



Tracking the trends 2023
The indispensable role of
mining and metals

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Introduction

The indispensable role of mining and metals

The world is at a critical point in time, socially, environmentally, and economically. The latest projections by the United Nations suggest that the global population could hit 8.5 billion in 2030 and 9.7 billion in 2050.¹ With a growing population comes a growing demand for the metals and minerals that underpin societal progress. From civil infrastructure to transportation, and technology to agriculture, the products that the mining and metals sector produces, support and enable virtually every sector globally.

The paradox is that, while the need for mined products has never been greater, public opposition to mining activities has never been higher. The green energy transition is expected to be a mineral-intensive one—the International Energy Agency estimates that the demand for minerals used for electric vehicles and battery storage will grow tenfold by 2040.² Yet, at the same time, approvals for projects that could become important providers of critical minerals, such as lithium (see Rio Tinto's Jadar project in Serbia³), are being hampered due to protests. The juxtaposition between need and want is stark, and the gulf between them creates a very real threat to global climate change mitigation.

For too long, the stories told about the mining and metals industry have centered on the negatives. However, the opportunities

that mining and metals companies can offer to provide for and enhance the prospects of the population, as well as the environments they reside in, are vast. Mining underpins approximately half of the global economy⁴ and therefore, it has the greatest potential of any industry to positively influence social, environmental and economic development.

This year, Deloitte Global's Tracking the trends 2023 focuses on the indispensable value that mining and metals companies can deliver, with the emphasis on taking action now for a better tomorrow. In each of these 10 trends, our network of Mining & Metals sector professionals globally offer up expertise, insights, and examples to spark conversations about how mining and metals organizations can make a difference in the world.

Changing perceptions of the industry by putting people and natural capital front and center in strategies; designing organizations and products for circularity; creating safer, more respectful places of work; and innovating together to make the possibility of ultra-efficient mines a reality will be key to creating a healthy, regenerative ecosystem inclusive of people, planet and industry.

We're excited to discuss these trends with you and explore how they will shape your company's future. Thank you for your ongoing support.

Endnotes

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Trend 1

Valuing nature

Generating a strategic advantage through natural capital

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Mining and metals operations are a long-term investment. In today's fast paced, unpredictable and ever-changing environment, it's more important than ever for companies to be looking ahead and paving the way for sustainable, adaptable growth.

Access to capital is an important factor in this, and the metrics upon which mining and metals investors, both stalwarts and new entrants, base their decisions, are rapidly changing. Traditional net present value (NPV) calculations no longer provide a sufficient picture of the risks and opportunities presented over a project's life cycle. A more holistic approach may be needed and, subsequently, a rapidly growing area of focus is how companies interact with nature.

A market-led initiative—the Taskforce on Nature-related Financial Disclosures (TNFD)—was established in 2021 in response to the growing need to factor nature into financial and business decisions. The TNFD's overarching goal is to support “a shift in global financial flows away from nature-negative outcomes and toward nature-positive outcomes.”¹

In advance of the TNFD framework release in late 2023, mining and metals companies are beginning to perform stocktakes of their impacts and interactions with nature across their operations and that of their value chains. The aim is, in addition to the impacts, to highlight the dependencies, risks and opportunities associated with nature and, ultimately, to help enable the accurate valuation of natural capital in financial disclosures.

Ian Sanders, Global Mining & Metals Leader, Deloitte Global, explains: “This information can also be used to better integrate nature—and environmental, social, and governance (ESG) targets—into strategies, operations, and project valuations. In doing so, businesses have the chance to widen the pool of capital to which they have access and start to change the incumbent narrative surrounding mining and metals. Both will be critical in expediting minerals and metals projects—the output of which the green energy transition hinges upon—and in decarbonizing other important industrial and agricultural businesses.”

The positive power of mining and metals

Global economic output can be traced back to nature. Approximately half of the world's gross domestic product (GDP) is moderately or highly dependent on nature, without which, the other half of GDP could not be sustained. For example, manufactured capital requires access to natural resources such as metals for batteries, and access to talent relies on healthy employees with access to sunlight and clean water.² For long-term investors and managers of important ecosystems around the globe (e.g., forests, wetlands and grasslands), there is an opportunity for mining and metals companies to demonstrate leadership by fully understanding their reliance and impacts upon nature.

Making ESG an integral part of valuations

Despite most mining companies having broad, corporate-level ESG-based targets in place, nature-specific targets remain a rarity, and many still treat ESG matters as separate to their core business functions and activities. For instance, in the process of site selection, mine planning, operation of assets, and closure, it's mostly business as usual.

For example, Barrick Gold is working to proactively and holistically manage all aspects of sustainability. In the 2021 edition of their integrated sustainability report, the company noted: "We know the environment in which we work and our host communities are inextricably linked, and we apply a holistic and integrated approach to sustainability management...[this] is not only the right thing to do for our communities and wider society, it is also good for our business."³

There are other industries that mining and metals companies could look to for inspiration in this respect—the agricultural and consumer goods sectors are both examples of where progress in valuing natural capital and reflecting it within their business models has been made. The insights these sectors offer may be nuanced owing to their differing positions within value chains (proximity to feedstocks and direct exposure to consumers) and shorter product lifespans but are valuable nevertheless.

Michael Wood, partner, Climate & Sustainability, Deloitte Australia explains: "If we look at the core valuation of mining assets today, it's clear that the nature-related aspects, for example, sensitivities surrounding climate risk and biodiversity, aren't properly valued or integrated into the financial calculations or production methodology."

"There needs to be increased strategic integration, operational integration, and value chain integration of ESG and nature at a systems level, rather than a domain level, for assets to be valued appropriately."

Over the next five years, this systems-type shift and the speed at which it takes place could redefine the mining sector, elevating it from a resource user to a steward of nature and the community.

This is materializing in three ways: First, through understanding the company's reliance upon and impact on nature using stocktakes. Second, the integration of nature-related impacts and opportunities into asset valuations. And third, through the way in which circularity is built into project life cycles to reduce any negative impacts on nature (more on this in trend 2).

Building sustainable interactions with nature

Impacts on nature will affect most mining and metals companies, whether directly or indirectly through supply chains, over the next decade; the World Economic Forum estimates that, today, more than half of the global GDP (US\$44 trillion) is exposed to risk of loss of natural capital.⁴

These impacts have the potential to create or destroy value through a range of scenarios, and therefore it's critical that the impacts are properly reflected in valuations and strategies. Building capability and understanding will be central to businesses' ability to guard against threats and capitalize upon associated opportunities.

An example of this are nature-based solutions (NbS). These are actions that use nature to help address societal challenges through the conservation and protection, sustainable management and/or restoration of natural or modified ecosystems.⁵

Actions to mitigate climate change risks and build on the resulting opportunities have advanced more quickly than those targeted at nature-related risks. However, NbS are proving to be some of the cheapest and most effective tools companies have in meeting the goals of the Paris Agreement.⁶

For example, steelmaker ArcelorMittal is using NbS to create a carbon-positive balance at its operations in Brazil. At its largest mill, 2.6 million trees act as a green belt, helping to reduce fugitive emissions and noise pollution while buffering the operation's thermal effects. The company also manages 135,000 hectares of forests that were established in once-degraded pasture lands.⁷

Harnessing Indigenous insights

Historically, mining and metals companies have opted for transactional, rights-based, contractual partnerships with Indigenous groups in key mining regions. However, these arrangements plainly overlook the innate and deep understanding these cultures have of their natural environment and its value. In shifting away from outdated practices and seeking values-based relational partnerships instead for projects, mining and metals organizations have the chance to learn and grow their nature-based knowledge. Partnerships with Indigenous groups present an important opportunity to reorient the industry's trajectory toward regeneration and sustainability.⁸

Anglo American is rising to this challenge. In 2021, it collaborated with the International Union for Conservation of Nature (IUCN) to explore how NbS can deliver positive biodiversity outcomes while supporting its carbon-neutral goals and contributing to long-term socioeconomic sustainability for communities. IUCN is also supporting Anglo American in its development and implementation of strategic corporate commitments toward sustainable natural resource management that help contribute to global societal goals.⁹

John O'Brien, partner, Climate & Sustainability, Deloitte Australia, says: "Early thinking around the environment pillar of ESG has focused heavily on the transition to a low-carbon economy. However, to create strategies that will support growth and competitiveness over the next decade, we need to take a value chain view of concerns such as climate resilience, circularity and the company's interaction and reliance upon nature. To help ensure sustainable growth, we may need to go beyond the here and now."

Going forward, mining and metals companies that have an integrated and systematic approach to nature as part of their broader ESG strategy will find they may have a significant advantage in accessing funding, insurance, talent, and securing permits and a social license to operate. To be bankable, new mining projects should incorporate nature considerations at each stage, from inception to mine decommissioning and throughout the supply chain.¹⁰

This evolution should be viewed in a positive light; it's not just a challenge, but an opportunity to let the industry's purpose and dedication to being a responsible steward of nature shine through.

Nature as core to successful business

While NbS may be the most mature way in which mining and metals companies are currently thinking about nature, the need to go deeper is becoming increasingly apparent. It's important to consider how value chains as a whole interact with and affect nature, where companies are reliant upon the ongoing ecosystem services that nature provides, and how each organization can deliver enhanced value through thinking harder about its interaction with nature.

Reflecting the value of nature holistically in mining and metals ventures

- **Understand why nature is important:** To set the appropriate long-term strategy, help ensure the board has been given a comprehensive introduction on the concept of nature and ecosystem services. This will enable informed reflection and action upon the potential corporate risks and opportunities arising from nature-related interactions.
- **Perform a stocktake of current business activities:** Check the business's existing pledges and commitments. Understand what is already being done to assess environmental or social risks across the value chain and consider how these initiatives can be leveraged or extended to incorporate nature-related risks and opportunities too.
- **Use LEAP to prepare for TNFD alignment:** The TNFD has developed an integrated, voluntary assessment process for nature-related risk and opportunity management called LEAP. This is intended to support internal, nature-related risk and opportunity assessments through four steps: (1) Locate interfaces with nature; (2) Evaluate dependencies and impacts; (3) Assess risks and opportunities; and (4) Prepare to respond to nature-related risks and opportunities and report.¹¹ Organizations should use this as a starting point for the TNFD assessment and disclosure process in advance of the framework's publication in late 2023.
- **Identify the next steps:** Develop a road map for multiyear delivery that demonstrates how the business will investigate, disclose and address opportunities and risks arising from nature as a core part of its corporate strategy and operations. Design pilot programs for a single product or operation and define a process to help ensure that learnings from early mistakes are captured and built upon. This is an important step to help ensure that valuable insights are applied across the wider business, and that speed and agility are instilled in development efforts.
- **Inform and update stakeholders regularly:** Inform stakeholders and traditional custodians of the business's current status surrounding nature-based interactions, and outline the steps it's taking to improve. Set a timeline for future updates and communications too. Claims and commitments should be transparent and verifiable to mitigate accusations of greenwashing. Be upfront that the priority is taking action, even if it is small to start with, rather than mapping every touchpoint.

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Trend 2

Conscious circularity

The role of mining in a circular economy

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The global economy may be undergoing a metamorphosis. The way that value is defined is changing to support a bid for greater sustainability, as evidenced by the introduction of carbon pricing; environmental, social, and governance (ESG) measures; and the evaluation of biodiversity risk, among other things. Driven by this change, mining and metals companies are beginning to reconsider their traditional roles as metal producers, finding ways to capitalize on previously untapped sources of value and exploring new avenues for value creation.

Change on this scale is daunting, but necessary. The intensification of climate change, environmental degradation, and widespread pollution are products of a linear economic model, one that has reached peak maturity and is starting to fail under the weight of a rapidly expanding population; according to the United Nations (UN), the global population reached 8 billion in November 2022.¹

A circular economy (CE) presents a more sustainable alternative. It can provide a framework for an economy decoupled from finite materials, while minimizing negative impacts to people and the planet. CE is underpinned by the move to renewable energy and, as the providers of the raw materials needed to create these technologies,² no industry is better positioned than mining and metals to lead this change.

Much more than decarbonization and waste management

In general, the mining and metals industry is well progressed in unconscious circularity—the sector has a strong history of waste recycling and water reuse and recycling, and the creation of products from tailings is fast becoming a part of the conversation. The notion of circularity is also being adopted in the energy space with mine electrification and energy storage, and companies have been regenerating landscapes for some time. However, these initiatives are mainly driven by liability, regulation and resource scarcity, rather than by value creation.

The positive power of mining and metals

Early CE adopters should not only benefit from preferential access to responsible sourcing markets and investors;³ but these companies also have the opportunity to influence those downstream, accelerating the growth of the wider circular economy. Mining, minerals and metals form the start of many different supply chains, from steel used in wind turbines to potash and phosphates used as fertilizers. The way in which the industry operates and conducts itself sets the standard for what follows.

When it comes to “conscious” circularity and shifting mindsets around value and materials reuse further down the value chain there is still much work to be done. Since the linear economy drives the need for mining, many perceive CE as a threat to their industry as it is now. Systematic change is often considered risky, too costly, or simply too difficult; a view which usually results in inaction.

Georgine Roodenrys, partner, Sustainability & Climate Change National Circular Lead, Deloitte Australia explains: “As a result, the mining and metals industry as a whole is relatively unaware of what a CE proposition can provide. Of course, this is not true of all. Collectively, the industry still has a long way to go, but because these companies already have a lot of the fundamental skills and technologies needed for CE, they are well placed to move quickly.”

There is also relatively little in the way of practical resources specifically designed to help mine operators reconfigure their businesses in a gradual and manageable way to ultimately support the creation of a sustainable ecosystem. The result is that steps toward CE in mining so far have tended to manifest as waste management and decarbonization projects.

While these types of efforts are important steps toward CE, to implement them in a siloed manner or as stand-alone company initiatives is to miss the very point of circularity. To reap the full benefits of CE, each step within the mining and metals system should be reconfigured to keep metals in their most valuable form, design out waste, and maintain the health of the physical environment.

Despite the incumbent challenges, the industry and its collaborators should accelerate their CE journey today to support the drive toward global sustainable economic transformation.

Relearning value and its circulation

The first step is to better understand value and that value creation is intrinsically linked to organizational business models. In the case of traditional mining and metals companies, their value and growth are based on the exploitation of finite resources and the creation of financial value for a narrow group of stakeholders. However, miners of the future are expected to provide many different types of value, including social and environmental. This involves not only mitigating negative impacts but actively creating positive impacts.

CE can enable this through three key principles:⁴

1. Design out waste and pollution;
2. Keep products and materials at their highest value;
3. Regenerate natural systems.

CE centers on value retention. In a linear system, chain, or process, value is often incrementally lost along the way. Mine tailings are a good example—the value invested in creating tailings is lost the minute they separate from the product, often becoming an immediate cost-management exercise. Companies are beginning to realize the value held within residue minerals and to explore ways to capture it through reprocessing or divergent product streams.

In a circular economy, the system is optimized to design out value leaks or turn them into loops. Retention of value is also a cost-avoidance exercise. For example, tailings storage facilities must be managed far beyond active operation and represent a massive financial and social liability for operators.

Tailings are just one of many examples of how value can be lost or retained in a metals-focused ecosystem. Examples such as this make it easier to see how adopting

circular principles could help companies to generate a competitive advantage through lower costs, fewer regulatory constraints, better ESG scores and securing a social license to operate.

A critical part of the shift to CE lies in how we measure nonfinancial value, such as biodiversity or trust. It's difficult to build a solid business case for CE initiatives if we cannot fully communicate the value they deliver. Currently, businesses are simply reacting to the costs associated with these "externalities." Digital transformation will be key in this respect, aiding with quantifying and modeling value flow throughout value chains today and ecosystems tomorrow.

Think systematically

Viewing business activities and operations as part of an interconnected ecosystem also allows investment in the appropriate innovations across business models and portfolios. This gives companies a better understanding of the risks and opportunities surrounding them⁵ and allows them to create meaningful value in the areas where they operate. This knowledge is important in building resilience at many levels of an organization, in attracting new sources of investment and entering new markets.

Andrew Lane, Partner, Energy, Resources & Industrials Leader, Deloitte Africa says: "There's huge potential risk and opportunity for circularity in mining. But most mining companies do not understand that this is an economic proposition; it's about their place within the global economy, as opposed to them implementing the next wave of sustainability initiatives."

New models for new value

The scaling of green financial tools, such as biodiversity markets, will encourage mining and metals companies to create new value streams (e.g., through environmental regeneration) and bolster the development of new CE-based business models.

It is easier to instill circular principles into a new business, but there are also examples of traditional mining and metals companies that have successfully pivoted their business models to embrace CE. Anglo American is applying circular principles to optimize its use of resources, eliminate physical waste, and maximize process efficiency at its operations. The company aims to have a neutral or net-positive impact on the environment which, in turn, helps local communities to thrive.

Through its value chains and marketing business, Anglo is working to maximize the value of its products during their life cycle, and it actively supports the development of new technologies that advance this goal. The company summarizes the importance of CE to its evolution in the following statement: "Through holistic business transformation, we are growing our business in ways that adapt to and shape the change around us. Circularity is one of the lenses that we use to support our journey from mining and metals company to material solutions provider."⁶

Patricia Muricy, Partner, Energy, Resources & Industrials Leader, Deloitte Brazil adds: "There are only three principles required to create a CE, and we already have the framework needed to effect change. The key lies in changing mindsets and breaking down the challenge into manageable chunks, examining how we can apply those principles at every level within mining and metals companies. To do that successfully, there must be recognition that a systemwide shift is required."

Time for change

Rethinking the flow of value throughout the metals and minerals ecosystem is one of the biggest opportunities this sector has to positively influence sustainable development, both today and tomorrow. The journey will not be easy, but organizations that are willing to try will likely be rewarded tenfold through greater longevity.

Initiating and accelerating circular economy in mining and metals

- **Get strategic:** As part of organizational strategy setting, consider how the company defines and measures value today. If the current system doesn't accurately reflect nonfinancial forms of value, explore how it could be rethought to support the creation of CE-centered business cases. By questioning what is valuable today versus 10 years ago, and what will be valuable in another 10 years' time, businesses will be better positioned to build circular principles into their core strategies.
- **Map the value ecosystem:** It is likely that most mining companies will already be mapping their sphere of influence as part of their Scope 3 emissions reduction efforts. Use that exercise to consider value flow throughout the known ecosystem of suppliers, customers, stakeholders and environments. Identify the roles that the mining company plays in each scenario, as well as threats and opportunities to value retention. Understand the gaps that could present an opportunity for a new product, service or alliance.
- **Invest in the appropriate people and partners:** Consider whether the organization currently has the knowledge and capabilities needed to apply circular principles and close any value leaks. Be strategic about those roles and identify where investment is needed to build a resource inhouse or outsource to a business whose values are aligned.
- **Scale current successes:** Circular principles can be applied at every level within a mining and metals business, from the process level all the way up to enterprise. Companies are good at applying circularity at the process level; for example, using closed-loop water circuits to reduce loss through mineral processing. Where leading practices currently exist, replicate and scale them across the business. Sharing these examples and learnings, both internally and externally, will also accelerate the industry's collective impact.
- **Act fast to safeguard market share:** To help ensure mining and metals companies maintain competitive market share, CE should become a core strategic imperative. Many traditional mining companies of all sizes are pivoting to embrace circularity, and there will be new entrants in the coming years. There is also the threat of rising costs as ore grades decline.

Endnotes

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Trend 3

Driving down embodied carbon in metals

Supporting the decarbonization of economies

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The creation of low-carbon, future-fit building materials, vehicles, energy technologies and more is reliant on the minerals and metals from which their key components are produced. Although the mining and metals industry does contribute to global carbon emissions,¹ the sector's foundational role as a provider of raw materials means that its handprint, or potential to lower carbon emissions across the broader economy, outweighs its footprint.

Across the industry, efforts are well advanced to lower Scope 1 and 2 greenhouse gas (GHG) emissions. Research from the University of British Columbia has shown that 90% of total emissions from mining and metals globally originate from the manufacturing of iron and steel.² Scope 3, or avoided emissions produced by activities up and down the value chain, including smelting and refining, can constitute up to 98% of an individual company's total GHG emissions.³

Scope 3 decarbonization efforts have only recently begun in earnest. Part of this lag can be attributed to the time required for companies to map out their complex supply chains and work with alliances to align their thinking. It also takes time to identify where existing processes and technologies can be adapted to lower emissions and where the development of new ones are required.

John O'Brien, partner, Climate and Sustainability, Deloitte Australia, says: "We're seeing increasing supply chain pressure from the manufacturers of end products, such as batteries, cars, phones, and packaging, for mining and metals companies to provide verifiably carbon-neutral commodities. A proactive approach to lowering Scope 3 emissions will allow early movers to differentiate themselves and their products, capturing a greater share of the market."

Value chain decarbonization is one of the biggest challenges that miners and metal producers face. However, by assembling the different players, embracing their potential as influencers, and helping other organizations to lower their footprints, there are also opportunities to create exciting new roles, speak to younger generations who are keen to work in a purposeful sector, and invite new ways of thinking and working.

Collaborating for progress in steelmaking

According to joint research by Shell and Deloitte Global in their recent report: "[Decarbonising Steel: Forging New Paths Together](#)", the global steel industry currently generates around 10% of global CO₂ emissions, which could increase as demand is expected to rise by 10-35% by 2050 compared to 2019⁴. The steel sector is still highly reliant on coal to meet 75% of its energy demand,⁵ and because metallurgical coal is also the primary reducing agent used during steelmaking, its substitution is complex.

However, because the steel market is relatively concentrated and close knit, there are significant opportunities for decarbonization through coordinated efforts.

Grischa Sauerberg, Vice President, Sectoral Decarbonization & Innovation, and Head of Mining at Shell, frames the possibility: "If the 20 largest steel companies decarbonize their plants, the potential total emissions of the steel industry could be reduced by up to a third."

The International Energy Agency (IEA) states in its 2021 Iron and Steel tracking report: "While energy efficiency is important for net-zero by 2050 alignment, on its own it cannot decarbonize the sector. Transformational change is required, and the groundwork for breakthrough technologies needs to be laid before 2030."⁶

Anticipating this need, many miners and metals producers are forming collaborations to support or actively participate in research and development initiatives with downstream companies in a bid to develop and accelerate breakthrough cleantech.

Dr. Andrew Zoryk, director, Consulting, Deloitte Germany says: "Many miners and metals producers have anticipated this need and are forming partnerships to support or actively participate in research and development initiatives with downstream companies in a bid to develop and accelerate breakthrough cleantech."

For example, in 2016, Swedish miner LKAB teamed up with SSAB and Vattenfall to form the HYBRIT initiative, which aims to create fossil-free steel at an industrial scale by 2026. In June 2021, the HYBRIT pilot plant in Sweden completed test production of hydrogen-reduced sponge iron. Using this reduces around 90% of emissions from steelmaking, and SSAB's transition to it will reduce Sweden's CO₂ emissions by 10% and Finland's by 7%.⁷

BHP, which faces Scope 3 emissions from both iron ore and metallurgical coal, has taken a diversified approach to accelerate green steelmaking. In recent years, it has partnered with steelmakers across four different economies—POSCO, China Baowu, JFE Steel, and HBIS Group—to explore GHG emissions reduction opportunities.

In July 2022, it also signed a Memorandum of Understanding (MoU) with India's Tata Steel to reduce the emission intensity of blast furnace steel through the use of bioenergy and carbon capture and sequestration (BECCS).⁸ Through its venture capital arm, BHP is backing startup Boston Metals, whose molten oxide electrolysis technology aims to decarbonize steelmaking.⁹

Cleantech to decarbonize transport

Vale is also looking to cleantech development to reduce its Scope 3 emissions generated through shipping (the company contracts ships from third parties to transport its ore). In July 2021, the company announced the installation of air lubrication technology on the Sea Victoria, a 325,000-ton capacity Gaaibamax very-large ore carrier (VLOC).¹²

Compressors installed on the ship's deck send air to devices positioned under the ship to produce a carpet of bubbles that reduce friction between the hull and the water, thus reducing fuel consumption and emissions. The technology could be replicated on the remainder of the contracted fleet committed to transporting the company's ore. Conservative estimates point to a 5% to 8% fuel reduction and a 4.4% reduction in annual emissions from Vale's maritime transport of iron ore.¹³

Antofagasta Plc's efforts to lower its own Scope 1 and 3 emissions have also seen the company take on the role of an enabler, developing solutions that help other mining and metals companies to lower their own Scope 3 emissions.¹⁴ The company's transport division is key in supporting the economic activity of the Antofagasta region in Chile through rail cargo services that connect various mining operations with ports on the Pacific coast.

The positive power of mining and metals

Efforts to lower embodied carbon in metals are also spawning opportunities to boost circularity. In 2018, Rio Tinto joined forces with Alcoa, with support from Apple* and the governments of Canada and Quebec, on a joint venture called ELYSIS. ELYSIS is developing a smelting technology that produces no GHGs, only pure oxygen. Its first metal was produced in November 2021, and the technology is now being scaled for industrial deployment beginning in 2023.¹⁰

In September 2022, Rio Tinto also signed a strategic alliance with Volvo Group under which Rio Tinto will supply responsibly sourced, low-carbon products (including ELYSIS aluminum) to Volvo. In turn, Volvo will assist in decarbonizing Rio Tinto's mining operations using autonomous hauling solutions.¹¹

Antofagasta announced in February 2022 that it's evaluating green hydrogen as a potential fuel for its locomotive fleet. The project is in development with the Green Hydrogen Accelerator of Chile's Energy Sustainability Agency, and the team plans to have a pilot running in the next two to three years. Antofagasta has also agreed to evaluate the feasibility of HyEx green ammonia produced in northern Chile (a project led by energy multinational, Engie, and Chilean explosives company, Enaex). As a possible off-taker, Antofagasta would use ammonia as a fuel for its trains, haulage trucks, and ships.

Unique companies need unique solutions

Dr. Adriaan Davidse, director, Consulting, Deloitte Canada, explains: "Every organization has a Scope 3 emissions profile that is influenced by its unique circumstances. Therefore, it should select different alliances and investments to create a net-zero pathway that is optimized for its specific challenges and opportunities. In doing so, organizations can meet their own climate change mitigation goals, create new types of value, and secure off-take agreements in what is fast becoming a buyer's market."

The examples provided earlier detail the efforts of some of the world's largest mining and metals companies as well as their suppliers and consumers. They illustrate how an ecosystem mindset can be harnessed to successfully tackle value chain emissions and support the creation of a more sustainable economy.

Leveraging green hydrogen

Fortescue Metals Group (FMG) is innovating in a different way. The world's fourth largest iron-ore producer is leveraging its subsidiary, Fortescue Future Industries (FFI), an emerging global producer of green hydrogen (made from renewable energy, producing only steam as a by-product) to decarbonize its mining and shipping fleet, including trucks, drill rigs and trains. FMG aims to achieve carbon neutrality by 2030 and responsibility for achieving this lies with FFI¹⁵. Around 10% of FMG's annual profits contribute to funding FFI¹⁶. The aim is to produce 15 million tons of renewable hydrogen annually by 2030, and the company will also supply other organizations that are looking to drive down their emissions¹⁷.

Creating a cleantech portfolio that supports Scope 3 reductions

- **Go digital to map the business ecosystem:** Understand the value chain better by digitally mapping where Scope 3 emissions come from. By gaining a deeper understanding of the different layers of industries involved in the company's value chains, and their associated emissions intensities, organizations can generate better insights about how their business activities are ultimately associated with Scope 1 emissions. This transparency makes it easier to evaluate where companies can influence the development of abatement options.
- **Identify abatement opportunities:** Make time to listen to your suppliers and customers. There may be collaboration, investment, or enablement (or other) opportunities available that the organization hasn't yet considered both with direct and indirect (consumer product companies) players. Once opportunities have been identified, priorities, boundaries, and data-sharing protocols can be established to support the initiative.
- **Be clear on costs:** Transparently assess and address the commercial implications of value chain decarbonization. Understand where capital will be required, value in the end product, and how to redistribute that value along the value chain. Form a view of the least-cost decarbonization pathway for the full value chain.
- **Seek out collective actions for greater impact:** Scope 3 emissions may only be effectively addressed by working together across the value chain. The creation of buying consortiums that value the reduction of Scope 3 emissions and are willing to invest in decarbonization options, or to provide a premium off-take market for investments by others for decarbonizing the value chain, could also catalyze change for others. The ELYSIS project, which involves Apple, Rio Tinto, Alcoa, and the governments of Canada and Quebec working together to develop a GHG emissions-free smelting technology, is an example of this powerful collective action.¹⁸
- **Think circular:** Adopting different roles and strategies to tackle Scope 3 emissions can provide ways for miners to boost circularity in metals supplies, such as urban mining. With the ability to track metals throughout their life cycle with new chemical markers and digital platforms such as blockchain and equivalent applications, effective urban mining and recycling can replace a great share of primary mining over time. It can become a source of continuous revenue for mining companies that think more holistically and adopt business models that benefit from the increased focus on reducing Scope 3 emissions.
- **Understand the time frame:** Decarbonization of end products must happen as soon as possible. Solutions must be developed, optimized, and scaled in the next few years to achieve the goal of net-zero by 2050. Find the appropriate alliances who want to collaborate on developing these solutions, and then synchronize changes needed across the value chain to better time investments and scale solutions more broadly. Once a single value chain has been assessed, develop a road map for scaling across products, and identify the order of priority based on the timing of when carbon-neutral end products will be needed to meet market demand.

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Trend 4

Collaborate, incubate, accelerate

Speeding successful innovation for greater value

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Van Ramsay, partner, Mining & Metals Leader, Deloitte Canada

Christopher Lyon, partner, Energy, Resources & Industrials Leader, Deloitte Chile

While innovation is a topic that's been addressed many times in the Tracking the trends report over the years, the imperative continues to build.

Technological innovation can lower the costs, dangers and environmental impacts associated with mining ever-deeper deposits, helping to ensure that operations remain profitable and sustainable over time. Social innovation can help mining companies secure and maintain a social license to operate, allowing smoother permitting for projects, which is required to meet the needs of the green energy transition. Through business model innovation, companies can incorporate circular principles, realize the full value of their assets and safeguard their businesses against disruption.

It's easy to assume that the benefits of innovation stop at the company; however, in continuing to strive for excellence, mining and metals companies are providing the highest-quality materials at the lowest cost, with the lowest possible environmental impact (even reaching net-positive in the future). They can also provide employment and development opportunities for communities in areas that might be less attractive to other types of investment and rehabilitate landscapes damaged by legacy industrial activities, to name just a few.

The environmental, social, and governance (ESG) revolution in mining has acted as a catalyst for collaborative innovation efforts in particular, driving many companies of all sizes and types to join forces to tackle problems, such as decarbonization, that transcend the capability of any one organization. Now, mining and metals companies should take the insights garnered from those initiatives—what works and what doesn't—and use them to scale and speed different innovations across the value chain for the best possible impact.

Business ecosystems: What, why, how?

In Deloitte Canada's 2016 report, [Business ecosystems in exploration](#), business ecosystems are described as “dynamic and co-evolving communities of diverse actors who create and capture new value through increasingly productive and sophisticated models of both collaboration and competition.”¹

Christopher Lyon, partner, Energy, Resources & Industrials Leader, Deloitte Chile, says: “Most ecosystems are formed to achieve something that lies beyond the scope and capacity of a single business or group of similar players. They provide a structured way for organizations to share information and risk to advance their mutual objectives, and usually include (but are not limited to) a mix of mining companies, nonprofits, research institutions, original equipment manufacturers (OEMs), and technology providers.”

Research has shown that, over the years, collaborative efforts have been more successful in developing breakthrough innovations than individuals or organizations working in isolation. As part of the aforementioned report, Deloitte conducted a review of more than 200 of the most important innovations over a 600-year period (from 1400 to 2010). The results showed that 85 were developed through a small, coordinated team within an organization, while 122 evolved through collective, distributed processes, with many groups working on the same problem.²

The positive power of mining and metals

The demand for low-carbon and responsibly sourced minerals and metals is growing as consumer companies produce the wind turbines, electric vehicles, building materials and more needed for net-zero by 2050. Mobile equipment accounts for 40% to 50% of mining's CO₂ emissions, and collaborative innovation with companies in adjacent industries are helping to break down the technological barriers that stand in the way of decarbonizing mine haulage.

In October 2022, Shell announced the formation of a nine-member consortium to develop an end-to-end, interoperable electrification system for mining vehicles that reduces emissions without compromising on efficiency or safety.³ The pilot combines a high-powered battery solution with ultrafast charging and a standardized microgrid energy system. This can be complemented with renewable electricity generation onsite or through the grid to create a holistic, low-carbon haulage solution.

Addressing common challenges

Business ecosystems are not new in mining and metals. Australia-based Amira Global was established more than 60 years ago by six mining companies to tackle challenges that were larger than any one organization could address.⁴ The group continues to develop projects at scale that support its members across a range of topics, including characterizing and optimizing the extraction of complex ore types and the evaluation of tailings storage monitoring technologies.⁵

More recently, the Canada Mining Innovation Council (CMIC) was founded in 2009 as a nonprofit. It's now 100% funded by the private sector and led by more than 30 mining companies globally with a focus on the co-development and co-deployment of technologies.⁶ Current projects include BluVein, which is adapting the e-highway technology developed by Swedish company, Evias, for heavy haulage in underground mines, thus overcoming the limitations of today's battery electric vehicles.⁷ CMIC is also leading development of the Conjugate Anvil Hammer Mill, which provides a more efficient alternative to high-pressure grinding rolls and semi-autogenous grinding mills.⁸

The caveat is that collaborative innovation does not come easily to an industry that is characterized primarily by capital-intensive, long-life assets and companies that are not designed or accustomed to sharing their data openly.

Developing a new technology, strategy or concept is one thing, but proving it at commercial scale and achieving widespread adoption are quite another. Time and time again, there have been instances where innovations stall, not because they're unviable, but because the structures, finance and growth mechanisms needed to progress them are not in place.

High-performance pressure filters for the dewatering of mine tailings are an example of a technology that, for social and environmental reasons, is crucial to the future of mining. However, the perceived financial and operational risks of deploying the technology at full scale in copper and iron ore operations (which produce the largest share of the 8 billion tons of tailings produced globally each year⁹) have meant that widespread adoption is yet to be achieved.

In October 2022, BHP and Rio Tinto announced a partnership to tackle this. The organizations will work in collaboration with technology and equipment providers, technical experts, research groups and the academic sector to test a large-volume filter unit at a BHP copper mine in Chile. This would remove up to 80% of the water in the tailings stream before it is deposited in a storage facility. The pilot construction is due to begin in early 2023 and operations are scheduled to commence in early 2024.¹⁰

Ecosystem evolution

Traditional mining ecosystems continue to bring forth valuable innovations, but what's interesting is the way in which the innovation ecosystem model is maturing and evolving (devolving really) to deliver different types of value for different players and through nonlinear pathways. The aim is to overcome some of the stumbling blocks that have prevented certain innovations from reaching their full potential thus far.

Van Ramsay, Partner, Mining & Metals Leader, Deloitte Canada, says: "Today, the key to success in collaborative innovation is taking a tailored approach depending on what companies want to achieve and the types of value they do and don't want to create. Once these have been determined then it's possible to define a program or model that could deliver those innovations in the most time-, capital-, and resource-efficient ways possible."

One example of a next-generation innovation ecosystem is the Charge On Innovation Challenge. The challenge is facilitated by Austmine, the crowdsourcing project that was founded in 2021 by BHP, Rio Tinto and Vale to

accelerate commercialization of solutions for charging large (220-ton capacity and above) electric haul trucks. The challenge, which now has 21 mining company patrons, received hundreds of technology entries in its initial open application phase and, in May 2022, eight were selected for further development.¹¹

What makes Charge On different is the level of due diligence that the patron companies performed as part of the initial assessment to help de-risk the adoption process, and the structures in place, including commercialization opportunities with OEMs and venture capital, to progress the winning entries.¹²

Joining forces to decarbonize steelmaking

In October 2022, BHP signed an agreement with ArcelorMittal and Mitsubishi Heavy Industries Engineering for a multiyear trial of Mitsubishi's carbon capture technology in steelmaking. The agreement includes a trial at ArcelorMittal's steel plant in Ghent, Belgium, and at one of its North American direct reduced iron plants. The companies will also conduct a feasibility and design study to support progress to full-scale deployment. The move was described as "a critical milestone in BHP's strategy to support decarbonization efforts in steelmaking."¹³

Venture capital: The next frontier

Some tier one mining companies, such as BHP and Vale, have gone a step further and created venture capital divisions to collaborate with innovative startups.¹⁴ This represents a very different approach to the noncompetitive-type ecosystems outlined previously and serves a different purpose, although the aim is still to incubate and accelerate.

Independent, consortium-type programs tend to focus on identifying, incubating and accelerating a range of innovative solutions to urgent, large-scale industry challenges; there is an understanding that these efforts are “for the greater good.” However, challenges that are more site or company specific, for example, mechanical rock cutting or mineral exploration, may provide a chance for companies to differentiate themselves or their product based on the development of new solutions. By taking a stake in a range of startups, mining and metals companies with more generous balance sheets can spread their risk, maximize their chances of returns and potentially create a competitive advantage.

Andrew Swart, Partner, Energy, Resources & Industrials Leader, Deloitte Canada, explains: “We are seeing tier one miners standing up venture capital to support the development of innovations that could, in time, prove strategic to their businesses. As a result, we’ve seen a marked increase in career creation, progression, and capabilities in innovation, ventures and collaboration teams. This represents an exciting frontier for the sector.”

For example, in August 2022, Vale announced the creation of Vale Ventures, a US\$100 million venture capital fund designed to create new business opportunities and innovative technologies to incorporate into Vale’s operations. Through this, the company will acquire minority stakes in startups focused on four themes: value chain decarbonization, zero-waste mining, energy transition metals and disruptive technologies.¹⁵

Purpose-driven innovation for the 21st century

Next-generation collaborative innovation efforts, whether internally or independently led, are the future of mining and metals innovation. The key lies in determining which approaches best suit each organization based on the desired outcomes and the resources available to incubate, accelerate and capture the value of different innovations.

Regardless of the models or strategies chosen, there are a number of things that mining and metals providers can do to help ensure they get the most from any collaborative innovation effort.

Laying the foundations for collaborative innovation

- **Sequence your relationships:** Collaboration is hard. It's important to establish relationships between collaborating companies at different technical levels and to have ongoing coverage and support from senior management. Supporting functions, such as legal and procurement teams, should also be introduced at the appropriate time.
- **Sharing the appropriate data:** Data sharing and security are naturally concerns in any collaborative innovation effort. Mining and metals companies should ensure that they're sharing only the necessary data at the appropriate time with the appropriate parties in order to achieve the desired outcomes. Digital tools such as homomorphic encryption, which anonymizes data but allows relationships within data sets to be maintained thus allowing analysis and trends to be identified, can prove useful in this respect. User errors can also result in unwanted data sharing. Review and test data governance procedures ahead of any new collaborative effort.
- **Security equals trust:** Organizational risk frameworks (enterprise, supply chain and cyber) should be set up in a way that supports dynamic and collaborative innovation. For example, using a zero trust architecture that supports real-time verification each time a person, device, or product connects with the business will help to foster trust between partners.
- **Scan the ecosystem:** The startup space is evolving rapidly. It's important to scan the wider ecosystem for startups that are aligned with your organization's key focus areas. Consider looking to adjacent industries, such as oil and gas or manufacturing, for potential new partners.
- **Communicate successes:** Innovation is an attractive characteristic to investors, stakeholders and potential employees. Make successful innovation projects a key part of your marketing activities. Cross-correlate campaigns with those of your innovation partners for greater impact.

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Trend 5

Building resilient supply chains

Securing future metals and minerals supplies

René Waslo, partner, Global Risk Advisory & Cyber Leader Energy, Resources & Industrials, Deloitte Global

John Diasselliss, principal, US Mining Leader, Deloitte & Touche LLP

In today's interconnected world, mining and metals organizations depend on their supply chains for many things—from the parts and supplies that enable their production and processing infrastructure, to the services they require to run their day-to-day operations. Without these, they cannot provide the minerals and metals needed to build, power and tech-enable the modern world or feed the growing population. This critical interdependence makes supply chain security an imperative for these globally connected businesses.

Today, concerns including high transportation and logistical costs, labor/material shortages and increased prices that were triggered by the COVID-19 pandemic are being compounded by the Russia-Ukraine conflict. Metal provenance is now a key concern—China is the world's largest producer of rare earth metals, dominating 80% of supply¹; a realization that has prompted governments, including the US, to declare their supply a matter of national security².

As the energy crisis unfolds, metals manufacturing companies that rely on gas and electricity have also announced belt-tightening measures, with some furloughing workers and cutting production.³ For example, half of Europe's aluminum and zinc production was taken offline during 2022.⁴ In other cases, manufacturing facilities are switching from natural gas to diesel to maintain production—a difficult decision given global net-zero ambitions.⁵

While the challenges are many, by taking a fresh look at risk and fortifying their own supply chains, mining and metals companies can do their part to help safeguard global raw material and metals supplies that support other important industrial and consumer manufacturing industries and enable continued decarbonization and societal progress.

The positive power of mining and metals

Blockchain technology will be useful in driving transparency in transactions across global metals and minerals supply chains. Today, these are still largely paper-based or handled through point solutions leaving them open to duplication and fraudulency.

In December 2021, MineHub Technologies Inc. announced that its Hyperledger Fabric-based platform had been used by BHP and China Minmetals in the first cross-border copper concentrate trial shipment processed on blockchain technology. This followed BHP's 2020 pilot transaction in iron ore with China Baowu.⁶ BHP now has a subscription to the MineHub platform, which will help it “gain improved visibility into [its] supply chains to proactively mitigate against disruptions,” among other benefits.⁷

Assess, anticipate, and mitigate risk

This ambition has spurred mining and metals companies of all sizes to better understand their own risk exposures within their supply chains. Many are diversifying their supply networks wherever possible, using near- or offshoring tactics to help ensure the resiliency and longevity of their operations.

The degree of disruption that supply chains have experienced over the past three years is expected to continue, if not worsen. Therefore, the importance of effective third-party risk management (TPRM) evaluations is more critical now than ever. Considering the heightened complexities being introduced by changing societal expectations and global interconnectivity, truly effective TPRM evaluations will need to factor in broader strategic risk factors associated with doing business with third parties, such as potential impacts to their company's brand / reputation, as well as cyber security exposures that could be introduced.

René Waslo, partner Global Risk Advisory & Cyber Energy, Resources & Industrials Leader, Deloitte Global explains: "Mining and metals companies should be looking to build AI-based predictive models that can enable them to look into the future and perform risk analysis on suppliers at different levels of the supply chain. This will allow them to strategically plan for and lower their own exposure to risks, such as human rights violations, failing of debt structures, or poor reputation in the media."

Building resilience across the board

A resilient supply chain is also a secure supply chain. Cyberattacks on third-party vendors are on the rise as criminals look for any weaknesses in a company's defenses, and there are complex economic, environmental, political and ethical dynamics at play.

These risks can impact the safety, integrity, availability, and/or reliability of a mining and metal company's supply chain – and therefore its ability to achieve production targets. These new complexities are compelling them to take a more integrated approach to security, which includes:

- **Addressing digital risks.** Supply chains accounted for 62% of system intrusion incidents in 2021.⁸ In response, some governments are proposing laws and regulations and declaring executive orders that call for increased vigilance in cybersecurity supply chain risk management (C-SCRM) for software and digital products.⁹
- **Evaluating third-party risks throughout the vendor life cycle.** While reliance on vendors is helpful for speed and competitive advantage in today's markets, it comes with risks. The 2021 edition of [Deloitte's Extended Enterprise Risk Management survey](#) by Deloitte & Touche LLP found that managing risks from increasingly digitized ways of working—including accelerated supply chain digitization has become a significant emerging risk in third-party management, with 71% of respondents identifying it as a top priority.¹⁰ The survey also revealed that 51% of organizations have faced one or more third-party risk incidents since COVID-19 officially became a global pandemic in March 2020.
- **Anticipating and preventing disruption.** The COVID-19 pandemic's squeeze on the global supply chain, the increase in attack surface from increased digitalization and associated cyberthreats, more frequent natural disasters and increasing geopolitical uncertainty have all contributed to recent supply chain disruptions. In fact, 85% of surveyed global supply chains have experienced at least one disruption.¹¹

- **Improving operational efficiency and effectiveness.** Traditional risk management frameworks are not designed to handle the complexity and volatility of the modern risk landscape, nor have the speed that is required help inform decision-making in today's competitive business environment. With ever-evolving logistical complexities, technologies, regulations, and consumer expectations, organizations need new ways to manage sources of third party and supply chain risk to keep their operations resilient.

The security imperative

Cyberattacks call into question an organization's ability to trust not only its cyber defenses, supply chains and partners, but also its ability to respond and/or recover effectively. While historical cybersecurity trends have led to an expanded focus on operational technology (OT), these third-party risks are now forcing mining and metals companies to further expand cybersecurity exposure evaluations to include the wider supply chain and vendors.

In addition to boosting supply chain resilience, real time monitoring of third-party suppliers' cyber stance can also speed up and improve compliance. There are also cost benefits that can't be overlooked; the expense of remediating a cyberattack far exceeds the cost and effort required to implement an effective cybersecurity-oriented TPRM program, and further, some damages—for example, to company reputation—cannot be recouped.

John Diasselliss, principal, US Mining Leader, Deloitte & Touche LLP, says: "A supply chain ecosystem that factors in appropriate cybersecurity considerations is critically important in our tech-enabled world. Mining and metals companies need to work with their vendors to implement coordinated and integrated methods to establish trust that the equipment, devices and other digital components being procured and deployed across the business are secure and reliable, therefore not further complicating what is already a complex cybersecurity risk landscape."

Make supply chain security a strategic matter

- **Transform third-party risk management evaluations:** TPRM is usually focused on evaluating vendors upon establishing new relationships and refreshing that evaluation infrequently—approximately every one to three years. Today, that's simply not enough to keep pace with the fast-moving threat landscape. Assessing suppliers' strategic brand and risk exposure, as well as their cyber posture, through improved vulnerability monitoring and analytics, on a real-time basis, may close that gap.
- **Optionality of suppliers:** Based on the risk management evaluations, strategic decisions can be made as to who your organization does business with. Also consider your options for near- and offshoring. There is often a trade-off around security and aspects such as sustainability (i.e., the carbon footprint associated with different options). Find a range of solutions for different products and services based on your organization's risk tolerance and priorities.
- **Secure supplier access:** Deploy and operate identity and access management (IAM) and zero trust capabilities that better enforce authorized and tightly control third-party access to systems and data (referred to as "least privilege access"). This will reduce the consequences of a compromised supplier or vendor.
- **Autonomous operations security:** Enable security for the autonomous, automated and other digital elements of the supply chain that play a critical role within the organization's operations by deploying security controls, such as stringent evaluations of enabling software, firmware updates, patches, etc.
- **Step up supply chain risk management:** For organizations that have a TPRM program in place, ensure its focus adequately considers cybersecurity exposures. For mature organizations, consider a more robust supply chain risk management (SCRM) program that is focused on establishing a holistic secure supply chain, inclusive of cybersecurity as well as broader exposure considerations around geopolitical, natural disasters and emerging regulations.

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Trend 6

Making change more holistic

Using systems thinking to drive next-level operational excellence

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Achieving operational excellence is a perennial matter in mining and metals. The long-term convergence of factors, including depleting ore grades, waste management challenges, rising costs and labor shortages, have seen companies double down to generate efficiency improvements in recent years. Most now lean heavily on advanced analytics and artificial intelligence-based solutions to produce more minerals with fewer resources and a minimal footprint.

These initiatives have risen even higher up the agenda over the past 12 months driven by the global energy crisis and booming demand for critical minerals—mineral demand for clean energy technologies alone is expected to quadruple by 2050.¹

To sustain important future industrial activities, including manufacturing, civil infrastructure and agriculture, and to support the green energy transition, mining and metals companies must once again step up their quest for operational optimization. In doing so, there is a chance to provide even greater value to stakeholders, speak to new sources of talent and investment, and change perceptions of an industry that is wrongfully thought to shy away from leading edge innovation.

To deliver next-level operational performance requires a new, more integrated, dynamic approach to mining and metals—one that considers the impact of new energy sources, extraction methods and processes holistically across all systems, roles and functions within the business and beyond. This is where systems thinking, design and modeling can add value.

Understanding and navigating complex systems

Systems thinking involves understanding and characterizing a whole system (including the smaller systems within it) by examining the linkages and interactions between its different elements. In practice, it encourages the exploration of interrelationships (context and connections) and the perspectives of each actor, as well as boundaries.²

Systems thinking is widely considered to be critical in handling the economic complexity facing the world in the coming decades.³ It helps us to see the bigger picture, which is useful when seeking to understand how macro-level disruptions, such as climate change or economic evolution, could affect individual companies and their ecosystem of suppliers, customers and stakeholders. Conversely, it also helps us to understand how seemingly micro-level changes in companies or operations can contribute to larger-scale improvements.

The positive power of mining and metals

Increased uptake of integrated systems design and modeling in mining and metals could create a number of new and exciting roles for younger generations—enterprise and business architects, modeling specialists and data scientists—who are looking to contribute to societal and environmental progress in an impactful way. No other industry has the potential to effect positive change to the same degree as mining and metals.

Systems design is a method that is useful when dealing with complex adaptive challenges and events where value conflict is common.⁴ It combines design thinking (an iterative process that seeks to understand users, challenge assumptions, redefine problems and create and test innovative solutions)⁵ with systems thinking.

Dr. Adriaan Davidse, director, Consulting, Deloitte Canada, explains: “Integrated systems design thinking is under-appreciated in mining today, because it’s a design technique rather than a technology. It offers significant potential for improvement, but integrated design thinking needs to go hand-in-hand with integrated systems modeling. The mining industry tends to focus on deploying point solutions, for instance, battery-electric or hydrogen trucks, rather than fundamentally rethinking the mine design, material movement and energy systems to create the best possible system solution. Point solutions may appear simpler, but they tend to be more expensive and often leave inherent inefficiencies and waste in the existing system intact.

“When transitioning to clean renewable energy, for instance, integrated systems redesign could allow mines to capture the benefits at a lower system cost compared to adapting the new energy sources to the incumbent system with minimal change.”

From operational optimization to value chain redesign

Some mining and metals companies have started showing signs of a new way of thinking and operating and are looking to advanced simulation and modeling technologies to rapidly assess the implications of different plans and designs over the long term. For example, mining and metals company, Sibanye-Stillwater, recently engaged simulation specialist, MOSIMTEC, to develop a digital twin of the underground mine, surface logistics

and concentrator at its Nye site in Montana in the United States.⁶

The aim was to create a single intelligent system to predict overall system capacity and schedule delivery of backfill to better match the mine plan. The digital twin integrates with corporate IT systems for data inputs and outputs and can provide the ability to automatically or manually run scenarios to compare risks and surpluses and proactively adjust plans to mitigate bottlenecks. Sibanye-Stillwater estimates that, following implementation of the model, backfill modeling and scheduling now take 20 minutes instead of two to three hours per week, and bottlenecks and sequencing issues can be identified and proactively addressed months in advance.⁷

Another example of the potential that systems thinking creates is in designing mines to be digital first. Rio Tinto did this at its Gudai-Darri iron ore mine in the Pilbara region in Australia. The operation’s autonomous assets are monitored remotely from an operations center 1,500 kilometers away in Perth, and a full digital replica of the processing plant allows teams to monitor and respond to data collected from the plant. The same digital asset data is used to provide an interactive 3D environment for virtual reality training.⁸

Systems modeling can also identify levers as well as potential risks across the value chains and can even be used to rearchitect them completely. OZ Minerals’ Scalable and Adaptable Mining Challenge, the results of which were published in July 2022,⁹ reimagined mine design using flexible and modular solutions. The premise is that new mining and processing methods may unlock access to new deposits, accelerate project development, decrease environmental impact, open alternate ownership models and improve the ability to respond rapidly to volatility.

Inspire Resources teamed up with OZ Minerals and used a systems approach, collaborating with domain experts and equipment suppliers, and applying whole-system models that allowed the complex interactions between elements to be revealed. This allowed the team to prove the hypothesis that an end-to-end simulation of the mining value chain can quantify the value created through flexibility, for example, by simulating management decisions in response to variable renewable power generation and volatile metal prices.

Herman Lombard, partner, Consulting, Deloitte Canada, says: “These examples illustrate how integrated systems thinking, design and modeling are beginning to find their appropriate place in mining. While most applications are currently isolated, the power these tools hold in unlocking larger, more complex challenges and creating new pathways for value means that they will be key in de-risking future technologies, mine designs, and product pathways, and in reducing waste from mining systems.”

Reimagining future mines

Projects like these are a good start, but to make a lasting and impactful change, organizations should also embed systems thinking into their wider work practices, decision-making processes and strategies.

Roland Labuhn, partner, Consulting, Deloitte Canada adds: “This requires visionary leadership as well as support from stakeholders, including educational institutions, investors, Indigenous groups, and suppliers.

“By thinking differently, mining and metals companies have an opportunity to generate new types of value (including social and environmental); to see the full benefit of future technologies and energy sources, such as renewable hydrogen; and to shape a better future for people and the planet.”

Embedding integrated systems design and modeling

- **Think big but start small:** If the organization is new to systems design and modeling, identify process- or operations-level projects that could act as an entry point for applying new thinking and modeling tools. These initiatives will foster valuable skill sets within the organization (for example, soft skills such as the ability to understand complex cause-and-effect relationships and also hard skills in applied mathematics or data science). They will also build confidence in tackling larger, cross-functional or cross-organizational projects at a later date.
- **Curate the tools and knowledge required:** It's rare for a mining and/or metals company to have mature systems design and modeling expertise in-house. If building and maintaining this capacity is prohibitively expensive or impractical, seek out alliances or service providers who can augment and enhance the organization's capabilities. Many software vendors provide off-the-shelf solutions with systems modeling capabilities. Look to these before embarking on costly custom software developments.
- **Involve the ecosystem for holistic transformation:** Digital modeling approaches and tools can speed the transformation process by exploring opportunities at low cost and risk and by making system-level trade-offs visible for decision-makers. But large-scale change also requires changes in the systems that surround and support mining operations. For example, organizations could consider working closely with educational institutions to better align their programs with future industry needs.
- **Strike while the iron is hot:** Even five years ago, large-scale change in mine processes and designs seemed a distant dream. However, today, mounting operational costs and environmental, social, and governance (ESG) requirements make it easier to understand the limitations of current technologies and processes, as well as the need to change how mining organizations develop new solutions. For the first movers, there is an opportunity to capture the greater share of the value-creation potential.
- **Expect resistance to change:** Undertake a risk assessment to identify barriers that could prevent systematic change from reaching its full potential. These could range from resourcing or finance, through to change management. Also consider the implications to your operating model, organizational structure, processes, and key performance indicators (KPIs) to fully unlock the value of each project as most organizations will inherently resist change. Once identified, create a multifaceted plan to help address and overcome these and review it regularly.
- **Create a psychological "safe" space for people to learn:** Learning involves failure and typically, the culture in mining is focused on eliminating failures. While digital approaches and tools don't carry the kinds of physical failures that mining companies want to eliminate, failures in pursuit of learning and developing new practices should be celebrated as praiseworthy rather than blameworthy.

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Trend 7

Rethinking external talent pathways

Solving complex workforce challenges through collaborative solutioning

Janine Nel, partner, Consulting, Deloitte Canada

Pedro Bravo, partner, Mining & Metals Leader, Deloitte Chile

Like many other global industries, mining and metals continues to see unprecedented changes that are impacting its workforce and ways of working. Among the prevailing challenges, companies are scrambling to navigate a fast-evolving labor market amid a global shift toward purposeful employment. This is compounded by efforts to rebrand the industry in line with responsible sourcing and the energy transition.

Janine Nel, partner, Consulting, Deloitte Canada, explains: “We’ve been hearing a lot of commonalities in the mining and metals industry’s people challenges. Across continents and countries, we see leadership teams working to balance labor shortages with booming demands. There are also requirements to attract and retain the appropriate talent and skills, source diversity of talent, bring forth diversity, equity and inclusion in the workplace, and shape and embed sustainability into organizational DNA.”

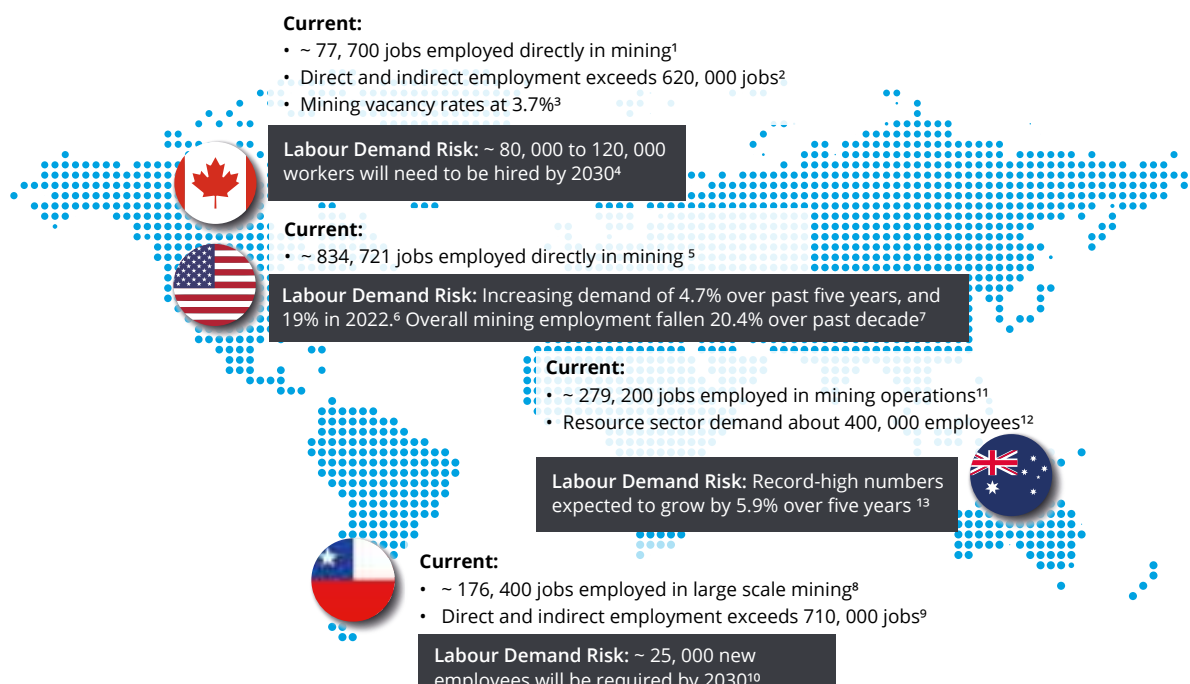
By effectively charting a course through these concerns and better reflecting the value of people within their corporate strategies, organizations can secure a future-ready pipeline of talent, provide exciting new paths for career development, and create truly diverse, equitable, and inclusive workforces.

In short, the industry’s future, and its prospects as an employer, will be brighter than ever.

Circumventing the skills shortage

Figure 1 illustrates the magnitude of today’s labor shortages across key mining and metals markets. Job vacancies are exacerbated by many factors. First, there has been a worldwide rush for minerals as countries work to pivot away from fossil fuels and toward decarbonization. Simultaneously, the mining and metals workforce is aging, and the looming retirement of experienced employees combined with low recruitment numbers from younger generations means there is a danger of critical knowledge and skills being lost. Today, many mine workers are at least age 46, and nearly 50% of skilled engineers are reaching retirement age in the next decade. As the nature of jobs evolve, so does the skills needed to perform them. According to the World Economic Forum, industries are facing a reskilling emergency globally as more than 1 billion jobs are likely to be reshaped by technology over the course of the next decade.¹

Figure 1 : Map showing extent of skills shortage in key mining markets



Source: Included in endnotes

To tackle this, leaders are exploring ways to balance and strategize between sourcing for new talent and upskilling and reskilling the existing workforce. In doing this, it's important to focus on the soft skills of today, while also preparing for the unknown technical skills of tomorrow. Companies will also need to improve workforce planning and update their operating models to respond to new roles, teams and priorities, including preparation for and acting on the energy transition and sustainability goals.

The COVID-19 pandemic accelerated the shift away from siloed ways of working in mining and metals toward more integrated and intelligent operations. This is increasing the industry's adoption of digital technologies, including artificial intelligence and analytics. In particular, the use of remote operations centers or "nerve centers" is creating new roles, such as nerve center orchestrators and data scientists, integrated master schedulers, and team performance scientists. Many of these roles have similar counterparts in other industries; for instance, emergency response coordinators, who could find exciting opportunities in the future of mining and metals.⁶

The positive power of mining and metals

In the recently published report, [The skills-based organization: A new operating model for work and the workforce](#),³ Deloitte US hypothesizes that the most fundamental building block of work—the job—could be hampering many organizations. Instead, skills-based models could be useful in meeting changing demands and business priorities.

By decoupling some work from the job—either by dividing it into projects or tasks or broadening it to focus on problems to be addressed, outcomes to be achieved, or values to be created—people can be freed from being defined by their jobs.

There are examples from other industries that mining and metals organizations could look to for inspiration. For instance, at Unilever, an internal talent marketplace enables skills to move fluidly to different projects and tasks across the organization, either as a permanent employee or as a "U-Worker"—that is, a worker who has a guaranteed minimum retainer along with a core set of benefits, and who contracts with Unilever for a series of short-term projects.⁴

By breaking down department silos and taking a more granular view of employees' contributions focused on outputs and skills, rather than on years of experience with a job title, recruitment becomes more targeted and internal mobility of talent improves, allowing the appropriate talent to be applied to the appropriate tasks and projects to accelerate business performance.⁵

From upskilling to DEI

Improving diversity, equity, and inclusion (DEI) and gender parity within the workforce are also high on the labor issue agenda, as are reducing discrimination and underrepresentation of groups, such as Indigenous people, in the workplace.

To hire diverse talent, companies should diversify their recruitment efforts. This means moving beyond fitting someone into a job description to hiring based on skills and potential. For example, rather than looking to traditional engineering campus hires or experienced mining and metals hires, going forward, organizations could look at hiring the same or similar skill sets from other programs or industries. This shift broadens the talent pool and brings talent with diverse experiences, skills and capabilities.

The nature of these challenges requires mining and metals organizations and their leadership teams to be vulnerable. This means acknowledging that this is not a single-organization challenge but one that requires an industry-wide solution and collaboration against the backdrop of a complex stakeholder environment.

Bringing together multiple stakeholders across various parts of the mining and metals ecosystem, from

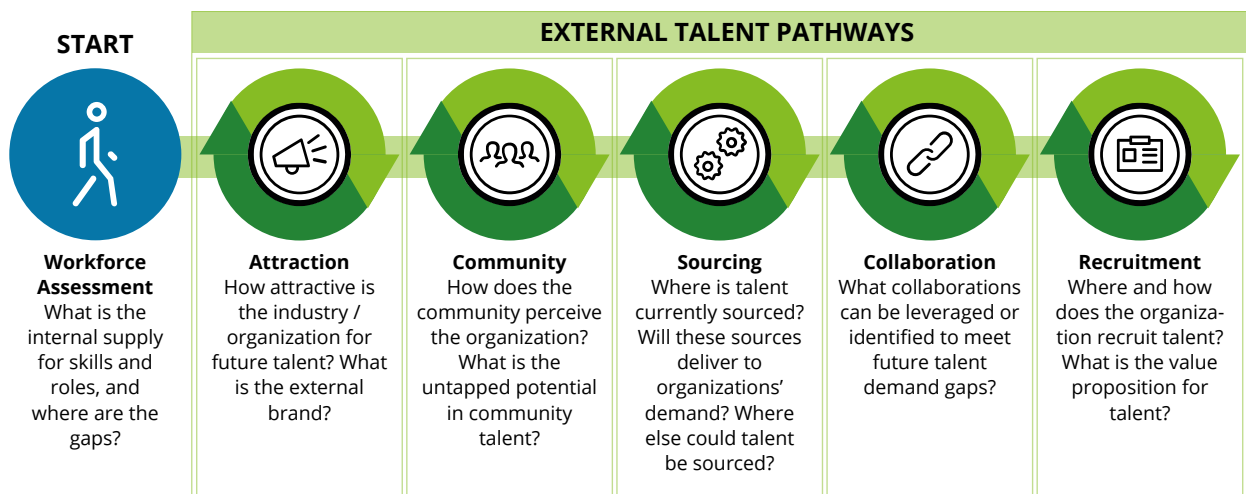
governance, to regulators, to educational entities and private bodies, will help shape a multifaceted solution to talent sourcing, one which will have long-term, sustainable impacts for both the existing and future workforce.

One example is to build training facilities in local communities to foster specific skills and capabilities that can drive education and employment in local communities, improve diversity of talent, and contribute to societal gains. In another instance, the coming together of private bodies and leading thinkers in government and academia as a consortium focused on one vision—such as accelerating improvements in environmental performance—leads to collaborative action and innovation on a broader scale for the whole sector and drives accountability.

Revisiting talent pathways with a fresh lens

As the mining and metals industry flexes and shifts toward collaborative solutioning, companies could focus their efforts on revisiting external talent pathways with a focus on DEI and sustainability. Deloitte Canada's External talent pathway model allows organizations to holistically consider their existing talent pathways and associated factors to access future-ready and diverse talent (figure 2).

Figure 2. Deloitte Canada's External talent pathway model



Source: Deloitte Canada analysis

In each part of the model, there are opportunities to assess the current state of the industry and organization, to develop an alternative plan of action, and to execute for a successful outcome. This process begins internally by assessing which roles and skills need to be built, bought, or borrowed to align to the strategic direction of the organization. Companies can then look externally at targeted improvement opportunities. The following are examples of improvement areas across the talent pathways.

Attraction: Improving talent attraction could result in a rebrand of an organization and a refreshed communication strategy which more loudly disseminates the employee value proposition to targeted labor audiences. Social media platforms can play a central role in attracting younger generations.

Community: Improving community perception requires organizations to look at surrounding communities and determine which drivers and inhibitors are impacting the supply and demand of local talent.

Sourcing: Optimized sourcing strategies go beyond skills and target the human level through personification and needs evaluations. There should be numerous sourcing channels which can access various pools of unique talent, and which look beyond mining to other industries with adjacent skills and capabilities.

Partnerships: Improving on partnerships, means looking beyond traditional partners / stakeholders and considering the broader ecosystem to identify potential new partners. Whether looking at recruitment firms, training centres, universities, etc., companies need to look to build deep relational partnerships that are not superficial to drive impact.

Recruitment: High performing recruitment ensures that all previous pathways are aligned, and that candidates who make it to screening and interviews are justly and fairly evaluated. The evaluation process must be candidate-centric not recruiter-centric, efficient yet effective, and automated but high touch.

Once this assessment is done, companies can move into strategic and long-term workforce planning and ensure that there is a continuous feedback loop to the first pathway. This way of thinking serves to support the future of the industry and workforce and proactively addresses many of the emerging people problems that mining companies are encountering.

Look for the art of the possible

People are the most valuable assets that mining organizations have, and their importance should be reflected through enhanced and sustained investments to get the right people in the right place, at the right time and with the right skills and capabilities. Efforts must be made to invest for today, while proactively investing for tomorrow.

How to rethink the organization's talent pathways

- **Tell the appropriate stories:** Changing perceptions of the mining industry by using its role as a catalyst for sustainable social, environmental, and economic growth will likely be central to attracting new talent and creating an environment that retains people in the workplace. Companies should actively seek out opportunities to engage with younger generations through multiple channels, and connections should be made early and often.

From community outreach initiatives to job fairs at universities, mine tours for children, etc., there are many ways to create interest in the sector. For instance, video game company Minecraft has partnered with the Mineral Council of Australia, University of Queensland, and Mining Education Australia to bring gaming into classrooms and make mining a part of school curriculums.⁷ The industry's purpose must be central to communications and efforts.

- **Build ESG on the ground:** Focus on developing quality, two-way relationships, with local communities. A collaborative approach to social development allows mining organizations to demonstrate respect and follow through on their ethical promises while building a positive reputation among local talent. It also creates opportunities to better understand the existing skills and capabilities base, and the future needs of the local workforce.
- **Community-led ESG efforts:** Local and Indigenous communities often have a better understanding of the land and environmental requirements than mining and metals companies and, with the appropriate training, can support or even lead company's ESG efforts. These types of community collaborations create experiences that can be reflective of the industry's sustainability values, serve the environment, and answer the need for diverse talent and social contributions.
- **Source talent from home and abroad:** Companies must find a balance between building skills within local communities, outsourcing or borrowing skills and jobs internationally, and bringing exited talent back into the sector through incentives. These approaches are necessary to successfully execute on future work. To do this, companies should leverage automation, digitization and the possibilities of virtual and remote work.
- **Get creative:** Moreover, as the shift toward the energy transition intensifies, new jobs with new skills and capabilities will be needed. To respond to this, mining and metals companies should find more creative ways to source such talent. Recruitment tactics must be supported by an employee value proposition that resonates with younger generations. This means that both purpose and social and ethical values must be at the center of the mining work and job narrative.

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Trend 8

Layering safety for greater sustainability

Making workforce health and safety fit for the future

Nicki Ivory, partner, Mining & Metals Leader, Deloitte Australia

René Waslo, partner, Global Risk Advisory & Cyber Energy, Resources & Industrials Leader, Deloitte Global

Mining and metals companies have made significant strides in improving physical safety at their operations over the past 20 years, and this is evident in ever-decreasing rates of fatalities and serious injuries. For example, in the United States, statistics from the National Institute for Occupational Safety and Health (NIOSH) show that the number of occupational fatalities in mining fell 59% between 2010 and 2020,¹ while in Australia, between 2003 and 2015, the fatality rate in mining decreased 65%.²

This progress can be partly attributed to the proliferation of automated and digitally enabled mining technologies, which now underpin production at almost every operation. But improvements are mainly thanks to the way that physical safety has been embedded into workplace culture; today it's the number one concern when setting foot onsite.

However, safety is evolving. There are now new aspects that must be considered to keep people safe—and to continue building diverse, respectful and inclusive workplaces that help enable each employee to achieve their maximum potential.

The positive power of mining and metals

The ways in which mining and metals organizations tackle other persistent health and safety concerns may set expectations for other industries too. By taking a proactive and transparent stance in eradicating unacceptable behaviors, such as bullying and cultural discrimination, in the mining industry, there is also a chance to elevate awareness as well as visibility of potential strategies and solutions in sectors such as infrastructure, construction and oil and gas.

Extending the physical safety focus

Recently, there has been a renewed focus on people in mining and metals and the value that they provide to organizations, with the realization that technology is not a silver bullet for sustainability. The understanding that greater diversity, equity and inclusion (DEI) makes for an advantaged and, most importantly, happy workforce has pushed many companies to set ambitious targets to diversify their workforces. The wider community has welcomed these goals, however, progress toward them has been slow thus far.

During this time, there has also been a rise in reports of sexual harassment, bullying and discrimination in major jurisdictions. The 2022 “Enough is enough” report,³ following a Western Australia Parliament inquiry into sexual harassment against women in Australia's fly-in-fly-out (FIFO) mining industry, confirmed these problems.

As a result, organizations are now investing significant time and resources to understand these inherent concerns and how best to combat them. Some have even chosen to conduct internal inquiries and openly share their findings, encouraging greater transparency and accountability in other organizations too. Rio Tinto's workplace culture report,⁴ which was published in February 2022 was something of a watershed moment for the mining and metals sector in this regard.

Taking responsibility for poor past performance and detailing corrective and tangible actions sends a powerful message to the industry's workforce, to its stakeholders and to the general public that change is truly underway.

Incorporating psychological and cyber safety

Both physical and psychological safety are prerequisites for sustainable mining activities—people need to feel safe as well as be safe to perform their roles to the fullest, to feel valued and to achieve job satisfaction.

However, workplace health and safety is evolving, and in today's digitally connected world, safety is also a virtual matter. In 2021, the average number of cyberattacks and data breaches increased by 15.1% from 2020.⁵

Data security doesn't just impact companies through the psychological safety of their workforces who need to know that their personal data is secure. The physical safety of workers onsite can also be compromised through operational technology (OT) security breaches. The 2012 Shamoon cyberattack on oil producer Saudi Aramco demonstrated how the cyber environment can be manipulated to pinpoint and launch physical attacks on key operational assets.⁶ The asymmetric attack took down more than 30,000 computers and put 10% of the world's oil supply at risk.⁷

Data security can also impact organizations' relationships with customers and other third parties. Safety is essential to trust, and trust determines who companies collaborate with and to what extent. Implementing a comprehensive cybersecurity plan will open new business opportunities for mining and metals companies.

The criticality of cultural safety

Cultural safety is another relatively new but important concept. Respecting traditional custodians and their environments, as well as the cultures and communities in which miners and metal providers operate is non-negotiable in winning trust and maintaining a license to operate. It's also key in boosting Indigenous employment in mining, which again, is important to operational and environmental sustainability.

A culturally safe workplace helps people call out safety concerns and can lead to decreased injury. It also attracts, engages, and retains diverse talent when people feel valued, allowing them to bring their whole selves to work. Increasing the number of Indigenous people in leadership positions is key in fostering cultural safety, and mining and metals companies should actively look for opportunities to recruit or upskill and support candidates into these roles. Government funding and initiatives, such as the Australian government's US\$14.2 million (AU\$21.9 million) Indigenous Leadership and Governance package, which was announced in February 2022,⁸ can also help to accelerate this.

Nicki Ivory, Partner, Mining & Metals Leader, Deloitte Australia, explains: "A culturally safe workplace creates an environment where people are respected, supported, heard, and celebrated whatever their cultural identity. To be culturally safe, people need to know that their whole health and well-being is understood and supported."

Company culture is also defined by the stories that organizations tell about themselves, and mining and metals companies should provide opportunities for minority groups within their workforces to be an integral part of the industry's narrative, both internally and externally. They can do this through helping to ensure that contributions from underrepresented groups, organizations, and businesses are recognized and honored through organizational celebrations and communications.

Organizations already know what to do

To maintain the high standards that they have set for themselves, mining and metals companies must continue to evolve their approach to workplace health, safety and culture. Most already know how to instigate positive change; the key to success lies in extending the laser-like focus from physical safety to include these newer types of safety.

In the 2022 report, [Safety 4.0: A new horizon for mining safety](#), Deloitte Australia outlined some of the opportunities linked to improvements in four types of safety.⁹

- 1. Physical safety:** Attracts workers from many walks of life whose skills (both emerging and traditional) are critical to mine production.
- 2. Psychological safety:** Attracts innovation and diversity of thinking, encouraging workers and partner organizations to explore new ways of working.
- 3. Cultural safety:** Encourages communities to welcome mining organizations onto their land and into their regions. This provides the foundation for strong working relationships across cultures and fosters opportunities for collaboration and streamlined approval processes.
- 4. Cyber safety:** Enables workers, customers, suppliers and shareholders to place their trust in an organization, both with their confidential information and the responsibility for taking care of their careers, businesses, and investments.

René Waslo, Partner, Global Risk Advisory & Cyber Energy Resources & Industrials Leader, Deloitte Global says: “These four layers of safety link and build upon each other to create foundations for a secure organization. Mining and metals leaders who can seamlessly integrate and have genuine engagement, action, and advocacy for all aspects of safety will lead their organization toward a more sustainable, secure, resilient, and prosperous future.”

How to widen the mining and metals safety lens

- **Double down on physical safety:** Mining and metals companies should continue to put physical safety at the forefront of operational environments, inclusive of accommodation and living facilities, transportation and offices. Regularly review and revise policies, systems, processes, structures, worksites, symbols, norms and accepted daily behaviors to help ensure people are always safe.
- **Budget for inclusivity:** Physical, psychological and cultural safety require workplaces that accommodate different types of diversity and ways of working. Some changes will be more costly than others. However, these should be seen as an investment rather than an expense and budgeted for accordingly.
- **Introduce screening for contractors:** Many contractor agencies do not carry out basic background checks on new hires. Mining and metals organizations should push for these to be introduced and, where necessary, carry out checks internally to avoid rehiring contractors who have previously violated safety rules.
- **Embrace collaborative learning:** If matters do arise, it's important for businesses to own them and share their learnings and actions openly to reduce the potential for recurring concerns. Also, be willing to learn from the experiences of other organizations in the broader industrial landscape and adjacent sectors.
- **Test procedures and governance:** Any reports of inappropriate behaviors, regardless of whether they are from an employee or third party, must be treated with gravity, investigated swiftly, and ensure appropriate action is taken. This requires watertight governance that can be tested through an internal audit once policies, procedures and responsibilities are determined.
- **Communicate the importance of cyber in workplace health and safety:** Cyber safety underpins the entire organization, and each employee must share in its responsibility. Make cybersecurity an integral part of health and safety training and briefings, and explain the impact a data breach could have on individuals' mental and physical health. Identifying any potential threats and implementing controls as soon as possible will help to prevent incidents.

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Trend 9

Transparency equals trust

Using tax and economic contribution reporting to change perceptions of mining

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While mining and metals organizations have long played an important role contributing to emerging economies around the globe, intensifying resource scarcity means that companies are more often finding themselves drawn to projects in less developed or higher-risk jurisdictions. This has the potential to make them a key component in the socioeconomic development of areas that might otherwise struggle to secure foreign investment.

With this power comes responsibility, and organizations can expect close and ongoing scrutiny of their tax and wider economic contributions from a range of stakeholders in the years to come—among them, tax authorities, investors, civil society and local communities.

Governments seeking to repair their balance sheets as they emerge from the COVID-19 pandemic and attempting to navigate the global supply constraints and inflationary pressures exacerbated by the Russia-Ukraine conflict may critically assess the share of economic returns they receive from their domestic extractive sectors. Due to the very direct impact of the conflict on global oil and gas prices,¹ it is in that sector where windfall taxes and other government revenue-raising measures have been most discussed lately, but the prices of many mined commodities have also retained their strength through the recent economic turmoil.

For mining and metals companies, building and reinforcing trust throughout their stakeholder communities has rarely been more important. A recent report from the Organization for Economic Co-operation and Development (OECD), [Tax morale II: Building trust between tax administrations and large businesses](#), cites openness, communication, and transparency as some of the key foundations for building a trusted relationship between businesses and tax authorities.²

The positive power of mining and metals

Mining and metals can be a powerful catalyst for socioeconomic growth provided that this is done in the right way. Through their investments, these organizations have the potential to generate critical revenue for building infrastructure; employment and educational opportunities for local and Indigenous communities; and, through shared values and local procurement initiatives, a mechanism to create regional prosperity that outlasts resource extraction.

Meeting mandatory reporting requirements

In defining tax morale as the intrinsic willingness of multinational enterprises to pay tax, the recommendations in the OECD report should not come as a surprise to a sector where the payment of taxes has long been part and parcel of mining and metals groups' social license to operate in their host countries. When it comes to transparency, the mining and metals industry (as part of the wider extractives sector) has a strong record of publicly setting out its tax and other economic contributions into government coffers.

Formed in 2003, the Extractive Industries Transparency Initiative (EITI)³ has been implemented in more than 50 countries and, for many years, has required mining groups to report payments of corporate income taxes; royalties and dividends to host country governments, disaggregated by company; and project and recipient government agency, among other things. After being independently reconciled and assured, collated country reports are then periodically published by the EITI for public scrutiny.

Furthermore, from the mid-2010s, large extractive groups parented or listed in the European Union, Canada, and Norway fell within broadly equivalent reporting regimes, which again required the public disclosure of taxes, royalties, dividends, and other payments to host country governments at both a project and government agency level and in every jurisdiction where extractive operations were undertaken.

Part of the rationale for these payments to governments transparency regimes was to shine a light on the level of revenues being received by host country governments from their domestic extractive sectors, and in that respect, they were not designed to capture the complete picture of any single mining and metals group's full tax and economic contribution across its entire geographical footprint, along its whole value chain, or throughout its various projects' life cycles.

Offering up voluntary data

To give this broader perspective for their increasingly sophisticated stakeholder communities, many of the world's largest diversified mining and metals groups have, for a number of years, supplemented these mandatory payments to governments disclosures with bespoke and stand-alone tax and economic contribution reports.

From filling in certain data gaps not covered by the scope of mandatory reporting regimes, these voluntary transparency reports have expanded beyond the numbers to help address matters where there may be at least a perceived risk of mistrust or misinterpretation—for instance, explaining a group's ongoing presence in low-tax jurisdictions, or articulating their policy in relation to accessing certain government incentives.

Those OECD-cited fundamentals of openness, transparency, and communication are also apparent as transparency reports have increasingly explained an organization's overall approach to tax (sometimes informed by The B Team's Responsible Tax Principles⁴). This covers tax strategy, governance, risk and control frameworks, as well as providing links and reconciliations to other corporate reporting, such as tax payment disclosures in audited group financial statements, or to Global Reporting Initiative (GRI) 2015 economic value data in sustainability reports.

Indeed, that link between tax transparency and sustainability reporting has now been fully bridged by the introduction of a specific GRI Sustainability Reporting Standard on tax—GRI 207.⁵ Tax is now firmly and formally an intrinsic part of the environmental, social, and governance (ESG) agenda.

Industry bodies, such as the International Council on Mining and Metals (ICMM), are firm supporters of such transparency initiatives. ICMM's Social and Economic Reporting Framework, published in May 2022,⁷ includes, as one of its core indicators for public disclosure, OECD or GRI 207-aligned country-by-country (CbyC) reporting on business activities, revenue, profit, tax and other financial data.

Filling in the gaps

For mining and metals companies, navigating and complying with this growing array of mandatory and voluntary transparency regimes may not be enough to fully inform stakeholders in their host countries of their economic contributions as part of their efforts to build trust and improve perceptions of the industry.

Valeria Vazquez, Partner, Mining & Metals Leader, Deloitte Mexico, explains: “Just as there are certain data gaps in the mandatory payments to government transparency regimes, the OECD and GRI-aligned CbyC disclosures may not tell the whole story of a mining group’s full contribution to its host countries’ economies.

“In being originally designed to provide granular financial information to tax authorities for their own private scrutiny, the basic CbyC dataset is very much focused on corporate tax. For a mining and metals group whose in-country payments to governments may also, or even exclusively, come via mechanisms such as profit-sharing arrangements, revenue-based royalties, or dividends on government free-carry equity stakes, the CbyC dataset can never give the full picture.”

Roman Webber, Partner, Mining & Metals Leader, Deloitte UK, agrees: “Since GRI 207 came into effect in 2021, we’ve seen much closer communication and collaboration between the finance, tax, and sustainability functions within organizations reflecting tax now truly being a part of the ESG imperative.

“In building trust across their broad stakeholder communities, mining and metals companies should continually evolve in their external communications to help ensure that the public perception of mining’s economic and social value is not based on single-year, single-tax snapshots. Instead, it should consider the complete range of different payments to governments across the mining and metals value chain from extraction, through beneficiation and logistics to sales and marketing. It should also encompass the entire project life cycle from exploration; through build, ramp-up, and full production; to closure, rehabilitation, and repurposing.”

A question of trust

The purpose of voluntary transparency reporting is to demonstrate value beyond compliance. This is vital in changing perceptions of mining and metals companies and their activities, which are often viewed in a negative light by civil society. Lack of trust, particularly with local communities, is still widely acknowledged to be one of the leading risks that mining and metals companies face.⁸

However, when done responsibly, mining and metals production has the potential to be a powerful driver of positive social, environmental, and economic development. Transparency around contributions to host economies can play an important part in building trustworthy relationships with landowners, including Indigenous people, and stakeholders such as regulators, NGOs, and investors who are increasingly cognizant of ESG measures.

That said, there is currently a spectrum of thinking around transparency among mining and metals companies. At one end, there are mining and metals companies that are embracing it, seeing enhanced disclosures as an important tool in demonstrating their credibility as an operator and responsible corporate citizen and showing that they are learning lessons from the past. At the other, there are organizations that have concerns that the information they disclose could be misconstrued, creating risk, or that think no amount of information may ever be enough for certain parties. Extended voluntary transparency reporting has an ongoing role to play in mitigating those perceived risks, and internal communication and organizational governance are also key.

Andrew Stevenson, director, Tax, Deloitte UK adds: “Finance, tax, sustainability, and external communications functions within organizations should collaborate seamlessly to help ensure that their transparency reporting can engender trust with stakeholders. Reporting should also be underpinned by appropriate governance frameworks and internal assurance processes; and larger mining groups are increasingly seeking external assurance opinions on key parts of their reporting.”

One step at a time

We are starting to see the trickle-down effects of voluntary transparency reporting. While some of the largest diversified mining groups have been publishing reports for more than a decade, several single-commodity focused groups—particularly precious metals producers—have recently published their first stand-alone tax and economic contribution reports.

This behavior sets a precedent, and it's highly likely that others will follow over the next 12 months. Ultimately, the level of transparency that this action creates can play an important part in supporting the mining and metals industry as an integral force for sustainable development in regions of the globe where investment can be hard to come by—which can only be a good thing.

Using tax and economic contributions as a tool for transparency

- **Be proactive:** Make time to assess where the organization sits within the fast-evolving landscape of transparency reporting regimes and map this against expectations from industry bodies and other stakeholders. Calculate the investment required for aligning with transparency regimes and initiatives (in terms of internal resourcing, etc.) versus potential returns (including qualitative types of value) over the long term.
- **Use voluntary reporting to paint a complete picture:** Assess whether the organization's current disclosures, whether mandatory or voluntary, paint an accurate picture of its contributions to host nations. If the current level of detail does not invite trust in the corporate entity, then consider enhanced transparency reporting to supplement this.
- **Uphold your commitments:** If the organization already uses a responsible tax framework, ensure that commercial activities are aligned with it. This could impact how the company's operations and tax department are run and how it engages with tax authorities and regulators.
- **Embrace cooperative compliance:** Where regimes and relationships allow, reviewing a company's tax affairs openly with the relevant authorities can be beneficial in terms of resolving and expediting tax positions freeing up the company's resources. Moving from retrospective to near-real-time auditing could help ensure that issues are brought to the fore more regularly or can be planned for in advance. Be very clear, not only about the organization's payments, but also the relationship between tax, investment, and returns in each jurisdiction. Authorities need this information to make informed decisions.
- **Link tax with sustainability:** Identify and be able to articulate, internally and externally, the tax implications of your sustainability strategy.⁹ For instance, tax incentives might potentially accelerate progress toward the organization's sustainability goals. Assign ESG roles and responsibilities within the tax function, working as business collaborators with the organization's sustainability team.

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Trend 10

The power of cloud

Building an industry that thrives through change

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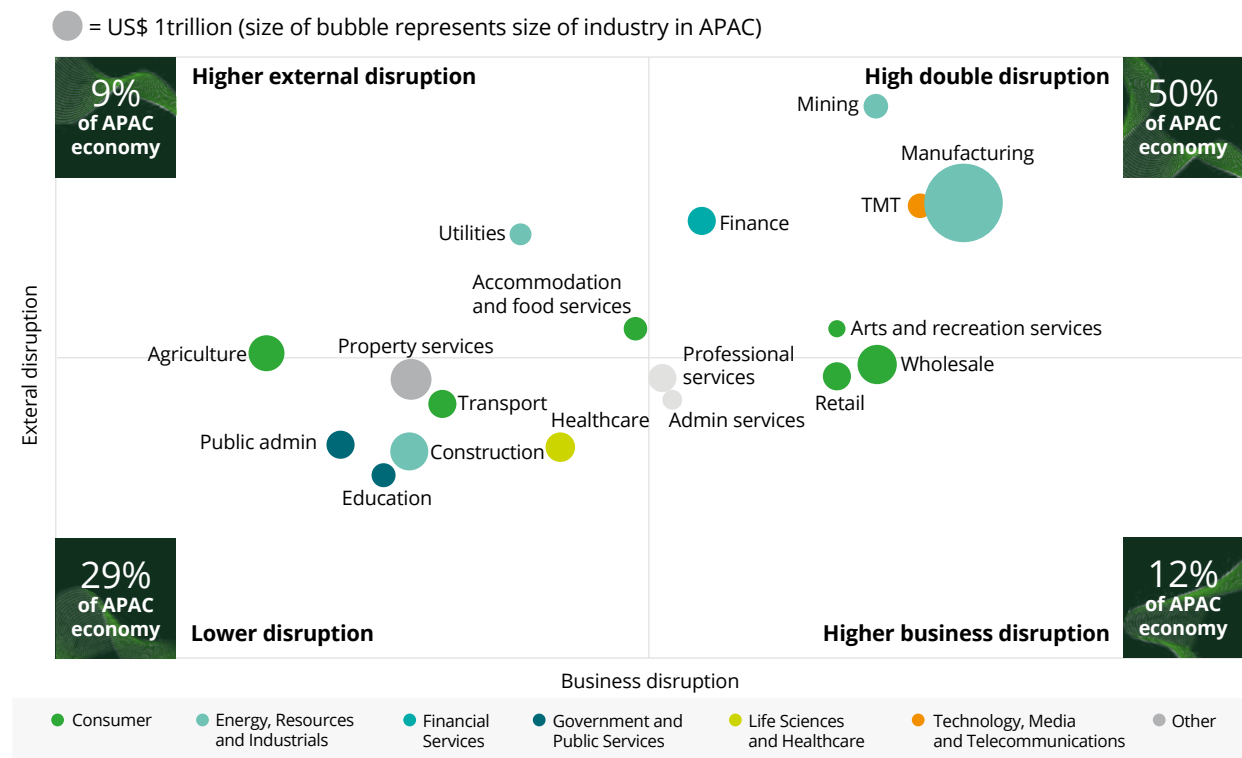
As the provider of raw materials for many other industries, the mining and metals industry is in a unique position; one that presents both challenges and opportunities. While these companies are no strangers to disruption, over the past years the frequency and types of changes that they have faced have grown substantially.

As part of the 2021 report, [The cloud imperative: Asia Pacific's unmissable opportunity](#), Deloitte Australia Access Economics surveyed 600 companies across 18 industries in the Asia Pacific region to develop a disruption map (figure 1). This revealed that businesses operating in mining (a significant contributor to the Asia Pacific

economy) are among those expected to face the most significant level of disruption in the future, with changes coming from both external forces (e.g., environmental pressures, commodity price fluctuations and supply chain disruptions) and internal threats (e.g., skills shortages, use of technology or competition).¹

Dan Newman, partner, Cloud Transformation Leader, Deloitte Australia, and author of the report, says: "Our research identified that mining and metals companies, while being exposed to this double level of disruption, are also some of the least prepared to respond and adapt to changes."

Figure 1: Disruption map*



Source: Deloitte Australia Access Economics

Note: *The disruption map was developed as part of Deloitte Australia Access Economics' The cloud imperative: Asia Pacific's unmissable opportunity report.

In [Tracking the trends 2021](#),² Deloitte Global highlighted the need for organizations to boost their resilience in a way that would stand them in good stead through a range of scenarios. This is even more important today as the rate of economic, social and environmental change is expected to continue to increase over the coming decades. In building resilience, mining and metals companies will not only enhance their own longevity; they will also help secure supply chains that underpin global food production (potash, phosphate salt), energy provisions (critical and battery metals) and infrastructure (steel and iron), to name just a few.

Turning challenges into opportunities

For miners and metal providers to thrive through change (whether predictable or unpredictable) requires that their structures, processes and operations become more dynamic. Ultimately, this will allow them to respond faster to both challenges and opportunities through new partnerships, attracting new talent and accelerating innovation efforts.

Cloud computing serves as an enabler during times of disruption and has supported value creation in multiple industries over the past decade.

Cloud involves using a network of remote servers accessible over the internet to store, manage, and process data (as opposed to local servers or personal computers). It's commonly used to deliver tools and services such as databases, networking, software, analytics and intelligence on demand.³ The ability to rapidly deploy and scale resources up or down is a major advantage to businesses. Cloud allows even the smallest companies to access the same tools and services as the largest enterprises.

Around 80% of the organizations surveyed for Deloitte Australia's Cloud imperative report stated that by implementing cloud they were better prepared to help address future challenges and organizational needs. A similar proportion said that cloud enables them to innovate more quickly and frequently, and seven out of 10 respondents indicated that cloud allows them to instantly scale projects up or down.⁴

The positive power of mining and metals

Cloud technology is also accelerating the decarbonization of the minerals and metals upon which the energy transition depends. In May 2022, Australia's Electric Mine Consortium (EMC), which comprises some of the world's leading mining and services companies, announced that Amazon Web Services (AWS) would be joining its ranks and funding the creation of a new data-sharing platform.⁵

Based on AWS S3 cloud storage technology, the platform will capture, clean and share real-time data relating to mine site energy consumption and storage, electricity usage and renewables output. The aim is to help member companies better understand the impact of different projects and investments on their carbon footprint.

EMC will also be able to leverage other technologies, such as Amazon SageMaker, a service that builds and trains machine learning (ML) models to predict energy usage spikes at mines and track the carbon efficiency of infrastructure.

Accelerating cloud adoption and maturity

Today, the level of cloud adoption and maturity varies within the mining and metals industry. Early movers include tier one companies, such as Rio Tinto. Rio began moving its SAP applications to the Microsoft Azure cloud platform in 2016 as part of its digital transformation.⁶

More recently, BHP selected AWS and Microsoft as its long-term cloud providers in June 2021.⁷ AWS will provide data analytics and ML tools to rapidly deploy digital solutions and improve BHP's operational performance. Meanwhile, Microsoft Azure will host BHP's global applications portfolio. This will enable BHP to leverage its existing Microsoft licenses and SAP applications portfolio and reduce its reliance on regional data centers.

Rakesh Surana, Partner, Mining & Metals Leader, Deloitte India explains: "Most companies will already be using some cloud-enabled functions. However, there would be increased business benefits and value gained if they were more prepared and ready to progress toward a greater level of cloud adoption."

As these examples demonstrate, cloud maturity, even within large mining and metals companies, is still at a relatively early stage. Many companies are only recently moving from building appropriate infrastructure and data centers to application migration and data modernization. However, once organizations have a digital core in place, then they can start tapping into cloud-based resources for a range of exciting use cases.

The tip of the "cloud" iceberg

In mining and metals, some of the most promising applications for cloud include data integration to enable analysis of mine site data, predictive maintenance of equipment to better manage and extend asset life, and the integration of supply chains.

Transforming maintenance in metals

In 2021, Swedish steelmaker, SSAB Europe, selected IFS Cloud to support seven of its production plants in Finland and approximately 2,500 users, including subcontractors and mobile work order users. The move is enabling the replacement of SSAB's legacy maintenance system and delivering maintenance planning capabilities, document management, quality assurance, warehouse management, mobile work orders, and B2B contracting for subcontractors.

The companies cited scalability of the platform as a key driver—it can be quickly and easily expanded as the business grows. And as information is stored centrally and accessed from anywhere, communication between stakeholders in SSAB—as well as production facilities, different organizations, and across processes—will benefit from better decision-making.⁸

Migrating legacy data from enterprise warehouses, or even specialist cloud databases, into a cloud-native data lake offers two advantages. First, it democratizes access to data by decoupling it from existing systems. Second, it allows companies to correlate events and trends across different domains. This supports the use of advanced simulation programs such as digital twins, which can be invaluable in process and operational optimization.

Newman adds: “We’re also seeing a push toward edge computing as part of miners’ cloud strategies. In Australia, a number of large companies are collaborating with hyperscalers, such as AWS, and Google, and localized data centers to leverage cloud providers’ edge solutions and enable low-latency workloads in the field. These are essential to autonomy and other Internet of Things-based technologies.”

Data integration through cloud also allows insights to be shared across supply chains, which will be vital in improving traceability and in lowering Scope 3 carbon emissions.

Cloud users can also benefit from the expertise within their cloud provider’s teams. The level of knowledge, for instance in data science, held within a company such as IBM will be infinitely broader, deeper, and more recent than that held within even the largest mining or metals company. Through cloud subscriptions, mining and metals organizations can leverage this capability and combine it with their own subject-matter knowledge to accelerate their innovation efforts. This will be particularly valuable to junior and mid-tier companies that may not be able to afford to build and maintain a large data science team in-house.

“Moving to the cloud means that organizations can focus on their core business and source of differentiation, rather than maintaining computing infrastructure and data centers,” says Newman. “Organizations should overcome any reservations on moving to cloud, embrace the opportunity, and act on it, as cloud is here to stay.”

Laying the foundations for cloud transformation

- **Develop an integrated cloud-business strategy:** In addition to having a solid technical plan for cloud migration, integrating delivery of this with the business's overall organizational strategies will help to drive top-level visibility and ensure success. Linking key performance indicators (KPIs) to delivery of the integrated strategy and assigning them to senior managers will further enhance accountability. KPIs should extend beyond technology targets from cloud initiatives to enhance business outcomes in specific areas, such as innovation, collaborative projects and employee satisfaction.
- **Create a cloud culture:** Leaders should actively communicate progress toward cloud targets and share positive use cases, both from inside and outside of the mining industry. Success stories will aid the creation of a cloud-enabled culture, generate interest in upskilling, and inspire new applications.
- **Plan for a cloud-ready workforce:** Through collaboration with cloud providers and migration partners, mining companies should identify any skill gaps in their current workforce and provide appropriate training. Also consider how the organization's human capital requirements could change over time as the organization and its cloud applications mature.
- **Out with the old systems, in with the new:** Legacy systems that have exceeded their point of maximum maturity can become a financial burden to maintain, hindering further organizational growth. The cloud transition can provide an opportunity to perform a stock take of current systems. Where appropriate, modernize and transfer these systems to the cloud environment, or phase out any that no longer serve their purpose.
- **Rethink cyber risk:** Increasing uptake of cloud services is driving change in the cyber risk landscape. The 2022 edition of IBM's X-Force Threat Intelligence Index revealed a 146% increase in new Linux ransomware code and a shift to Docker-focused targeting, which could potentially make it easier for criminals to leverage cloud environments for malicious purposes.⁹ Mining and metals companies must work with their cloud providers to help ensure seamless integration between traditional, hybrid and provider-based security measures.
- **Don't forget ESG:** When selecting a cloud provider, ensure organizational alignment with the supplier on ESG matters as they will become part of the mining organization's Scope 3 carbon footprint. Many hyperscalers are already ahead of other industries in reaching their net-zero targets. For instance, Google has offset historical emissions since its founding in 1998 and pledges to operate on completely carbon-free energy by 2030.¹⁰ Selecting a net-zero cloud provider will reduce miners' energy intensity by reducing local servers, and it will lower their overall carbon footprint.

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