



The State of Play: Mining strategy in a changing world

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About State of Play and major sponsors

About State of Play™

State of Play™ was initiated in 2012 to create a platform to support industry discussion of innovation and performance at a strategic level and provide macro-level insights into the industry ecosystem.

The State of Play™ surveys enable us to uncover the impediments and success factors driving innovation across the industry supply chain and provide business executives with a health-check of how their companies benchmark against their peers. More broadly, the results have the potential to position the industry for a strategic shift.

This is our sixth biennial report on strategy and innovation in the global resources industry. The report represents a broad cross-section of the industry; it surveyed every continent, across mining and services companies and features a large number of respondents from executive or senior management levels.

The report and various supporting reports on key regions and issues of critical importance to the industry are available at: **www.stateofplay.org**

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We acknowledge the traditional owners of all lands on which the mining industry operates globally. We pay our respect to their Elders, past, present, and emerging.

About our major sponsors

METS Ignited

METS Ignited is the Industry Growth Centre for the Mining Equipment, Technology and Services (METS) sector, funded by the federal government Department of Industry, Science and Resources. The goal of the growth centres is to accelerate commercialisation of innovation, enhancing industry capabilities and grow exports in sectors where Australia has a natural competitive advantage. METS Ignited supports Australian technology companies in translating local innovation into products and services, to serve global markets from within the national economy.

www.metsignited.org

CSIRO

As Australia's national science agency and innovation catalyst, CSIRO solves the greatest challenges through innovative science and technology. They work with organisations large and small, delivering world-leading research and development solutions to help their business innovate, improve and grow. CSIRO is involved in developing technologies that enable the transition to renewable energy, including critical minerals discovery, environmentally sensitive extraction, and value-adding through processing and manufacturing in Australia.

www.csiro.au

Slate Advisory

Slate provides strategic advice to the natural resources, energy and infrastructure industries to help solve the challenge of adapting to external forces. Slate advises established businesses on navigating these forces, through the design of business and functional strategy and tailored reviews. Slate also builds new businesses based on deep industry insight, through the design of business models and the bringing together of partners, capital and capability.

www.slateadvisory.com

The State of Play team would like to thank individuals from the following organisations for their participation in this research through interviews and interpretation of survey results:

Anglo American	METS Ignited
Aquila Consulting	MineHub Technologies
BHP	Mining3
Carrington Day	Pilbara Minerals
Chalice Mining	Resource Capital Funds
Cornwall Lithium	RCF Jolimont
CSIRO	Strayos
Hiseis	Turini Consulting
Imdex	United States Geological Survey
Lumenary Investment Management	Usiminas Mining

The method:

In 2023, State of Play partnered with CSIRO, METS Ignited and Slate Advisory to undertake the biennial Mining Industry Survey.

The research consisted of:

- 720 individual surveys from miners, suppliers, government, investment and researchers involved in the mining industry. Respondents were collected from 50 countries.
- 18 interviews with industry leaders.
- Desktop research and analysis.

The recommendations in this report do not necessarily reflect the views of all our sponsors and contributors, and are conclusions drawn by State of Play after analysis of the survey data, desktop research and interviews.



Table of contents

Foreword	7
Introduction	8
External Forces	10
Can miners keep up with the changing climate?	13
Beneath the surface: The technology transformation	16
Keep your (geopolitical) friends close	18
Pay now or pay later?	20
Strategy	22
Community: Beyond care and maintenance	25
Marketing: A missed opportunity?	28
The battery driven boom	30
The eternal promise of exploration technology development	34
The all-important capital equation	38
Organisational Architecture	40
Aligning with the times	42
The road to innovation is paved with strategic intentions	46
The building blocks of transformative growth	48
Mining for new talent	50
AI & mining people: competitors or co-workers?	52
Conclusion	54

Foreword

A decade after our first survey, we are proud to deliver State of Play's sixth biennial Mining Industry Survey report.

The report comes amidst a growing movement demanding change. Society is looking for more from our industry – more consideration for the environment, more responsible practises, and more meaningful engagement with community.

At the same time, the energy transition is altering the way supply chains operate, the demand for commodities, and the price attached to them. How do we ensure that critical minerals are mined in environmentally responsible ways? How will companies be rewarded for being more ESG conscious? What role does technology play? How do we navigate the geopolitical tensions that will reform supply chains? And how do we find enough skilled workers to enable the success of the energy transition?

As the industry evolves, so does the research State of Play conducts. We stand by our vision to positively influence the resources industry and communities through the strategic insights we create. To do that will require working even closer

with the industry and the broader community to make sure our data can have the most impact possible in decision-making and strategy.

One thing that won't change is our fierce independence and curiosity. We will keep asking the big questions and uncovering the important insights needed to assist senior executives in their decision-making process.

Finally, we say thank you to all those who have generously given their time to respond to surveys, join our interviews, and participate in wide-ranging conversations. Your insights and support are the reason we can continue to do what we love.

Graeme Stanway
Chair of State of Play

Introduction

The mining industry finds itself at the epicentre of shifting global dynamics – external forces are challenging the status quo, forcing companies to embrace new ways of operating.

Supply chains continue to transform, four years after the COVID-19 pandemic disrupted them in an unprecedented way. This time, we are seeing nations rush to secure the critical minerals fundamental to the energy transition. New alliances are being formed, countries are onshoring more of their operations and capturing more of the value chain is becoming a lucrative business opportunity.

Businesses are required to embrace new technologies or risk being left behind. The topics of artificial intelligence and automation are not new in the mining industry – both have been invested in extensively over the last decade. What is changing is the pace at which technology is evolving. The world saw how quickly technology like ChatGPT could transform the business landscape – what will the future of mining look like with machines running the show?

Branding and PR, which have never been a focus of the industry, may suddenly be key to unlocking value (and revenue) for companies that choose to take that path. Green premiums continue to be discussed extensively within both industry and the media, but there is still much uncertainty as to how this will play out. What is clear is that delivering the best environmental, social and governance outcomes from the new energy minerals being mined, whilst also delivering affordable inputs to end-user products (such as electric vehicles), is a juggling act that the critical minerals supply chain has not yet mastered. Will we see a green premium

appear? Will those producing more carbon intensive materials end up experiencing a brown penalty? The jury is still out.

Industry also continues to run into issues with people, both in the mining workforce and the wider community. The industry clearly sees the value in their employees — our data shows that they consider their people as a leading area of competitive advantage. At the same time, the broader community's negative perceptions of mining are becoming more serious, perhaps driven by businesses' failure to meaningfully engage with society's growing environmental and social expectations. We see this manifest in operational disruption due to protests and withdrawn social licences for miners. More broadly, we see a global skills shortage, as the mining industry struggles to attract talent over other, more positively perceived industries.

Underpinning all of this change is the energy transition. Where we are going to find the minerals, how we are going to source enough, what will be the dominate energy sources going forward and what will operations look like under these new energy sources, are questions that continue to be asked.

This tornado of external forces is requiring the industry to rethink their strategy, organisational architecture and innovation approaches. More than ever, there is a requirement to think long term, embed innovation within strategy and rethink business models to capitalise on the next generation of mining opportunities.

This report unpacks how the industry is transforming and what they need to do to harness opportunities and navigate challenges in the ever-evolving world. Look at this report

as your handbook to help guide you through your decision-making processes when it comes to strategy, organisational architecture and innovation.

We hope you enjoy it.

The State of Play team

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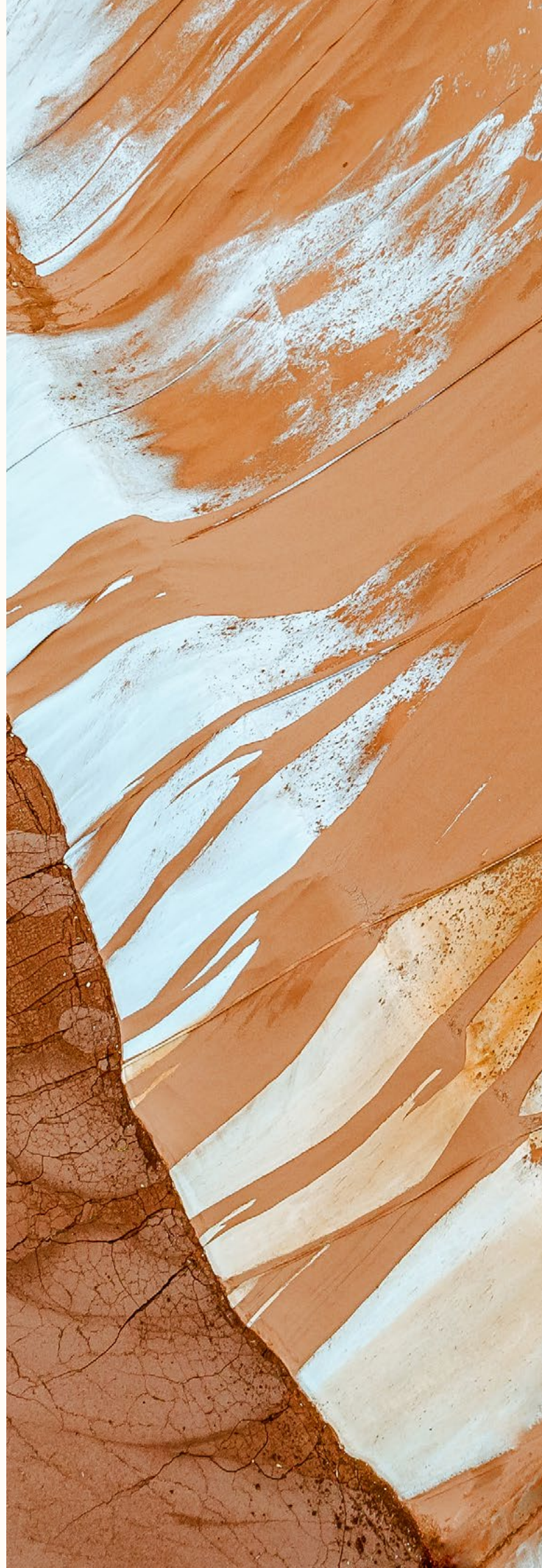
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External forces



As part of the survey process, we interviewed a range of leaders in the mining industry to understand their views on the evolution of industry and the external trends impacting it. We asked the interviewees what were the big issues that kept them awake at night, and while the answers differed, there were several common themes that we discuss in this section.

The world has been going through an extended period of structural change over the past two decades. Advances in technology, the development of Asia and climate change have created a volatile picture for strategic planners in the mining industry to navigate. In most cases, the shifts to date have been positive. Asian growth has created a new era of profitability in the industry, while technology has improved the productivity and safety of businesses. Climate change has presented a more mixed picture, however. The promise of reliable renewable energy for sites, and safer, more productive electric mining vehicles remain just that – a promise. Upfront cost, supply availability and organisational change

“...so what’s keeping me awake at night? It’ll be how do we create a future that we’re proud of?”

- CEO, RESEARCH ORGANISATION

are presenting themselves as stubborn obstacles. In addition, the changing climate has brought with it a dynamic regulatory environment and a new profile of risks for global businesses like miners.

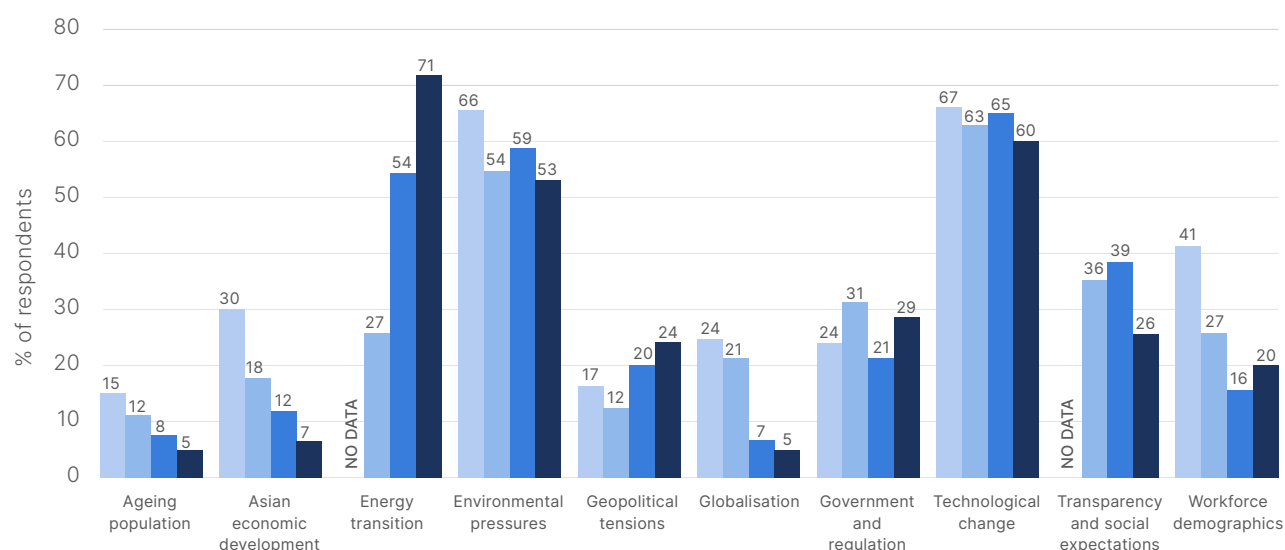
Discussions around these external trends provide the opportunity to truly examine how the mining industry is currently responding, and how these trends may ultimately impact the industry over the next 15-20 years.

QUESTION

Which of the following global trends will have the biggest impact on innovation over the next 15 years?

Respondents given 3 answers.

2017 2019 2021 2023



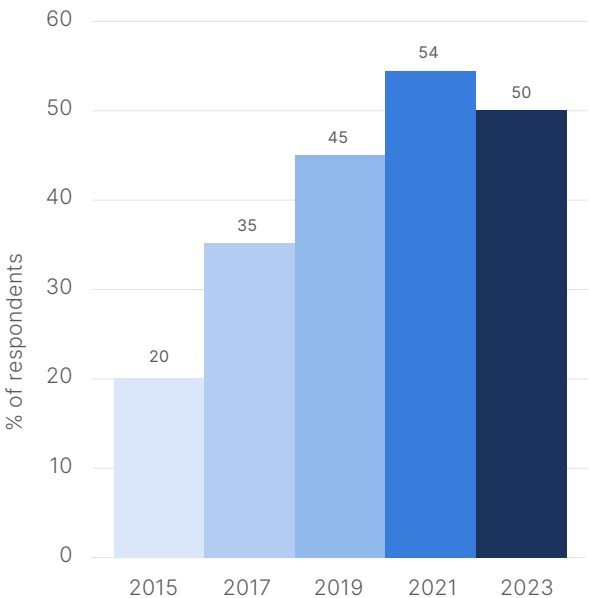
Can miners move as quickly as the changing climate?

The pressure to address climate change has been mounting over the last few decades but has particularly accelerated in the last 10 years. This is evident in our data – in 2015, environmental concerns were 8th on the list of industry trends predicted to have the biggest impact on mining over the next 15 years. In 2023, it is 2nd, surpassed only by the energy transition, itself catalysed by the need to address climate change.

QUESTION

Which of the following industry trends will have the biggest impact on mining over the next 15 years?

*Environmental concerns respondents only.
Respondents given 3 answers.*



2023 was the warmest year since modern record keeping began (around 1880) and the past 10 consecutive years have been the warmest on record.¹ The world is witness to an increasing number of unprecedented climate related events and every credible climate model predicts these will continue to increase going forward. While our ability to adapt has improved, unforeseen climate driven events will continue to threaten lives — Libya’s recent flash flooding in which more than 11,300 people were killed, being a recent example.²

The mining industry is cognisant of its connection to climate change. 91% of industry believe they are viewed negatively by society with respect to the climate, and there has been a concerted effort in the last decade to embed ESG in decision making. In addition to this, both the energy transition and environmental pressures are in the top three global trends that are expected to have the biggest impact on innovation in mining over the next 15 years. The energy transition has taken centre stage with a large shift in predicted impact on innovation in mining, from 54% in 2021 to 71% in 2023.

“We are going through one of the biggest transitions in the energy side, from reliance on the current state of energy to a new state of energy.”

– CEO, TECHNOLOGY COMPANY

1. [Nasa](#)
2. [The Guardian](#)

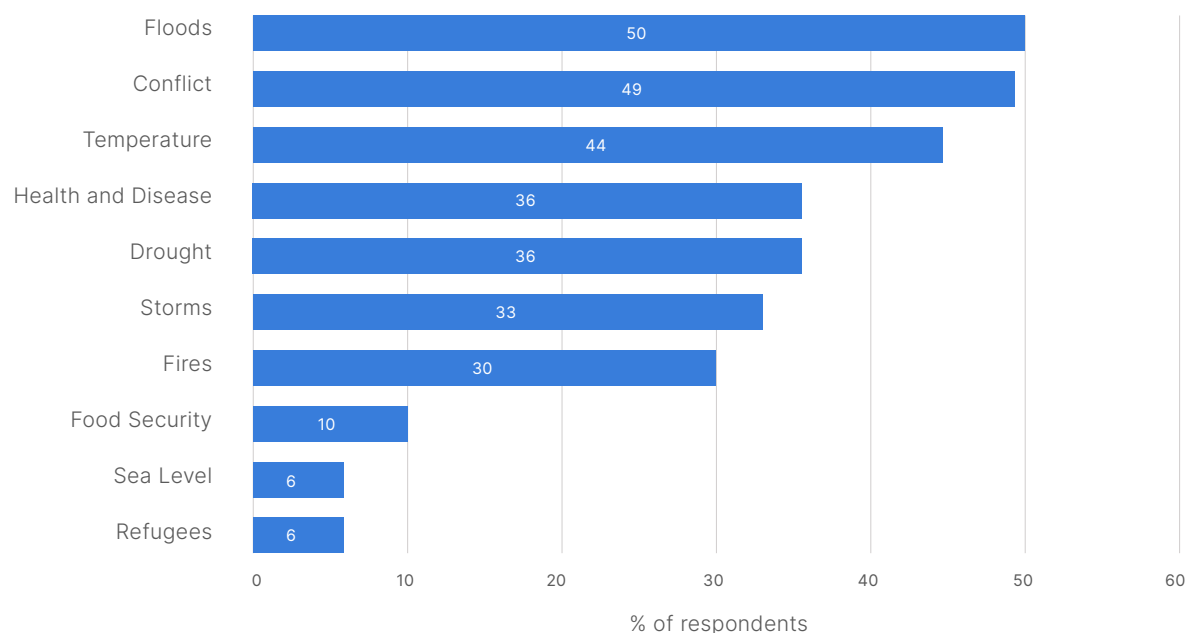
Industry's need to address the role they play in climate change is twofold. Societal expectations of mining are influenced by the way people see the industry behaving – and the picture is not flattering. Despite renewables having a near universal positive business case for miners in simple commercial terms, State of Play analysis shows average renewable penetration across certain sites can be as low as 10%. Several companies like Bellevue Gold and Gold Fields have demonstrated the viability of operating with high renewable penetrations, but their efforts are notable for their comparative rarity. The emerging position is that the mining industry will not pursue carbon reduction alone, and instead, stringent regulation and external pressure will be required.

Significant changes to weather patterns (driven by the climate crisis) could also severely impact mining businesses. Our data shows floods, conflict and temperature are seen as the three climate change risks which pose the greatest threat to mining businesses.

Flooding will impact transport but also mine site design and operation. For example, the contemporary design of tailings dams is less safe as severe rain events can cause shock loading to the dams, impacting their structural integrity. Conflict will become an increasing issue for those vulnerable communities where there is already competition between companies and communities for resources, which may impact social licence to operate. Extreme temperature will impact infrastructure, operations, and people – a phenomenon that has already become commonplace. Heat tolerance standards for infrastructure and equipment will need to increase, potentially jeopardizing the safety of existing capital assets. People will require increased air conditioning, shorter shifts, and less manual work during extreme temperature events – with obvious impacts on productivity and liability for miners. Changing climate patterns will also create major uncertainty in revegetation requirements, especially when planning for mine closures decades into the future.

QUESTION Which climate change risks pose the greatest threat to your business?

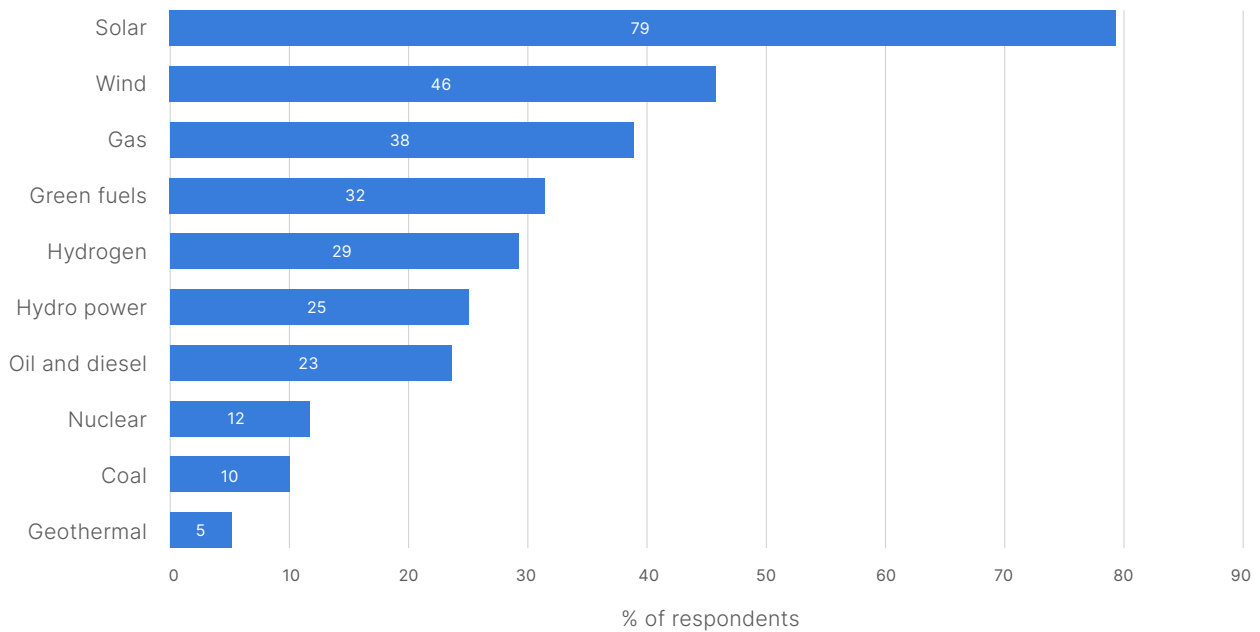
Respondents given 3 answers.



QUESTION

What energy sources will become the most widely used in your country's mining companies over the next 15 years?

Respondents given 3 answers.



Typically, miners have not embraced the small number of solutions from vendors on how to address the energy transition - choosing to leverage their positions with existing suppliers rather than utilising the new vendors in earnest. But as the momentum for the transition grows, so to do the availability of solutions - renewables are now cost effective, the application of electrification is broadening, new forms of energy storage are

being developed, and new clean fuel sources are emerging. The expectation of solar, wind and green fuels being widely used as energy sources within mining in the future is growing, a clear disruptor to oil and diesel. In 2019, 44% of respondents saw oil and diesel as the most widely used energy source for mining over the next 15 years. Fast forward to 2023 and that has halved to 23% - an extraordinary shift.



Beneath the surface: The technology transformation

From a distance, mining appears to be done the same as it ever was: big shovels, big trucks, big trains and big ships. But look beneath the surface, and a bottom up and slow burn transformation of the industry continues unabated. The accumulated effect of 15 years of digital adoption is beginning to show. Telematics on equipment, internet connectivity across sites, immediate personal communication, remote control and cloud computing are changing the way the industry works – and there's no going back.

Over the past three or four years, it has also become clear that the shift from a fuels-based operating model to an electricity-based operating model will accelerate this shift even more – providing the missing

foundational pieces to fulfil the long promise of digitally dense and automated mining operations. Electrification of all things will unlock an entirely different way of mining. The degree of integration and optimisation once everything is connected on a single power system is technically unattainable in a fuels-based system. As we have seen in other industries, new service models will also emerge that may begin to reshape the definitions of resources and services companies.

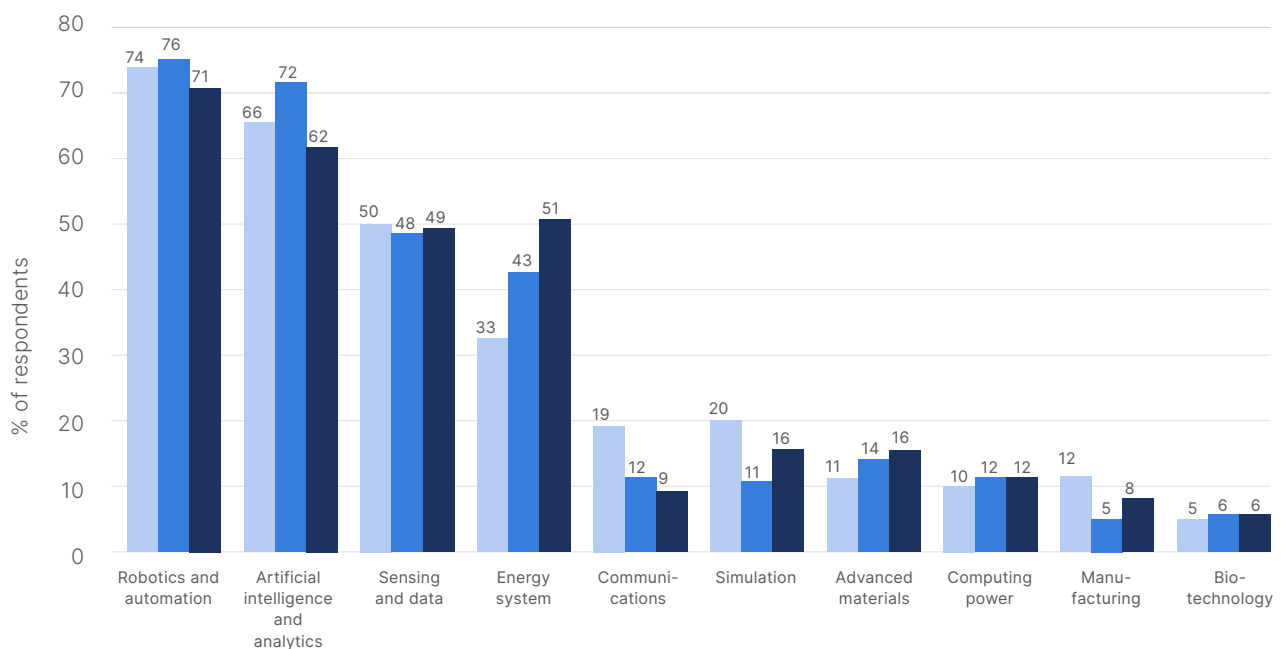
60% of respondents believe technology will have the biggest impact on innovation in mining over the next 15 years – and it is hard to see how they could be wrong.

Technology trends: Longitudinal

QUESTION

Which underlying technology areas will have the biggest impact on mining over the next 15 years?

Respondents given 3 answers. ■ 2019 ■ 2021 ■ 2023





“As an industry we try to solve one problem at a time rather than sort of look at systems redesign. I get it’s like that because we had humans. But what if we didn’t have a human, then how would we change this thing?”

– CEO, MINING TECHNOLOGY SERVICES COMPANY

In the geological space, we are beginning to see the types of technologies and service companies that have been long predicted, but slow in arriving. Companies like FLEET Space are providing new technologies for mineral exploration, allowing miners to visualise the subsurface and drastically improving targeting.³ Orebody knowledge within operating assets is improving. Companies like PETRA have built machine learning algorithms that analyse geological data to optimise the extraction of minerals.⁴

Companies like Tyton Ecological Intelligence are using artificial intelligence for rehabilitation and vegetation condition monitoring, whole-of-site weed detection, targeted species searches, and carbon quantification monitoring in diverse systems.⁵ What we see in the next decade in this space will look like science fiction in comparison to today. The smart mining companies are testing, understanding and building the skills in these technologies, and several have been for some time.

“What it means is billion-dollar capital investment decisions in mining are made on 1% of 1% of the ore body knowledge. That’s like deciding to perform surgery to remove a tumour just by looking at you from the outside....

We do it because we don’t spend the money upfront to understand the ore body. And maybe the technologies haven’t been available upfront to understand the ore body. But as those technologies become available, will the behaviour change? Those are the precursors to precision mining.”

– CEO, MINING SERVICES COMPANY

^{3.} [Fleet Space](#)

^{4.} [Petra](#)

^{5.} [Tytonei](#)

Keep your (geopolitical) friends close

There has been much written over the past five years on the concept that the global economy is separating into two large economic blocs – one dominated by China, and one dominated by the US. While this holds some validity for mining companies, the reality is nuanced, with notable exceptions in critical minerals.

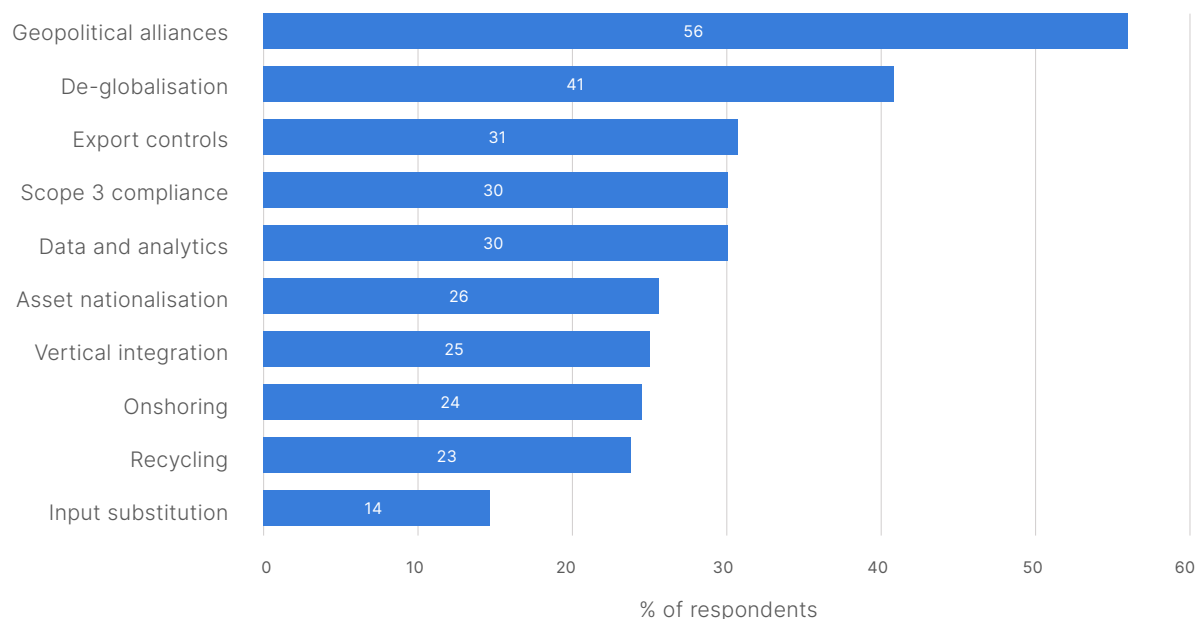
For now, most mining companies can sell their products from anywhere to anywhere. It is more of a question of choosing which market offers the best mix of inducements, market

size and pricing. Even then, the choice is rarely irreversible. Current market settings in China and the US are a form of market protectionism that the mining industry has navigated with skill for well over a century in different markets. Other commodities are the same – Australian, African, Asian and Canadian agriculture has long been heavily obstructed from selling into Europe.

QUESTION

Which of the following will have the biggest impact on global supply chains in the mining industry?

Respondents given 3 answers.



What makes this cycle unique is the rise in the importance of battery and critical minerals. Both are seen as strategically important commodities for many countries, and crucially, both are growing enormously relative to their market size over the last few decades. As a result, the location and ownership of their value chains is up for grabs – and China, the US and Europe are offering handsome incentives

to have them in their sphere of influence and control. Emblematic of the more robust policy approach from governments is the US' Inflation Reduction Act (IRA) discriminatory Local Content Restrictions for tax breaks and China's ongoing ad hoc restrictions on the export of gallium and germanium.

"I think previously, it was genuinely a more global economy, where trade relationships are more liberal. I think it is now getting far more picky. And so... what flows out of all of that is there will be a reinforcement of trade relationships to countries who are friendlier with each other. And I think there'll be preferential trade relationships and support. And we're starting to see some moves, IRA being one of them."

– CEO, MINING COMPANY

The world has experienced a sustained period of globalisation since the latter half of the 20th century, but now, collective demand from countries around the world to democratise the production, transmission, and consumption of energy is altering international alliances, with everyone turning to focus on their domestic priorities. This shift is reflected in our data – the predicted impact of globalisation on innovation in mining in the next 15 years has dropped almost 5-fold in the since 2017.

With the move to onshore capacity building comes a shift in perceptions around the role of Asian economic development. Over the last few decades, we have seen China become an economic powerhouse, averaging GDP growth of over 9% a year and experiencing significant foreign investment.⁶ China also continues to dominate downstream processing after spending decades developing capabilities in this space (China holds between 85% and 90% of all the downstream processes for rare earths).⁷ Despite China's growth slowing more recently, Chinese dominance in mining and manufacturing is unlikely to change anytime soon.

None of this can explain that only 7% of the mining industry believe Asian economic development will have an impact on mining innovation in the future (down from 30% in 2017). China, Korea and Japan are building most of the world's battery gigafactories and are responsible for most of the innovation in battery and renewable technologies, including being home to some of the biggest electric vehicle manufacturers in the world. Indonesia is forecast to be the world's 4th largest economy by 2050, which will have an increasingly significant impact on mining value chains.⁸ It is truly difficult to conceive that 93% of the industry don't see continued Asian development as one of the top three trends impacting mining innovation over the next 10 -15 years. In this case, the truth appears to be hiding in plain sight.

6. [The World Bank](#)

7. [ASPI](#)

8. [OECD](#)

Pay now or pay later?

The nickel market is currently facing huge disruption, catalysed by the change in Indonesian government policy to restrict the export of raw ore. This spurred a significant domestic investment cycle (encouraged in part by Chinese enterprises) that doubled Indonesia's primary nickel production in a few short years, and subsequently flooded the market. The plummeting nickel price has heavily impacted high-grade nickel producers in predominately developed countries. Incumbent miners are calling for a more level playing field, whether that be in the form of direct government support, such as production tax credits, or green premiums for more ESG conscious raw materials.⁹

These demands miss the central economic issue – ‘the tragedy of the commons’. Indonesian nickel, known as class 2, has a considerably higher level of embedded carbon than Australian or Vietnamese nickel, which is known as class 1. The social cost of a tonne of carbon has been calculated at around US\$258/t.¹⁰ The Indonesian are able to sell their nickel at a discount with the global community picking up the difference in the form of increased climate impacts.

Across all metals markets, a similar story is playing out, albeit in less dramatic fashion. Miners complain that they cannot make the investments necessary to lower carbon emissions because customers are not paying them to do so – that is, aren't paying the green premium. At the same time, there have only been a handful of initiatives in the industry designed to create a green premium pricing mechanism, despite it being a very common discussion topic over the past decade.

“Whoever can find a way whereby we can deliver exceptional returns to investors in a way that's acceptable to a broader community, is going to win.”

– CEO, RESEARCH ORGANISATION

No doubt consumer demand plays a role, and the broader society must be aware of what a demand for higher standards means – higher costs. However, we are ultimately still left with the question – how can a customer pay a green premium if it is not being offered?

Until the industry makes a deliberate shift to pricing models that account for carbon content on the major metals exchanges, it is difficult to see the large-scale and broad-based investment required to clean up and modernise the industry. Until this happens, external perceptions of the industry will remain anchored where they are.

Inaction will come at a cost. Over 50% of investors said in a recent survey that they were preparing to increase their allocations to ESG investments in 2024.¹¹ Despite this, industry believes that transparency and social expectations will have less of an impact on the future of innovation in mining than it did two years ago (just 26% of respondents in 2023, versus 39% in 2021). This may just be that the energy transition is overwhelming other ESG considerations, or it could be another blind spot for industry, who will traditionally invest capital and time innovating in spaces in which they can maximise returns, such as processing and energy.

9. AFR

10. NY Times

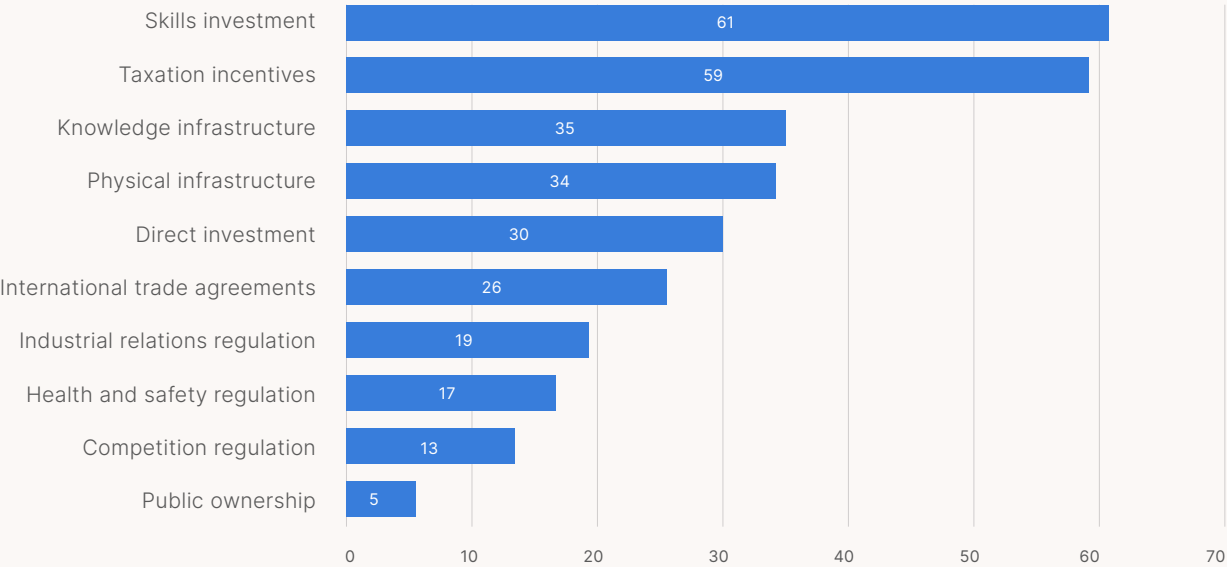
11. deVere Investment

Industry do understand the increasingly important role of government in setting the right conditions to overcome the challenges they are facing. According to our data, the industry believes that government policy can best accelerate innovation through skills investment. It's predicted up to 194,000 workers will require training in new skills specific to the renewable energy industry in Australia alone, across solar, wind, hydrogen and storage.¹² With the current talent shortage existing across most industries, government has a role in investing in solutions which will provide the skills required for the future of mining.

Whether individuals believe that decarbonisation is warranted or not, there can be little doubt that it is the great industry shift for the current generation of executives and politicians. Embracing the shift and working together as an industry and government to make the decisions and train the workforce necessary provides the only real chance for the industry to rise from its place as one of the world's most poorly perceived industries. A clean, high-tech, safe and prosperous industry is the only pathway to achieving a greater and more sustainable social license that can underpin the industry's success for the decades to come.

QUESTION **How can government policy best accelerate innovation in mining?**

Respondents given 3 answers.



12. ARENA

"I think the role of government is to create the conditions that incentivize certain industries."

– PARTNER, PRIVATE EQUITY FIRM



A night view of a city skyline across a river, likely the Huangpu River in Shanghai. The skyline is filled with illuminated skyscrapers and buildings. The river is dark, with several boats visible, including a large brightly lit ferry in the foreground. A large, white, semi-transparent semi-circle graphic is overlaid on the image, centered behind the word "Strategy".

Strategy



The strategic environment for miners is in a dynamic phase. International efforts to respond to climate change through rapid decarbonisation is creating challenges and opportunities for the world's mining industry. As explorers chase new deposits in battery minerals to cash in on the high price environment, the story is more complicated for developers and operators. The opportunity to gain exposure to a big growth market is likely to have a volatile cost profile and may require risky downstream capital allocation for processing. In so doing, these companies would be accepting greater asset design and capital intensity risk – something they have typically tried to avoid over the last several decades.

At the same time, the industry is also facing community and regulatory pressure to reduce its own impact on the environment and contribution to climate change, increasing its value to both local and global communities in the process. For those who choose to,

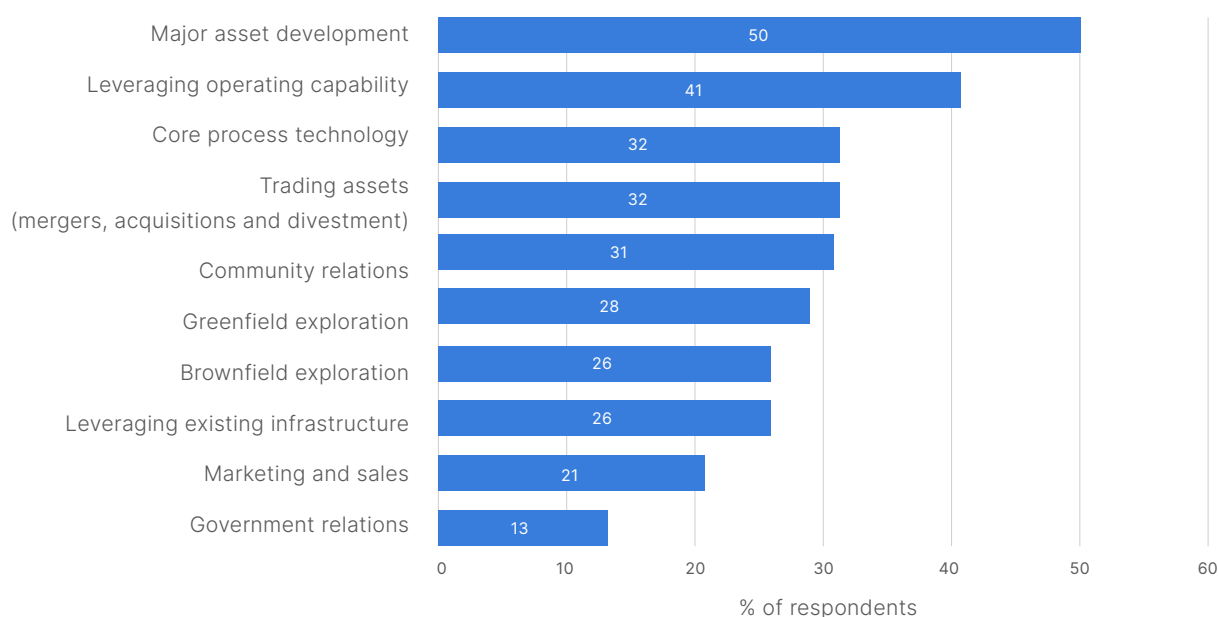
addressing these pressures also opens the opportunity to gain exposure to the potential for selling new green products priced at a premium to current products, mitigate regulatory imposts, and differentiate in attracting employees.

So far, we have seen a sharp uptick in M&A as the industry consolidates and restructures to meet the demands of the moment and companies make their bets on how to position for the cycle ahead. For some, this will test their assumptions on where their competitive advantage lies and how this could shift, leading to potential changes in their business model.

How the industry looks at the end of this cycle is anyone's guess. It is the first cycle in modern history that is not driven by regional economic development, but by a global social and regulatory shift. Through this chapter, we take a look at a few of the early strategic implications already emerging.

QUESTION**What are the most important elements of your strategy?**

Mining company respondents only. Respondents given 3 answers.



Community: Beyond care and maintenance

Modern mining is increasingly grappling with conflicting priorities. Shareholders demand operational efficiency and a return on investment, while there is an increasing expectation from investment firms and banks surrounding ESG considerations and reporting. In fact, a recent survey revealed that 64% of respondents believe local community impact is the most scrutinised ESG factor by investors.¹³ More broadly, communities expect miners to operate safely, ethically, and sustainably, to meaningfully contribute to the local economy, and to address the urgent climate crisis.

“We would not invest in a company purely on the basis of being a social good... [but] it's got to be embedded in the offering.”

– DIRECTOR, MINING INVESTMENT FUND

Whilst mining companies are typically well versed at navigating financial priorities, local communities remain less of a strategic consideration. Just 10% of State of Play respondents identified community as a primary focus of their innovation efforts, and less than a third of respondents consider it a key element in their business strategy.¹⁴ Despite this, our data shows that 24% of respondents foresee community as a main disruptor along the mining value chain. The mismatch revealed between the mining industry's current priorities and their future areas of disruption could suggest risks of an increase in major community-related consequences for mining operations.

13. EY

14. In this context, *primary* means it was selected among the top three from a list of ten items.



How mining disrupts communities – the good, the bad, and the ugly

Where some miners see community as a risk to be managed, it is the local communities themselves who face tangible, urgent, multifaceted impacts when mining operations come to town. Mining may promise to deliver social and economic prosperity to a region, but too often this falls short or is accompanied by a slew of detrimental local outcomes.

Around the globe, mines have damaged precious community lands, from cultural heritage sites though to once-productive pastures – a resource which is particularly crucial for survival and self-determination in rural and impoverished regions. These regions often play host to artisanal and small-scale miners (including around one million children each year), whose suffering is enabled by the lack of downstream transparency and due diligence.¹⁵ The responsibility to address this harm is not solely the miners'; the entire value chain, including the consumers demanding cheap products built from mining materials, are also complicit. While many miners do not directly exploit people, the overall inadequate duty of care and lacklustre industry standards represent serious problems for communities.

From 2010 to 2022, nearly half of all critical minerals miners with at least one human rights allegation actually had human rights policies in place, and two-thirds of allegations were directed at just 13 firms (including some multinational mining majors.)¹⁶ Given this record, it's not surprising that mining has

emerged as the worst industry for indigenous, minority, and gender rights risks, ranking an extreme risk for Women and Girls' rights in over 83 countries and an extreme risk for minority right in 77 countries.¹⁷

In certain countries, if you are unlucky enough to be "sitting on a gold mine", you may be pressured to move or forcefully evicted by mining companies without fair compensation (this practice often occurs within a regulatory framework that allows for dispossession by governments that are reliant on mining royalties). If you remain in proximity to a mine site, you and your loved ones may encounter alcohol and drug abuse or social issues arising from transient worker populations. You may experience health issue from mining accidents, or from the toxic aerosols and particulates released into the air by mining activities. You may also suffer from a multitude of vital water issues, from freshwater contamination and scarcity to tailing pond failings.

In the US alone, an estimated 189 million litres of contaminated mining wastewater poisons local water sources each day, and in Brazil mining contamination has been linked to seven-fold increases in infant mortality rates.¹⁸ ¹⁹ More directly, violent altercations may arise with the security staff of mining companies who are granted tenements on your borders; over a 15-year period, 28 Canadian mining companies operating in Latin America were associated with 44 deaths and 403 injuries. ²⁰

15. [University of Manchester](#)

16. [Business & Human Rights Resource Centre](#)

17. [Maplecroft](#)

18. [Associated Press](#)

19. [Mining Technology](#)

20. [York University](#)

Derisking communities through earnest engagement, from mine to marketplace

When neglecting to act on community interests in their strategy, miners are exposing themselves to serious reputational, operational, and legal risks. Less than a quarter of the aforementioned deaths in Latin America were reported by the publicly listed companies; subsequent media coverage led to shareholder backlash including price drops, institutional divestment, and class action lawsuits. Operations themselves have been interrupted by community opposition – in 2023, multiple miners were issued cease-and-desist orders by local governments in the Philippines after hundreds of residents protested their operations using human barricades.²¹ In the same year, Rio Tinto and Alcoa withdrew exploration plans in Western Australia after facing over 1,500 community objections.²²

Positioning community as an integral strategic pillar of a mining enterprise is no simple task; communities comprise a diverse set of cultures, customs, and generations, whose values must all be understood and respected. To do so, miners should consider a more transparent, holistic, and long-term view of their relationship with community (an approach which is also more aligned with that of many Indigenous peoples).²³

Greater communication and accountability need to take place the entire way down the supply chain. Individual miners need to do their bit by implementing initiatives that catalyse strong community

“We want to be at the table as equals, not beneficiaries. We have been disenfranchised in the past, which is a factor in our approach today. We bring the authority of knowing the land in a way that extends beyond the cultural elements.”

**- MANAGING DIRECTOR,
TJIWARL CONTRACTING
SERVICES PTY LTD**

partnerships. These initiatives may be as simple as communications strategies to help communities feel heard (and to manage expectations), or as hands on as building schools or organising artisanal miners into more protected cooperatives. For these strategies to be effective, companies first need to maintain high operational standards around their worker safety, environmental impact (particularly regarding local waste and pollution), Indigenous respect, and interactions with locals. Companies (and especially downstream marketplaces and processors) can champion provenance certification, supply transparency, and price floors for certain commodities to improve conditions for artisanal and small-scale miners. Purchasers can also simply ask questions as to the exact location and conditions of a mineral's extraction. Conveniently, this move supports a green price premium for operators with high ESG standards and bolsters the overall mining brand on a global scale.

²¹. [Palawan News](#)

²². [ABC](#)

²³. [Common Ground](#)

Marketing: A missed opportunity?

Mining has traditionally defined marketing in a distinct way to other industries, in which it really covers trading and logistics, not so much branding. Perhaps, this may be about to change. Branding and public relations is becoming a crucial way for miners to distinguish themselves from an ever-growing pool of competitors (in Australia alone, nearly 500 new mining businesses were registered between FY2020 and FY2023).²⁴ By articulating their brand identity to their value-chain partners and even end consumers, miners may attract price premia, access to talent and resources, favourable approvals, and preferential partner terms.

Miners tend to focus on upstream operational strategies to drive business growth – a natural consequence of wealth generated by privileged access to ore bodies. Meanwhile, the downstream demand profiles for commodities are changing rapidly in the face of the fossil-fuel driven climate crisis. End-product consumers are shifting to prefer (and in some cases insist on) environmentally and socially conscientious brands.²⁵ This is evident in the profile of consumer goods offered by Unilever, whose Sustainable Living Brands (e.g., social justice ice-cream company Ben & Jerry's) experience faster growth than their other brands. Similarly, electric vehicle sales are climbing while internal combustion engines have decreased 5% year-on-year since 2019.²⁶ If these trends persist, miners may benefit from paying more attention to their market positioning (beyond the usual technical requirements and trading mechanisms).

It's not yet clear exactly how the demand for ethically sourced products will manifest further up the resource value chain, leaving industry to debate whether producers of low-emissions commodities will ever be rewarded with a so-called "green premium". While 67% of the mining industry believe that there will be a carbon-based price differential for their commodities in the next 5 years, others doubt that this is possible without drastic measures like government intervention or more standardised carbon accounting.

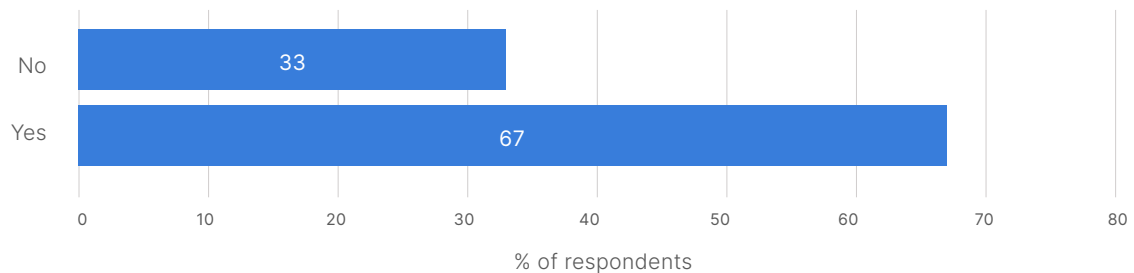
"From what I've observed, it seems that the only effective way to push for a premium market for ethically sourced and Western-origin materials is through government regulation... if governments were to set requirements that a certain portion of raw materials must come from like-minded countries or adhere to specific ethical standards, it would incentivize end buyers to follow suit... I believe that government involvement will be essential to drive this change, not just in Australia but in other parts of the world, including China."

– SENIOR FINANCE EXECUTIVE

²⁴. ABS

²⁵. Unilever

²⁶. Statista

QUESTION**Will there be a carbon-based price differential for the commodities you work with in the next 5 years?**

For now, the absence of any significant green premium is negatively impacting enterprises who have invested in responsible mining practices. For instance, electric vehicle manufacturers' willingness to purchase the glut of cheap so-called 'dirty nickel' coming from Indonesia over a higher ESG standard (but consequently, higher cost) product has caused panic in Australia, whose government is backing an ESG price premium to protect thousands of jobs in its floundering nickel industry.²⁷

This sentiment is supported in Western markets by initiatives such as the EU's new Battery Regulation, which requires future electric vehicles and rechargeable industrial batteries have a low carbon footprint.²⁸ In lieu of a green premium, industry may see differentiated commodity prices come in the form of "brown penalties" such as costly environmental remediation or regulatory fines or penalties (including liability for third-party infractions along the supply chain). It may also manifest as more expensive capital raising, with financiers beginning to consider ESG performance as part of an entities' credit rating and dedicated platforms being established to track these metrics. In the market itself, industry representatives are pressuring trading platforms to vet the sustainability of commodities they sell.

From all angles, it appears that the safest way to manage risk is for miners to demonstrate a high ESG standard of operations across their asset portfolio, and market their products to customers with similar values.

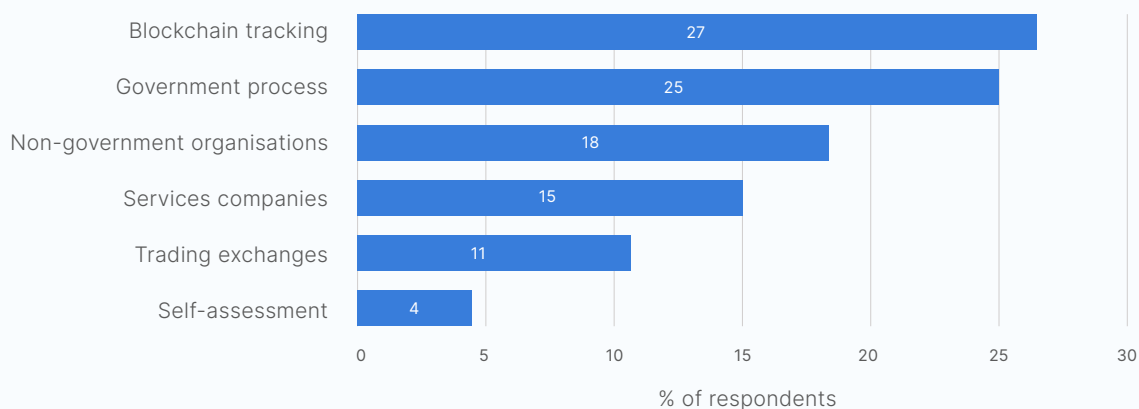
The push for greater ESG standards leads to the question: How might miners certify their responsibly sourced commodities? Our respondents believe the most promising avenues will be blockchain tracking and government certification, which can be more rigorous than relying on exchange platforms to verify the ESG quality of products they trade. We have seen first-movers invest in this sort of provenance tracking already – Bellevue Gold has secured a separate refinery pathway for their differentiated "green gold" product, and Ford Motor Company is using blockchain technology to trace the battery materials it sources from Huayou Cobalt. If the provenance validation trend continues, it promises even tougher market conditions for miners who neglect to update their strategies. On the contrary, successful brand management then allows motivated partners to easily identify and engage with values-driven resources companies, particularly in immature markets.

²⁷. AFR

²⁸. European Commission

QUESTION

What is the best method to certify low-emission commodities?



The battery driven boom

The market size of key energy transition minerals has doubled over the past five years, reaching USD 320 billion in 2022.²⁹ The demand for rare earth elements is expected to grow 400-600% over the next few decades and it's predicted that mineral demand for clean energy technologies will rise by at least 4x to meet climate goals by 2040, requiring hundreds of new mines.^{30, 31, 32}

Remarkably, over 80% of respondents think battery minerals will offer the most attractive

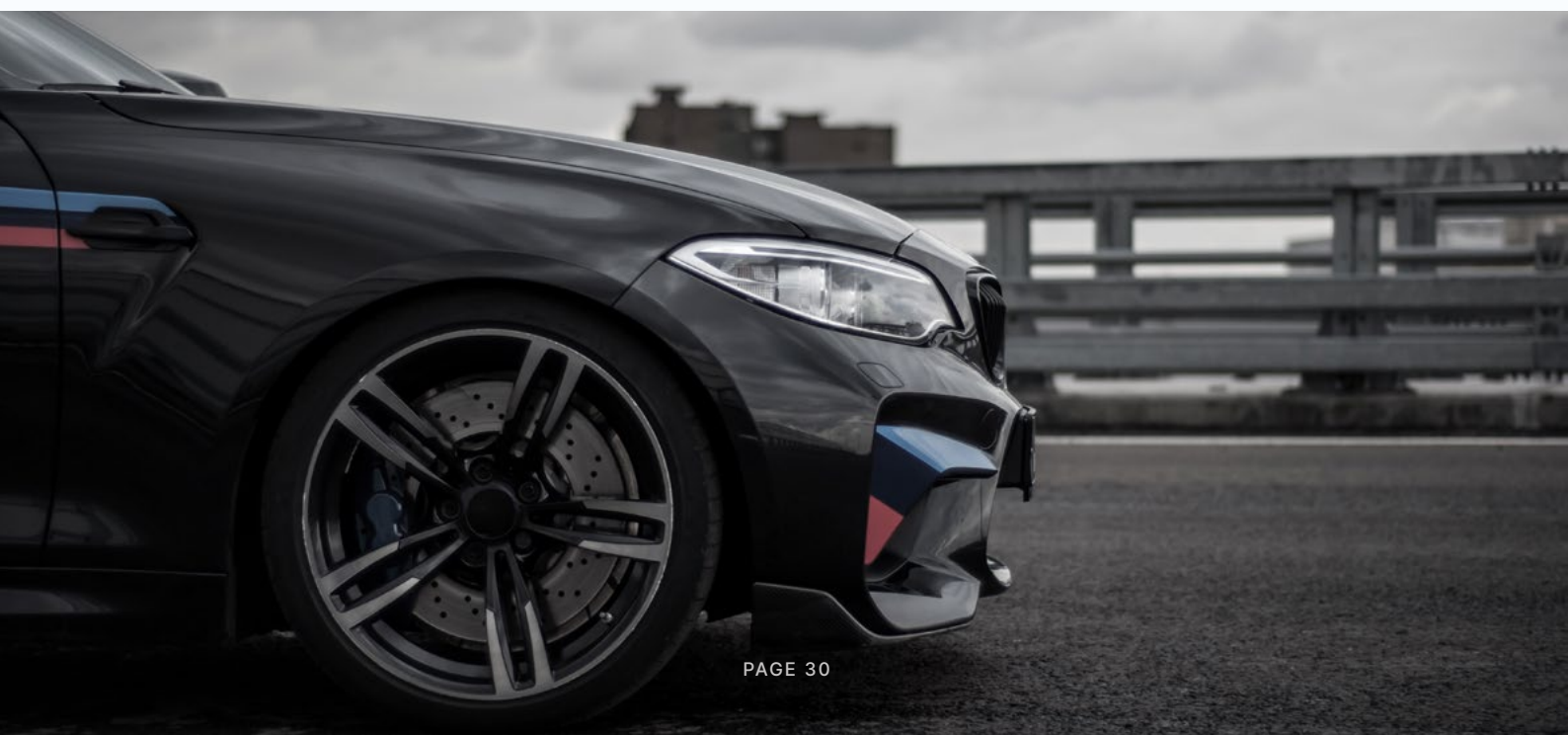
returns over the next 15 years. This highlights the scale of change underway and offers a unique opportunity for those companies which want to strategically pivot into the new energy minerals space and capitalise on these potential gains.

29. [International Energy Agency](#)

30. [Columbia Climate School](#)

31. [International Energy Agency](#)

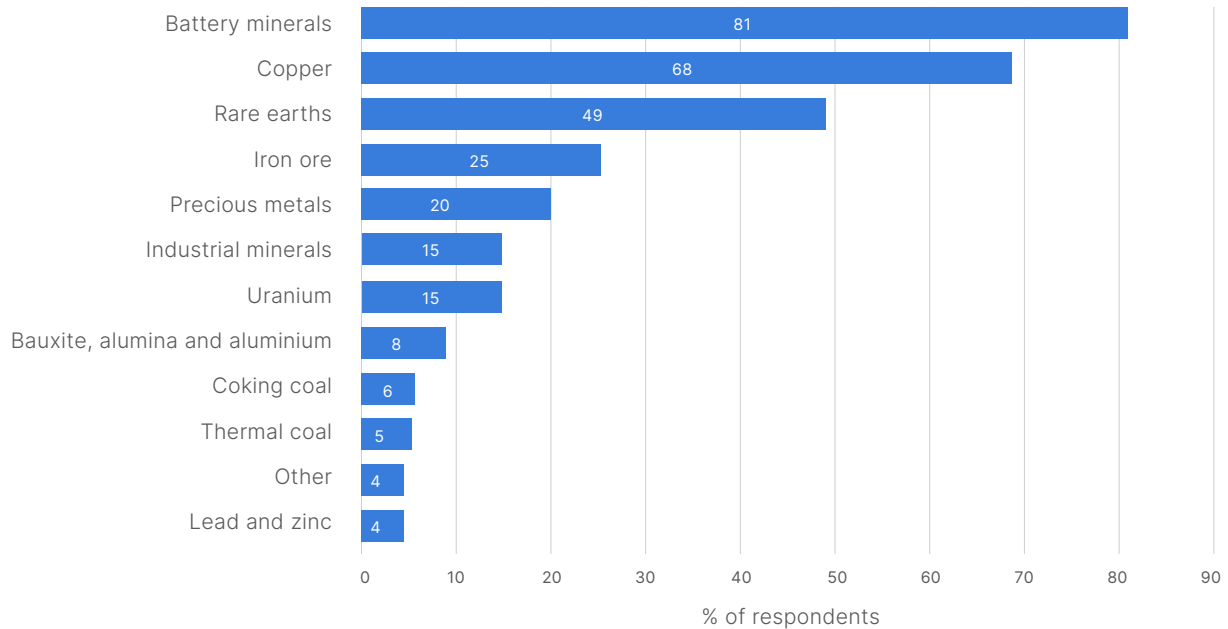
32. [Mining.com](#)



QUESTION

Which type of new mining projects will offer the most attractive investment returns over the next 15 years?

Respondents given 3 answers.



Drilling into the unknown

So far, the growth of these new markets has been led by new entrants such as Pilbara Minerals and Core Lithium, with the majors taking a back seat. There are several reasons why established players may not be keen to step into the new energy minerals space.

Firstly, volumes traded are still small when compared to other metals. Australian export volumes of spodumene for 2022-2023 were ~3,000 kt, compared to ~895,000 kt of iron ore.³³ This small size leads to enormous price volatility in what have been far shorter cycles (2-3 years, versus 5-7 years for traditional commodities).

There is also the issue of technical capability. Mining new energy minerals tends to be more complex. In mining lithium, for example, there can be challenges with producing the required product purities for lithium batteries and dealing with the large amounts of waste produced. For an established company which has experience in mining more traditional

metals, it might not be worth their time or effort to acquire the skills and technical capabilities required.

The geopolitical complexity of new energy minerals may be another deterrent for large companies considering stepping into the space. Developing new relationships, navigating new supply chains and trying to overcome complex geopolitical and policy issues may be too much of a strategic shift for some companies, particularly when considering strategic metals like rare earths.

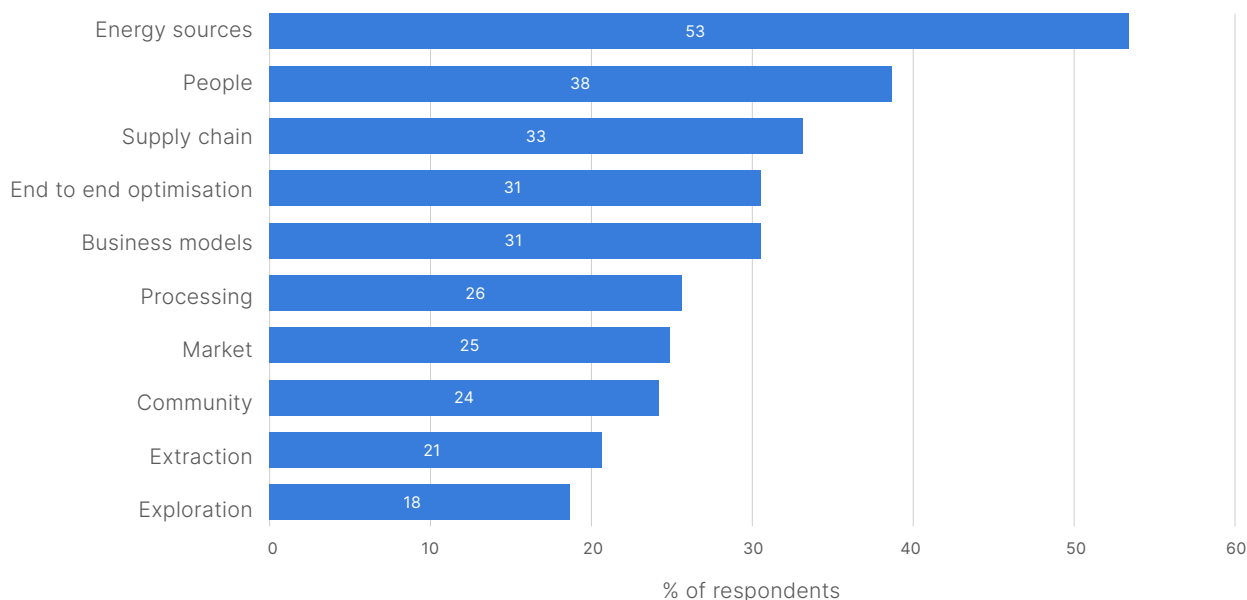
The choice of whether to enter these markets will include attitudes towards investing heavily in renewable energy, downstream processing and accepting asset design risk. These three things have not been a large part of the strategic appetite of the majors over the past 20 years. Our data suggests that this appetite is building.

³³. [Department of Industry, Science and Resources](#)

QUESTION

Where along the value chain is disruption in the mining industry most likely to occur?

Respondents given 3 answers.



Will the energy shift result in a broad shift to downstream processing and new asset designs?

Processing innovation is critical in a world undergoing an energy transition whilst simultaneously facing declining ore body qualities and increasing costs. We are already seeing the flow on impacts of declining quality for those minerals critical to the energy transition. Declining copper ore body quality has resulted in the volume of ore sent to concentrators increasing by 44% over the last 10 years – it's predicted the volume will need to increase by another 44% by 2031 to supply the amount required for the transition.³⁴ Processing is particularly energy intensive, with crushing and grinding rock in the processing stage accounts for approximately 40% of the energy that mining operations use.³⁵

Low-cost renewable energy is shifting the cost and strategic assumptions around going downstream. The opportunity to co-locate energy intensive processing with mines and large-scale, behind-the-meter renewables is available to most miners, particularly those in the battery minerals without deeply established value chains. Companies such as MP Minerals in the US have co-located both the mine site and processing facilities, while other companies are actively taking steps to replace their current energy systems with renewables. Antofagasta Minerals' Minera Zaldívar mine in Chile is powered by 100% renewables, and IGO's Nova mine has just expanded their solar farm to allow their operations to run on 100% renewable power for 8-9 hours per day in spring and summer.³⁶

34. McKinsey

35. University of Queensland

36. Mining Technology

When it comes to asset design, miners tend to be more risk averse. In fact, only 14% of respondents said they would be willing to accept risk in asset design to increase financial returns. Given assets can have anywhere from a 10 to 30-year life span, risk aversion in this area is problematic. Innovation in asset design will be key to the energy transition and the successful electrification of mines and processing. Everything from mine layout, optimal material movement and renewable energy infrastructure needs to be considered. Implementation in greenfields projects will be easier than retrofitting existing operational mines.

Those that are willing to take the risk in asset design can potentially reap large rewards. Glencore's Onaping Depth project has set out to become an all-electric mine, resulting in a rethink around how they design their asset. The mine will include mine-wide Wi-Fi communications, autonomous and battery powered mining equipment and a redesigned ventilation and cooling system. The benefits to this are numerous – reduced energy costs, a smaller environmental footprint and fewer health concerns for employees.

"I think it's because there's a real business opportunity around the right innovation. Whether it's automation, AI or decarbonisation, [these] are some of the types of categories where I think big gains can be made – and businesses can smell that opportunity."

– CEO, MINING COMPANY



The eternal promise of exploration technology development

The exploration sector is very much aware of the money to be made from the current gold rush-type environment for battery minerals, with global exploration spending rising by 20% in 2022, largely driven by record growth in lithium exploration.³⁷

Despite recent subdued pricing environments for several metals, including lithium and nickel, there are still numerous companies continuing exploration activities in the hopes of capitalising on the future demands of the energy transition.

As demonstrated in the figure below, the amount spent on Australian exploration activities has increased significantly since the 2012-2014 collapse, however the majority of the recovery has come from brownfields expenditure. Less than half of the metres drilled in 2022 were in greenfields exploration campaigns. The disproportionate focus on brownfields exploration, whilst lower risk in the short-term, will only amplify long-term issues for global mineral supply, as incremental expansion of known resources will fail to underpin a sustained increase in demand for most critical minerals.

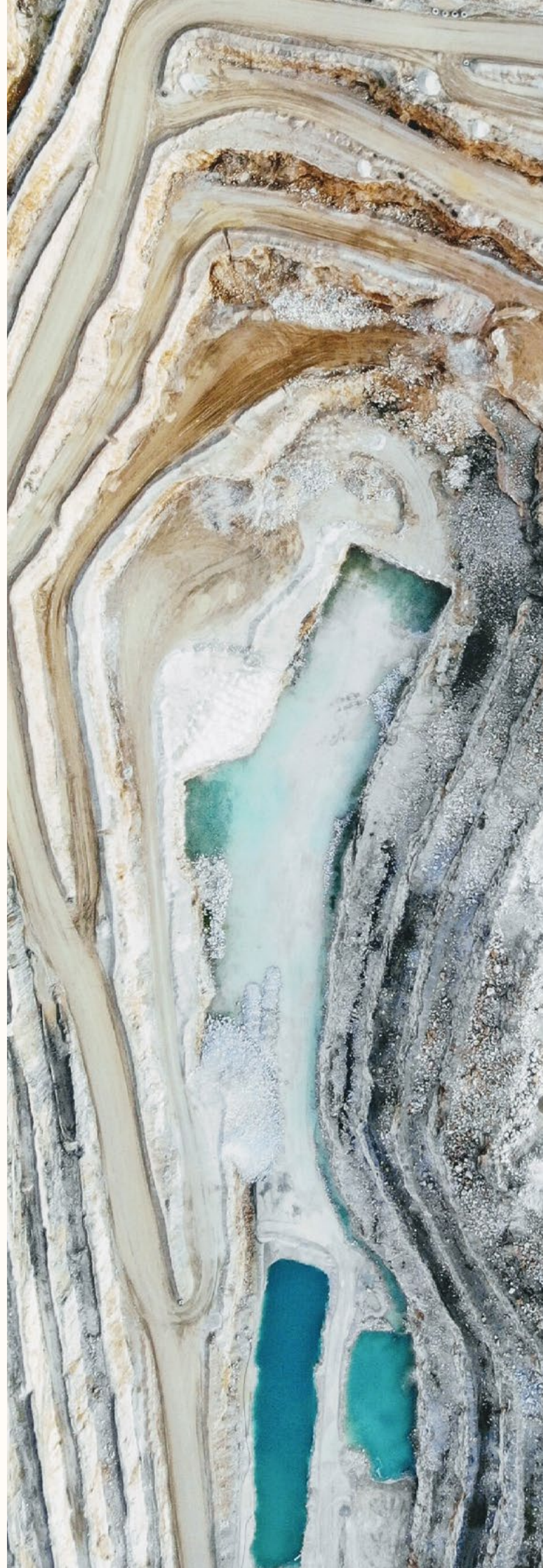
Total Australian mineral exploration expenditure and drilling (Geoscience Australia)



37. International Energy Agency

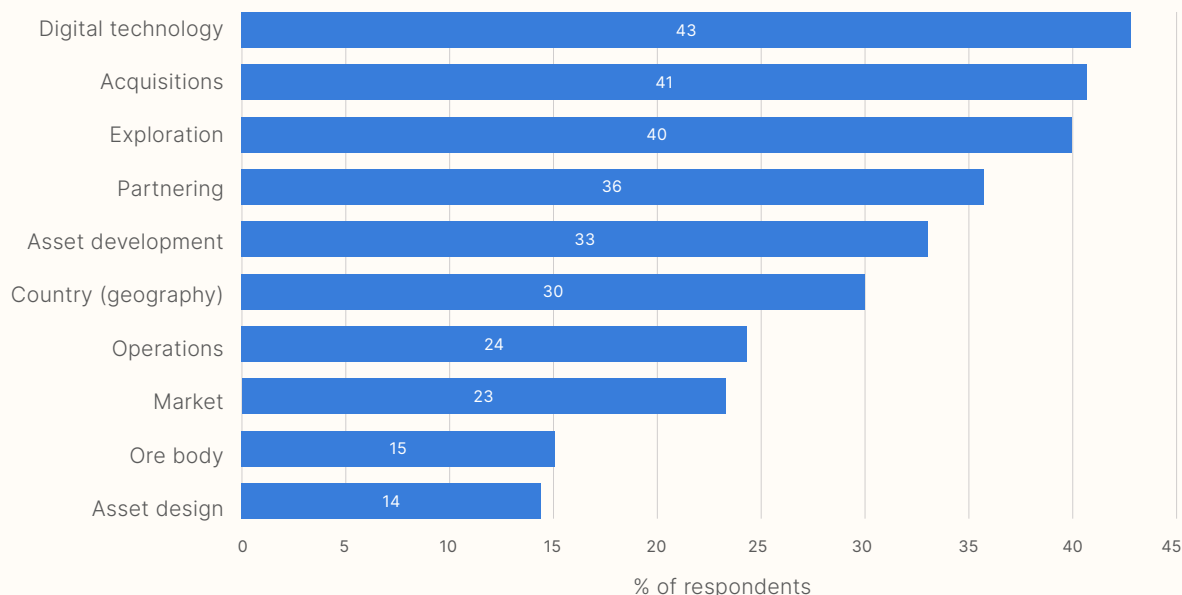
The industry will need to overcome several key barriers to improve its historically low rates of exploration success. Greenfields exploration is a long-term and high-risk effort that rarely offers quick returns. The chances of significant discovery are relatively slim, and the rewards are often not reaped during the tenure of current decision-makers. As a result, many large operators have instead chosen to focus on brownfields, exiting the greenfields exploration space with the expectation that the more nimble, junior companies will deliver the discoveries.

As a result, the productivity of greenfields exploration success has not materially advanced in the last three decades, despite efficiency gains in other areas of the industry. Traditional techniques such as geological mapping, geochemical analysis, and geophysical surveys have proven effective in uncovering potential mineral resources near the earth's surface, however, the deeper the target, the greater complexity there is in analysing the composition and structure of the rocks. Subsurface innovation efforts have been stunted by such technical complexities. The proliferation of AI models used for ground selection and geophysics for ground definition is promising, however both of these innovations remain in their infancy.



QUESTION As a mining business, where would you accept risk in order to increase financial returns?

Respondents given 3 answers.



Industry segmentation has further exacerbated the lack of innovation effort. The current approach of relying on the junior sector, who are structured to focus on quick financial viability, has resulted in significant knowledge gaps, undermining the development of comprehensive ore body knowledge, and stagnating the industry's ability to progress exploration understanding. As technically complex as it is, innovation success requires the integration of multiple scientific disciplines, services, and investment. A junior explorer alone is unlikely to have the capital nor incentive to deploy novel exploration methods or technology. Catalysing advancements in exploration innovation will require the cooperation of several players within the mining value chain, of which the large mining companies will be pivotal.

When examining the vendor landscape, the picture is much the same. Current technology and services providers are incentivised to deliver solutions to the companies that can

pay for them. At the moment, these customers are the larger players who are focusing on brownfields exploration. Suppliers and services companies are the gateway for technology innovation, whether it be from R&D of their own product suites, or from the acquisition of technology from other industries. If they are not incentivised to develop greenfields exploration solutions, then they will not do so themselves.

These issues are all interlinked, and many can be overcome by better capitalised miners choosing to shift their focus towards greenfields exploration. With the capital to support the application of novel technologies and methods, and the balance sheets to fund long-term exploration campaigns, the large companies are the key to unlock exploration success and deliver minerals to meet the growing global demand. This suggests a renaissance in exploration technology development is waiting for the majors to take a more active investment in the quickly growing battery minerals sector.



The all-important capital equation

Recently, stock exchanges around the world have begun shrinking. The Australian Securities Exchange (ASX) has registered just one float worth more than \$100 million since the start of last year and there has been a more than two-fold surge in mergers and acquisitions (M&A) activity in Australia, with a significant share of that occurring within the resources sector.^{38,39} London's stock market has shrunk by 25% over the last decade and the count of publicly listed companies traded on US exchanges has fallen by more than 50% since its 1996 peak.^{40,41}

There are also examples of non-traditional players, such as OEMs, taking a more active financing role in the mining industry, investing further upstream to secure supply. This includes companies such as Volkswagen and Renault who have signed supply agreements with Vulcan Energy in Australia, and G.M. who agreed to invest \$650 million in Lithium Americas to develop the Thacker Pass mine in Nevada to secure supply.^{42,43}

Given all this movement, and an increasing demand gap in many critical minerals, there is a question of what will happen next. History tells us that if the prize is significant, a period of consolidation will be followed by the addition of new large-scale players. In 2008, off the back of rapid industrialisation and urbanisation in China driving commodity prices higher and a flurry of M&A deals and consolidation, there was an emergence of influential new players to the market, such as Fortescue in Australia, who exported their first iron ore in that year.

Acquisitions are one of the quickest ways a business can increase its exposure to a commodity and the financial gains that can be made from it. This is particularly important as it becomes increasingly difficult to uncover new orebodies. With many companies looking to increase their exposure to critical minerals, as well as industry going through a period of consolidation, we have seen the number of M&As grow. As mentioned earlier, mining has played a significant role in the growth of M&A activity over the last decade. More specifically, the M&A data for the the top 40 mining companies in 2022 shows that 66% of deals involved critical minerals, with 85% of these transactions involving copper.⁴⁴ Examples include BHP's takeover of OZ Minerals, a strategic move to increase BHP's exposure to copper and nickel, and the Allkem-Livent lithium merger to create Arcadium Lithium.

There is a general strategic imperative to grow resources investment, especially given the growing demand for minerals. We are already seeing signs that the two main ways a mining company can grow its portfolio of resources – through exploration (green or brownfields) and M&A – are increasing. A third option is via innovation – the ability to improve extraction to a point where previously uneconomic ore bodies become viable will bring greater minerals to market. History suggests efforts to innovate through extraction will yield incremental, rather than transformative results. It is therefore more likely that companies will continue to focus on the former two options (exploration or M&A) as their primary drivers of growth.

38. AFR

39. Mining Technology

40. Bloomberg

41. CNN

42. SP Global

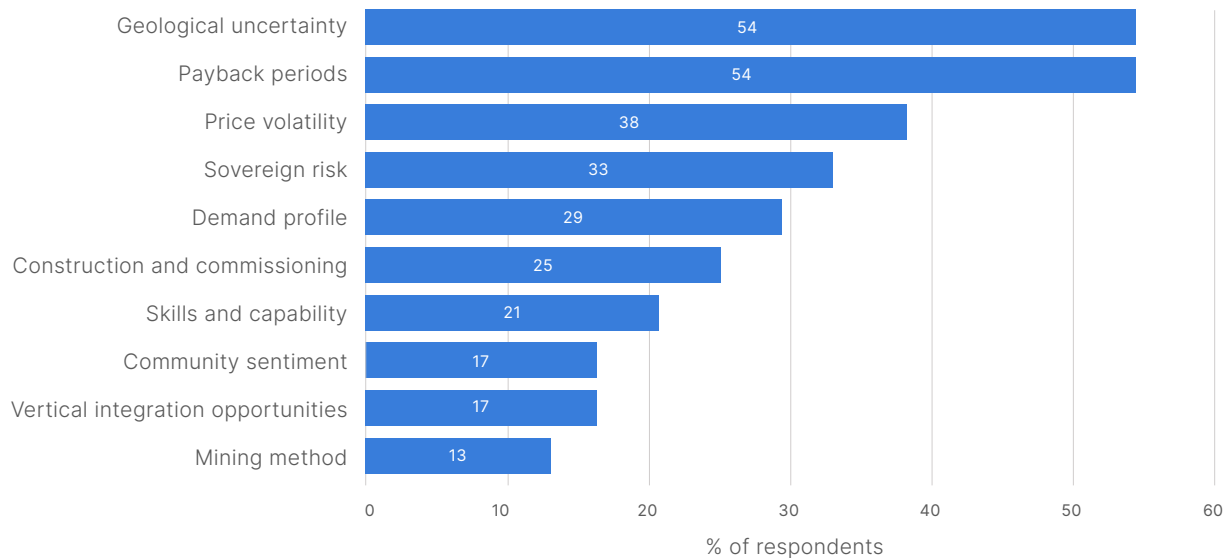
43. NY Times

44. PWC

QUESTION

Which of the following are the biggest considerations when investing in mining projects?

Investment respondents only. Respondents given 3 answers.



An investor's mindset

There will always be demand for commodities, but this is likely to be supercharged by the energy transition. This will result in greater inflow of capital investment into the sector, something we are already seeing signs of.

Growth in the sector will in turn pique the interest of all kinds of investors. However, given the sheer number of mining related companies listed on global stock exchanges – there are over 900 companies listed on the ASX under mining and metals and over 1000 companies listed under extractive industries on the Toronto Stock Exchange – how do investors evaluate which ones to invest in?

Our data shows that geological uncertainty, payback period and price volatility are the three major considerations when investing in mining projects. As ore bodies get deeper and more complex to mine, having certainty around the quality and quantity of minerals available becomes even more critical. Copper,

for example is a critical resource expected to experience a universal shortage in future due to declining ore grades and higher costs impacting production. With the average ore grade decreasing approximately by 25% in the last 10 years, global mined copper output is projected to fall over 2025-30, whilst copper demand is estimated to nearly double to 50 million tonnes by 2035, widening the supply and demand gap.^{45,46} This supply gap provides an attractive opportunity for investors if they can find companies that sit low on the cost curve to protect from price volatility and operating cost inflation.

Understanding future demand and projected payback periods for investment is a key determinant of project profitability. Price volatility also feeds into this certainty around payback, as those commodities which are highly volatile introduce significant uncertainty around investment.

45. MDPI

46. Global X

A photograph of three business professionals in a modern office setting. Two men and one woman are engaged in a conversation. The man in the center is gesturing with his hand while speaking. The woman on the right is listening attentively. The background shows a large window with a view of a cityscape. A large, semi-transparent white circle is overlaid on the image, containing the text "Organisational architecture".

Organisational architecture



The best organisations can both withstand and take advantage of disruption caused by major external forces. The process starts with hiring the best talent, but continues with incentives, leadership, strategy, technology, and innovation capability. This will be unique for each business and requires a deep understanding of what they are trying to achieve.

Over the years, the mining industry has delivered some great innovations, in everything from extraction through to processing and automation. But investors, governments, customers and communities are now demanding greater innovation at an increasing pace, and the misalignments that have emerged over the years are starting to show.

A number of factors impede the industry from aligning innovation with industry needs.

1. Technology innovation timeframes are long compared to the pace in which transformation needs to happen.
2. Executive planning horizons are short compared with the time it takes to deliver major innovations.
3. There is a disconnect between innovation and business strategy.
4. The focus of innovation has turned to continuous improvement versus truly transformative change.

The chapter aims to look closely at the aspects of organisational architecture to provide insight into how companies can build a coherent innovation strategy designed to address these contemporary challenges.

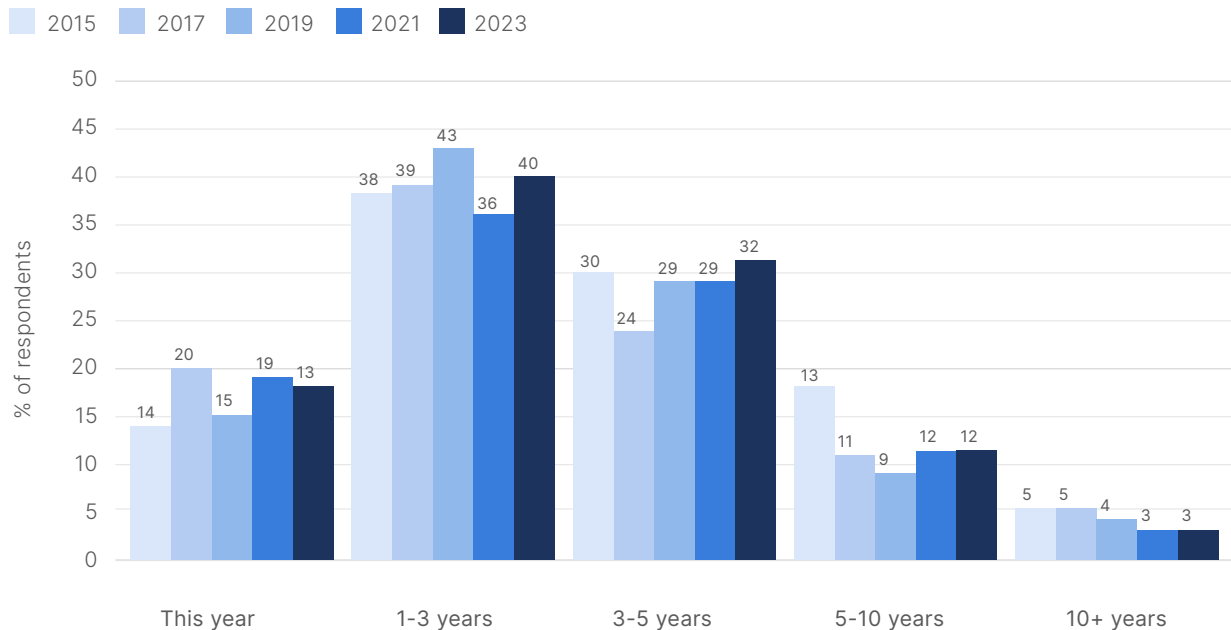
Aligning with the times

As we pointed out in the first section of this report, the mining industry has evolved considerably over the past decade. Change will continue as expectations around decarbonisation and emissions targets grow, economies develop, and market dynamics shift. Addressing these drivers will necessarily require industry to step out of its comfort zone and look for ways to rapidly innovate.

Despite the long-term changes underway, timeframes for innovation within mining continue to be short. In fact, over the last ten years, the key timeframes for innovation focus haven't varied significantly and remain mostly between one and three years. This may seem surprising given the rate at which the world is changing and how fast new technologies are emerging. Taking a deeper look into organisational leadership structures and innovation types provides some insight into why this might be the case.

QUESTION

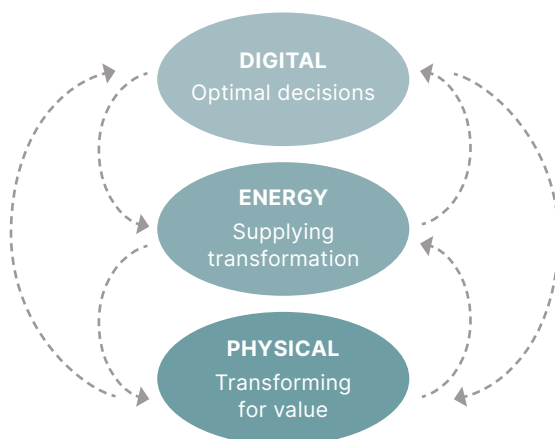
What is the key timeframe for innovation focus in your company?



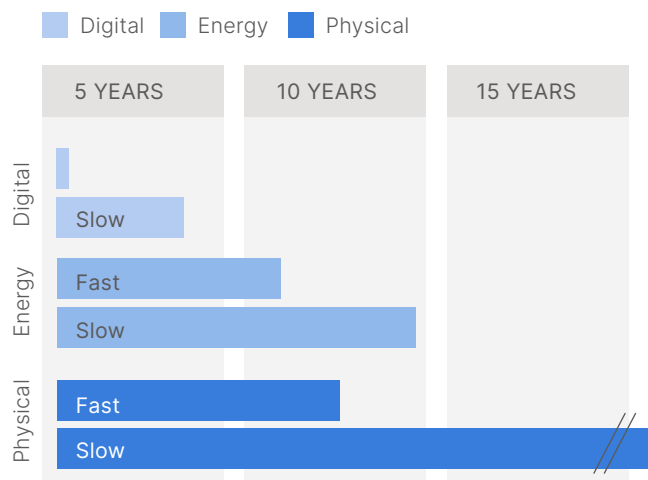
Between 2010 and 2019 the average CEO tenure of mining companies across the global industry was 4.4 years, whilst from 2013-2019, S&P 500 average CEO tenure was measured to be around 7.5 years.^{47,48} Both time frames are quite short relative to those

innovations that address large, long term industry trends. By virtue of this short tenure, CEOs are incentivised to think and plan in the shorter term, which is further reinforced by their remuneration agreements being tied to shareholder returns and company profits.

Feedback effects on technology development and evolution



Rates of possible step change adoption



47. EgonZehnder

48. Harvard

The short-term nature of CEO incentives has created a mismatch with the long-term nature of many innovation challenges faced in the resources industry. Our data further highlights this point, with nearly 70% of CEOs suggesting their timeframe for innovation focus was less than three years, while only 5% focused on innovation timeframes beyond 5 years, and none beyond 10 years. For reference, the largest miner in the world, BHP, has a maximum cash and deferred plan (aimed at incentivising performance within a financial year) sitting at 51% of the CEO's potential salary.⁴⁹

The long-term trends companies must deal with require innovation across both the digital and physical space. Traditionally, the implementation of digital innovation can happen a lot quicker than with physical innovation. To illustrate the point, over the last 40 years, billions have been invested in alternative iron and steel making technology, with minimal impact on the production profile of steel making globally today. In that same time, we have seen the complete emergence

of the internet and digital economy, with an estimated 1 in 4 venture dollars invested into AI related companies in the first half of 2023.⁵⁰

Physical innovation has a longer timeframe for adoption as a consequence of the capital intensity and complexity resulting from the range of functions, skills and stakeholders involved. The industry is understandably more cautious when considering investment in physical innovation because of this complexity and the value at risk. Notwithstanding the challenges, physical innovation is however, fundamental to the large-scale transformation the industry is going through, particularly in relation to the energy transition, which makes incentivising leadership to innovate in this space crucial.

So how can we overcome these hurdles?

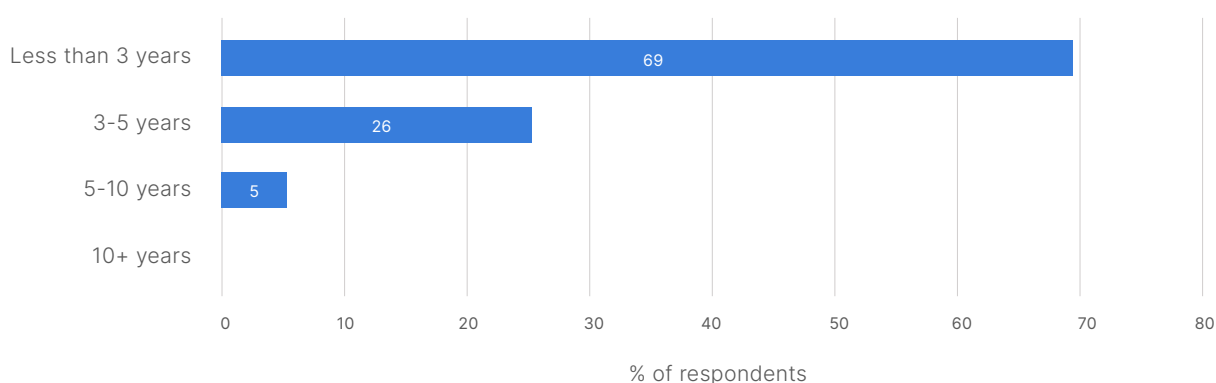
"The usual CEO will have a tenure that's shorter than the period in which you realise any actual return."

- MANAGING DIRECTOR,
INVESTMENT FIRM

QUESTION

What is the key timeframe for innovation focus in your company?

CEO respondents only.



49. BHP

50. Crunchbase

We can potentially learn from founder-led companies which typically have natural incentives that are aligned to the longer term, tend to engage in consistent longer term strategic thinking and are more deliberate about debt levels and expansions in terms of the broader strategic context.

Fortescue has been strategic in both its partnerships and growth plan, allowing it to grow sustainably over the years, as well as be bold in its ambitions for innovation in new energy. It also has a remuneration structure with 41% of CEO target salary being based on Long Term Incentive Opportunity (LTIP), of which a third is based on progress on strategic measures, including innovative renewable projects such as the Pilbara Energy Connect and the establishment and development of Fortescue Energy.⁵¹ Mineral Resources deploys similar tactics to incentivise longer term success, with long term incentives only granted if the four-year average of return on investment capital is 12% or greater. This incentivises management to pursue long term strategic growth opportunities that both maintains high operating returns over multiple years and delivers returns for shareholders.⁵² Outside of the mining industry, there are numerous cases of successful founder led businesses, most notably Facebook, Netflix and Amazon, all of which have had a long-term focus. In the case of Amazon, for example, they have consistently prioritised the long-term view that customer retention is key, which has seen them often sacrifice the size of their short-term profits in pursuit of this goal.⁵³

⁵¹. Fortescue

⁵². Mineral Resources

⁵³. Livewire

⁵⁴. Bellevue Gold

“If you’re developing innovation, it usually involves a lot of costs and oftentimes more than you expect. When I look at these founder-led companies, they have that capability to wait longer than usual, because they have ownership and on the investment side of things, they have the influence to be able to allocate that capital to see it.”

– *MANAGING DIRECTOR,
INVESTMENT FIRM*

Companies have long utilised incentive structures such as stock options to replicate a founder mindset and improve company performance. Strengthening the link between remuneration and the outcomes of company strategic goals is another critical way to incentivise long term mindset. This will likely involve increasing the proportion and timeframe of performance-based shares where remuneration occurs in the year or years following a return on investment once strategic goals are realised.

“From my perspective, as a technology-focused company in the supply chain, the risk-averse culture and the aversion to change in mining can hinder the speed of innovation and adoption.”

– *FORMER CEO, TECHNOLOGY COMPANY*

The industry is beginning to see a shift to a founder mindset within some resource companies. Bellevue Gold for example, has introduced a unique one-off net-zero emissions incentive for executives and all employees if the company achieves net-zero scope 1 and 2 emissions by 2026.⁵⁴

The road to innovation is paved with strategic intentions

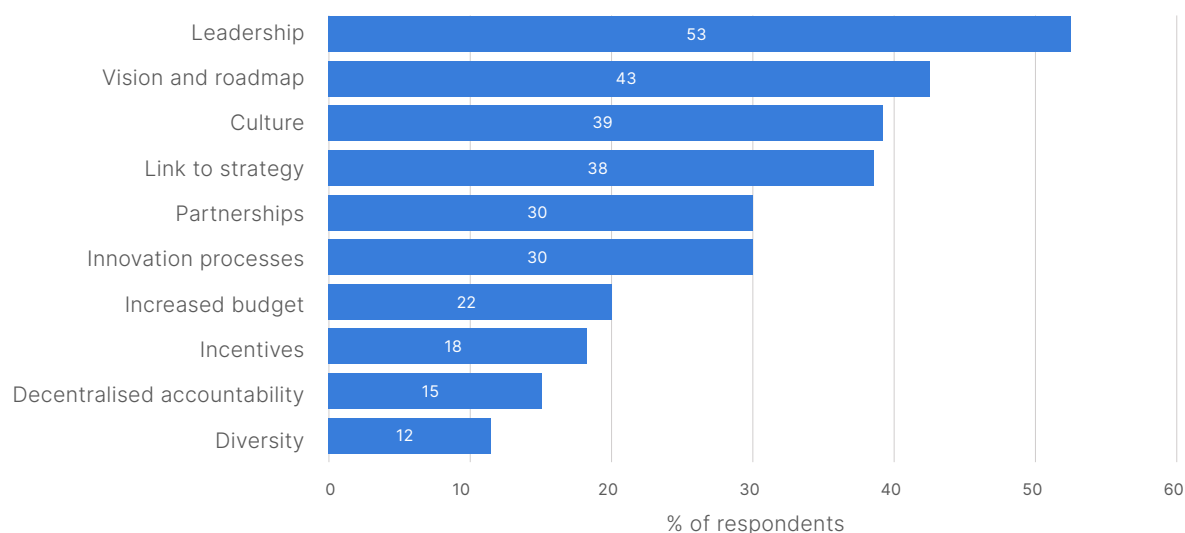
The key purpose of strategy is to create growth through competitive advantage, and competitive advantage can only be created and sustained through innovation. Over the last seven years, we have consistently seen a link to strategy listed as one of the top ways to improve innovation in a company, indicating a disconnect between innovation and strategy. Our latest data is no different, with 38% of respondents stating a link to strategy as how to best improve innovation in a company. By prioritising long-term innovation, companies like Sandvik have demonstrated tangible results. With innovation at the core of their values, Sandvik has effectively integrated it into their R&D programs, resulting in numerous breakthroughs stemming from initiatives such as the annual Sandvik Innovation Prize, which acknowledges employees for their contributions to industrial innovation. Notable examples include the development of their 3D-printed diamond composite and the AutoMine underground drill rig.⁵⁵

Acknowledging the link between strategy and innovation is just the first step – without someone proactively driving the connection, innovation efforts are bound to falter. Leadership is critical to innovation success – they set the vision, culture, and strategy within the organisation.

A company vision needs to be compelling but also plausible. It should inspire staff and stakeholders, whilst also aligning with the purpose of the business. Recent Havard Business Review research showed that 50% of those involved in successful company transformations said the vision energised and inspired them to go the extra mile.⁵⁶ Setting and communicating a company's vision for innovation is the fundamental role of leadership and frames the roadmap for implementing company goals. Mineral Resources exemplifies a purposeful integration of innovation into its strategic framework. Over the past five years, the company has made substantial

QUESTION How could you best improve innovation in your company?

Respondents given 3 answers.



⁵⁵. Sandvik

⁵⁶. Havard Business Review

“...We are doing something new, and it’s around the culture, that you’re doing something that has not been done... We’re trying to create something new and solve problems. And then really ensuring that when they [the employees] are in that process or journey, they get rewarded while they’re working instead of when it’s done.”

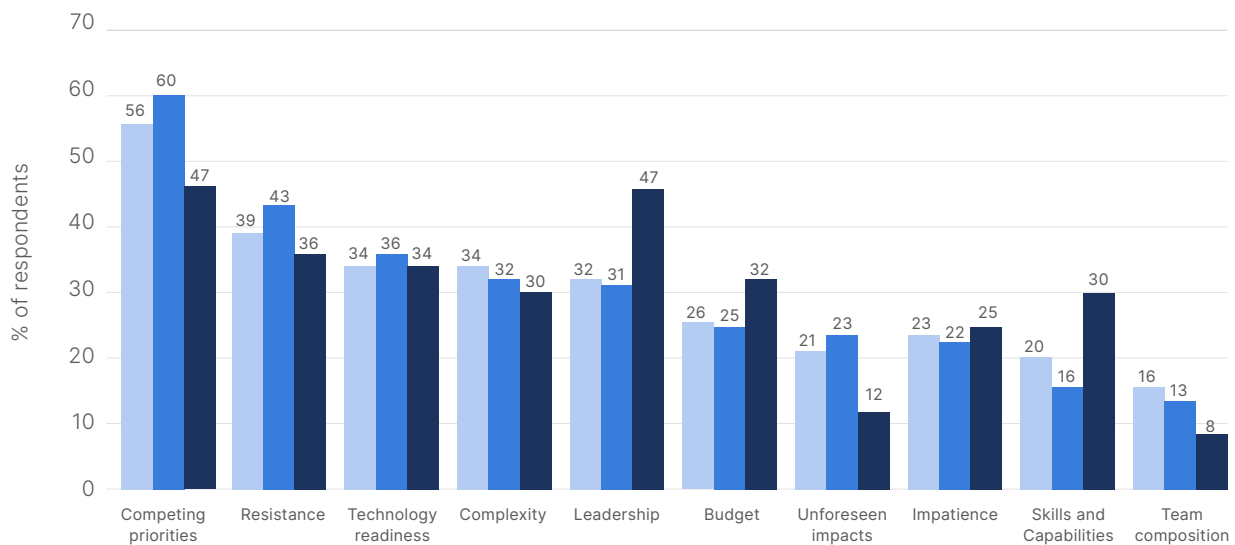
– CEO, TECHNOLOGY COMPANY

QUESTION

When implementation programmes of new innovations fail, what is generally the reason?

Respondents given 3 answers.

2019 2021 2023



investments in large-scale innovation projects, notably launching an autonomous road truck program and making significant strides in modular crushing technology.⁵⁷

The endpoint of failing to link strategy to innovation is also clearly laid out by respondents. Our survey data shows that 47% of respondents list competing priorities as a reason implementation programmes of new innovations fail. Without a coherent and well-communicated vision and strategy for innovation, spending and management of innovation is likely to become misaligned throughout the organisation, leading to inefficient delivery and parts of the business working at cross purposes with one another.

Leadership and culture are two sides of the same coin, and both apply in the case of innovation. Culture starts with the behaviours set and demonstrated by leaders and the

systems they put in place to reinforce these expectations. Companies that have a more innovative culture and embrace risk, encourage collaboration, and grant autonomy to their teams are 60% more likely to be innovation leaders.⁵⁸

To breed a culture of innovation, leaders need to prioritise the demonstration of innovative behaviour and embed it into the vision and roadmap of the organisation.

It’s also fundamental that leaders make the space and time for their teams to engage in innovative behaviour. When we asked, ‘How do you primarily incentivise your workforce to innovate?’ respondents predominately answered autonomy (31%), followed by peer recognition (28%). It’s clear that teams are motivated by being given the space to innovate, and then being recognised for their successes.

57. InvestMets

58. BCG

The building blocks of transformative growth

Over the past 40 years, the mining industry has gone from an extended low growth period through the 1990s, to rapid broad-based growth driven by China in the 2000s and 2010s into what will be an extended period of core process redesign driven by the need to decarbonise. Each of these periods required different approaches to strategy and innovation, and different ways of structuring for innovation as a result.

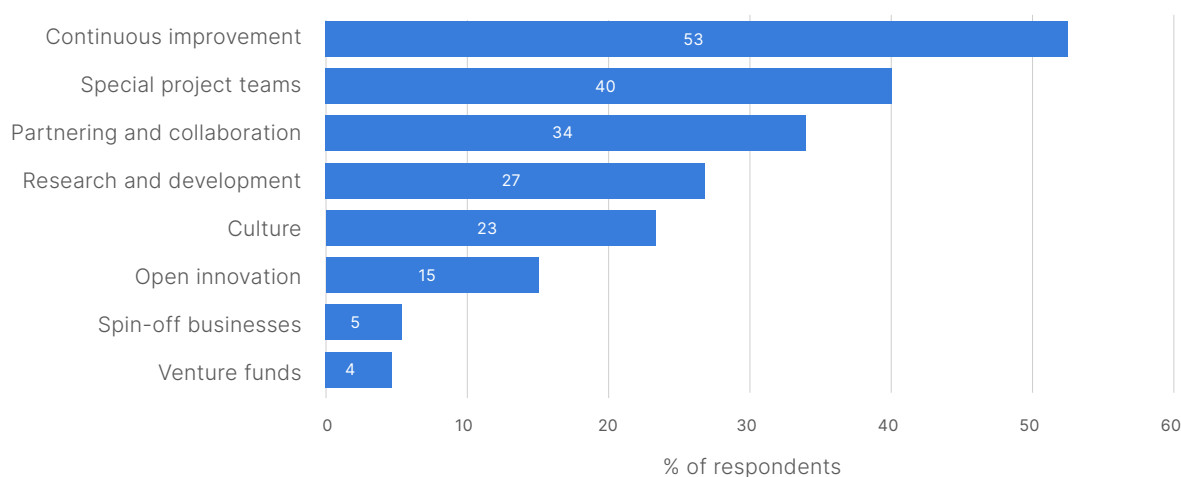
When we look at the data provided by respondents to this year's survey, it seems like the responses were from an earlier time – the low growth, cost cutting era of the 1990s. By far, the largest innovation structure deployed by miners across the world today is continuous improvement. When considering the contemporary large-scale transformations required of miners by boards, regulators, investors and communities, we can see a clear disconnect.

Whilst continuous improvement is an essential complement to any innovation program, it is unlikely to be the main structure in successful, transformative innovation. And yet, the data states 53% of respondents use continuous improvement as the structure their business primarily uses to innovate. The central approaches to innovation being taken by today's miners are not fit for the task before them.

Which does beg the question – how can a mining company build an organisational structure that is able to deal with the long timeframes and big asset risks of the current industry transformation? If we flip this chart, we have our answers. Transformation demands transformative innovation structures – venture funds, spin-off businesses, open innovation, culture, partnerships and collaboration, special project teams. Just 4% of respondents stated they use venture capital as a primary form of innovation, and just 5% for spin off businesses. 15% prioritise open innovation.

QUESTION What structures does your business primarily use to innovate?

Mining company respondents only. Respondents given 2 answers.



There are some companies that are stepping into bolder innovation structures, and for good reason. It's been reported that organisations that embrace open innovation had a rate of revenue growth 59% higher than those that don't. ⁵⁹

BHP's Think & Act Differently program (formerly part of OzMinerals), has hosted various challenges aimed at encouraging open innovation. These initiatives have resulted in advancements, particularly in the core process of extracting metals from copper concentrates. Technologies piloted through these challenges use bacteria to leach copper and cobalt minerals.⁶⁰ In the venture capital space, Vale established its venture fund in 2022, and since then has invested in projects such as the biology startup, Allonnia, which takes novel approaches in engineering and biotechnology with the aim of developing new biological systems for various industry applications.⁶¹

Major asset developments and transformations are complex and capital-intensive projects, which can benefit from special project teams. In the case of Evolution Mining, they had a

project team dedicated to their Cowal (CGO) underground project which, despite facing several challenges relating to extreme weather and an in-demand construction market, was ahead of schedule in delivering its first ore and is a project expected to be completed on budget.⁶²

Partnerships and consortiums, such as the Electric Mine Consortium (EMC), can assist with the complexity of asset development through shared risk, reduced time frames and reduced costs. Since the establishment of the EMC in 2020, there have been over 50 vehicle trials conducted, assisting the transition of members' fleets to electrified trucks, supported by significant work conducted in simulation and mine design. For a single company to complete, the work would have been both high-risk and time-intensive, however by leveraging the number of members within the EMC, both risk and cost are reduced.

⁵⁹. IBM

⁶⁰. Oz Minerals

⁶¹. Vale

⁶². Evolution Mining



Mining for new talent

Building an organisation so it is positioned for success is no easy feat. Understanding the role of people in building an innovation strategy for a mining company is no easier. Getting the right people into an organisation, and training them, is fundamental to its success and ability to adapt to change. Industry is aware of the importance of the talent they hire, with 47% of all respondents stating they derive their competitive advantage from people.

Attracting that talent, however, is not easy. Access to skilled workers is already constrained across several industries and jobs, and the mining industry is dealing with further hurdles and complexities, namely perceptions and a changing skills profile.

In Australia, 51% of workers required to achieve 2030 energy transition goals are in occupations facing national shortages, including electricians, engineers, truck drivers

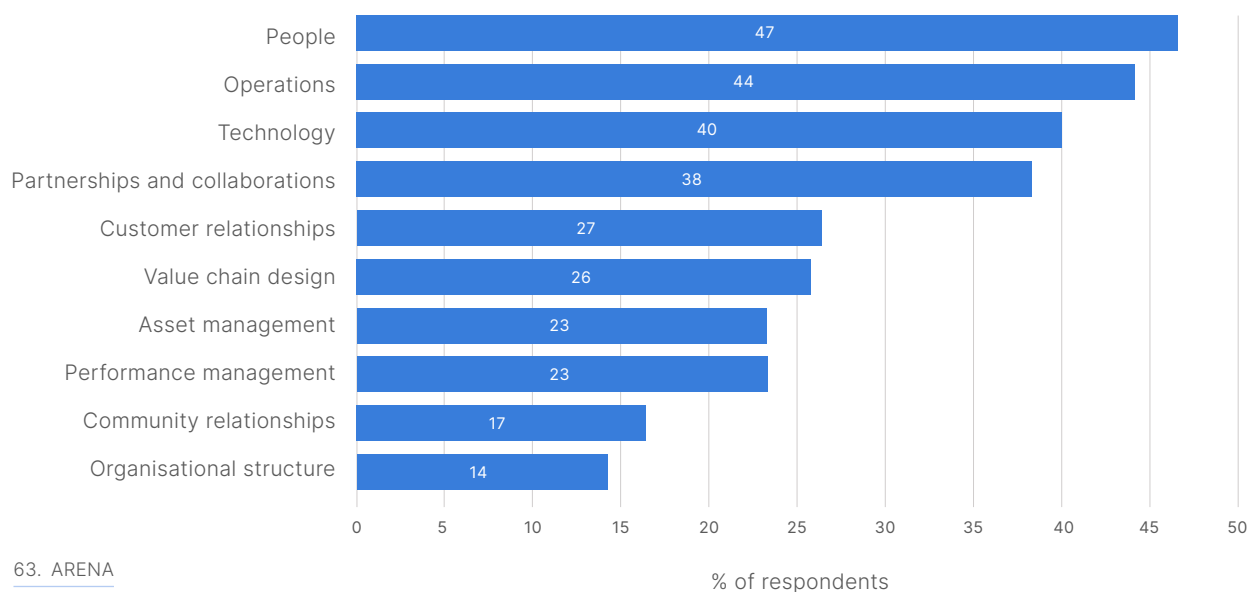
and construction and mining labourers.⁶³ Autonomous and electric vehicle specialists topped the list for the most in demand jobs for 2023 by the World Economic Forum, with more than 40% growth expected over the next five years.⁶⁴ 71% of mining leaders stated the talent shortage is stopping them from delivering on production targets and strategic objectives.⁶⁵ It's clearly become critical to put action in place to address this issue.

Companies such as BHP have focussed on developing programs to ensure they have the right talent. In 2020 they launched the BHP FutureFit Academy, which offers paid training pathways into the industry for those with no prior mining experience. By the middle of 2023, the program had seen over 500 people graduate with qualifications and a guaranteed job with BHP.⁶⁶

QUESTION

Where in your operating model do you generate your competitive advantage?

Respondents given 3 answers.



63. ARENA

64. World Economic Forum

65. McKinsey

66. BHP



Whilst attracting the next generation of workers is critical to mining's success, and company programs such as the BHP FutureFit Academy are helpful, there is no simple answer as to how to overcome the current barriers at an industry level. As it stands, 70% of 15–30-year-olds in Canada stated they would probably not or definitely not consider working in the mining sector.⁶⁷

There is more and more evidence to show that younger generations are driven by purpose and a desire to contribute to the greater good. A recent UK survey showed that one in three people aged between 18 and 24 years old had turned down a job because a company's ESG commitments were not in line with their values.⁶⁸ Whilst progress has been made within mining, it's unsurprising to hear that people are reluctant to move into an industry traditionally associated with social inequities and environmental destruction. The industry needs to make some serious progress with ESG credentials if they want to seem attractive to future employees.

⁶⁷. BHP

⁶⁸. KPMG

"I gave it [a mining company branded pencil] to her because she likes to write and do drawings, and she said, "... I really don't want that." I asked why not, and she said, "I don't like miners, and that'll remind me about miners if you give me that." If a 10-year-old has that perception, we've got a real problem. That's where we need to be doing a lot better work."

– CHAIRMAN, MINING ASSOCIATION

Solving this challenge will also require a need to think creatively around training and education. Micro-credentials, re-training and upskilling programs funded by government and stronger partnerships between educational institutions and industry are all required to help the skills challenge. Ultimately however, there needs to be a whole of industry shift to becoming a clean, high technology industry that is diverse, before mining can begin to truly compete in the global competition for talent.

AI & mining people: competitors or co-workers?

Regardless of the speed at which we attract new talent, there is more than likely going to be a shortage of workers within the mining industry, which will increase costs and constrain growth. This then raises the question of how can technology – in particular, artificial intelligence (AI) – be used to support the workforce to innovate and where will it supplant the workforce?

We are already seeing examples of how AI driven automation systems, including autonomous trucks, will improve efficiency, minimise human error and reduce the risks of accidents. For example, Statum AI, a company designing AI solutions to help mining companies increase their yield, has seen some clients experience a 58% accuracy increase in predictions, quarter on quarter.⁶⁹ AI enabled tools in the recruitment process can assist in reducing biases and promote diversity. There are examples of technologies that can assist in improving mining production processes, those that are using AI to provide data driven insights for ESG reporting and those using automation with machinery to improve productivity as fewer shift changes and breaks are required.

“Humans are really bad at doing the same things the same way every time – computers are much better at that.”

– VICE PRESIDENT, MINING COMPANY

Other industries provide hints at where a technology augmented mining industry could also go. The George Washington University Hospital in Washington DC first implemented its precision virtual reality technology in 2017, revolutionising the processes of neurosurgery and thoracic surgery by allowing students, trainees and surgeons alike to explore a patient's brain and body in a no-risk environment before performing a procedure. As a result of virtual reality assistance, surgical performance is reported to have improved by 230% compared to traditional methods.⁷⁰ With experimental technology proven to have a sizeable positive impact in the healthcare industry, similar disciplines are naturally beginning to emerge within other industries where risk minimization is paramount and lives are at stake, namely mining.

⁶⁹. IMARC

⁷⁰. US Chamber of Commerce



Beyond the clear benefits AI brings, it must be acknowledged that the efficiencies resulting from technology will see job losses. Research shows that generative AI could enable up to 70% of business activities to be automated between now and 2030.⁷¹ This will have flow on impacts to jobs that repetitive in nature or more likely to be entry level roles. It's predicted that 40,000 Australian frontline mining jobs could be redundant due to technology change by 2030.⁷² Minimising the impact of these losses by retraining and reskilling those in roles replaced by technology will be key to maintaining an engaged and skilled workforce.

The skills challenge is not an easy one to tackle. Between the shifting skill requirements with the increasing pace of technology and AI implementation, the difficulty with attracting new talent, and the need to upskill and reskill at a rapid pace, will require innovation across the board to be able to achieve what is required. Will the industry be willing to adopt artificial intelligence in a broad-based way, or will it look to lock down and control its use from the top – which philosophy is the most appropriate? It will be a fascinating decade watching this unfold.

71. McKinsey

72. Australasian Mine Safety Journal

Conclusion

As we established at the beginning of this report, there were a number of key themes raised across the industry leaders we interviewed. One quote in particular stood out, as it summed up some of the complexities being experienced by the mining industry.

"I think we've got quite an interesting conundrum that's playing out [with the social acceptance of mining]. You saw it at the World Mining Congress, where every single CEO got up and said, 'well, guess what, you have to love us because we're going to produce the metal that's going to save the world. And therefore... be nice to us and stop being quite so critical.'

And then you had an equal number of people getting up saying, 'We agree. We do need quantities of metal like we've never seen before. But you absolutely have to do it in a responsible way, that makes sure that both the communities...where the activities are happening, and the broader society, are benefiting.'

And then of course, you have the investors who are saying, 'we want to invest in these businesses because we think it's going to be very profitable, but we also have to demonstrate to those people giving us our money... that their money is being invested in responsible businesses.'

So, we've got this trade off.

Whoever can find a way whereby we can deliver exceptional returns to investors in a way that's acceptable to a broader community - that's what's going to win.

I think that's what's going to drive change."

– CEO, RESEARCH ORGANISATION

As we have seen in these chapters, the external drivers of change force innovation to take place. The energy transition, environmental concerns, geo-political tensions, economic growth, technology, need to attract talent, and community expectations are requiring the mining industry to undertake greater innovation at an increasing pace.

Within these spheres of change, companies will have critical strategic choices to make, both in respect of how they harness the competitive opportunity that change brings, and how they withstand the inherent risks. The one thing that is clear is the need for all business to move to greener, cleaner practices, making strategic responses to the energy transition a focus of innovation and building these strategies into business models.

This is not easy. In the organisation architecture section of this report, we saw how complex it is to construct an organisation that can innovate at the pace required. Businesses need to be agile with their strategies, which may see them take on greater risk to capitalise on new market opportunities. At the same time,

businesses need to navigate the delicate task of satisfying a diverse array of stakeholders, each with unique demands and priorities – from employees and investors to the broader community and supply chain participants.

We look forward to seeing how the industry transforms over the next few years, and the innovations that emerge as a result.

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SLATE



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