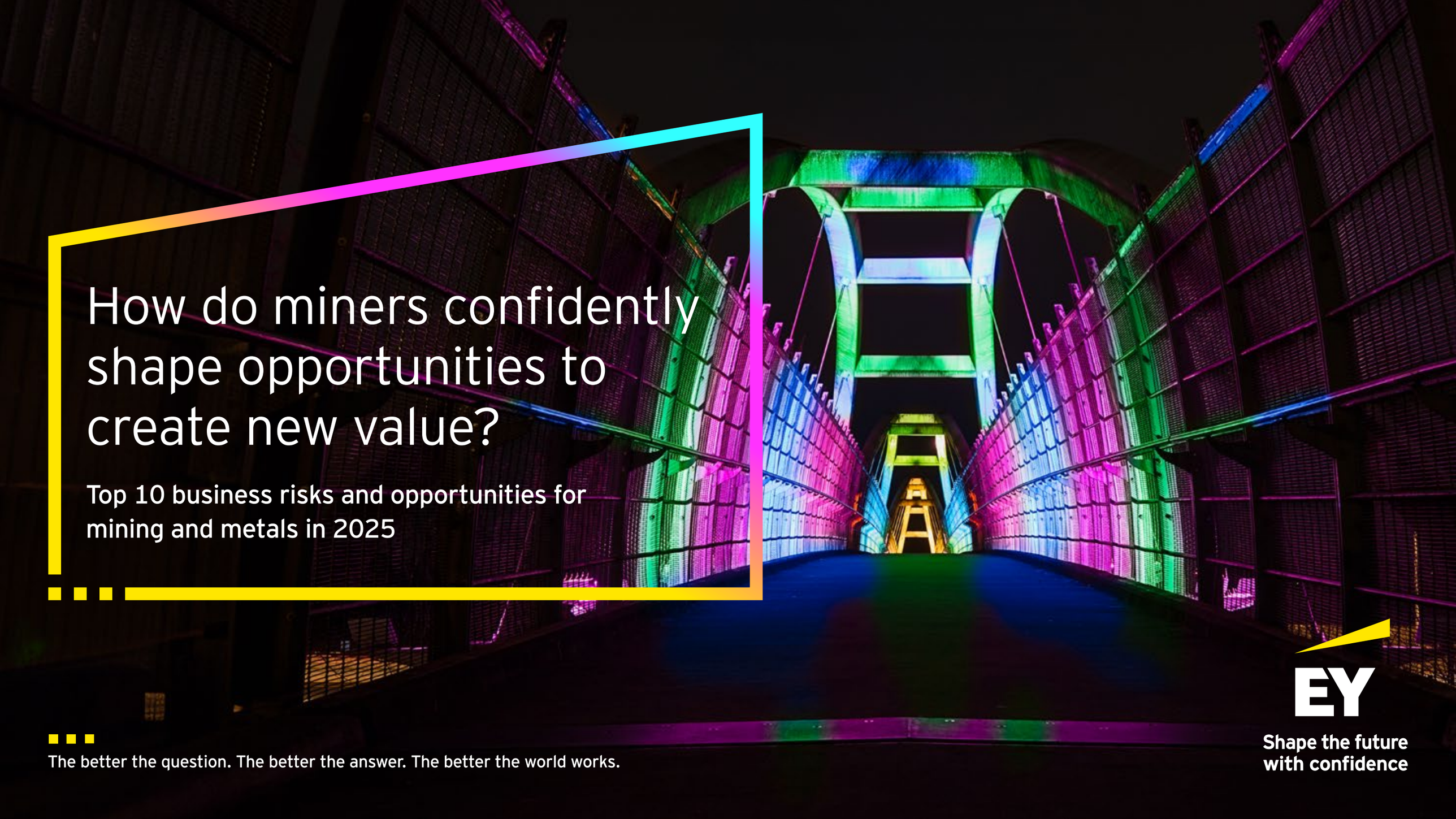
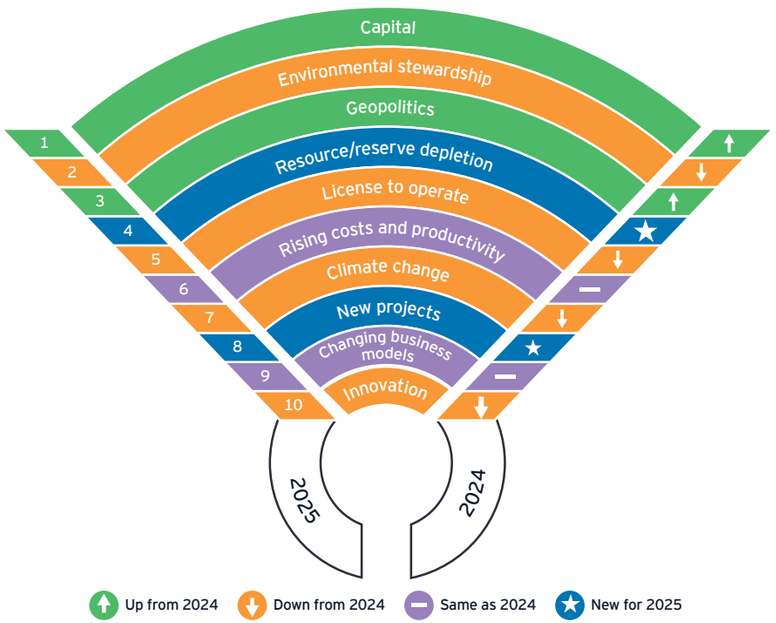


How do miners confidently shape opportunities to create new value?

Top 10 business risks and opportunities for mining and metals in 2025

The better the question. The better the answer. The better the world works.

Shape the future with confidence



Now is the time for organizations to act, to transform, to shape the future with confidence.

An urgent focus on the energy transition is disrupting the mining and metals sector and permeating this year's risks and opportunities radar. The world has realized that the energy transition will not happen without a greater supply of minerals and metals, but the sector faces a trifecta of challenges: achieving sustainable mining while managing capital discipline and meeting higher stakeholder expectations. Significant transformation of the sector is now critical, requiring innovation, collaboration and agility. It's time to reimagine mining.

Long-term growth requires a new approach to capital

No one in the sector will be surprised that capital is the number one risk this year. Nearly every mining company highlights its ongoing focus on capital discipline in its quarterly earnings calls, and the market rewards those exhibiting strong capital management. But unlocking growth requires a shift in focus. Miners will need to think beyond yield, using excess capital to invest in future value.

The quest for value is also behind more consolidation and portfolio repositioning. Miners are determining what to keep and what to divest, and we are seeing spin-offs of both high-growth assets into separate companies as well as noncore assets.

Surging demand highlights strategic risks

This year's ranking is evidence of a move toward strategic risks. New risks — resource and reserve depletion, and new projects — demonstrate this shift. Respondents told us of the challenges presented by long lead times on new projects, declining ore grades at existing projects, and the rising complexity of extracting ore both economically and sustainably.

New projects are also being developed differently. Environmental, social and governance (ESG) considerations are front of mind, with a greater focus on sustainability and local consultation. Economic considerations are inherent in assessing technical and operational risks, requiring a laser focus on capital and cash flow management. Collaboration through joint ventures (JVs) and partnerships is becoming critical to make the best use of capital and mitigate geopolitical risks.

Ongoing economic volatility makes for a challenging backdrop. Governments and central banks continue to balance bringing inflation totally under control with stimulating growth. Markets are skittish on economic releases amid continued concerns around recession, particularly in developed markets. While recession currently seems unlikely, we could see lower growth, which may restrict capital available for new energy projects. This could slow demand in mining, push up input and operational costs, and increase the cost of capital.

Omission of four risks sounds alarm bells

This year's survey saw four risks fall out of the top 10 radar, raising questions about whether miners have minimized the impact of key issues:

Governance: The de-prioritization of the "G" in ESG was unexpected, as we see this as a gap for miners, given the increased importance of resource replacement taking place in countries with potentially weaker regulatory oversight. Net-positive programs also require board-level oversight to ensure the net-positive story does not lead to accusations of greenwashing. Strong governance policies are critical to support commitments to human rights and to outline the steps required to identify, assess and address risks related to forced labor, child labor and any other form of modern slavery.

Digital: More than half (59%) of respondents say digital initiatives are critical to the success of the organization, yet the issue did not make the top 10. As in previous years, we believe that miners now view digital as business as usual, rather than a specific risk or opportunity. Investment in digital remains strong, with more than half of respondents looking to increase funding into artificial intelligence (AI), innovation, and research and development over the next year.

Workforce: With the sector facing significant challenges in attracting and retaining the talent it needs to thrive, we feel that this is an alarming omission from the radar this year. Workforce issues impact so many other risks, yet 55% of our respondents did not include it in their top 10 ranking.

Cybersecurity: While still investing in cybersecurity, miners appear to be in cyber "maintenance mode" after establishing cybersecurity functions and capabilities. But as risks continually evolve, so too should cybersecurity programs. Time will tell if the confidence of the 55% of respondents who say they are well positioned to take on future cyber threats is justified.

The year ahead calls for decisive action. Mitigating risks and making the most of opportunities requires companies to take a proactive, diversified approach to transformation. Reviewing and adapting current business models, adapting new ones, and pushing ahead with partnerships and innovation can help companies seize competitive advantage while meeting demand in a sustainable, optimal way.

About this report

During June and July 2024, EY surveyed senior mining and metals leaders from organizations with US$1b in revenue through an anonymous online survey. In total, 353 unique responses were collected, with 17% of respondents at board or C-suite level; 48% leading departments, business units or commodity groups; and 35% at president, vice president or director level.

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1. Capital ↑

Miners need to accelerate growth while maintaining discipline and returns.

Tough financing and macroeconomic conditions are making it more difficult for miners to raise capital despite the growing need for critical minerals. Investors now expect a strong focus on capital discipline and returns through dividends and share buybacks, and this drives greater scrutiny of how investment capital is deployed.

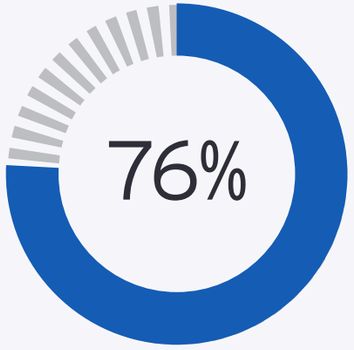
Market valuations are increasingly diverging, with high-growth stocks being rewarded with stronger multiples, typically on the back of portfolios focused on the supply of critical minerals into the energy transition. This is forcing management to look hard at portfolios, and we are beginning to see structural changes, with M&A at the core.

In a recent EY CEO Outlook Pulse Survey, all mining and metals respondents said they plan to undertake some form of transaction over the next 12 months. Indigenous knowledge and sustainable land management experience make communities essential partners in meeting nature-positive goals.

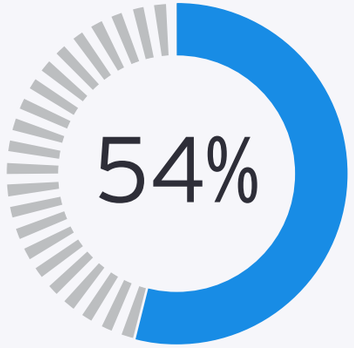
Mergers of the past few years have largely been in gold as companies scale operations and secure strategic assets. With a robust outlook for copper demand, we expect to see more consolidation of copper assets by the majors, e.g., the BHP-Lundin Mining JV US$3b acquisition of Filo Corp. in Argentina.[1]

Mining companies are also spinning off either noncore or high-growth assets into separate companies, e.g., Vale Base Metals.[2] We expect this trend to accelerate as management looks at ways to balance portfolios to contribute growth or much-needed investment capital to be redirected toward growth projects. This year's respondents noted capital being allocated to **new or changing business models** as mining companies look to invest in growth areas, e.g., integrating recycling or vertical integration into advanced processing. We explore this more in our "Changing business models" section. **Brownfield projects and acquisitions remain areas of focus.** Bringing on new supply is challenging. Exploration and greenfield projects are not receiving the investment required to head off supply deficits in many commodity markets (we explore this further in the "Resource and reserve depletion" and "New projects" sections). **The race for copper** may buck the trend, with promised high rewards encouraging exploration and new mine development. Rio Tinto has announced it will prioritize new copper mines to produce 1mtpa within the next five years.[3] End users of copper are also expected to consider partnerships with major miners to develop new projects.[4]

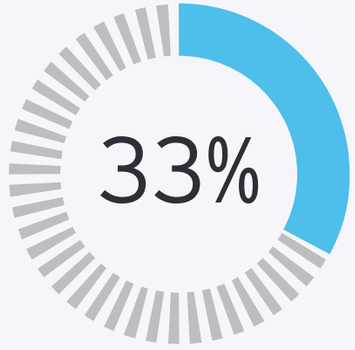
Do you expect to actively pursue any of the following initiatives over the next 12 months?



Divestments, spin-offs or initial public offerings



M&A



JVs and strategic partnerships

Source: EY CEO Outlook Pulse Survey April 2024.

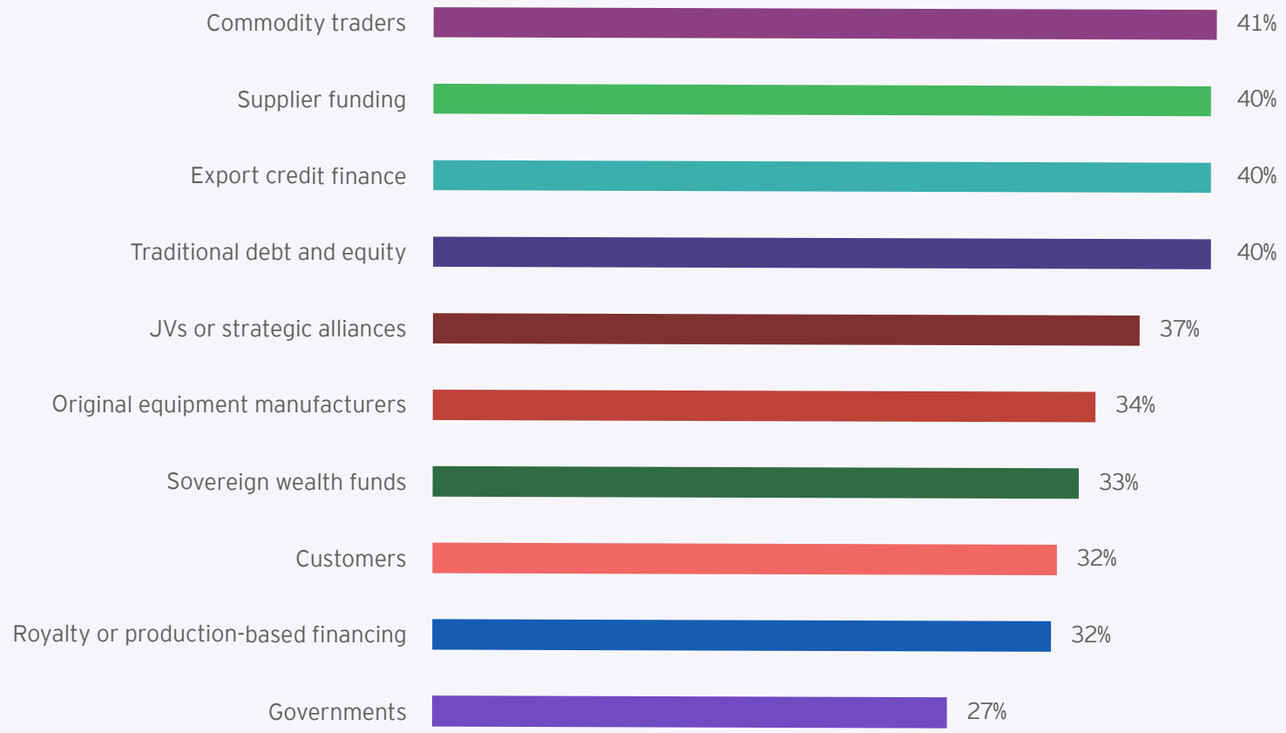
While **core upstream investments** carry the best long-term returns, they bring risk and create volatility in the short-term. To reduce this, mining companies could consider investing in different parts of the value chain (downstream, logistics, etc.). However, ultimately, miners will need to determine if these decisions dilute the returns required by investors over the long term.

We also see evidence that **battery mineral producers are rethinking capital allocation**. With lithium, cobalt and nickel prices down, players are maintaining capital discipline and holding off on exploration and development. For example, Albemarle anticipates reducing investments this year to US$1.6b, compared with US$2.1b in 2023.[5] Over the longer term, this is likely to tighten the battery mineral market as demand increases.

Some companies may delay major investment decisions as **elections are creating some uncertainty**. This could, for example, impact the flow of capital into the US mining sector, particularly in areas related to critical minerals and battery technology. However, there are also opportunities to access a range of production tax credits, subsidies, loans or guarantees offered under government policies.

Mining companies have become yield plays and are not necessarily able to access the same level of capital as a result. This approach to financing will likely need to change for companies seeking to bring greater supply online for the energy transition. Mining companies are accessing a wider range of capital. On average, our survey respondents are considering up to four sources of finance and they rank alternative sources of capital such as commodity traders, supplier funding and export credit finance as highly as traditional debt and equity. Miners are also considering partnerships, JVs or integration to help share the financial burden and mitigate risks of large-scale projects.

Sources of capital under consideration



Note: Respondents could choose more than one option.
Source: EY Business Risks and Opportunities Study 2025.

Capital

1

Up from 2024

Key considerations:

- **Evolve capital strategy to navigate long-term challenges:** Organizations that adapt capital strategies can better accommodate potential long-term market shifts. This includes refocusing or reidentifying core business areas, and meticulously planning and prioritizing initiatives that align with strategic objectives and goals.
- **Invest in managing sustainability risk:** Capital allocated to ESG-related initiatives might not show returns in the short term but has the potential to deliver value in the longer term. Examples of these investments include new technologies aimed at preventing adverse events (e.g., tailings dam failure or investment in progressive rehabilitation and remediation of closed mines).

2. Environmental stewardship ↓

Miners have elevated environmental stewardship above a broader focus on ESG.

A significant uplift in nature-positive initiatives is evident since our last report. Almost half of respondents (46%) are extremely or very confident about meeting their nature-positive obligations.

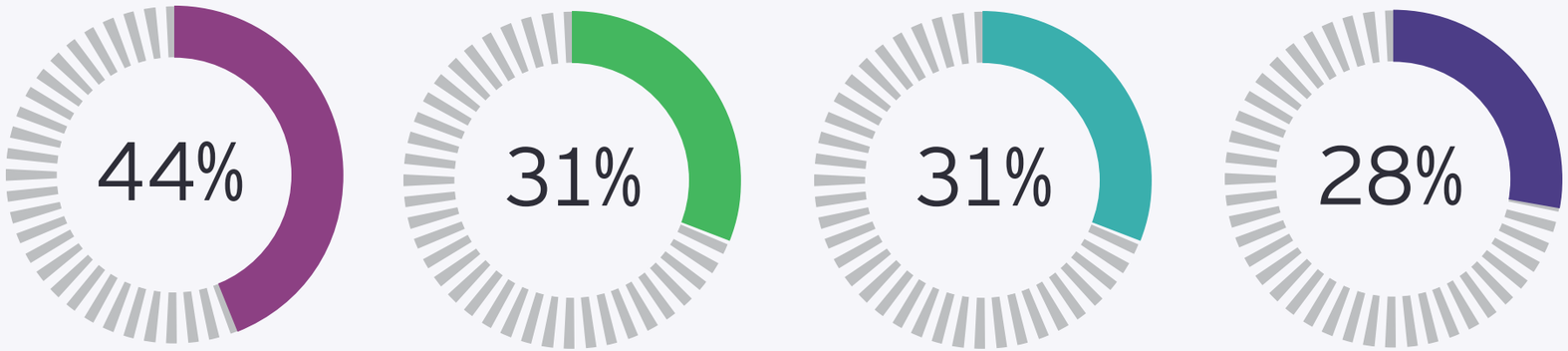
The International Council on Mining and Metals (ICMM) members are leading the way, having announced nature-positive commitments in January 2024. The Chair of ICMM's Council Nature Advisory Group and CEO of Teck Resources Limited, Jonathan Price, explains: "Collaboration across all sectors is essential to help stop and reverse nature loss, and ICMM's nature commitments will help companies to scale up their existing efforts and drive local and regional partnerships to better protect and restore our landscapes and ecosystems for the benefit of all."[6] It is estimated that a quarter of the earth is in the care of Indigenous communities — and these areas are in better environmental shape than others.[7]

Growing expectations around sustainability performance and more complex obligations are stretching small in-house sustainability teams. As a result, we see miners focusing on those areas being measured, particularly as new standards such as the Taskforce on Nature-related Financial Disclosures (TNFD) and Global Industry Standard on Tailings Management (ISTM) loom large.

Interestingly, our study found **the focus on waste is broader than tailings**. Progressive miners are capturing value from waste through improving mining performance (higher strip ratios or use of marginal ores), implementing closed loops to minimize waste and emissions, and reprocessing tailings. Universities have been supporting these efforts.

For example, the Critical Materials Innovation Hub at Colorado School of Mines focuses on improving primary mineral processing and recovery, as well as secondary recovery through recycling of manufacturing waste and end-of-life products.[8]

Which areas of ESG will face the most scrutiny from investors in the mining and metals sector over the next 12 months?



Note: Respondents could choose more than one option.
Source: EY Business Risks and Opportunities Study 2025.

Environmental stewardship

2

Down from 2024

Key considerations:

- **Identify opportunities to achieve a net-positive impact.** Miners should consider the entire mining lifecycle – from exploration to reclamation – ensuring there is a defensible baseline.
- **Determine strategies to use technology and data.** Enhanced use of digital can improve ESG monitoring and measurement, particularly in areas under greater investor scrutiny, such as water stewardship and tailings management.
- **Ensure an integrated approach to managing ESG risks and opportunities.** Integrating ESG issues into existing governance and oversight models mitigates the risk of unidentified gaps in risk coverage across the company.

3. Geopolitics ↑

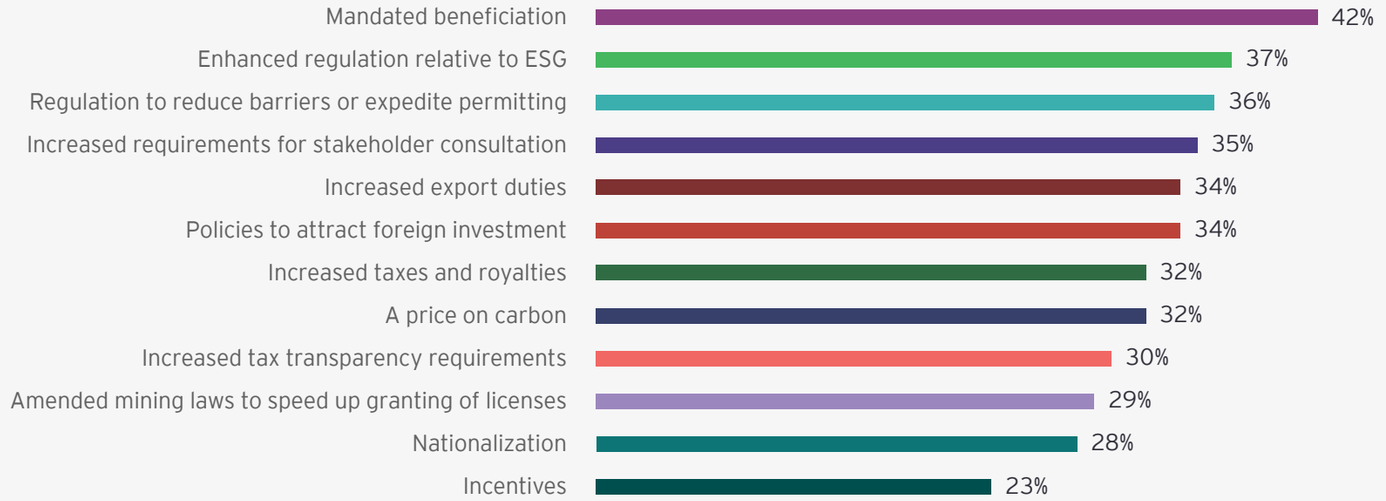
The energy transition and increased geopolitical uncertainty demands the sector to take a more strategic role.

More governments are prioritizing self-sufficiency in strategic sectors, such as mining, to bolster national security. Some are funding mineral projects both domestically and abroad to ensure supply – Japan will subsidize up to half the cost of new critical mineral mines and smelting projects, while Saudi Arabia has announced US$182m in exploration incentives.[9] In mineral-rich countries, efforts are underway to build value-added processing capabilities.

The world's supply of strategic minerals and metals is highly concentrated, creating geopolitical complexity and highlighting **the importance of transparent supply chains**. The US has unveiled plans to source critical minerals from "friendly" countries but also wants to ensure that refining and processing facilities are not linked to investment from "covered nations" (currently defined as China, Iran, North Korea and Russia in the US Bipartisan Infrastructure Law (BIL)). From 2024, under new US Foreign Entity Ownership Rules, domestic manufacturers will not receive a section 30D Clean Vehicle Tax Credit if an electric vehicle (EV) contains battery components manufactured or is assembled by a "foreign entity of concern", which the BIL defines as an entity "owned by, controlled by, or subject to the jurisdiction or direction of a government of a foreign country that is a covered nation".[10] This creates particular challenges for nickel and graphite supply chains.

Resource nationalism is affecting tax rules. As outlined in a recent ICMM report (supported by the EY Mining & Metals team), Unlocking Prosperity: Tax Principles for Sustainable Mining, governments need to balance national revenue goals, expected investment returns over a mine's life and benefits to community. Mining companies look for certainty within a predictable fiscal regime over the life of mine to enable long-term planning and return on investment. This means governments should aim to design taxes that encourage large initial capital investment in long-term projects. To unlock the investment in mining that is needed to enable the energy transition, governments should aim to design policies that encourage large initial capital investment in long-term projects. Over the next 12 months, **policies and regulation of new governments** are likely to accelerate geopolitical uncertainty. Mining companies will need to be ready to not only navigate challenges but also seize opportunities. In South Africa, the sector hopes for a refocus on mining investment, while in India, policy support for infrastructure and manufacturing – which would support demand for minerals – is expected to continue. In Mexico, the new government could ban open pit mining.[11] Most notably, a change in government in the US could have significant consequences for the mining sector domestically and abroad, particularly around regulations and policy-induced demand for minerals, such as via support for EV production and sales.

What actions do you expect governments to take over the next 12 months in relation to the mining and metals sector?



Note: Respondents could choose more than one option.
Source: EY Business Risks and Opportunities Study 2025.

↑ Up from 2024

Key considerations:

- **Develop alternative strategic options.** Considering different approaches, such as JVs with local companies and licensing, can help derisk investment in new projects in new geographies.
- **Build supply chain resiliency.** Mapping supply chains and stress testing under multiple scenarios can help companies understand and address the impact of ongoing and future disruptions, and identify major weaknesses. Corporations can also consider deploying AI in supply chains for demand planning and procurement. In an EY study on generative AI (GenAI) and supply chains, 83% of miners responded that integrating GenAI into supply chains will provide competitive advantage.
- **Explore opportunities in EVs and energy.** As government investment in these areas increases, minerals and metal suppliers, in both the largest markets and geopolitical swing states, should assess how policies create opportunities. Assessments should consider the impact of geopolitical dynamics and alliances.

4. Resource and reserve depletion ★

A supply shortfall may occur if there isn't sufficient investment in exploration and mine development.

If the world is going to achieve net-zero goals, we will need at least 41 million tonnes of copper per year by 2050, which would require building around 40 new copper mines the size of Quellaveco (~300kt/year).[12] But we are not seeing a large uptick in exploration expenditure, raising the risk of depleted resources.

The issue is exacerbated by **declining ore grades**, which is increasing the cost of extraction. High-grade resources are nearing exhaustion, and accessing metals from new projects with lower ore grades requires greater expenditure and energy. Most of the planned global copper greenfield projects have a grade of 0.5% or lower,[13] compared with an average 0.8% grade in 2010.[14]

Capital raising is down 4% y-o-y in 2023, with this **lack of financing hindering mining activity**. 2023 saw just US$11.6b in funds raised by junior and intermediate companies,[15] with the decline mainly attributable to lower commodity prices and higher cost of capital.

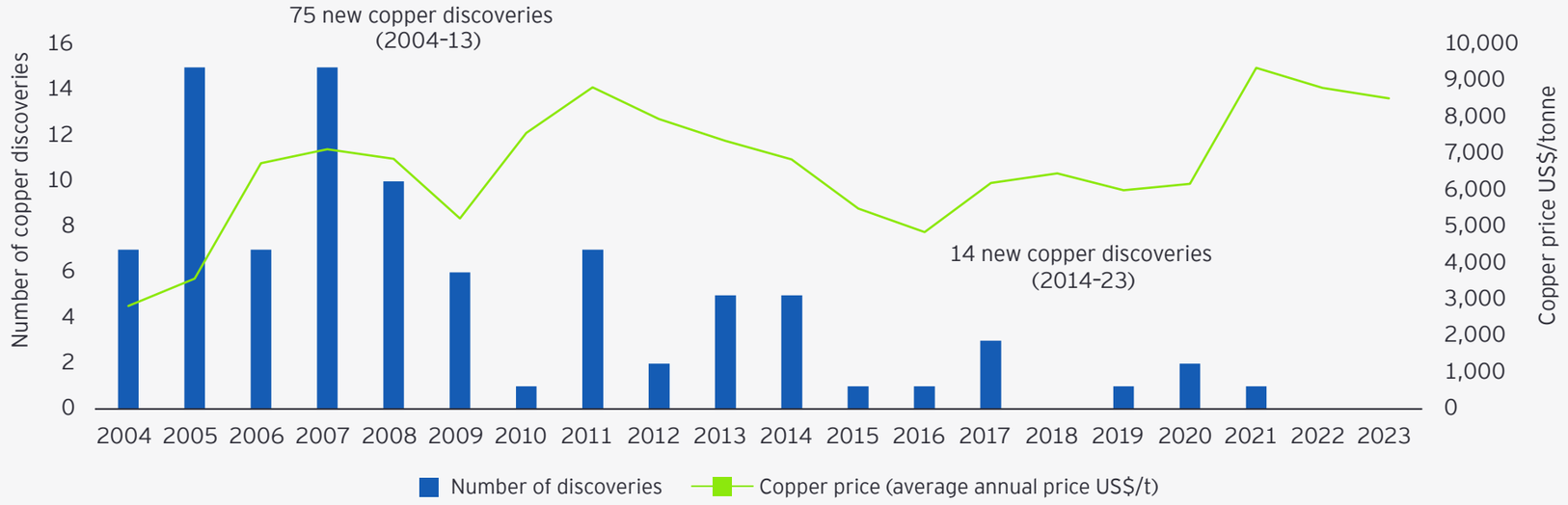
Exploration budgets are up 37% on 2019 figures, and **investment remains focused on gold**. In 2020–22, more than half of exploration investment was directed at gold, with copper capturing 21% of total exploration budgets. In 2023, we saw the beginnings of a shift, with copper, lithium and nickel exploration budgets up 12%, 77% and 45% respectively.[16]

The last two decades have seen few major new copper discoveries (see chart below). Over the same period, the cost of exploration has soared – the estimated cost of copper exploration in 2011 was US$91/tonne but increased to US$802/tonne in 2020.[17]

Miners' ability to effectively replace or increase reserves is also hindered by **long lead times on projects**. Average lead times are ~18 years for mines starting operations in 2020–23 versus ~13 years for mines that commenced 15 years ago.[18] Despite shorter construction times, mine development takes longer, as permitting processes can be challenging and require substantial stakeholder negotiation.

Extracting reserves economically and sustainably is complex. Extracting deep mineral deposits requires advanced extraction technology and equipment that are highly capital and energy intensive, and may have long-term environmental impacts. In the US, mineral extraction is estimated to consume ~4b gallons of water a day, which is equivalent to the average daily water use of 40,000 households.[19]

Major copper discoveries have declined 2004–23



Source: S&P Global Market Intelligence exploration data; Macrotrends; EY analysis.

Resource and reserve depletion

4

★ New for 2025

Key considerations:

- **Invest in new exploration technologies.** AI and machine learning can support exploration, helping miners analyze large amounts of geological data to enhance predictions.
- **Replace lower reserves through M&A.** Companies that acquire projects can replenish depleting reserves and gain synergies to ensure higher productivity. In the gold sector, high prices have incentivized exploration, which is accelerating resource depletion and encouraging consolidation as players seek to sustain production levels.
- **Focus on improving productivity.** Innovative mining techniques and advanced mineral processing can optimize recovery and enhance productivity. Leaching technology has proven beneficial in recovering metals from lower ores — Rio Tinto's Nuton technology can achieve recovery rates of up to 85%.[20]
- **Explore unconventional mining frontiers.** We see more interest in exploring critical minerals embedded in the ocean and extracting resources from asteroids through extraterrestrial mining. These are areas to watch, but miners should be aware of uncertainty over the economic feasibility and environmental impact of such methods.

5. License to operate ↓

A greater focus on demonstrating mining's positive impact now and into the future can build trust and long-term value.

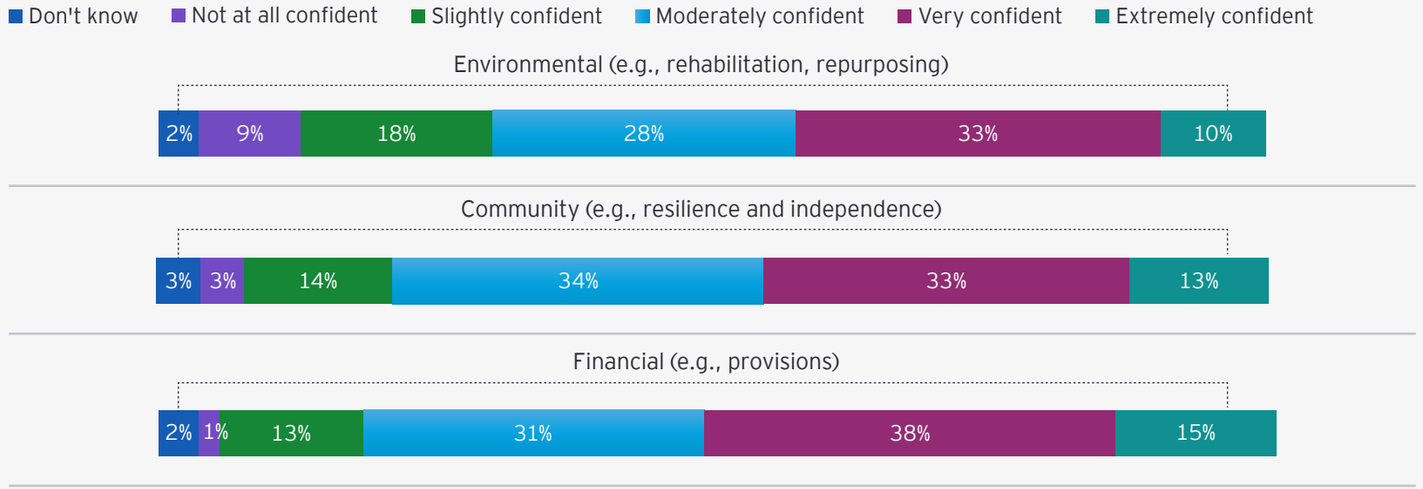
Enhancing community impact and Indigenous trust remains high on the agenda of miners and investors, and an area where there is significant room to improve. Around the world, communities and governments expect miners to do more to support communities now and leave a positive legacy for the future. A 2023 report by State of Play[21] found respondents were positive about the local economic impact made by mining (a Canadian study estimated that every CA$1 invested in a community adds CA$1.75 to the community)[22] but were increasingly negative around local environmental impact, community engagement and historical legacy. Miners must do better in communicating the value they add in these areas.

Miners can reap the benefits of building trust when they **do what is right, not just what is regulated.** In Indigenous communities, recognizing the significance of land, culture and self-determination is crucial. It involves acknowledging systemic challenges, such as marginalization, and empowering communities as partners rather than stakeholders. Successful collaboration occurs when the right people are included in discussions. BHP is working in partnership with local and Indigenous communities, as well as municipal and federal governments, as it plans the development of the Jansen potash mine.[23] [24]

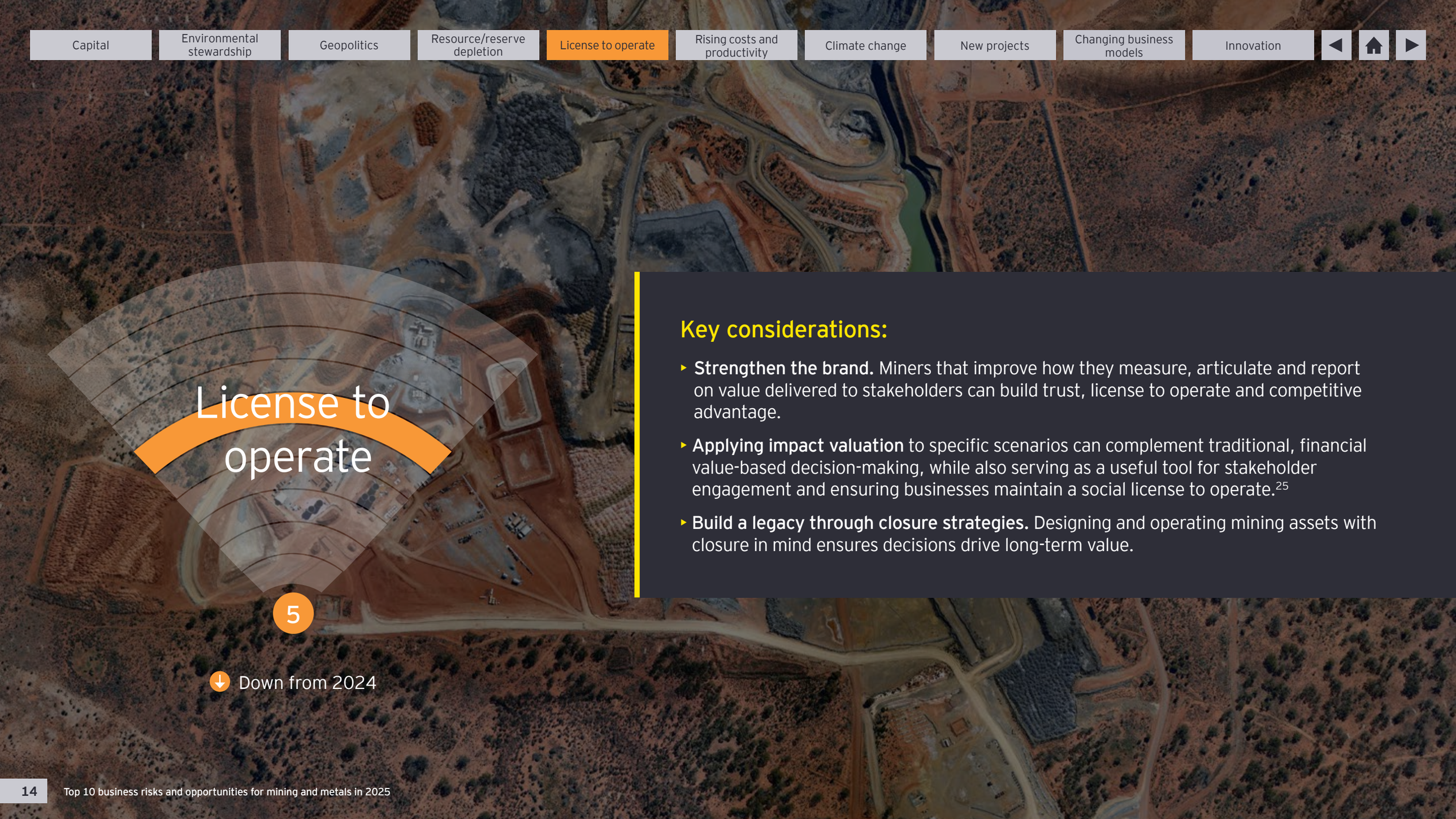
Effectively measuring and reporting on the value delivered to stakeholders can help miners secure license to operate and, ultimately, gain competitive advantage. Some progressive miners are beginning to consider impact valuation as a way of quantifying and valuing a company's impact related to society and the environment.

Miners need to consider the legacy they want to leave behind by **planning mines with closure in mind.** Mine closure is extremely complex, impacting a wide range of stakeholders with different, and increasingly high, expectations. A poor closure creates a negative legacy that is extremely difficult and costly to remediate. Despite the dangers of getting it wrong, **only 5% of our respondents see it as a key risk or opportunity.** Creating value beyond the life of the mine – through sustainable jobs, environmental stewardship, etc. – enables communities to thrive post closure. Only 35% of legacy assets and just 50% of operating assets have closure strategies. Yet most of our respondents say they feel confident in understanding mine closure risks, especially around financial aspects, but many companies lack a strategic approach to closure.

How confident are you that your organization has control over the following aspects of the mine closure process?



Source: EY Business Risks and Opportunities Study 2025.



License to operate

5

Down from 2024

Key considerations:

- **Strengthen the brand.** Miners that improve how they measure, articulate and report on value delivered to stakeholders can build trust, license to operate and competitive advantage.
- **Applying impact valuation** to specific scenarios can complement traditional, financial value-based decision-making, while also serving as a useful tool for stakeholder engagement and ensuring businesses maintain a social license to operate.[25]
- **Build a legacy through closure strategies.** Designing and operating mining assets with closure in mind ensures decisions drive long-term value.

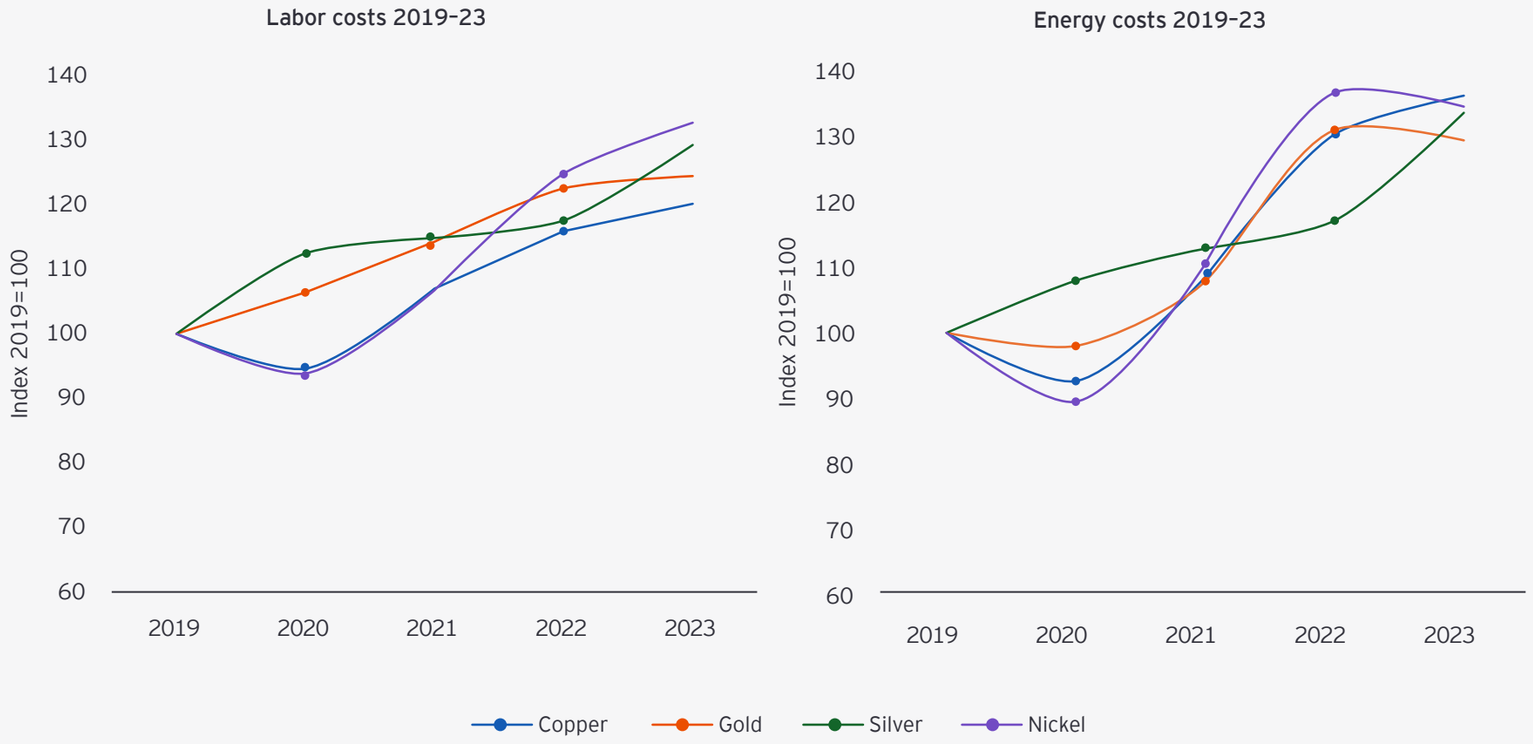
6. Rising costs and productivity –

Higher demand, costs and prices put productivity in the spotlight.

In many commodity markets, we are entering a period of **high commodity demand and increasingly volatile prices**. At the same time, structural costs are high as some elements of inflation prove "sticky," particularly the cost of labor and energy. **Skills shortages are impacting productivity**, with some individuals ill equipped for their roles, putting onboarding processes under pressure and potentially elevating safety risks.

At the same time, a growing **prioritization of ESG priorities is competing with the productivity agenda**. More than a third of respondents agree or strongly agree that the focus on ESG is distracting from productivity, highlighting the need to better link the two issues. A recent study of mining operations productivity by the University of British Columbia (UBC) for EY teams found a need for more guidelines when implementing environmental metrics (e.g., carbon intensity) as measures of productivity. Integrating ESG into the productivity and cost agenda could see miners reap benefits.

Labor and energy costs remain higher in selected markets



Source: S&P Global Market Intelligence; EY analysis.

Rising costs and productivity

6

Same as 2024

Key considerations:

- **Manage the variables that impact productivity**. Unlocking genuine productivity gains requires miners to proactively manage:
  - **Geological uncertainty:** Improved modeling and real-time sampling can help miners gain a better understanding of geology.
  - **Asset reliability:** Understanding the value and the productivity potential of each asset across the value chain can be a starting point, with analytics able to provide real-time asset health as an input into mature, predictive maintenance strategies. These can be coupled with digital twins to optimize machinery and avoid breakdowns.
  - **Operational discipline and management:** Analyzing exactly where value comes from and defining the optimum operating model is the starting point to transform productivity. Driving this transformation requires a strong case for change that creates buy-in across the organization. The next step is to define the operational behavioral change that will underpin productivity shifts, examining the operation's executional coordination and discipline to determine what needs to be done differently to deliver consistent results. That's when miners should consider new business models and practices.
  - **Integration with markets:** Integrated operating models, scenario planning and management have allowed better integration and alignment with markets and the ability to respond rapidly to market opportunities or threats.
- **Keep people at the center of change**. Designing an integrated operating model with humans at its heart will enable, encourage and lock in sustainable productivity improvements. Only then should technology be selected, to ensure it aligns with all elements of the value chain and broader business aims.
- **Stay flexible**. In an uncertain environment, both technology and operating models should be ready to gear up or down quickly and maintain a stable cost base amid revenue stream volatility.

7. Climate change

A proactive, comprehensive action plan can build resilience, accelerate decarbonization and meet investor expectations.

The World Economic Forum's 2024 Global Risk Report states that, "In a 10-year context, climate-related risks contribute five of the top 10 threats as the world nears or crosses 'climate tipping points'."[26] This trend presents challenges to mining operations in terms of productivity, safety and environmental impact.

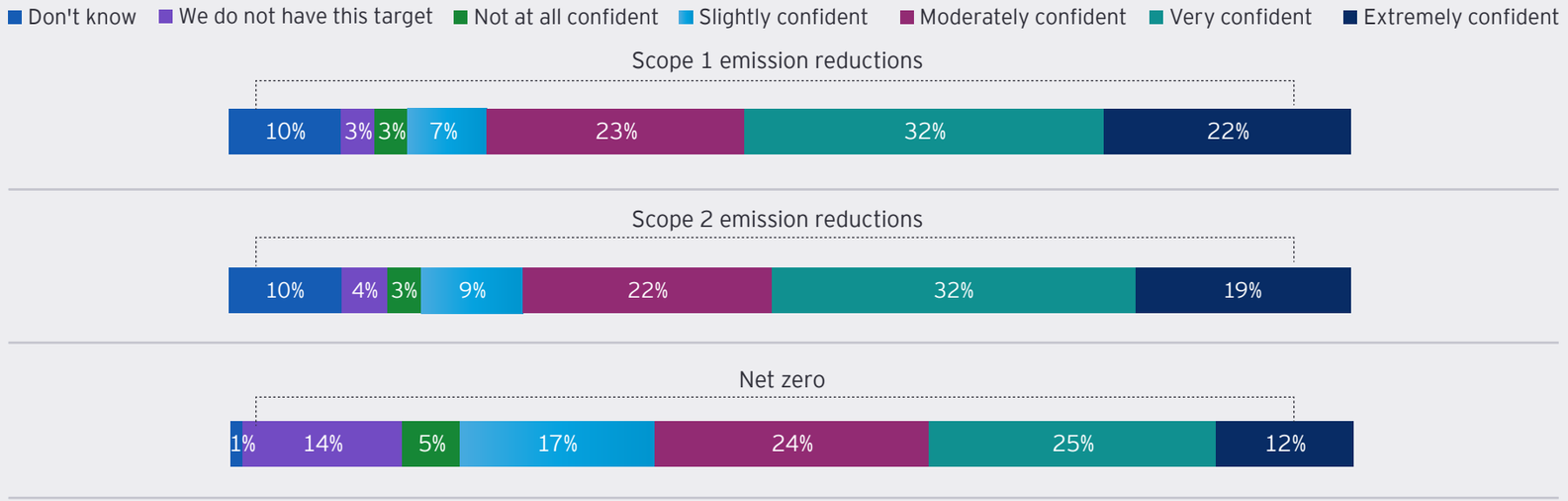
Scrutiny around Scope 1, 2 and 3 emissions is growing, with miners under more pressure to improve the transparency of emissions and climate risk reporting, and meet new standards, including those of the International Sustainability Standards Board (ISSB).[27] Evidence suggests miners have improved the quality of reporting — the EY Global Climate Risk Barometer 2023 saw the disclosure quality score for the mining sector jump from 42% in 2022 to 51% in 2023 — but this is still disappointingly low. With time running out to keep global warming on a below 2°C trajectory, stakeholders are now expecting companies to embed a genuine, rigorous culture of continuous improvement in relation to climate action.

However, more than half of respondents are extremely or very confident of their ability to meet Scope 1 and 2 emission reduction targets within their set time frame. This confidence may be partly due to encouraging **progress in decarbonizing operations**, with mine site emissions intensity declining by approximately 10% since 2020.[28]

Mining companies have focused on integrating renewable energy sources into mining operations, either through large-scale renewable energy projects with energy storage systems, often in partnership with energy companies, or via hybrid energy systems to counter supply intermittency.

However, **integrating clean energy into mining operations** is not easy, requiring trade-offs between high initial capital costs, technological limitations, environmental impact and the remaining life of existing assets. For example, the amount of land required for solar farms can lead to land disputes, deforestation and possible biodiversity loss.[29] There are also challenges in electrifying mining equipment, particularly in areas with unreliable electricity.

Miners remain confident in reaching their climate-related targets



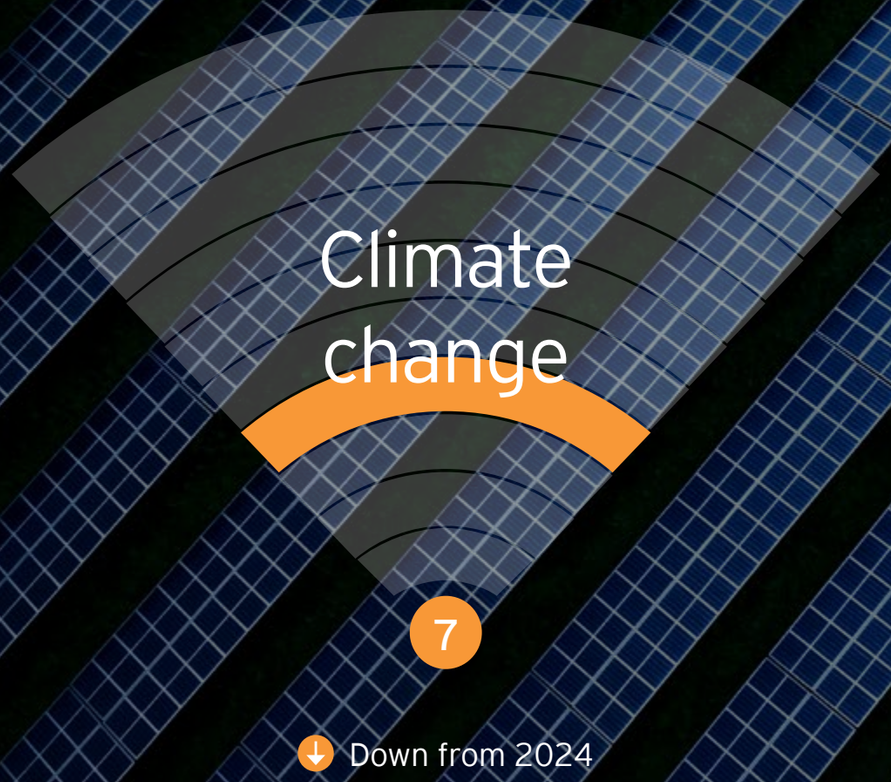
Source: EY Business Risks and Opportunities Study 2025.

The confidence of respondents in reaching their net zero targets was lower, with just over a third extremely or very confident in reaching their commitments. While the **push toward low-carbon metals** continues, with several pilots underway to replace coal with green hydrogen to produce greener steel, commercializing this technology remains challenging. This is mostly due to insufficient electrolyzer capacity. Producing a tonne of steel with hydrogen requires ~300MW of electrolyzer capacity running continuously; however, current global electrolyzer capacity has only just reached 1GW. Hydrogen deployment is not occurring as fast as expected.[30]

Carbon prices and regulations are increasing pressure to eliminate embedded emissions. Carbon instruments, such as the EU's Carbon Border Adjustment Mechanism, are likely to be adopted across more countries, impacting steel and aluminium producers exporting to countries with these instruments in place and increasing prices for local consumers.[31]

Countries that develop their own carbon tax policies and emission trading systems could reap benefits in terms of compliance revenue retention and the promotion of sustainable practices. However, the impact on companies in countries that do not could be significant, requiring them to buy certificates from 2034 to cover the carbon price gap.

Mining companies depend on **nature-based carbon offsets** for both direct and indirect emissions, but their use brings the risk of greenwashing claims. Companies will need to balance offsets with tangible action on renewable energy sourcing and generation, improving energy efficiency and adopting abatement technologies.



Key considerations:

- **Partner with equipment manufacturers to scale up technology.** Miners that move to adopt innovative technologies can get ahead of carbon regulations and address Scope 3 emissions.
- **Consider restructuring or optimizing portfolios.** Focusing on minerals and metals with lower downstream emissions or those that are easier to abate could pay off as carbon prices rise.
- **Innovate to reduce emissions intensity and add long-term value.** Implementing low-carbon technologies can help steel and aluminium producers avoid carbon taxes now and create sustainable value.
- **Adopt Global Reporting Initiative Standards to improve transparency.** The use of standardized metrics will enhance miners' reporting of supply chain emissions.
- **Mitigate climate-related disruption through scenario planning.** Investment in emerging technologies, such as machine learning, can improve planning, helping miners assess how every aspect of operations will be impacted by extreme weather events. Rio Tinto uses machine learning to forecast rainfall six months in advance to enhance preparedness.[32]

8. New projects ★

Filling the demand gap will require overcoming multiple complex barriers to new projects.

Over the next 30 years, we will need to mine more mineral ores than humans have mined over the last 70,000 years.[33] The exponential demand for minerals critical to the energy transition will create a significant supply gap, necessitating immediate investment from mining companies.

Miners are finding that **regulatory issues prolong the time from discovery to production**, with long delays to obtain permits, navigate overlapping red tape from different authorities and mitigate litigation risks. For example, it takes 29 years to develop a mine in the US, second only to Zambia's 34 years.[34]

Higher taxes and royalties are an additional barrier. In Chile, mining companies face a tax burden of 41% to 44%, with producers in Peru dealing with similar rates.[35] In Queensland, Australia, coal royalty rates range from 7% for prices below AU$100/tonne to 40% for prices exceeding AU$300/tonne, in addition to direct and indirect taxes.

In some markets, a l**ack of standardization can create pricing complexities.** For example, there is not yet a globally recognized standard lithium product.

Inflation, lower ore grades and infrastructural issues mean the **capital intensity of projects is increasing.** For example, the initial capital expenditure for the Simandou iron ore mine is estimated to be approximately US$11.6b (US$5.1b for the mine and US$6.5b for the rail and port infrastructure).[36] Inflation has also pushed copper capital costs up from approximately US$16,000/tonne in 2021 to over US$20,000/ tonne.

Higher costs, talent pressures and proactive closure strategies are driving a new approach to mine development, with a focus on autonomous, electrified and sustainable projects.

But **modern mines require higher upfront costs.** Large open-pit mines perform well, but large underground block cave mines present technical challenges and take years to ramp up.

Miners are seeing a shift in the workforce toward other energy transition projects. As a result, across the mining sector, **a lack of skilled workers** is making timely project delivery more difficult.

New projects

★ New for 2025

Key considerations:

- **Strengthen license to operate.** Deepening connections with all stakeholders, particularly during the initial project stages, can earn trust and help resolve conflicts.
- **Derisk capital projects.** Integration across the supply chain can significantly reduce capital expenditure and mitigate risks when developing new projects. By coordinating activities from exploration to production, companies can streamline processes, eliminate redundancies, optimize resource allocation and enable more accurate demand planning.
- **Tap into new pools of talent.** As new projects are developed with sustainability, automation and electrification in mind, a different set of skills is required. This provides the ability to attract talent from outside the industry and from a more diverse pool of skills and abilities.

9. Changing business models –

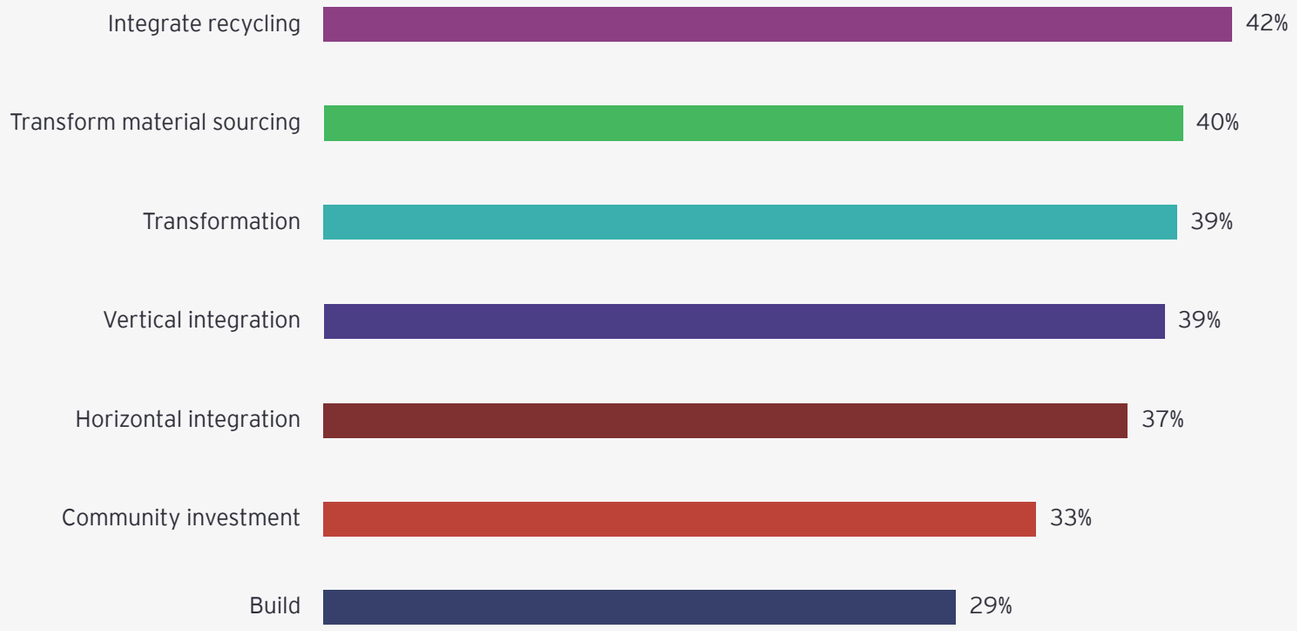
Mining and metals companies are repositioning portfolios for growth and assessing how to capture more value.

As miners explore and adopt new business models, both vertically and horizontally across the value chain, they are considering a range of approaches:

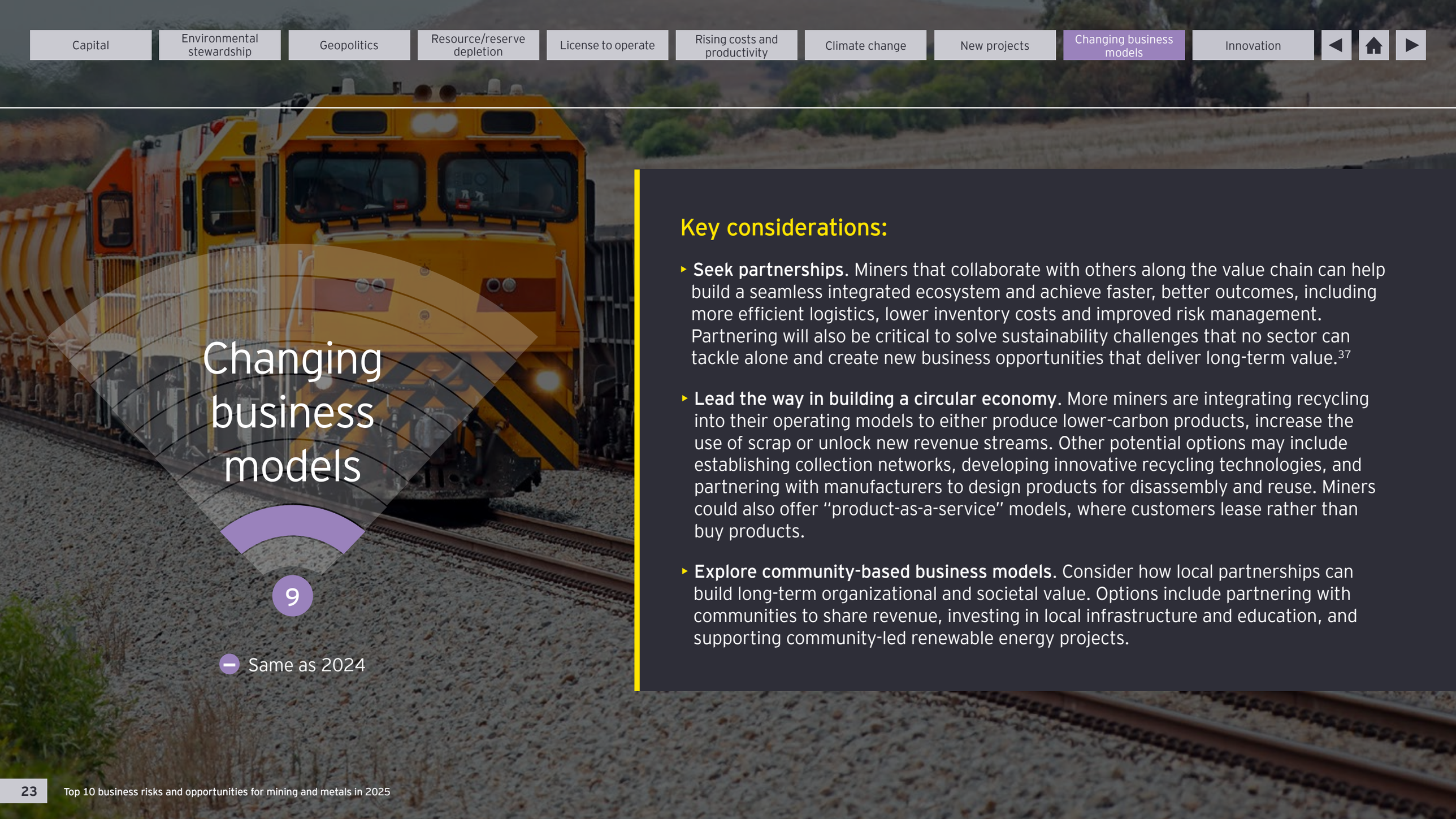
- **Vertical integration into advanced materials**: investing or co-developing new materials with advanced material manufacturers
- **Integration into the changing energy system**: diversifying revenue through collaboration across the clean energy value chain (e.g., miners that partner with EV manufacturers can both mine critical minerals and co-develop new products, such as lighter vehicles or higher-performance batteries)
- **Mine-to-market approach**: covering more of the value chain with investment in exploration as well as considering advanced processing
- **Mining as a service**: sharing revenue from minerals with a mineral rights owner and collaborating with them and communities to establish local supply chains (this could be an option in countries where governments seek more participation in mining or where obtaining a license to operate is challenging)

Miners can leverage a **growing focus on sustainability** to further reshape business models, including through expansion across the value chain to accelerate decarbonization. For example, investment in smelting gives miners greater control over decarbonizing the process and creates opportunities to capture more value from premium, cleaner products. Some companies are also exploring how to capture value from waste through playing their part in building a circular economy and reprocessing waste within closed loops.

Which of the following capital allocation options are you considering?



Note: Respondents could choose more than one option.
Source: EY Business Risks and Opportunities Study 2025.



Changing business models

9

Same as 2024

Key considerations:

- **Seek partnerships.** Miners that collaborate with others along the value chain can help build a seamless integrated ecosystem and achieve faster, better outcomes, including more efficient logistics, lower inventory costs and improved risk management. Partnering will also be critical to solve sustainability challenges that no sector can tackle alone and create new business opportunities that deliver long-term value.[37]
- **Lead the way in building a circular economy.** More miners are integrating recycling into their operating models to either produce lower-carbon products, increase the use of scrap or unlock new revenue streams. Other potential options may include establishing collection networks, developing innovative recycling technologies, and partnering with manufacturers to design products for disassembly and reuse. Miners could also offer "product-as-a-service" models, where customers lease rather than buy products.
- **Explore community-based business models.** Consider how local partnerships can build long-term organizational and societal value. Options include partnering with communities to share revenue, investing in local infrastructure and education, and supporting community-led renewable energy projects.

10. Innovation

More miners are investing in new approaches, but a focus on low-risk areas may overlook the biggest opportunities.

Sustainable, cost-effective mining at scale requires a great deal of innovation, particularly as resources deplete, costs rise, talent becomes scarce and environmental pressures increase. More than half (54%) of respondents anticipate greater investment in innovation in the next 12 months (15% say this budget will increase by 20% or more), but much of the focus remains on lower-risk areas. Forty-five percent of executives say innovation efforts are around processing and alternative energy sources.

The soaring demand for minerals to support the energy transition means innovative exploration and extraction should be top of the industry's agenda, yet only 30% of respondents see it as an area that would have a big impact. A lack of budget for junior explorers is seeing the continued use of traditional, proven exploration methods rather than new innovative methods.

Breakthroughs cannot happen in a vacuum, yet 50% of our respondents stated there was not enough collaboration to drive innovation in the sector.

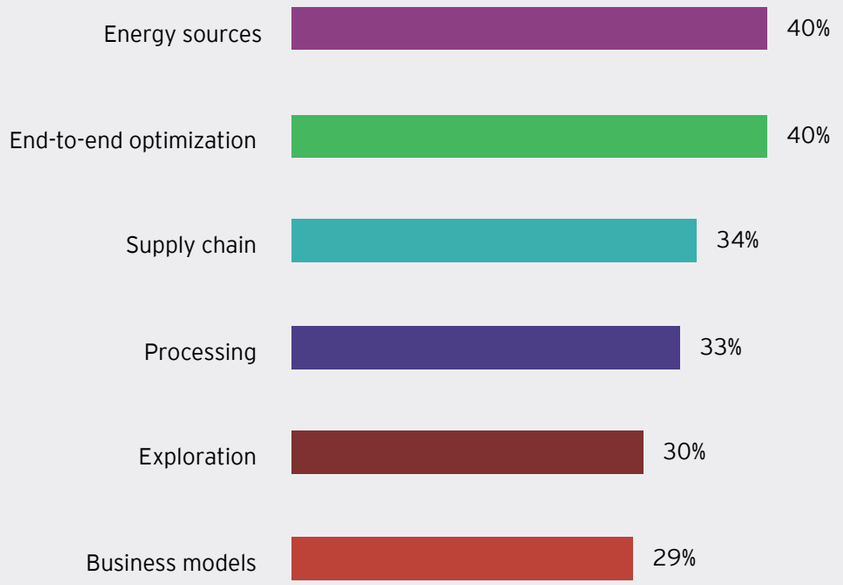
Many organizations surveyed for the EY Reimagining Industry Futures Study 2024 viewed innovation through collaborative ecosystems as "nice to have" rather than mission critical. Some inhibitors to innovation included:

1. Lack of strategic alignment with other organizations
2. Limited awareness of collaboration opportunities
3. Low willingness to share data with other organizations
4. Lack of time and resources for innovation

Collaboration with competitors is often challenging. But we are encouraged by efforts from the mining majors and industry associations to align around topics that can only be progressed through collaborative innovation, e.g., the ICMM initiatives around nature positive, the International Copper Association's Copper Mark, and the collaboration between Rio Tinto and BHP with Caterpillar and Komatsu to test large battery-electric haul truck technology in the Pilbara.[38]

Innovation also depends on diverse industries and teams working together. Universities can act as a conduit for innovation, working with mining companies and other industries to break traditional silos and create innovative solutions. Rio Tinto for example has committed US$150m to create a Centre for Future Materials led by Imperial College London, in partnership with a selection of international academic institutions.[39]

Miners believe lower-risk innovation will have the greatest impact by 2030



Note: Respondents could choose more than one option.
Source: EY Business Risks and Opportunities Study 2025.

Innovation

10

Down from 2024

Key considerations:

- **Be strategic**. Focus innovation around ways to accelerate delivery of the company's strategy and drive a competitive advantage.
- **Collaborate and partner.** Act now to form alliances around your greatest business priorities and challenges.
- **Support a culture of innovation.** Without a clear vision, budget and strategy, innovation programs will fail. Build a culture of innovation, supported by strong leadership and underpinned by an end-to-end approach that embeds itself across all operations.

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