2021) and competence is “a combination of knowledge, skills and attitudes” (EU Science Hub, ND).

ESG serves as a framework for addressing Environmental, Social, and Governance aspects that organisations encounter in their operations, which is especially pertinent to the mining sector. The connection between JET and ESG was one of the topics explored in the literature review.

3.1 JET Skills Framework in the MMS

This section was focused on determining if a JET skills framework existed globally, or within the local context of South Africa.

Skills for JET require improving basic educational levels in labour-intensive industries, and upskilling/reskilling for green jobs (Presidential Climate Commission, ND). This would be well addressed by considering how environmental knowledge and awareness are addressed at all levels of education. Strategies recommended by the European Training Foundation (2023) include:

- Environmental information should be included at all levels in formal curricula in age-appropriate ways.
- Professional development programmes should be developed for educators that improves environmental knowledge.
- Improved collaborative efforts between schools/training institutions and environmental organisations such as workshops.
- Utilising digital methodologies to improve access to environmental training.

Three key categories of skills for the green transition, as identified by the European Training Foundation (2023), were identified as follows:

- Sustainability skills - the competencies that enable individuals to make decisions and take actions that contribute to environmental preservation, social equity, and economic viability for current and future generations.
- Technical skills - the abilities required to adapt, implement, or maintain standards, processes, services, products, and technologies that support environmental protection. These include reducing energy, materials, and water consumption while promoting biodiversity and ecosystem preservation.
- Transversal skills - essential competencies that enable individuals to adapt to the evolving demands of a sustainable and digital economy. These skills include critical thinking, teamwork, problem-solving, creativity, and effective communication.

Ramsarup *et al.* (2024) have also identified that JET skills are more multi-dimensional than the changing technologies. Still, they are also inclusive of those skills that would improve people's lives whilst protecting and reducing harm to the environment and natural resources.

The International Labour Office (ILO) and European Centre for the Development of Vocational Training (CEDEFOP) undertook a study into skills for green jobs which looked at 21 countries, including South Africa (Strietska-Ilina, Hofman, Haro & Jeon, 2011). The findings from this study indicate that extractive and fossil fuel industries would experience job losses and mitigating this problem would require intra-industry restructuring and employment shifts towards other industries. This could be achieved through training into renewable energies and skills upgrading into sustainable practices, energy and resource efficiency, new green technologies, clean coal, carbon capture and storage (Strietska-Ilina *et al.*, 2011).

A summary of the skills identified through multiple studies on a global and in a local context is contained in Table 1 below.

Table 1: Consolidated list of skills, local and global

Soft skills	Technical skills (as it relates to occupations)
Social Engagement ^{1 4 5}	Policy ^{1 4}
Adaptability & transferability ²	Sustainability ^{1 2}
Teamwork ²	Energy integration ³
Resilience ²	Maintenance, repair, and non-electrical technical courses ³
Negotiation and communication ²	Engineering and technical specialisations ³
Analytical thinking ²	Courses to upskill/reskill existing employee skills levels ³

¹ Source: Ramsarup *et al.*, 2024.

² Source: McCoshan, 2019.

Soft skills	Technical skills (as it relates to occupations)
Innovation skills ^{2 4}	Educator skills in post-school engineering and climate sciences ³
Consulting skills ²	Climate science and energy nexus courses ³
Strategic and leadership skills ²	Climate/engineering educator courses ³
Leadership ^{3 4}	Specialisations in electric vehicles, green hydrogen and integrated energy systems ³
Life skills ³	Entrepreneurial ^{2 3 4}
Collaboration skills ⁴	Coordination, management & business skills ²
Continuous learning/adaptability ⁴	Marketing skills ^{2 3}
	Automation and robotics engineering ³
	Automated machine installation and repair ³
	Environmental skills ⁴
	Air quality ⁵ : <ul style="list-style-type: none"> • Atmospheric Dispersion • Monitoring • Carbon Accounting • Energy Efficiency Climate Change • Risk and Opportunity Assessors • Energy Analysis • Air Quality Modelling • Plant Management • Air quality impact assessment/modelling • Fugitive dust sampling and monitoring

³ Source: SANEA, 2023.

⁴ Source: MQA, 2023.

⁵ Source: MQA, 2018.

Soft skills	Technical skills <i>(as it relates to occupations)</i>
	<ul style="list-style-type: none"> • Lab analysis • Underground dust suppression • Dust fallout and urban pollutants monitoring • Radiation licensing and air quality monitoring • Stack monitoring and sampling • Energy management and electricity consumption monitoring • Air quality monitoring - PM10 monitoring, NOx & SO2 monitoring • Carbon emissions reporting, carbon accounting, and CC management • Greenhouse gas reporting • Mass balance, dispersion modelling & sampling • Energy audits
	<p>Water quantity & quality⁵:</p> <ul style="list-style-type: none"> • Water modelling • Water Policy and Regulatory • Implementation Skills • Groundwater modelling • Aquaculture skills • Wetland Delineation • Flood line Delineation • Water use licencing • General water management • Ground and surface water sampling • Hydrological/Geohydrological Impact Assessments • Surface water assessment incl. aquatics, flood line, etc. • Sewage plant management

Soft skills	Technical skills <i>(as it relates to occupations)</i>
	<ul style="list-style-type: none"> • Stormwater management • Water quality (potable) monitoring and analysis • Ground and surface water monitoring • Water sample analysis • Water quantity provision monitoring <hr/> <p>Waste generation & management⁵:</p> <ul style="list-style-type: none"> • Pollution incident management • Waste minimisation technologies • Preparation and implementation of WMP • Waste characterisation/classification • Contaminated land assessments, rehabilitation • Landfill management & maintenance • Mine residue management and reclamation of aggregates • Waste management: sorting, separating, recycling, and handling general waste • Waste management: hazardous waste • Waste permitting and reporting • Waste rock dump management • Radioactive study, reading and RPM readings • Waste management: auditing • Geochemical surveying and assessments <hr/> <p>Biodiversity⁵:</p> <ul style="list-style-type: none"> • Biodiversity conservation & management • Spatial biodiversity management • Rehabilitation skills: research and development into effective rehabilitation • Marine & Coastal Management technical and enforcement skills

Soft skills	Technical skills <i>(as it relates to occupations)</i>
	<ul style="list-style-type: none"> • Bioprospecting • Biosafety • Heritage management • Biodiversity assessment and action plan • Ground stability assessments • GIS • Soil management • Exterminating pests; handling of hazmat • Closure and rehabilitation management • Agricultural assessment • Protected trees permit applications • Biodiversity and slope design, erosion management • Alien Plant Removal • Ecological Assessments • Blasting/rock engineers • Conservation • Marine and coastal management • Biomonitoring
	General environmental ⁵ : <ul style="list-style-type: none"> • Cleaner Production Skills
	Renewable energy expertise ⁴
	Energy management ⁴
	Technological proficiency ⁴
	Renewable energy technologies ⁴
	Networking, IT and language skills ^{2 3}
	Legislation and regulation ^{3 4 5}
	Financials ³
	Forecasting/modelling ³

Soft skills	Technical skills <i>(as it relates to occupations)</i>
	Local government skills related to energy provision and governance ³
	Human resources staff require upskilling in energy-sector job requirements ³
	General environmental ⁵ : <ul style="list-style-type: none"> • Sustainability reporting • Sustainable development planning • Environmental accounting and costing • Environmental Monitoring, Evaluation & Auditing
	Project management ⁴
	Transition management ⁴

In a local context, there is currently a great deal of focus on technical skills, while there is a clear need to develop softer skills in conjunction with technical skills.

According to the existing literature, there seems to be no established framework for JET skills within the MMS. Although numerous studies provide a wealth of *ad hoc* data and information, none have synthesised these findings into a coherent structure of skills with appropriate definitions and descriptors. A shared finding in both local and global research is the necessity to broaden current job roles to include non-core skills, like sustainability and softer skills, as previously mentioned. Collaborating with industry to identify precise, up-to-date skill requirements at the appropriate level is crucial for building a JET skills framework.

3.2 JET Skills Availability in the MMS

The African Climate Foundation (2023) undertook a Roundtable Report which considered ‘What are the skills needs and how can we address them while implementing a JET in the mining sector?’ The following were the main points from the discussion (African Climate Foundation, 2023):

- A national mapping process of the skills ecosystem in mining needs to be undertaken, this should be cognisant of skills transition timeframes.

- There are basic skills that require retraining, and these should be identified.
- Hard skills needed include maintenance and new technologies.
- Soft skills needed include project management and leadership skills.
- Attention should also be given to broader stakeholders in terms of:
 - Skills needed by the workforce and industries
 - Municipal skills and capability
 - Capacity development within communities
 - Curriculum development.
 - Legislation and regulations

It is apparent from findings in section 3.1 - and the paragraph above - that there still exists a need to determine JET skills needs within the MMS. To address this need, NBI (2024) recommends utilising a methodical approach, that would look to estimate skills needs more accurately as shown in Figure 4, which also includes the community engagement element - highlighted by NBI (2024), Ramsarup *et al.* (2024) and Hunkin (2023). This provides a high-level framework of considerations to structure the collection of data for the creation of a more accurate skills needs framework.

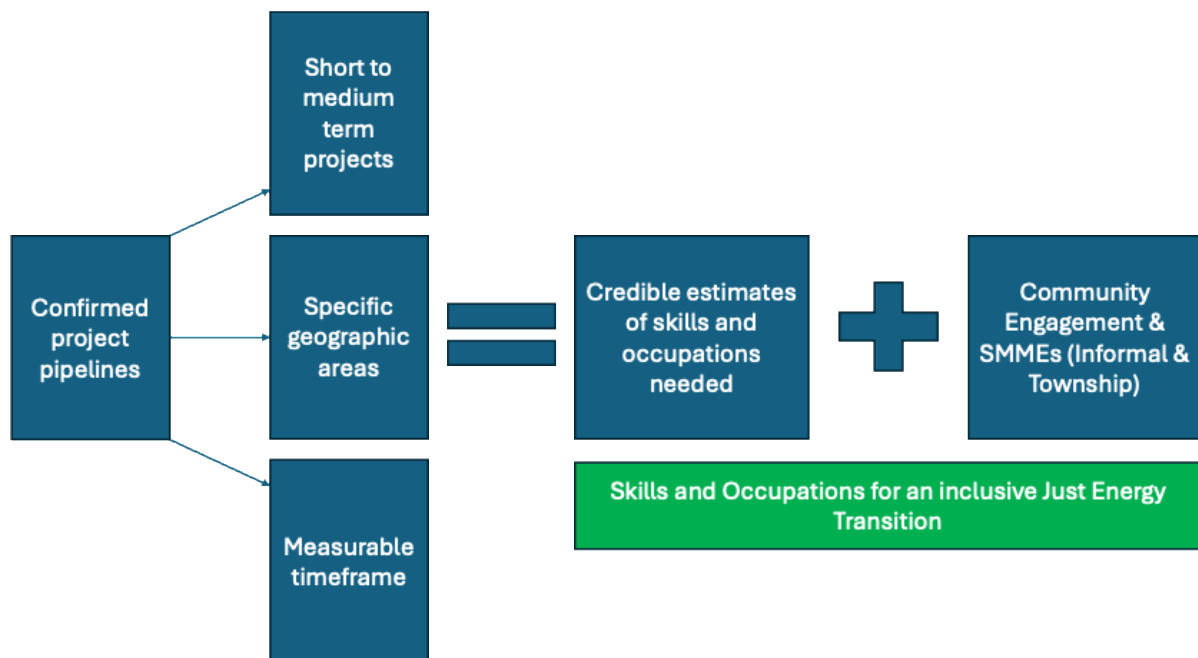


Figure 4: Skills analysis methodology (Source: NBI, 2023).

The MQA (2024) undertook a study to develop a framework for identification of future skills needs in the MMS and the result was a 6-step process shown in Figure 5. This figure highlights the process to be undertaken to gather the actual data, in a way that is coherent and inclusive of stakeholder validation.

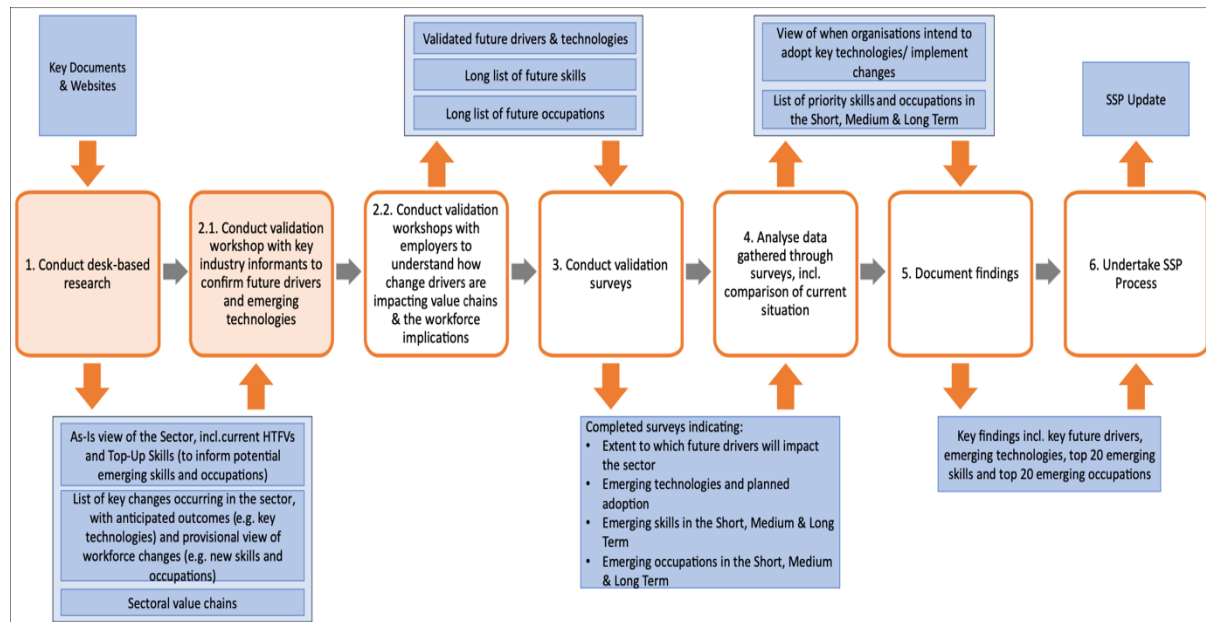


Figure 5: MQA developed framework - future skills identification in the MMS (Source: MQA, 2024)

In conjunction with the skills analysis methodology developed by the NBI, this skills identification framework may create a sound methodology for identifying the correct skills attached to actual timelines at a level detailed enough to allow for action. The combination of Figure 4 and Figure 5 may result in a model that includes additional skills analysis methods.

As far as is possible, accurately identifying skills needs required by the various stakeholders, within the MMS and the larger South African economy as it relates to JET; is essential for reducing skills mismatches, which occurs when the skills of employees/potential employees do not align with market requirements (ILO, 2020).

3.3 Supporting JET Skills Needs

JET skills inherently cross sectors, addressing energy and green skills relevant beyond just the energy sector. This necessitates a more extensive stakeholder mapping process for skill

analysis planning. Additionally, it is crucial to collect detailed quantitative data linked to actual projects, with measurable timeframes. Flexibility is essential, as various factors will influence projects; they do not operate independently. This consideration is vital when addressing job losses (Strietska-Illina, Hofman, Haro & Jeon, 2011) and mine closures, significantly affecting community sustainability (Meggersee & Guvuriro, 2023). It underscores the importance of evaluating skills not only from the industry's internal perspective but also in the context of broader community needs, as advocated by Ramsarup *et al.* (2024). Support for Small and Micro Enterprises (SMME) in informal areas and townships is vital through enterprise development and other initiatives to foster economic growth within these communities (NBI, 2024).

Ramsarup *et al.* (2024) found that skills planning is currently approached in silos, resulting in a short-term focus that is reactive and ad-hoc. This approach fails to provide adequate data for informed decision-making regarding educational needs, particularly in areas with multi-sectoral and national significance. Similarly, the NBI (2024) highlighted these issues, detailed in the following list of challenges related to skills planning:

- There is no comprehensive understanding of skills supply and demand, leading to potential mismatches and delays in skills availability.
- Stakeholders are operating in silos, resulting in *ad-hoc*, and disjointed skills development initiatives.
- JET training is not part of core curricula - and curricula is not correctly aligned, with actual skills needed.
- Training institutions are not in tune with local communities, missing an opportunity for regional focus of curricula.

Further to this, the identification of relevant skills needs is an important foundation for the creation of training and development initiatives. Currently, when examining the existing training and development initiatives for JET skills needs in South Africa, Ramsarup *et al.* (2024) found the following:

- Courses are centred around focus areas of educational institutions.

- There is a lack of renewable energy education within Technical and Vocational Education and Training (TVET) institutions.
- Courses are focused on intermediate to high skilled occupations. However, in a report drawn up by the NBI (2024), their study indicates, that low and semi-skilled positions, have the greatest demand.
- Required training courses are not always available in areas where such skills should be utilised.
- The majority of courses available, are short courses - that focus on a specific topic, rather than an occupation, and are often not accredited as the need for these courses already exist, and accreditation processes are lengthy. This brings into question; the quality of some of these development offerings.

From a policy and framework perspective, the JET Implementation Plan 2023 – 2027 (The Presidency Republic of South Africa, 2023) identified several barriers that would challenge the transition:

- Lack of co-ordinated efforts for JET skills development.
- There is no clear indication of the demand and supply of JET skills. Multiple studies have been undertaken, nationally, however; these follow different methodologies, and the results cannot be coherently combined.
- Difficulty in anticipating skills needs. This data is reliant on employers that may not be able to determine these skills needs.
- The time taken to analyse skills needs, and address them educationally, is disjointed.
- There is a lack of skills for building curriculum and capacity in lecturers and training institutions.
- Training institutions and communities are disconnected.

Implementing policies and frameworks can be challenging, especially in uncertain environments where rapid adaptation and responsiveness are needed. While there is some degree of planning, there is a lack of coherent strategies for the implementation. Additionally, stakeholders are working in silos, neglecting the full range of skills within the ecosystem.

3.4 ESG Framework

ESG considers the 3 factors of Environmental, Social and Governance and as such requires consideration of legislation relevant to each factor.

3.4.1 Environmental

Mining activities are recognised for their significant impact on the surrounding environment. Consequently, there exist several important legislative measures concerning mining and environmental protection within South Africa. These measures can be summarised as follows (White, Katumba & Beech, 2022):

- The National Environmental Management Act, No. 107 of 1998 (NEMA). Provides a framework for co-operative environmental governance, through decision-making principles, that seeks to balance environmental protection, with economic, and social development, ensuring a healthy environment for current and future generations (Republic of South Africa, National Environmental Act, 1998).
- The National Environmental Management: Waste Act, No. 59 of 2008 (NEMWA). Seeks to reduce the impact of waste on the environment, and public health, through waste management principles and regulations (Republic of South Africa, National Environmental Management: Waste Act, 2008).
- The National Environmental Management: Biodiversity Act, No. 10 of 2004. Intended to safeguard biodiversity in South Africa, promote sustainability, and provide for equitable sharing of biological resources (Republic of South Africa, National Environmental Management: Biodiversity Act, 2004).
- The National Environmental Management: National Forests Act, No 84 of 1998. Seeks to maintain a balance, of forest conservation, with economic and social benefits (Republic of South Africa, National Forests Act, 1998).
- The National Environmental Management: Protected Areas Act, No. 57 of 2003. Seeks to protect, and conserve ecologically viable areas, and promote cooperation with

public consultation, regarding areas that are protected (Republic of South Africa, National Environmental Management: Protected Areas Act, 2003).

- The National Heritage Resources Act, No. 25 of 1999. Seeks to create a comprehensive system for managing, and protecting South Africa's national heritage resources, through the establishment of various heritage resource authorities, and encourages public participation in heritage management (Republic of South Africa, National Heritage Resources Act, 1999).
- The National Environmental Management Air Quality Act, No. 39 of 2004. Provides pollution, and ecological degradation prevention measures, with a focus on sustainable development - as it relates to standards for air quality monitoring, management and control (Republic of South Africa, National Environment Management: Air Quality Act, 2004).
- The National Environmental Management Laws Amendment Act, No. 2 of 2022 (NEMLA). This Act amends several existing environmental legislative measures; to improve effectiveness and clarity through new definitions, a register of environmental management instruments - and clarifications of roles and responsibilities, improves measures for public participation, and the remediation of environmental damages (Republic of South Africa, The National Environmental Management Laws Amendment Act, 2022).

The Bill of Rights in the Constitution affords all people the right to a nonharmful environment. Environmental legislation includes several measures that seek to hold mining houses responsible for ensuring as little damage as possible to the environment (Centre for Environmental Rights, 2013). The Centre for Environmental Rights also provides guidance on taking legal action against mines that do not adhere to environmental laws.

Several legislative policies impact the MMS and require compliance. The use of an ESG framework creates a holistic perspective of the environmental, social, and governance aspects, allowing for management while enabling an understanding of the impact if implemented accordingly.

3.4.2 Social

The social aspect of organisations and the community usually translates back to Corporate Social Responsibility (CSR). This CSR can be voluntary or mandated. The Mineral and Petroleum Resource Development Act (MPRDA) was used to improve CSR in mining in South Africa (Corrigan, 2019).

From a regulatory perspective, this takes the form of a Social and Labour Plan (SLP), which is required for mines to have a license to operate. Municipal Integrated Development Plans usually inform these SLPs and must focus on sustainable investments that will last beyond the life of mine (Corrigan, 2019).

Within the ESG framework, other components of the social metric include labour standards, and health and safety. In South Africa, these areas are subject to stringent regulations enforced by entities like registered trade unions and the Mine Health and Safety Council. Furthermore, the Mine Health and Safety Act of 1996 acts as a legislative framework that outlines health and safety requirements (Barter, 2023).

3.4.3 Governance

From a legislation perspective, governance within mining is regulated by the following policies (Barter, 2023):

- Mineral and Petroleum Resources Development Act (MPRDA)
- Mine Health and Safety Act (MHSA)
- National Environmental Management Act (NEMA)
- Broad-Based Black Economic Empowerment (B-BBEE)

Another key element is the Broad-Based Socio-Economic Empowerment Charter for the Mining and Minerals Industry, or “The Mining Charter,” which covers all the elements of ESG, including transformation, sustainable growth, and human rights (Umsizi Team, 2021).

King IV, as a corporate governance tool, is a benchmark - and is especially required when a company is JSE listed. These reports are considered best practice, principles for good corporate governance, although they are not binding (Cliffe Dekker Hofmeyer, ND). ESG is not a new concept, and has existed, in various forms, for at least decades (Byrne, 2024). The challenge is that there is no single set of rules or framework, and different companies measure different things (Hannay, 2024).

Within the South African context, the JSE has created, The JSE Sustainability Disclosure Guidance, which aims to address the matter of sustainability, and ESG in the South African context. This guideline was developed for listed companies but may be utilised by other organisations (JSE b, 2022). This guideline takes guidance from a number of frameworks, inclusive of the frameworks mentioned above, as well as KING IV. Utilising all these sources, the JSE has developed the JSE Sustainability Narrative Disclosure and Sustainability Metrics which addresses ESG as follows (JSE a, 2022):

- Environmental Metrics:
 - Climate change
 - Water security
 - Pollution and waste
 - Biodiversity and land use
 - Supply chain and materials
- Social Metrics:
 - Labour standards
 - Human rights and community development
 - Health and safety
 - Customer responsibility
 - Supply Chain
- Governance Metrics:
 - Board composition
 - Ethical behaviour
 - Remuneration
 - Compliance and risk management
 - Tax transparency

Within the disclosure guideline, it is recommended that seven key areas be addressed, to ensure a quality report (JSE a, 2022). Figure 6 outlines the seven key areas in a quality report.

7. Monitoring

This involves the use of external parties for the monitoring and assurance of the report and data. This may be handled internally through internal monitoring and evaluation processes.

6. Measurement

This concerns the use of the correct data in the correct way and through methods that are conducive to the process, such as existing data reporting systems.

5. Means

The focus here is on ensuring the data is collected in an integrated way across the organisation.



1. Motivation

Why is the report being written? Is it for compliance purposes or to measure impact?

2. Market

For whom is the report being written? The report should be structured to address the needs of the stakeholders reading it.

3. Materiality

It is important to understand if the report should focus on material or impact materiality to inform the content.

4. Medium

Determine the most appropriate method of reporting, e.g. traditional report, meeting, etc.

Figure 6: Effective reporting guidelines for an ESG Framework (Source: JSE a, 2022)

For listed companies, some of which are in the MMS, the use of this ESG framework is a requirement for listing, but other organisations may also use it and adjust it to best suit their operations. What gets measured gets done, and by implementing a sound framework for measuring the achievement of ESG goals, organisations can determine what to improve, adjust, and change to see the return on their efforts.

3.5 Conclusion

The review of the existing literature indicates that JET skills planning is currently underway but remains fragmented. Stakeholders are predominantly working in silos rather than collaborating to tackle the transition. There is a lack of detailed skills lists based on specific projects and tied to defined timeframes for the short to medium term. Moreover, current lists tend to be outdated or ambiguous, especially concerning the MMS.

A skills ecosystem approach that considers a holistic approach nationally and then breaks it down per sector is the suggested methodology, particularly as JET skills are inter-sectoral. This also requires expanding traditional stakeholder engagement from private industry to include the public sector and communities/informal/township stakeholders, as there are micro-economies that exist within mining areas.

Training and development initiatives are not correctly aligned with needs, as needs are not correctly understood, and the response to skills needs appears to be quite reactive. Many courses are not accredited, and the lengthy accreditation processes create a risk of utilising poor-quality curricula.

JET fits well within an ESG framework. It is concerned with improving citizens' lives, redressing past inequalities, protecting the environment, and fostering sustainability mindsets. This allows JET to fit into the ESG aspects of the ESG framework. Utilising a framework would benefit stakeholders by creating an understanding of the impact of ESG activities.

From a detailed skills planning perspective, a practical investigation should be undertaken into a detailed skills ecosystem. A realistic timeline should be established to undertake the required level of stakeholder engagement at the level of detail that will allow for actual skills planning decisions.

4. UPSKILLING IN THE SUPPORT OF JET, IN LINE WITH AN ESG FRAMEWORK

This section of the report will address the data gathered from stakeholders on ESG frameworks and JET skills and compare the results to the information gathered during the literature review.

4.1 ESG Frameworks

The literature review found several options for addressing an ESG framework, but no set ESG frameworks within South Africa must be adhered to within the MMS. The exception is the ESG framework developed by the JSE, as described in section 3.

This study aims to determine the prevalence of ESG frameworks within the MMS and their effects on employees. Through stakeholder engagements, it was revealed that over 50% of participants in the online survey reported using an ESG framework in their organisations, with 43% of this group belonging to large organisations, as illustrated in Figure 7.

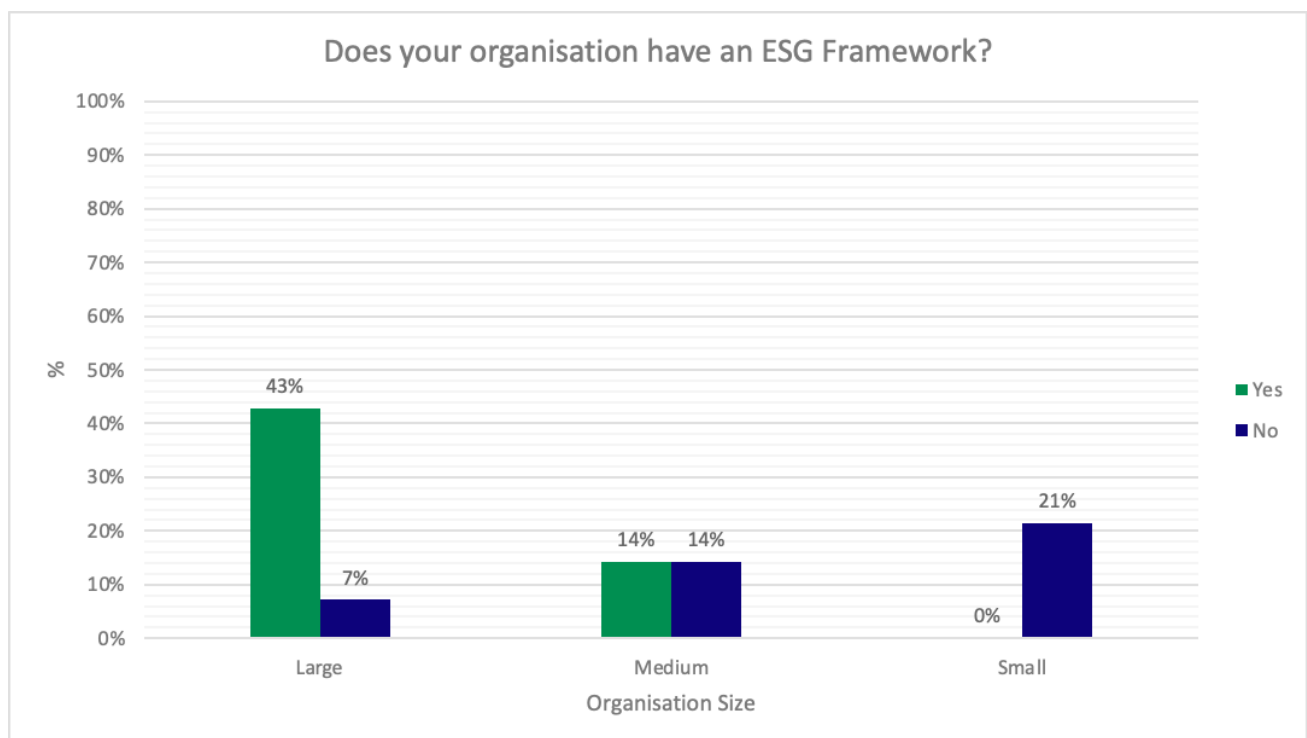


Figure 7: Presence of ESG frameworks in operations

During engagements, it was observed that the current ESG approach is impractical and presents challenges for mining operations. It struggles to integrate into established mining routines, and its implementation often stems from regulatory obligations outlined in section 3 rather than being a

voluntary choice. This issue is regarded as a corporate concern, with the research team noting that different organisations approach it variably, a conclusion consistent with section 3. The team recommended enhancing leadership engagement and aligning employees to reinforce ESG initiatives, similar to how safety protocols are enforced.

Regarding the relationship between ESG and JET – it was indicated that JET is not yet incorporated into ESG.

4.2 JET Skills Framework and Availability

The data collected from stakeholders resulted in a list of primarily technical skills outlined in Table 2. Occasionally, the feedback is presented in broad terms, such as engineers, business management, or Science, Technology, Engineering, and Mathematics (STEM). The literature review identified a similar difficulty in pinpointing skills, where some indicators are either too generalised or pertain to job titles that are operationally oriented, making them challenging to apply at the sectoral or national level. The sections highlighted in green can be clearly linked to the skills list derived from the literature review reflected in Table 1.

Table 2: Skills list from stakeholder engagements

Soft skills	Technical skills
Business acumen	4IR related artisanal competency
Change management	Aerodynamics
Leadership skills for women	Agricultural
People management	Artisans
	Automation
	Biodiversity conservation
	Boilermakers
	Business management
	Carbon management
	Circular economy principles
	Climate adaptation

Soft skills	Technical skills
	Coded welders
	Data
	Developmental (knowledge transfer)
	Digitalisation skills
	Electrical skills
	Energy efficiency
	Engineering
	Environmental management (including restoration)
	Financial management (including financial planning)
	Fitters
	Green mining techniques (generic comment from stakeholders)
	Management of greenhouse gas (GHG) emissions
	Mechanical, including hydraulics and pneumatics
	Occupational Health and Safety
	Project management
	Risk management
	Science, Technology, Engineering, and Mathematics (STEM)
	Solar (including installation and maintenance)
	Steam (installation and maintenance)
	Structural engineering (also see engineering)
	Sustainability
	Technical energy skills related specific to women in mining
	Technicians
	Waste disposal
	Water management

Soft skills	Technical skills
	Wind (including turbines/power generation and maintenance)

Annexure B provides more insight into, the specific skills identified, by both the literature review, and stakeholder engagements.

Further feedback on the skills required for JET indicated that:

- A wide range of skills, across sectors and technologies, are required, this aligns with the findings in the literature review in section 3.
- Retraining, and upskilling of workers in sustainability, and green skills, should be focus areas, while vocational training - should look at providing operators and technicians, with skills in new equipment, and renewable systems.

It was also found that in some instances, new projects would need to use sustainable and renewable practices from inception to reduce their carbon footprint. However, certain green skills are only required during set-up and are not necessarily longer-term skills needed within an operation. In those instances, external specialists should be utilised. Renewable energy skills, such as solar installation and maintenance, could be potential skills to train within communities.

Other instances where skills are called for outside of operations are large maintenance or shut-down activities, where the original equipment manufacturers (OEMs) handle the work required. This is sometimes essential from a legal aspect. OEMs are not necessarily part of the MMS sector, highlighting the need for understanding skills at an inter-sectoral and, as such, national level.

Stakeholders were asked; how they determine their JET skills needs, and an array of responses were received:

- Needs analysis and skills mapping.
- Uncertainty of how to determine the needs.
- Managed on a case-by-case basis - as the operation is small.
- Done as an outsourced function.

- Not applicable. In some instances, JET is viewed as not applicable within the MMS.

Some of the feedback received indicated an uncertainty about JET as a concept, resulting in limited information regarding required training and skills frameworks and availabilities. Responses such as “it is not applicable to the industry” indicate a lack of understanding of the application or impact of JET.

The matter of artisan skills was mentioned, and it was suggested that, as the current absorption rates of artisans do not match the rate at which they are being trained, they may be transitioned into JET fields.

Stakeholders were asked, to indicate to what extent the JET skills are available or trainable in the current workforce, and the majority of respondents indicated - ‘a few of the skills’ followed by - ‘none of the skills’ - as shown in Figure 8.

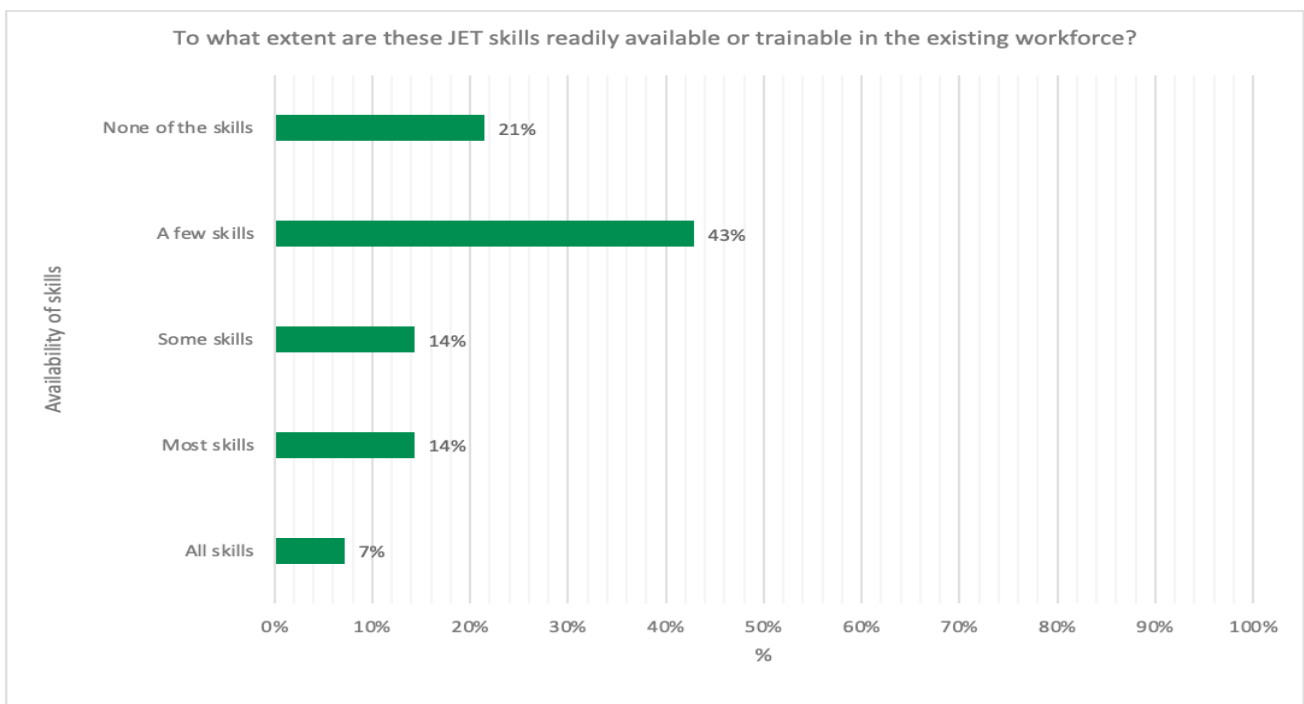


Figure 8: Availability/trainability of JET skills in the existing workforce

Figure 9 illustrates the capacity of the current educational system to fulfil the skills development requirements for JET. A predominant number of stakeholders indicated that the system is capable of

doing so only to a limited extent, followed by a moderate extent. This suggests that stakeholders are addressing some skill requirements through the existing curricula or available courses.

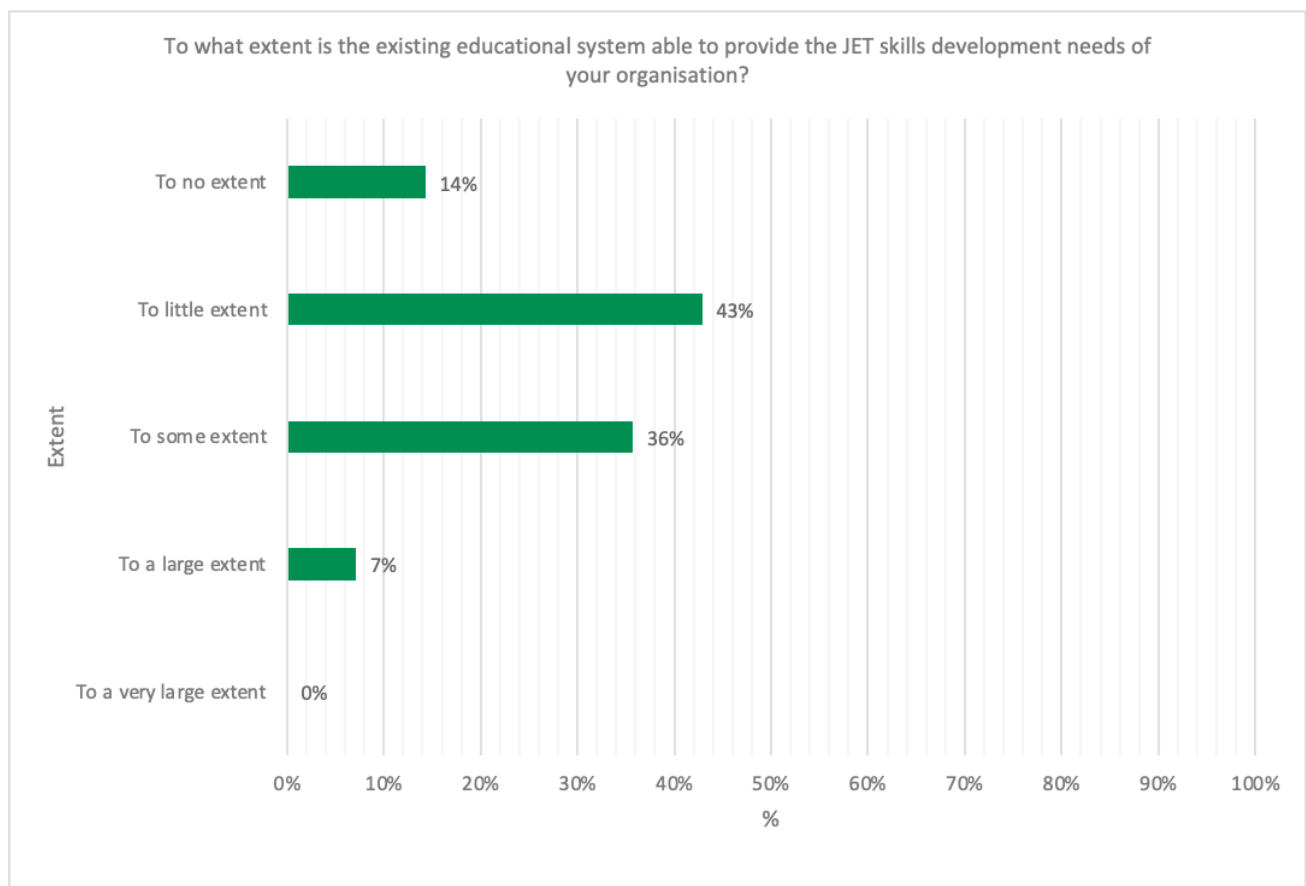


Figure 9: Educational system ability to meet JET skills development needs

Training providers were asked how relationships are managed with mining operations, and the common theme was one of partnership, and honest and ongoing communication and engagement. Specific emphasis was placed on the need for interaction and co-creation, between operations and training providers.

In terms of how they undertake planning for the skills needs of the economy, training institutions indicated the following:

- Collaborating with public and private institutions.
- Review of curriculum, and provision of occupational qualifications, aligned with the Quality Council for Trades and Occupations, and other relevant short courses.
- SSP and collaboration with the MQA, as well as the Provincial Skills Development Forum.

On a final point of JET skills, within the MMS; it was recommended that research and development should focus on *'material sciences, energy storage and battery technology (including renewable energy), and life-cycle analysis, focusing on alternative materials, and environmental impact assessment'*. Additionally, it was indicated that research and needs analysis should be utilised to inform the MMS sector of the JET skills needs.

Stakeholder feedback supports the literature, indicating that there is no well-defined framework for JET skills within the MMS. The identified skills predominantly emphasise technical abilities, though they are sometimes described in overly general terms, hindering practical application. Additionally, there is a necessity for skills-needs planning both at the sectoral and national levels.

The next section is focused on interventions to support JET skills, in the MMS.

4.3 Interventions to support JET skills within the MMS

The scope of this study included determining interventions that may be undertaken to address JET skills needs within the MMS. To address this requirement, stakeholders were requested to indicate barriers to addressing JET skills and enablers to form an understanding of challenges and successes. In addition, stakeholders were asked to indicate what interventions they deemed supportive.

The identified barriers included:

- Financial challenges in the form of:
 - Limited funding for training.
 - Technology costs, particularly for smaller operations.
- Resistance to change and fear of uncertainty.
- Geographically, skills are not aligned or available around the local areas of operations, in some instances, skills are duplicated.
- The skills training is not always sustainable, beyond the training course.
- Limited understanding of JET, and its impact and implications.
- Insufficient training infrastructure, and limited access to training.
- Skills mismatches, with differences between skills supply and demand. Existing skills development centres are not equipped to deliver on the industry's required technical levels.

- Industry being excluded from the development of the skills roadmap.
- Legislation - there is a greater focus on larger entities that can cope with legislative compliance requirements. Additionally, ESG is forced on operations, making it a grudge implementation exercise (i.e., tick-box approach to compliance), not a societal improvement exercise.

The identified enablers were listed as:

- Investment into renewable energy and related enabling policies at a national level.
- Government support and policy alignment.
- Employee engagement is an enabler when it is undertaken positively.
- The increase of qualified employees has a positive impact on the average levels of employees.
- Benchmarking with organisations that are advancing well with new technologies
- The private sector and colleges are positioned well to deliver on the skills required in local areas.
- Collaboration between TVETs and the MQA, with available funding and a willingness to learn will enable greater skills development in line with JET.

Stakeholders identified the following interventions that would assist with developing JET skills:

- Financial support and incentives. Focused on training but also educational infrastructure and equipment.
- Raising awareness regarding JET - the application of frameworks and skills development requirements/initiatives.
- Focusing on supporting employees in fossil-based industries by:
 - Developing policies to support employees being phased out.
 - Undertaking targeted training interventions, for upskilling and reskilling.
 - Developing social protection measures.
 - Partnering with trade unions to protect the rights of employees.
- Create certification programs. Establish certification schemes for specific skills, such as energy efficiency, environmental management, and carbon capture, to ensure workers have the necessary qualifications to transition to green jobs.

- Alignment of efforts between stakeholders and communities
- SETA support.
- Leadership and other soft skills development.
- A support structure for learners, training providers and operations.
- Investing in technology and potentially incorporating VR and AI into learning initiatives.
- Co-develop demand-driven curricula.
- Research into skills demand and supply, inclusive of 4IR and future skills, and the provision of updates of national skills needs in sectors.
- Training of educators – where there is currently a need to upskill the facilitators providing education.

An important indicator in this section is the need for awareness in the JET sector and the determination of skills needs. Financial support and stakeholder alignment are other key interventions that stakeholders have raised.

5. KEY FINDINGS

JET prioritises environmental concerns and energy management without harming the climate while enhancing citizen well-being. This aligns closely with the ESG framework, which emphasises tracking environmental, social, and governance impacts. Rather than viewing these issues separately, they can be integrated into a unified model, positioning JET within the ESG context. Figure 10 shows how JET fits into the ESG framework.



Figure 10: JET as a subset of ESG (Source: Author's own)

As indicated by the JSE, the framework may provide a good base for organisations to utilise for ESG.

There is a clear gap in awareness of JET skills within the MMS, with requests for information to be disseminated. Coupled with this is the lack of a clear framework on JET skills within the MMS. This highlights the need to undertake detailed skills needs analysis on a sectoral and national level. Based on the literature review, Figure 11 depicts a suggested consolidated model for skills needs analysis.

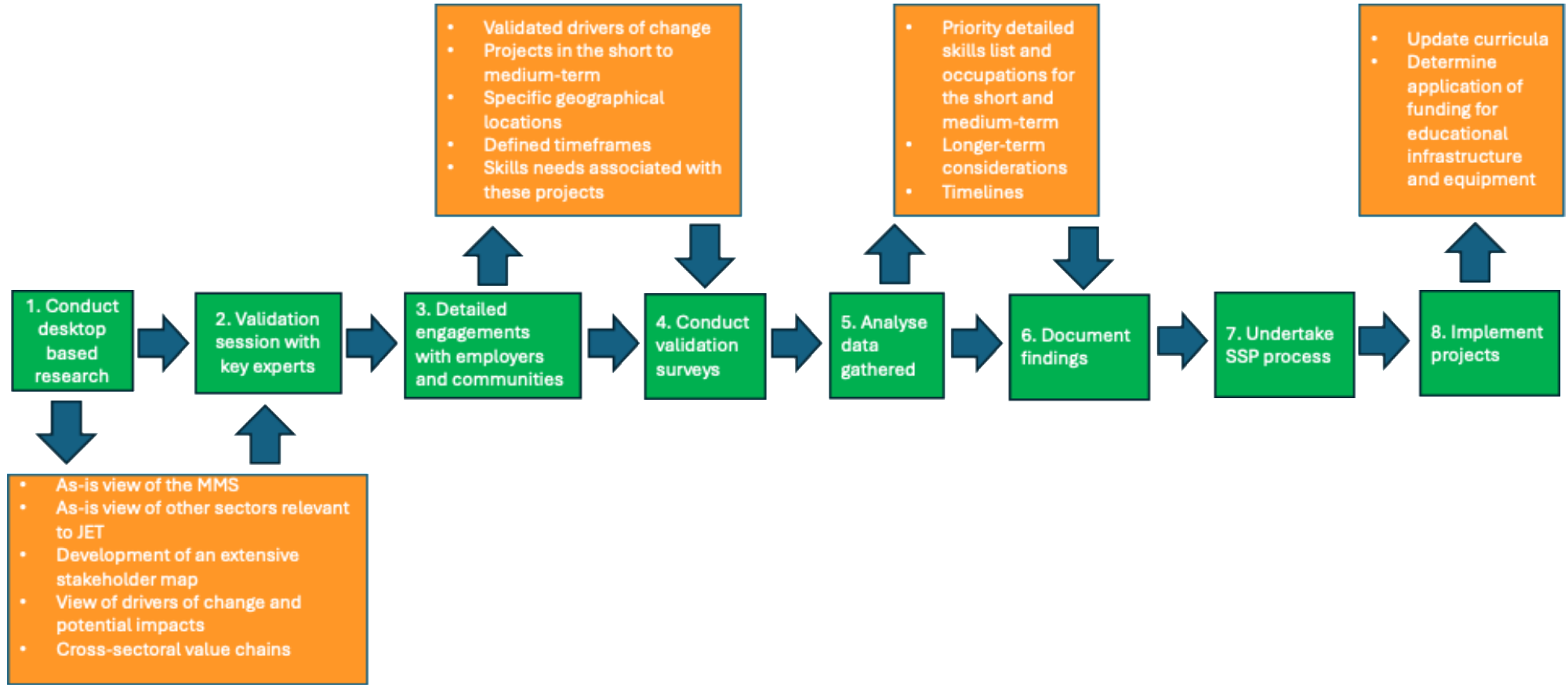


Figure 11: Consolidated skills needs analysis framework (Adapted from MQA, 2024 & NBI, 2023).

Notes to the model:

- Stakeholder mapping requires a much more extensive view, with skills needed to be identified for:
 - Operations in the MMS. This addresses changing skills needs, based upon operational needs, and where employees must be transitioned into instances where there may be job losses.
 - Training and educational institutions. These institutions require qualified educators to ensure the quality provision of training and development initiatives.
 - Communities. Sustainable communities require skills for economies that will endure beyond the lifecycle of the mine.
- The commodity type is an important factor when considering whether operations would be downsizing or growing and the impact this would have on employees and the community.
- The organisation's size is an additional factor to consider, as smaller operations do not necessarily have the financial resources to undertake specialised skills mapping or adapt to technology—this was indicated as a challenge in section 4.3.
- A cross-sectoral approach is required. This will illustrate the potential for cross-skilling opportunities between sectors and job transitions between industries.

6. RECOMMENDATIONS

The following recommendations were developed, based upon the results of the study.

Table 3: Recommendations

Recommendation	Activity	Frequency
<p>Recommendation 1:</p> <p>There is a lack of awareness, within the MMS, not only on JET skills, but also the integration with ESG.</p>	<p>The MQA should develop informational materials, that may be distributed electronically to stakeholders.</p> <p>The MQA should undertake JET and ESG awareness sessions, for stakeholders to attend. This may be undertaken virtually, to reach more stakeholders and reduce costs.</p> <p>The content of the material, should include, but not be limited to:</p> <ul style="list-style-type: none"> • Definitions of JET & ESG. • The impact that these two concepts have upon the mining industry. • The implications of these concepts for different stakeholders. • What is required from various stakeholders, and the benefits of these concepts. 	<p>Annual updates of information should be undertaken, to keep industry up to date.</p> <p>Stakeholders can indicate, should they require more regular sessions to be held.</p>

Recommendation	Activity	Frequency
	<ul style="list-style-type: none"> • Latest findings, and best practices, from a local and global perspective. 	
<p>Recommendation 2: Consider the creation of an ESG Framework, that is relevant to mining and encompasses the aspects of JET.</p>	<ul style="list-style-type: none"> • Develop and ESG Framework that would be applicable to the MMS • Raise awareness around such a model and highlight the benefits in the application thereof. 	<p>Updates should be undertaken, when changes to relevant legislation and policies are made.</p>
<p>Recommendation 3: A detailed skills needs analysis should be undertaken - that encompasses a larger group of stakeholders, with a focus on timelines and geographic areas. A cross-sectoral approach is required. This may take the form of an over-arching support structure, perhaps DHET, overseeing detailed multi-sectoral skills needs analysis initiatives, that would complement one another. This type of supportive structure would assist in providing much needed alignment between stakeholders.</p>	<ul style="list-style-type: none"> • Finalise the model to be used to undertake detailed skills needs analysis, through stakeholder validation and engagement. • An overarching support structure must be created and tasked with the management of the skills needs analysis process. • Relevant sectors for JET must be identified, and on-boarded to participate in the skills needs analysis process. • A detailed stakeholder map must be developed, indicating the role, impact and requirements of every stakeholder. • Undertake skills needs analysis, as per the finalised skills needs analysis process. 	<p>Consider a timeline of 12 months to complete the initial skills needs analysis exercise.</p> <p>Stakeholders should be encouraged to undertake this exercise within their organisation annually - to provide them with up-to-date information for their WSP submissions.</p> <p>Annual SSP updates would be updated by WSP data as per standard practice.</p> <p>Major sectoral updates should align with SSP planning periods.</p>

Recommendation	Activity	Frequency
<p>Recommendation 4:</p> <p>It was found that updates are required to curriculum, infrastructure, and equipment of training institutions. This will allow for training institutions to provide better quality training and development interventions.</p>	<p>Utilising the results from the skills needs analysis described in recommendation 3:</p> <ul style="list-style-type: none"> • Determine a skills priority list - with assigned timelines. • Determine the curriculum, infrastructure, and equipment needs of training, and development institutions - linked to the identified skills priority listed above. This will require consideration of: <ul style="list-style-type: none"> ○ Geographic areas ○ Potential funding ○ Timelines that are realistic in nature ○ Potential partnerships between educational institutions to share infrastructure/equipment where feasible. 	<p>Major structural changes should be undertaken, in the medium to longer term, based upon the scale of the required project.</p> <p>Updates to curricula should be considered on an annual basis.</p> <p>The provision of relevant training equipment should align with structural, when on a larger scale or where appropriate. Where possible, this should align with curricula updates.</p>

7. CONCLUSION

JET could be incorporated as a subset of ESG. It encompasses all facets within the ESG framework and can be effectively monitored and assessed through its integration into an ESG model. A model was introduced, illustrating how JET conceptually aligns with ESG and can be tailored to meet different organisations' specific operational, social, and governance requirements.

The status of JET skills within the MMS framework remains ambiguous, as a comprehensive and detailed guideline for these skills has not been established. Feedback obtained from stakeholder engagements has highlighted a demand for additional information concerning this subject and for research initiatives aimed at identifying the specific JET skills pertinent to the MMS.

An adapted model for skills needs analysis has been introduced, offering a broader view on skill requirements since JET spans multiple sectors. It recognises that stakeholders include not just employers but also training institutions and communities. A key component of this model is the importance of timing; aligning skill needs with more precise timelines helps to decrease skills mismatches and identifies skills that may only be temporarily necessary, such as those in construction. Furthermore, the quality of education is enhanced by incorporating the skill needs of training providers. This model presents an opportunity for a central authority, like DHET, to lead in establishing a supportive and cohesive framework for identifying and addressing skills gaps on a larger scale, ultimately fostering alignment among stakeholders.

Bringing these key points together, creates an overview to determine potential changes to policies and/or legislation, that would benefit the MMS.

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ANNEXURE A: SURVEY QUESTIONNAIRE

* 1. Please select your stakeholder group

- Mining Operations
- Operations Incidental to Mining
- Manufacturing (Including Jewellery)
- Processing (Including diamonds)
- Training Provider
- Other (please specify)

Demographics

2. Please indicate your current job role.

3. Please indicate the size of the organisation

- Small (0 - 49 employees)
- Medium (50 - 149 employees)
- Large (150+ employees)

4. Please select all sub-sector/s applicable to the operations

- Coal Mining
- Gold Mining
- Platinum Group Metals (PGM)
- Other Mining (includes the mining of iron ore, chrome, manganese, copper, phosphates and salt)
- Cement, Lime, Aggregates and Sand (CLAS)
- Services Incidental to Mining
- Diamond Processing
- Jewellery Manufacturing
- Other (please specify)

Skills and upskilling of MMS workforces in the support of JET, in line with ESG

12. Does your organization have an Environmental, Social & Governance (ESG) framework?

- Yes
- No

13. How does your organisation determine Just Energy Transition (JET) skills needs?

14. To what extent is the existing educational system able to provide the JET skills development needs of your organisation?

- To a very large extent
- To a large extent
- To some extent
- To little extent
- To no extent

15. What are the skills required to achieve JET?

16. To what extent are these JET skills readily available or trainable in the existing workforce?

- All skills
- Most skills
- Some skills
- A few skills
- None of the skills

17. What interventions could be undertaken to support JET in the MMS?

18. Please indicate any barriers your organisation may have experienced in the development of skills for the JET transition.

19. Please indicate any enablers your organisation may have experienced in the development of skills for the JET transition.

Training Provider: Just Energy Transition (JET Skills)

30. Please indicate your current job role

31. Please indicate your institution type.

- University
- TVET
- Private training provider
- Other (please specify)

32. What are skills required for the Just Energy Transition (JET) in the MMS?

33. How are relationships with mining operations managed?

34. How does your institution plan for skills needed by the economy? Particularly as this relates to JET.

35. What support would your institution require to improve its responsiveness to changing skills needs?

ANNEXURE B: SKILLS NEEDS IDENTIFIED IN RELATION TO JET

Table 4: Skills needs identified in relation to JET

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
Business acumen	4IR related artisanal competency	<ul style="list-style-type: none"> Skills development is focused on automation, digitalisation, interconnected systems, and advanced technologies like artificial intelligence (AI), the Internet of Things (IoT), robotics, and additive manufacturing (e.g., 3D printing). Main components would include digital literacy, smart technology integration, data analysis and interpretation, understanding renewable energy systems and materials science, collaboration in interconnected systems. 	<ul style="list-style-type: none"> Using drones for survey work, AI-driven equipment diagnostics, and autonomous machinery in operations.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
Change management	Aerodynamics	<ul style="list-style-type: none"> • Wind energy integration • Ventilation systems optimisation • Transport efficiency • Dust and particulate control • Solar panel efficiency 	<ul style="list-style-type: none"> • Designing and positioning wind turbines to maximise energy capture based on wind patterns. • Minimising turbulence between turbines in wind farms. • Conducting computational fluid dynamics (CFD) analysis for site-specific wind modelling. • Efficient ventilation to maintain air quality and reduce energy consumption. • Developing aerodynamic barriers or systems to contain particulate dispersion. • Using CFD simulations to analyse airflow around installations for structural safety.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
Leadership skills for women	Agricultural	<ul style="list-style-type: none"> • Renewable Energy Systems Design and Operation - Knowledge of solar, wind, and biomass energy systems for agricultural applications. Skills to install and maintain solar panels, wind turbines, and biogas digesters on farms. • Energy-Efficient Irrigation Techniques - Expertise in energy-efficient irrigation systems like drip irrigation powered by renewable energy. Understanding of smart irrigation systems using IoT for energy and water savings. • Skills in operating drones and GPS-based systems for precision planting, fertilising, and pest control to optimise resource use. 	<ul style="list-style-type: none"> • Installing and maintaining solar panels and battery storage systems. • Operating energy-efficient cooling technologies. • Monitoring energy use with IoT-enabled systems. • Irrigation systems designer specialising in solar-powered solutions. • IoT technician for smart irrigation systems. • Solar technician for farm-based energy systems. • Biogas plant operator for converting agricultural waste into energy. • Battery systems specialist for farm-based energy storage solutions. • Microgrid technician for agricultural operations.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Data analysis to monitor crop growth and energy inputs for sustainable farming. • Energy Storage Systems Management - Knowledge of energy storage technologies like batteries to store energy from renewables for use in farm operations. Skills in integrating storage systems with renewable energy sources. • Climate-Smart Agricultural Practices - Understanding carbon sequestration methods like agroforestry, cover cropping, and soil management. Skills to implement low-emission livestock farming techniques. • Greenhouse Technology and Energy Management - Skills in designing and managing energy-efficient greenhouses with renewable energy 	

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>inputs (e.g., solar heating, LED lighting). Proficiency in IoT and automated climate control systems.</p> <ul style="list-style-type: none"> • Waste-to-Energy Solutions - Expertise in converting agricultural residues, manure, and food waste into biogas or bioenergy. • Skills in designing and operating anaerobic digesters. 	
People management	Artisans	<ul style="list-style-type: none"> • Renewable Energy Installation and Maintenance - Installing and maintaining solar panels, wind turbines, and battery storage systems at mining sites. • Energy-Efficient Machinery Operation - Operating and maintaining hybrid or electric mining equipment. 	<ul style="list-style-type: none"> • Solar technician, wind turbine mechanic. • Electric equipment operator, hybrid machinery technician. • Electrical artisan, system retrofitter. Hydrogen fuel technician, pipeline artisan. • IoT systems installer, energy technician. • Biogas plant operator, waste-to-energy artisan.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Electrical Retrofitting - Upgrading legacy systems to support renewable energy integration (e.g., solar inverters, smart grids). • Hydrogen Technology Applications - Handling and maintaining hydrogen-powered mining vehicles and storage systems. • Energy Management System Installation - Setting up IoT-based energy monitoring systems to optimise energy use. • Waste-to-Energy Systems - Operating biogas plants or systems converting mining waste into usable energy. • Ventilation System Optimisation - Designing and maintaining energy-efficient mine ventilation systems. 	<ul style="list-style-type: none"> • Ventilation artisan, HVAC technician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
	Automation	<ul style="list-style-type: none"> • Robotics Operation and Maintenance - Operating and maintaining autonomous mining equipment like haul trucks and drills. • Programming and Control Systems - Programming PLCs (Programmable Logic Controllers) and SCADA systems for energy-efficient operations. • IoT Integration - Installing and managing IoT sensors to monitor energy usage, emissions, and equipment performance. • Renewable Energy Automation - Automating renewable energy systems, such as solar panel tracking or wind turbine optimisation. • Digital Twin Technology - Creating and maintaining digital twins for predictive 	<ul style="list-style-type: none"> • Robotics technician, autonomous equipment operator. • Automation engineer, control systems technician. • IoT specialist, energy data technician. • Renewable systems automation technician, energy efficiency engineer. • Digital twin specialist, predictive analytics engineer. • AI technician, machine learning analyst.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>energy management and efficiency modelling.</p> <ul style="list-style-type: none"> • AI and Machine Learning Application - Using AI to optimise mining operations and reduce energy waste. 	
	Biodiversity conservation	<ul style="list-style-type: none"> • Environmental Impact Assessment (EIA) - Conducting biodiversity assessments to mitigate ecological harm from mining. • Rehabilitation and Restoration Techniques - Rehabilitating mined lands with native vegetation and restoring ecosystems. • Wildlife Management - Monitoring and managing wildlife habitats affected by mining activities. 	<ul style="list-style-type: none"> • Environmental assessment officer, ecological surveyor. • Land rehabilitation technician, restoration ecologist. • Wildlife conservation officer, habitat restoration specialist. • Sustainable development planner, GIS specialist. • Hydrology technician, water quality officer. • Carbon offset specialist, agroforestry technician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Sustainable Land Use Planning - Designing land-use plans that balance mining with biodiversity conservation. • Water Resource Management - Protecting aquatic ecosystems by managing water pollution and usage in mining. • Carbon Sequestration Strategies - Implementing afforestation and soil carbon capture to offset emissions. 	
	Boilermakers	<ul style="list-style-type: none"> • Fabrication for Renewable Energy Systems - Designing and fabricating structures for solar panels, wind turbines, and biogas plants. • Maintenance of Energy-Efficient Equipment - Repairing and maintaining boilers and piping systems optimised for lower energy consumption. 	<ul style="list-style-type: none"> • Renewable energy system fabricator, structural technician. • Energy-efficient boiler technician, green energy systems welder. • Hydrogen storage technician, biogas tank fabricator. • Sustainable infrastructure welder, repair boilermaker.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Pressure Vessel Design and Retrofitting - Building or retrofitting pressure vessels for hydrogen storage or biogas applications. • Structural Repair for Sustainability - Rehabilitating mining infrastructure to extend its lifespan and reduce waste. • Welding for Sustainable Mining Machinery - Working with advanced materials for energy-efficient mining equipment. 	<ul style="list-style-type: none"> • Welding artisan for hybrid machinery, advanced materials welder (various international codes).
	Business management	<ul style="list-style-type: none"> • Strategic Sustainability Planning - Developing strategies to integrate renewable energy and reduce carbon footprints. • Renewable Energy Project Management - Overseeing renewable energy projects in mining, including 	<ul style="list-style-type: none"> • Sustainability manager, strategic planning officer. • Renewable energy project manager, program coordinator. • Carbon management officer, compliance analyst. • Financial analyst for green projects, investment adviser.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p data-bbox="913 268 1263 360">budgeting and stakeholder engagement.</p> <ul data-bbox="864 389 1417 1249" style="list-style-type: none"> <li data-bbox="864 389 1417 596">• Carbon Accounting and Reporting - Measuring, managing, and reporting emissions to comply with environmental regulations. <li data-bbox="864 625 1417 833">• Financial Modelling for Green Investments - Evaluating the financial viability of renewable energy and sustainability initiatives. <li data-bbox="864 861 1417 1069">• Stakeholder Engagement and ESG Leadership - Managing stakeholder relations and implementing ESG principles. <li data-bbox="864 1098 1417 1249">• Supply Chain Sustainability - Managing green procurement and sustainable supply chain practices. 	<ul data-bbox="1451 272 2011 480" style="list-style-type: none"> <li data-bbox="1451 272 2011 365">• ESG manager, stakeholder engagement officer. <li data-bbox="1451 394 2011 480">• Sustainable supply chain manager, procurement officer.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
	Carbon management	<ul style="list-style-type: none"> • Carbon Footprint Assessment - Measuring and analysing carbon emissions from mining activities. • Emissions Reduction Strategies - Developing and implementing strategies to reduce Scope 1, 2, and 3 emissions. • Carbon Capture and Storage (CCS) - Designing and managing CCS systems to sequester emissions from mining processes. • Carbon Offsetting Projects - Creating and managing offset initiatives like reforestation or renewable energy integration. • Carbon Trading and Compliance - Navigating carbon markets and ensuring regulatory compliance. • Renewable Energy Integration - 	<ul style="list-style-type: none"> • Carbon analyst, environmental impact assessor. • Emissions reduction specialist, carbon efficiency consultant. • CCS technician, carbon capture engineer. • Carbon offset project manager, sustainability coordinator. • Carbon trading specialist, compliance officer. • Renewable energy systems integrator, green energy consultant.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>Replacing fossil fuel energy sources with renewables to lower carbon intensity.</p>	
	<p>Circular economy principles</p>	<ul style="list-style-type: none"> • Resource Recovery and Recycling - Extracting and reusing materials from mining waste or end-of-life products. Waste Management Optimisation - Designing systems to minimise waste and turn byproducts into valuable resources. • Lifecycle Analysis (LCA) - Assessing the environmental impact of mining processes and materials over their lifecycle. • Eco-Design for Mining Operations - Creating sustainable mining tools, infrastructure, and systems with reduced waste. 	<ul style="list-style-type: none"> • Recycling technician, resource recovery specialist. • Waste reduction manager, circular systems designer. • LCA analyst, sustainability officer. Eco-design engineer, sustainable systems planner. • Circular economy market analyst, materials trading officer. • Circular operations manager, industrial symbiosis specialist.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Secondary Material Market Development - Developing markets for secondary materials (recycled metals, minerals). • Closed-Loop Systems Implementation - Designing and managing systems where mining inputs are fully reused or recycled. 	
	Climate adaptation	<ul style="list-style-type: none"> • Risk Assessment and Management - Identifying and mitigating climate-related risks (e.g., floods, heatwaves) affecting mining operations. • Water Resource Management - Developing sustainable water use systems to adapt to droughts or water scarcity. • Infrastructure Resilience Design - Designing and maintaining mining 	<ul style="list-style-type: none"> • Climate risk analyst, adaptation planner. • Water resource manager, hydrology specialist. • Resilience engineer, infrastructure planner. • Environmental restoration specialist, ecosystem manager. • Climate data analyst, environmental monitoring technician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>infrastructure to withstand extreme weather events.</p> <ul style="list-style-type: none"> • Ecosystem-Based Adaptation - Restoring and managing ecosystems to reduce climate impacts on mining areas. • Data Monitoring and Forecasting - Using technology to monitor and predict climate impacts on mining operations. 	
	Coded welders	<ul style="list-style-type: none"> • Dependent on the codes required - refers to welding skills as applied to JET projects. 	<ul style="list-style-type: none"> • Specialised welding in JET projects.
	Data	<ul style="list-style-type: none"> • Data skills refer to the recording, management, interpretation, and use of data relevant specific to JET and ESG initiatives. IoT data and management skills, systems management and data collection, retrieval and reporting. 	<ul style="list-style-type: none"> • Data analyst, data adviser.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Also see digitalisation skills. 	
	Developmental (Knowledge Transfer)	<ul style="list-style-type: none"> • Incorporating the ability to transfer knowledge for development of others. 	<ul style="list-style-type: none"> • Train-the-trainer, coaching, on-the-job expertise transfer.
	Digitalisation skills	<ul style="list-style-type: none"> • Data Analytics and Visualisation - Analysing energy use and emissions data to optimise mining operations. • IoT System Deployment - Installing and managing IoT devices for real-time monitoring of mining equipment and energy systems. • Automation and Robotics - Programming and maintaining autonomous equipment for energy-efficient mining. • Digital Twin Technology - Creating virtual models of mining operations for predictive energy and process management. 	<ul style="list-style-type: none"> • Data analyst, energy efficiency specialist. • IoT technician, smart mining specialist. Automation engineer, robotics technician. • Digital twin specialist, simulation engineer. • AI technician, machine learning analyst. • Cloud administrator, cybersecurity analyst.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • AI and Machine Learning - Developing AI models to predict equipment failures and optimise energy usage. • Cloud Computing and Cybersecurity - Managing cloud-based systems for data storage and securing digital infrastructure. • Includes requirement for digital literacy development. 	
	Electrical skills	<ul style="list-style-type: none"> • Renewable Energy System Installation - Installing solar panels, wind turbines, and energy storage systems for mining operations. • Energy-Efficient Systems Maintenance - Servicing and maintaining energy-efficient electrical equipment and systems. • High-Voltage Systems Expertise - Managing high-voltage electrical 	<ul style="list-style-type: none"> • Renewable energy electrician, solar installation technician. • Maintenance electrician, energy systems technician. • High-voltage electrician, power systems engineer. • Electrical retrofitter, grid integration specialist. • Battery systems technician, microgrid electrician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>systems for renewable energy integration.</p> <ul style="list-style-type: none"> • Electrical Retrofitting - Upgrading existing electrical infrastructure to support low-emission technologies. <p>Battery Storage and Microgrid Systems</p> <ul style="list-style-type: none"> - Installing and managing battery storage and microgrid solutions in mining. <ul style="list-style-type: none"> • Electric Vehicle (EV) Infrastructure - Installing and maintaining charging stations for electric mining vehicles. <p>Basic skills include Wiring, Troubleshooting, Maintenance of turbine electrical systems</p>	<ul style="list-style-type: none"> • EV charging technician, electric fleet systems electrician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
	Energy efficiency	<ul style="list-style-type: none"> • Energy Auditing - Conducting energy audits to identify inefficiencies in mining operations. • Energy Management Systems - Installing and managing automated energy monitoring and control systems. • Optimising Mining Equipment - Retrofitting and maintaining equipment for improved energy efficiency. • Heat Recovery Systems - Designing systems to capture and reuse waste heat in mining processes. <p>Variable Speed Drives (VSD) Installation - Installing and maintaining VSDs to reduce energy use in motors and pumps.</p>	<ul style="list-style-type: none"> • Energy auditor, efficiency analyst. • Energy management technician, IoT energy specialist. • Equipment efficiency technician, optimisation specialist. • Heat recovery engineer, thermal systems technician. • VSD technician, electrical energy specialist. • Renewable energy integrator, hybrid systems engineer.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> Renewable Energy Integration - Combining renewable energy systems with traditional mining operations to reduce overall energy demand. 	
	Engineering	<ul style="list-style-type: none"> Renewable Energy Engineering - Designing and integrating solar, wind, and hybrid systems for mining operations. Electrical Engineering - Upgrading electrical systems, integrating energy storage, and supporting EV infrastructure. Mechanical Engineering - Developing energy-efficient machinery and retrofitting equipment for reduced emissions. 	<ul style="list-style-type: none"> Renewable energy engineer, energy systems specialist. Power systems engineer, electrical retrofitter. Equipment design engineer, mechanical efficiency specialist. Environmental impact engineer, water resource manager. Automation engineer, SCADA technician. Infrastructure engineer, resilience planner. Hydrogen systems engineer, thermal energy specialist.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Environmental Engineering - Managing water resources, emissions control, and sustainable mine rehabilitation. • Automation and Control Engineering - Designing automated systems to optimise energy usage and improve efficiency. • Civil Engineering - Designing resilient, energy-efficient mining infrastructure to adapt to climate impacts. • Hydrogen and Thermal Engineering - Designing hydrogen fuel systems and optimising heat recovery processes. 	
	Environmental management (including restoration)	<ul style="list-style-type: none"> • Cross-cutting with other technical skills listed in the table. Essential skills are highlighted as follows: Carbon Emissions Management - Measuring, monitoring, and reducing 	<ul style="list-style-type: none"> • Carbon management officer, emissions control specialist. • Waste management technician, recycling coordinator. • Hydrologist, water resource engineer.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>greenhouse gas emissions in mining operations.</p> <ul style="list-style-type: none"> • Waste Management and Recycling - Developing systems to recycle mining byproducts and manage waste sustainably. • Water Resource Management - Designing systems for efficient water use, pollution prevention, and water recycling. • Environmental Impact Assessment (EIA) - Conducting EIAs to evaluate and mitigate mining’s environmental impact. • Biodiversity Conservation - Restoring habitats and ensuring sustainable land use post-mining. • Renewable Energy Integration - Transitioning mining operations to 	<ul style="list-style-type: none"> • EIA specialist, environmental compliance officer. • Conservation officer, land rehabilitation technician. • Renewable energy specialist, energy transition coordinator. • Climate adaptation planner, sustainability strategist.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>renewable energy sources to reduce environmental harm.</p> <ul style="list-style-type: none"> • Climate Adaptation and Resilience Planning - Developing strategies to adapt mining operations to climate change impacts. 	
	Financial (including financial planning)	<ul style="list-style-type: none"> • Renewable Energy Project Financing (green financing) - Structuring and securing funding for renewable energy installations in mining. • Carbon Accounting and Pricing - Measuring, valuing, and managing carbon credits and emissions trading. Cost-Benefit Analysis for Sustainability - Evaluating the economic viability of JET initiatives, such as energy-efficient systems. • Energy Transition Risk Assessment - Assessing financial risks associated 	<ul style="list-style-type: none"> • Project finance specialist, green investment analyst. • Carbon accountant, emissions trading officer. • Financial analyst, sustainability cost manager. • Risk analyst, transition finance adviser. • Lifecycle cost analyst, financial planner. • Green bond adviser, investment manager.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>with transitioning to renewable energy.</p> <ul style="list-style-type: none"> • Lifecycle Costing - Calculating the total costs of renewable energy and energy-efficient technologies over their lifecycle. • Green Bond Issuance - Developing and managing green bonds to fund sustainable mining projects. 	
	Fitters	<ul style="list-style-type: none"> • Skill set is cross-cutting with various skills listed and describe within the table. • Maintenance of Renewable Energy Systems - Repairing and maintaining components of solar panels, wind turbines, and biogas systems. • Energy-Efficient Equipment Retrofitting - Upgrading mechanical 	<ul style="list-style-type: none"> • Renewable energy maintenance fitter, turbine technician. • Retrofitting technician, efficiency fitter. • Hydrogen systems fitter, fuel cell technician. • Equipment optimisation specialist, mechanical fitter. • Hydraulic systems fitter, energy-efficient systems technician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>systems like pumps, compressors, and conveyors for energy efficiency.</p> <ul style="list-style-type: none"> • Hydrogen Systems Installation - Assembling and maintaining hydrogen-powered equipment and fuel storage systems. • Mechanical Systems Optimisation - Diagnosing and optimising energy use in mining equipment to reduce emissions. • Pneumatic and Hydraulic Systems Maintenance - Servicing energy-efficient hydraulic and pneumatic systems used in mining. • Recycling and Waste Management Equipment - Installing and maintaining machinery for recycling mining waste. 	<ul style="list-style-type: none"> • Recycling systems fitter, waste management technician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
	Green mining techniques (generic comment from stakeholders)	<p>This skill set includes numerous areas discussed previously in the table; main skills areas include:</p> <ul style="list-style-type: none"> • Renewable Energy Integration • Energy-efficient Equipment Operation • Waste Management and Recycling • Water Management • Carbon Emission Monitoring • Automation and Digitalisation • Mine Rehabilitation and Ecosystem Restoration. 	<ul style="list-style-type: none"> • Renewable energy technician, green energy systems engineer. • Electric machinery operator, hybrid equipment technician. • Recycling specialist, waste reduction technician. • Hydrology technician, water resource manager. • Carbon analyst, emissions control officer. • Automation technician, digital systems specialist. • Land rehabilitation specialist, environmental restoration technician.
	Management of greenhouse gas (GHG) emissions	<ul style="list-style-type: none"> • GHG Monitoring and Measurement - Using tools and software to track emissions from mining activities. • Carbon Accounting and Reporting - Calculating and reporting Scope 1, 2, 	<ul style="list-style-type: none"> • Emissions monitoring technician, environmental data analyst. • Carbon accountant, sustainability officer. • CCS technician, renewable energy specialist.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>and 3 emissions for compliance and transparency.</p> <ul style="list-style-type: none"> • Emission Reduction Technology Integration - Installing and maintaining systems like carbon capture and storage (CCS) and renewable energy solutions. • Process Optimisation for Emissions Reduction - Modifying mining processes to improve energy efficiency and reduce emissions. • GHG Mitigation Strategy Development - Designing strategies to offset emissions, such as reforestation or renewable energy use. • Methane Capture and Management - Implementing systems to capture and use methane from mining operations. 	<ul style="list-style-type: none"> • Process improvement engineer, energy optimisation technician. • Carbon offset project manager, climate strategist. • Methane recovery specialist, gas systems technician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
	Mechanical, including hydraulics and pneumatics	<ul style="list-style-type: none"> • This skills set refers to the levels below engineering and relates to maintenance and support staff levels. Generic technical skills are associated with this skills cluster. 	<ul style="list-style-type: none"> • Maintenance and support staff
	Occupational Health and Safety	<ul style="list-style-type: none"> • Safety Protocols for Renewable Energy Systems - Ensuring safe installation and operation of solar, wind, and battery systems. • Hazard Identification for New Technologies - Assessing risks associated with hydrogen systems, electric vehicles, and automation. • Safe Handling of Energy Storage Systems - Managing and maintaining safety around lithium-ion batteries and hydrogen fuel cells. • Emergency Response Planning - Developing response strategies for 	<ul style="list-style-type: none"> • Renewable energy safety officer, electrical safety technician. • Risk assessor, technology safety adviser - change to OHS Representative requirements Battery safety technician, hydrogen safety specialist. • Emergency preparedness coordinator, safety response officer. • OHS trainer, ergonomics specialist. • Environmental safety officer, air quality technician. • OHS compliance officer, sustainability safety adviser.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>renewable energy and low-carbon technology hazards.</p> <ul style="list-style-type: none"> • Workplace Ergonomics and Training - Training workers on safe practices with new energy technologies and automated equipment. • Air Quality and Emission Monitoring - Monitoring and controlling dust, emissions, and air quality during green mining operations. <p>Compliance with Green Mining Regulations - Ensuring adherence to updated OHS laws related to JET technologies.</p>	
	Project management	<ul style="list-style-type: none"> • Project management skills apply, with specific focus provided to green/renewable energy projects (i.e. reporting, compliance and regulation management, and integration of green technologies) 	<ul style="list-style-type: none"> • Renewable energy project manager

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
	Risk management	<ul style="list-style-type: none"> • Climate Risk Assessment - Identifying and mitigating risks from extreme weather and climate change impacts. Energy Transition Risk Analysis - Evaluating risks of integrating renewable energy technologies and phasing out fossil fuels. • Regulatory Compliance - Managing risks associated with non-compliance to environmental and sustainability laws. • Financial Risk Management - Assessing investment risks for renewable energy and green technology projects. • Operational Risk Management - Identifying risks in using new equipment, automation, or energy systems. 	<ul style="list-style-type: none"> • Climate risk analyst, environmental risk officer. • Energy transition risk manager, renewable energy adviser. Compliance risk officer, policy risk adviser. • Financial risk analyst, sustainability investment manager. • Operational risk manager, equipment safety analyst. • Supply chain risk officer, procurement specialist. • Safety risk manager, OHS adviser.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Supply Chain Risk Mitigation - Managing risks in sourcing sustainable materials and maintaining green logistics. • Health and Safety Risk Management - Addressing hazards introduced by new energy technologies and systems. 	
	Science, Technology, Engineering, and Mathematics (STEM)	<ul style="list-style-type: none"> • STEM relates to generic skills and must be applied as the subjects relate to JET. 	<ul style="list-style-type: none"> • Multiple applications across technical areas.
	Solar (including installation and maintenance)	<ul style="list-style-type: none"> • Solar Panel Installation - Installing and wiring photovoltaic (PV) panels in mining operations. • System Design and Layout - Designing solar systems optimised for energy needs and mining conditions. • Battery Storage Integration - Installing and maintaining energy storage solutions for off-grid solar systems. 	<ul style="list-style-type: none"> • Solar installer, renewable energy technician. • Solar system designer, energy systems engineer. • Battery systems technician, microgrid specialist. • Solar maintenance technician, renewable energy service specialist.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Troubleshooting and Repairs - Diagnosing and repairing faults in solar panels, inverters, and wiring systems. • Performance Monitoring and Optimisation - Using tools to monitor and optimise solar system performance. • Safety and Compliance - Ensuring solar installations meet safety and regulatory standards. 	<ul style="list-style-type: none"> • Solar performance analyst, energy efficiency technician. • Solar compliance officer, safety technician.
	Steam (installation and maintenance)	<ul style="list-style-type: none"> • Steam System Design - Designing energy-efficient steam generation and distribution systems for mining. • Boiler Installation and Maintenance - Installing, inspecting, and maintaining low-emission boilers. • Steam Leak Detection and Repair - Identifying and fixing leaks to reduce energy loss in steam systems. 	<ul style="list-style-type: none"> • Steam systems engineer, energy efficiency planner. • Boiler technician, steam plant operator. • Maintenance fitter, leak detection technician. • Heat recovery specialist, thermal systems technician. • SCADA technician, steam system automation engineer.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Heat Recovery Systems - Implementing waste heat recovery technologies to improve steam system efficiency. • Automation and Monitoring - Automating steam system operations and monitoring energy performance. • Safety and Compliance - Ensuring compliance with safety and environmental regulations for steam systems. 	<ul style="list-style-type: none"> • Compliance officer, safety inspector.
	Structural engineering (also see engineering)	<ul style="list-style-type: none"> • Design of Renewable Energy Structures - Designing foundations and supports for solar panels, wind turbines, and battery systems. • Energy-Efficient Infrastructure Design - Creating mining facilities optimised for energy efficiency and sustainability. • Structural Retrofitting for Energy Efficiency - Modifying existing mining 	<ul style="list-style-type: none"> • Renewable energy structural engineer, solar infrastructure designer. • Sustainable infrastructure engineer, green building specialist. • Retrofitting engineer, structural modification specialist. • Climate resilience engineer, structural safety analyst.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>infrastructure to support renewable energy integration.</p> <ul style="list-style-type: none"> • Resilience Engineering - Designing mining structures to withstand climate impacts like extreme weather. • Material Optimisation for Sustainability - Selecting low-carbon and sustainable construction materials for mining projects. • Structural Analysis and Monitoring - Using digital tools to assess and monitor structural performance under renewable energy loads. 	<ul style="list-style-type: none"> • Sustainable materials engineer, structural materials specialist. • Structural analysis engineer, performance monitoring technician.
	Sustainability	<p>Identified that this skill set refers to combination of various elements stated in the table. Main skills considerations are:</p> <ul style="list-style-type: none"> • Sustainable Resource Management - Optimising resource use and 	<ul style="list-style-type: none"> • Resource efficiency manager, sustainability officer. • Renewable energy specialist, green energy coordinator. • Carbon reduction specialist, emissions manager.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>minimising waste in mining operations.</p> <ul style="list-style-type: none"> • Renewable Energy Integration - Planning and implementing renewable energy systems to power mining activities. • Carbon Emission Reduction - Developing strategies to reduce greenhouse gas emissions in mining processes. • Mine Rehabilitation and Land Restoration - Restoring ecosystems and landscapes after mining operations. • Environmental Monitoring and Compliance - Ensuring operations adhere to environmental standards and regulations. 	<ul style="list-style-type: none"> • Land rehabilitation officer, ecological restoration technician. • Environmental compliance officer, monitoring technician. • Circular economy coordinator, waste recycling specialist. • Community relations manager, ESG specialist.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Circular Economy Practices - Recycling mining waste and reusing materials to reduce environmental impact. • Community Engagement for Sustainability - Collaborating with local communities to ensure sustainable development. 	
	<p>Technical energy skills related specific to women in mining</p>	<ul style="list-style-type: none"> • Renewable Energy Systems Operation - Installing, operating, and maintaining solar and wind energy systems in mining. • Automation and Robotics - Operating autonomous mining equipment and programming automation systems. • Environmental Management - Managing waste, water, and emissions to meet sustainability goals. • Data Analytics and IoT Systems - Using IoT and analytics tools to monitor 	<ul style="list-style-type: none"> • Renewable energy technician, solar panel installer. • Automation technician, robotics operator. • Environmental officer, carbon emissions analyst. • IoT specialist, energy data analyst. • Maintenance technician, energy optimisation specialist. • Land rehabilitation technician, ecological restoration officer.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<p>energy efficiency and operational performance.</p> <ul style="list-style-type: none"> • Energy-Efficient Equipment Maintenance - Repairing and retrofitting mining equipment for reduced energy consumption. • Mine Rehabilitation and Land Restoration - Restoring mining sites with sustainable practices. • Leadership and Advocacy in Sustainability - Leading ESG initiatives and advocating for gender inclusion in energy transition projects. 	<ul style="list-style-type: none"> • ESG project leader, sustainability advocate.
	Technicians	<p>This relates to each specific installation and maintenance aspect within the renewable energy value chain in mining (covered in various areas in this table). The main skills areas were identified as being:</p>	<ul style="list-style-type: none"> • Renewable energy technician, solar systems maintainer. • Equipment maintenance technician, hybrid machinery specialist. • Automation technician, IoT systems operator.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Renewable Energy System Maintenance • Energy-Efficient Equipment Repair • Automation and IoT Systems • Carbon Monitoring and Control • Waste and Water Management • Battery and Microgrid Maintenance • Safety System Implementation 	<ul style="list-style-type: none"> • Carbon monitoring technician, emissions control specialist. • Water treatment technician, waste management specialist. • Battery systems technician, microgrid operator. • Safety technician, renewable energy compliance officer.
	Waste disposal	<ul style="list-style-type: none"> • Waste Segregation and Recycling - Identifying recyclable materials and managing waste separation systems. • Hazardous Waste Management - Safely handling and disposing of toxic materials in compliance with regulations. • Mine Tailings Management - Designing and maintaining systems to safely store and repurpose mine tailings. 	<ul style="list-style-type: none"> • Recycling technician, waste segregation specialist. • Hazardous waste technician, environmental compliance officer. • Tailings disposal technician, resource recovery specialist. • Waste-to-energy operator, biogas technician. • Landfill technician, storage systems designer.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Waste-to-Energy Conversion - Operating systems that convert mining waste into usable energy. • Landfill and Storage Optimisation - Designing efficient storage solutions to minimise environmental impact. • Circular Economy Implementation - Incorporating waste reduction into mining processes and reusing materials. 	<ul style="list-style-type: none"> • Circular economy technician, sustainability advisor. • Waste-to-Energy operator.
	Water management	<ul style="list-style-type: none"> • Water Recycling Systems - Designing and operating systems to recycle water used in mining processes. • Sustainable Water Treatment - Treating contaminated water to meet environmental standards. • Hydrology and Resource Management - Monitoring and managing water usage to minimise waste and impact. 	<ul style="list-style-type: none"> • Water recycling technician, process water specialist. • Water treatment technician, environmental compliance officer. • Hydrologist, water resource manager. • Rainwater systems technician, water harvesting specialist. • Effluent control officer, wastewater treatment technician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Rainwater Harvesting Systems - Implementing systems to collect and utilise rainwater in mining operations. • Effluent Management - Managing and treating mining effluents to reduce environmental damage. • IoT-Enabled Water Monitoring - Using IoT sensors to monitor water quality and consumption in real-time. 	<ul style="list-style-type: none"> • IoT water monitoring technician, smart water systems operator.
	Wind (including turbines/power generation and maintenance)	<ul style="list-style-type: none"> • Wind Turbine Installation - Assembling and installing wind turbines at mining sites. • Turbine Maintenance and Repairs - Diagnosing and fixing mechanical and electrical issues in wind turbines. • Power System Integration - Connecting wind turbines to mining grids and integrating with other energy sources. 	<ul style="list-style-type: none"> • Wind turbine installer, renewable energy technician. • Wind turbine technician, maintenance fitter. • Power systems engineer, grid integration specialist. • Wind energy analyst, performance monitoring technician. • Wind safety officer, compliance technician.

Soft skills	Technical skills	Technical Skills Description	Practical examples (skills application in occupations)
		<ul style="list-style-type: none"> • Performance Monitoring and Optimisation - Using sensors and analytics to monitor wind energy output and efficiency. • Safety and Compliance - Ensuring installations and operations meet safety and environmental standards. • Offshore/Remote Wind Farm Operations - Managing wind power systems in remote or challenging environments near mining sites. 	<ul style="list-style-type: none"> • Remote operations technician, offshore wind specialist.