Mine 2023: 20th edition

The era of reinvention

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Foreword

PwC is proud to share the 20th edition of our global *Mine* report. To recognise this anniversary, we have included a short section that recalls some of the more significant trends over the past 20 years. In that time, the evolution of the sector has been clear and dramatic, and there are no signs of it abating. In 2003, the market capitalisation of the Top 40 mining companies was less than US$400 billion. Last year it was more than US$1.2 trillion.

As we look to the next 20 years, the theme of transition, particularly energy transition, will remain dominant. Heightened societal awareness of the role of critical metals in any future energy system has prompted companies and governments to secure their supply chains in pursuit of diversification and energy independence. This report lays out the long-term implications of such government action and intervention.

We also highlight other important developments: decarbonisation, increased M&A and sector consolidation, and the rise of technology. We conclude the report this year with a review of the workforce challenges that could arise as the sector positions for the future. A focus on diversity, equity and inclusion will be critical for miners to meet workers' evolving needs. These are multifaceted issues that will require a partnership between the public and the private sectors to solve.

Please reach out to your local PwC team to discuss any of them in more depth.

Paul Bendall
PwC's Global Mining Leader

Executive summary

The world's big mining companies must find a new formula for success. The era of critical minerals has arrived, and it's the most momentous change the industry has seen in decades. Miners can no longer depend on yesterday's portfolios and practices to create value in this newly dynamic and fiercely competitive landscape. And mining CEOs seem to know it: of those polled in PwC's 26th Annual Global CEO Survey, 41% don't think their companies will be economically viable in ten years if they continue on their current path. The era of critical minerals must therefore be an era of reinvention.

One shift that demands a response is the emergence of an important new player in the critical minerals market: government. After seeing rapid demand growth and risky levels of supply chain concentration, governments have formed alliances, instituted new policies and mobilised funding to secure access to critical minerals. These moves will change the mining business. The inflow of public funds, for example, means that miners must rethink the rates of return they can expect on mining or supply chain assets. Miners will also need to contend with heightened investment risk and greater competition as governments alter the playing field with incentives and interventions.

Then there's the urgent task of decarbonisation. Miners will have to ramp up production to meet rising demand for the critical minerals and other commodities that are required for the energy transition. But they also know they must reduce their carbon emissions. More than one-third of mining CEOs see their company as highly or extremely exposed to climate-related risks. The good news is that decarbonisation can help miners create value at all points along the value chain. More and more, we're seeing miners boost efficiency with low-carbon technologies and methods, partner with processors to produce the "green metals" that customers increasingly want, and access sustainability-linked financing.

The transition to renewable energy and a low-emissions economy will not, however, be straightforward—and neither will changes in the mining industry's makeup. The Top 40 mining companies posted strong financial performance in 2022; total group revenue of US$711 billion nearly matched the highs of 2021. Their balance sheets are robust, and debt remains low. But EBITDA (earnings

before interest, taxes, depreciation, amortisation and impairments) margins decreased, as predicted, amid swelling costs and economic uncertainty.

What's more, the mix of revenue from mining commodities shifted. Surging demand made coal the biggest contributor to the Top 40's revenue for the first time since 2013, a sign that coal miners still have a role in meeting the world's energy needs. Nonetheless, the long-term trajectory for coal revenue clearly runs downwards.

These trends mean miners need to reposition themselves for long-term growth—and the merger and acquisition deals they struck in 2022 showed that they're using their financial resources to do so. Critical minerals dominated deal activity in 2022 as miners big and small raced to remake their portfolios for the global transition to clean energy. Large companies went for joint ventures and transformational deals, but some smaller ones made multibillion-dollar plays, too. Facing further consolidation, increased price volatility and continued government action, miners must act swiftly to capture dwindling deal opportunities.

Miners will need more than financial positioning to achieve ongoing success: the Top 40 must also attract workers. Tech talent, especially, is essential to the mining world's increasingly automated, digitised, AI-enabled operations. But mining companies simply need more workers overall, which requires them to create environments that are open and inclusive towards people who might not see themselves as potential miners. It will take reimagined workforce strategies for miners to attract employees in the future—just as it will take the reinvention of many other parts of the mining business. Only by transforming can the Top 40 create value and help bring about economic prosperity and a low-carbon future.

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世界上的大型矿业公司必须要找寻一个新的成功公式了。关键矿产的时代已经到来，这是该行业几十年来所看到的最重大的变化。在这个新的不断变化又充满激烈竞争的环境中，矿产企业不能再依赖过往的投资组合和惯例来创造价值。矿业企业的CEO们似乎也深知这一点：在普华永道第26届全球CEO年度调查中，有41%的受访者们认为，如果继续走目前的道路，十年之内他们的公司就将无法继续生存下去。因此，关键矿产的时代必须是一个重塑的时代。

关键矿产市场上出现了一个重要的新角色：政府。这一重大转变需要矿业企业的积极回应。在看到需求的快速增长及供应链集中的潜在风险后，政府已经形成了联盟，制定了新的政策，并调动资金以确保获得关键矿产。这些举措将改变采矿业。例如，公共资金的流入意味着矿业企业必须重新考量他们在采矿或供应链资产的预期回报率。由于政府通过激励和干预措施改变了竞争环境，矿业企业还将要面对更高的投资风险和更多的竞争。

此外，去碳化的任务也相当紧迫。矿业企业将不得不提高产量，以满足对能源转型所需的关键矿产和其他商品日益增长的需求，但他们也深知必须降低碳排放。超过三分之一的矿业CEO认为他们的公司高度或极度暴露在气候相关风险中。好消息是，去碳化可以帮助矿业企业在价值链的各个环节创造价值。我们看到越来越多的矿业企业通过低碳技术和方法提高效率，与矿产加工企业合作生产出客户越来越需要的“绿色金属”，并获得与可持续发展相挂钩的融资。

然而，向可再生能源和低排放经济的过渡不会是一帆风顺的，也不会改变矿业企业的格局。2022年，前40大矿业企业公布了强劲的财务表现；合计总收入为7,110亿美元，几乎与2021年的高点相当。他们的资产负债表很稳健，债务仍然很低，但EBITDA（息税、折旧、摊销和减值前的利润）则如预测一样，由于成本膨胀及经济不确定性等原因呈现下降趋势。

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更重要的是，矿业商品的收入组合发生了变化。需求激增使得煤炭自2013年以来首次成为40大矿企收入的最大贡献者，这表明煤矿企业在满足世界能源需求方面仍有一定的作用。尽管如此，煤炭收入的长期轨迹显然是下降的。

这些趋势意味着矿业企业需要为自己的长期增长重新定位——他们在2022年达成的并购交易表明，他们正在利用自己的财务资源来实现这一目标。在2022年的交易活动中，关键矿产占据了主导地位，因为大小规模的矿业企业都在竞相重塑投资组合，以应对全球向清洁能源过渡的必然趋势。大公司选择了合资企业和转型交易，但一些小公司亦投资数十亿美元。面对进一步的整合、不断加剧的价格波动和政府的持续行动，矿业企业必须迅速采取行动，抓住日益减少的交易机会。

矿业企业想要取得持续的成功，除财务定位外，40大矿企还需要吸引更多人才。特别是技术人才，对于采矿业日益自动化、数字化和人工智能化的运营至关重要。对于矿业企业来说，想要吸引更多的人才，就必须创造开放和包容的环境，让那些可能不认为自己是潜在矿产企业从业者的人员也参与进来。矿业企业需要重新规划人才战略，才能在未来吸引优秀的员工，就像需要重塑的采矿业的许多其他部分一样。只有通过转型，40大矿企才能创造价值，促进实现经济繁荣和低碳的未来。

Resumen ejecutivo
Executive summary

Las grandes empresas mineras del mundo deben encontrar una nueva fórmula para el éxito. La era de los minerales críticos ha llegado, y es el cambio más trascendental que la industria ha visto en décadas. Las mineras ya no pueden depender de las carteras de minerales y las prácticas de ayer para crear valor en este nuevo panorama, dinámico y ferozmente competitivo. Y los CEOs de la industria minera parecen saberlo: de los participantes en la 26ª Encuesta Mundial Anual de CEOs de PwC, el 41% no cree que sus empresas serán económicamente viables dentro de diez años si siguen por el camino actual. La era de los minerales críticos debe ser, por tanto, una era de reinvención.

Un cambio que exige una respuesta es la aparición de un nuevo actor importante en el mercado de minerales críticos: el Gobierno. Tras constatar el rápido crecimiento de la demanda y los riesgosos niveles de concentración de la cadena de suministro; los Gobiernos han creado alianzas, establecido nuevas políticas, y movilizado financiamiento para garantizar el acceso a minerales críticos. Estas acciones cambiarán el negocio minero. El ingreso de fondos públicos a la industria significa, por ejemplo, que las mineras deben replantearse las tasas de retorno que pueden esperar de los activos mineros o de su cadena de suministro. Las mineras también tendrán que hacer frente a un mayor riesgo de inversión y a una mayor competencia a medida que los Gobiernos alteran el campo de juego con incentivos e intervenciones.

Luego está la urgente tarea de la descarbonización. Las mineras tendrán que aumentar sus niveles de producción para satisfacer la creciente demanda por minerales críticos y otras materias primas esenciales para la transición energética. Pero también saben que deben reducir sus emisiones de carbono. Más de un tercio de los CEOs del sector minero consideran que su empresa está muy o extremadamente expuesta a los riesgos climáticos. La buena noticia es que la descarbonización puede ayudar a las mineras a crear valor en cada eslabón de la cadena. Cada vez vemos más mineras que aumentan su eficiencia con tecnologías y métodos de baja emisión de carbono, se asocian con procesadores para producir “metales verdes” que cada vez quieren más los clientes, y acceden a fuentes de financiamiento verde.

Sin embargo, la transición hacia las energías renovables y una economía de bajas emisiones no será sencilla, como tampoco lo serán los cambios en la composición de la industria minera. Las 40 principales empresas mineras lograron buenos resultados financieros en 2022; los ingresos totales del grupo, de 711 mil millones de dólares, casi igualaron los máximos de 2021. Sus balances se mantienen sólidos y los niveles de endeudamiento bajos. Pero los indicadores de EBITDA (las ganancias antes de intereses, impuestos, depreciación, amortizaciones y deterioros) disminuyeron, como se preveía, en un contexto de aumento de costos e incertidumbre económica.

Además, la combinación de ingresos procedentes de diferentes tipos de minerales ha cambiado. El aumento en la demanda convirtió al carbón en el mayor contribuyente a los ingresos de las 40 principales empresas mineras por primera vez desde 2013, una señal de que los mineros del carbón todavía tienen un papel que desempeñar para satisfacer las necesidades energéticas del mundo. No obstante, la trayectoria a largo plazo de los ingresos del carbón es claramente descendente.

Estas tendencias significan que las mineras necesitan reposicionarse para crecer a largo plazo, y las cifras de las fusiones y adquisiciones ocurridas durante 2022 demuestran que las mineras están utilizando sus recursos financieros disponibles para hacerlo. Los minerales críticos dominaron la actividad en 2022, ya que empresas mineras grandes y pequeñas se apresuraron a rehacer sus carteras para la transición energética mundial. Las grandes empresas apostaron por joint ventures y operaciones financieras transformadoras. Pero algunas empresas más pequeñas también realizaron operaciones de miles de millones de dólares. Ante una mayor consolidación, el aumento de la volatilidad de los precios y las continuas medidas gubernamentales, las mineras deben actuar con rapidez para aprovechar oportunidades de negocio cada vez más escasas.

Las mineras necesitarán algo más que un posicionamiento financiero para mantener su éxito: las 40 principales empresas mineras también deben atraer colaboradores. En particular, el talento tecnológico es esencial para las operaciones cada vez más automatizadas, digitalizadas y basadas en IA del mundo minero. Pero las empresas mineras simplemente necesitan más trabajadores, en general; lo que les exige crear entornos abiertos e inclusivos para personas que no necesariamente se ven a sí mismas como posibles mineros. Para atraer los colaboradores del futuro, las mineras necesitarán estrategias de capital humano renovadas – al igual que será necesario reinventar muchas otras partes del negocio minero. Sólo mediante la transformación, las 40 principales empresas mineras podrán crear valor y contribuir a la prosperidad económica y a un futuro con bajas emisiones de carbono.

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Les grandes minières mondiales sont à la croisée des chemins. Nous sommes à l'ère des minéraux critiques et l'industrie vit l'un des revirements les plus déterminants qu'elle ait connus depuis des décennies. Les gisements et les pratiques d'hier ne suffisent plus à créer de la valeur dans ce nouvel environnement dynamique et férocement concurrentiel. Les chefs de direction des sociétés minières le savent : 41 % des répondants à la 26e enquête de PwC auprès des chefs de direction ne pensent pas que leur société sera économiquement viable dans dix ans si elle ne change pas ses façons de faire. L'ère des minéraux critiques devra donc être celle de la réinvention.

L'émergence d'un nouveau joueur important sur le marché des minéraux critiques, le secteur public, exigera une réaction rapide. Devant la croissance rapide de la demande et les niveaux risqués de concentration dans la chaîne d'approvisionnement, les gouvernements ont formé des alliances, voté de nouvelles politiques et mobilisé des capitaux afin d'assurer leur accès à ces minéraux. Ces décisions changeront l'industrie minière. L'afflux de fonds publics, par exemple, signifie que les sociétés minières devront revoir les taux de rendement qu'elles attendent de leurs avoirs miniers ou de leur chaîne d'approvisionnement. Elles devront aussi composer avec des risques d'investissement plus élevés et une concurrence plus aiguë dans la mesure où les interventions et incitatifs gouvernementaux changent la donne.

Vient ensuite l'impératif de la décarbonation. La transition énergétique exigera des sociétés minières non seulement qu'elles accroissent leur production de minéraux critiques et autres matières premières pour répondre à la demande, mais aussi qu'elles réduisent leurs propres émissions de carbone. Plus d'un tiers des chefs de direction affirment que leur entreprise est hautement exposée aux risques climatiques. Cependant, la décarbonation peut aussi les aider à créer de la valeur à chaque étape de la chaîne. De plus en plus de minières parviennent à plus d'efficience grâce à des processus et technologies faibles en carbone, à des partenariats avec des entreprises de traitement pour produire les « métaux verts » que les consommateurs demandent et à l'accès à un financement lié à la durabilité.

La transition vers les énergies renouvelables et une économie à faible émission ne se fera pas sans heurts, cependant – ni les transformations structurelles de l'industrie. Les 40 sociétés minières les plus importantes ont enregistré d'excellents résultats financiers en 2022; le chiffre d'affaires total du groupe, à 711 milliards de dollars américains, a presque atteint les sommets de 2021. Les bilans sont solides et la dette reste faible. Toutefois, les BAIIA (bénéfice avant intérêts, impôts et amortissement) ont diminué, comme prévu, sous la pression des coûts et de l'incertitude économique.

La composition du chiffre d'affaires a également changé. Une envolée de la demande a fait du charbon la première source de revenu pour la première fois depuis 2013, signe que les producteurs de charbon ont encore leur place dans l'approvisionnement énergétique, quoique celle-ci soit clairement appelée à baisser sur le long terme.

Ces tendances doivent inciter les minières à se repositionner pour assurer leur croissance à long terme, et les opérations de fusion-acquisition qu'elles ont conclues en 2022 montrent bien qu'elles utilisent leurs ressources financières dans ce but. La majeure partie de ces opérations ont visé les minéraux critiques, les sociétés grandes et petites cherchant à reconstituer leur portefeuille en prévision de la transition mondiale aux énergies vertes. Les plus grandes ont opté pour des co-entreprises et des opérations transformationnelles; les plus petites ne sont pas en reste avec des investissements de plusieurs milliards. Étant donné la consolidation qui se poursuit, la volatilité des prix et les interventions gouvernementales, les minières doivent agir vite pour profiter des opportunités.

Cependant, il leur faudra plus que des investissements financiers pour assurer leur succès : les 40 premières sociétés minières devront aussi attirer des talents, particulièrement en technologie, si elles veulent automatiser et numériser leurs processus et introduire l'intelligence artificielle. Cela étant, les minières ont besoin de travailleurs dans tous les domaines. Elles doivent donc créer un milieu de travail ouvert et inclusif, qui saura attirer des gens qui ne s'imaginent pas peut-être pas dans le métier de mineur. Elles devront réimaginer leur stratégie de gestion de personnel pour l'avenir, comme elles devront réinventer plusieurs de leurs processus. Ce n'est que par la transformation que les 40 plus grandes minières mondiales réussiront à créer de la valeur et à assurer leur prospérité économique dans un avenir décarboné.

Chapter I

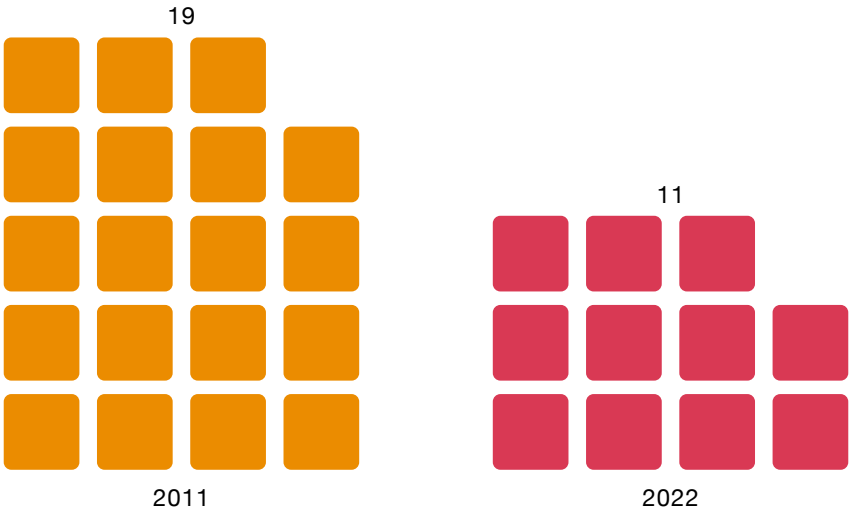
Insights from 20 Years of *Mine*

In 2004, PwC launched *Mine*, our first annual review of the world's largest mining companies. Since then, the industry has seen constant and often dramatic change. Here are our insights on what the changes have meant for today's miners, and what they might mean going forward.

A shifting commodity mix

Mine 2012 examined the role of coal in light of the greater attention being paid to renewable energy and climate change, noting that 19 of the Top 40 miners earned revenue from coal. Last year, only 11 did. Yet coal was the industry's biggest revenue generator in 2022, reflecting the disconnect between short-term price movements and long-term strategic positioning. Demand for critical minerals has also grown to support production of renewable-energy technologies and electric vehicles. As a result, the commodity mix of today's Top 40 is more diverse than it was a decade ago.

The number of Top 40 mining companies earning revenue from coal

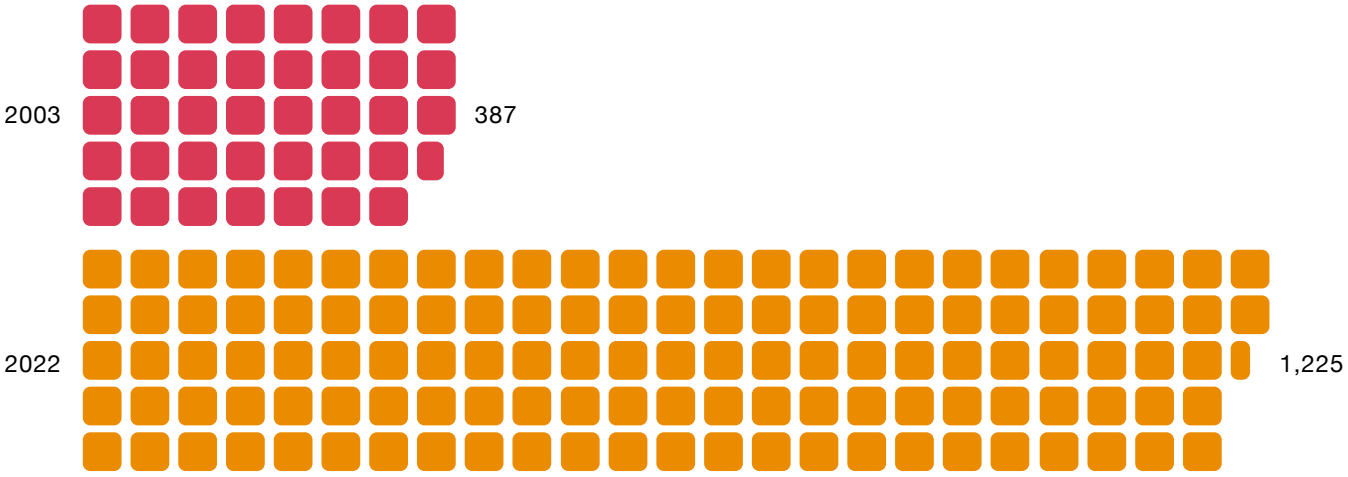


Source: Our World in Data, company annual reports, S&P Capital IQ, PwC analysis

Industry consolidation

Since the launch of *Mine* 20 years ago, the market capitalisation of the Top 40 has more than tripled, mainly because of consolidation. Of the Top 40 miners in our first edition of *Mine,* more than one-third have merged with other players through a series of huge, sector-altering transactions. We expect to see more megadeals in the coming years.

Market capitalisation of the Top 40 mining companies (US$bn)

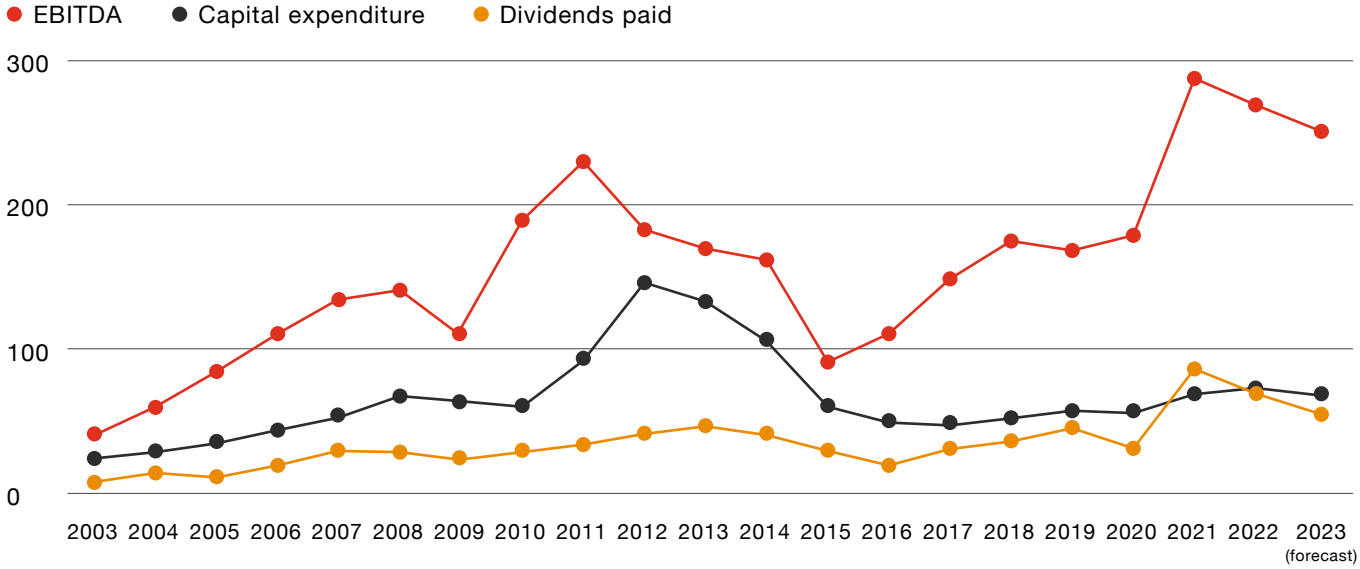


Source: Company annual reports, S&P Capital IQ, PwC analysis

New capital discipline

Miners have become much more disciplined with capital allocation over the past 20 years, but have they gone too far? In the lead-up to the global financial crisis of 2008, miners were focused on production and acquisitions rather than cash payouts to shareholders. Once the financial crisis abated, miners began raising dividends and capital investments while pursuing more acquisitions—sending the industry into survival mode in 2015 and 2016. Since then, the emphasis has been on repairing balance sheets and returning cash to shareholders, with making capital investments a lower priority. Even in recent years, as profits have soared, most capital investments have been aimed at modernising existing projects instead of growing the resource base. Whether these strategies will constrain miners' ability to deliver in the next demand–growth cycle remains to be seen.

Financial performance trends for the Top 40 mining companies (US$bn)



Note: Data for the year 2023 reflects forecasted performance.
Source: Company annual reports, S&P Capital IQ, PwC analysis

Digital transformation

Mine 2010 highlighted the emergence of new technology for remote and automated work, something that mining CEOs at the time said was 'unheard of' in the industry only a few years prior. By *Mine 2017,* most of the Top 40 were moving quickly to apply the latest digital technologies. Covid accelerated this trend, forcing miners to speed up tech adoption to operate safely. Today, automation, digitisation and AI are core elements of any mining operation—and require skilled workers who are often hard for miners to attract.

Licence to mine

Successful mining companies have kept up with stakeholder demands, particularly for sustainability priorities. We first discussed the idea that attention to stakeholder concerns is essential to safeguarding a miner's "licence to operate" in *Mine 2007.* But in 2012, only 40% of the Top 40 published standalone sustainability reports. Just five years later, 90% of them issued reporting on sustainability in line with the Global Reporting Initiative (GRI) Standards. And today, it's clear that disclosure alone is insufficient. To maintain stakeholders' trust, the Top 40 must set sustainability goals and demonstrate progress towards them.

57%

of mining companies see recruiting as the biggest barrier to adopting new technology.

Source: World Economic Forum

25

of the Top 40 miners published decarbonisation goals in their most recent sustainability reports.

Source: PwC analysis

Chapter II

Critical minerals: A new player steps in

The era of critical minerals has arrived, bringing opportunities for miners—along with concerns about the supply shortfalls that could occur amid booming demand. As national governments have moved to secure access to copper, lithium and other critical minerals, they've reconfigured the competitive landscape. Now, miners must reckon with a whole new set of industry dynamics.

Last year's edition of *Mine* highlighted the emergence of critical minerals as the commodity that will define the future of mining. Twelve months on, interest in the category has only grown, as nations have recognised the importance of these minerals to clean energy and defence. Geopolitical uncertainty has complicated the picture, sowing doubts about where critical minerals might come from. In response, governments around the world have taken swift action to form alliances, craft policies and laws, and fund initiatives that will stabilise their supplies of critical minerals. Their moves have altered the playing field for miners, intensifying competition and risk.

Three forms of government action

Alliances and agreements	Policy and legislation	Funding
Government-to-government strategic partnerships or trade agreements centred on critical minerals collaboration	Laws, policies or regulations created to protect, secure or drive growth in critical minerals and supply chains	Direct government funding or government-backed funds to finance ventures in critical minerals and supply chains

Strategic alliances and trade agreements

Over the past 12 months, more and more governments have sought to secure their access to critical minerals through reinforced strategic alliances or new trade deals. Most of these agreements have only just been struck, so their full impact has yet to be felt. But the implications could be immense. Reconfiguring existing supply chains will require enormous levels of new capital, and it could cause supply disruptions and price volatility.

Noteworthy agreements on critical minerals

Minerals Security Partnership (MSP) Announced June 2022	**Australia–India Critical Minerals Cooperation Agreement** Announced June 2022	**US–Japan Critical Minerals Agreement** Announced March 2023
Led by the US Department of State, the MSP is intended to stimulate government and private-sector investment. Partner governments include Australia, Canada, Finland, France, Germany, Japan, South Korea, Sweden, the UK, the US and the EU.	Australia and India established this partnership to strengthen cooperation in the development of critical minerals assets and supply chains.	This trade deal on battery minerals (lithium, nickel, cobalt, graphite and manganese) is meant to help Japanese automakers and critical minerals processors access the benefits of the 2022 US Inflation Reduction Act.

Policy and legislation

Recently, many countries have introduced legislation addressing critical minerals production, processing and manufacturing. Canada updated its Critical Minerals Strategy (December 2022), the EU released its Critical Raw Materials Act (March 2023), the UK refreshed its Critical Minerals Strategy (March 2023) and Australia is due to release an update to its existing strategy in 2023. But the most significant of these is the US Inflation Reduction Act (IRA), the largest piece of climate-focused legislation in US history.

With approximately US$370 billion in spending and tax credits to support clean-energy industries and supply chains, the IRA significantly increases the volume of public capital available for critical minerals investments. (Complementing the IRA are other US laws and policies, such as the CHIPS and Science Act and various “made in America” provisions.) The IRA presents vast opportunities for big mining companies. Though miners can’t physically move their mines to the US, they can make changes to their operating processes, investment plans, offtake arrangements, processing routes and workforces to capitalise on the IRA’s incentives.

US government initiatives in critical minerals

Loans	Production tax credit	Mining incentives
The Inflation Reduction Act (IRA) provided the Department of Energy's Loan Guarantee Program with an additional US$40 billion to accelerate the deployment of innovative clean-energy projects, including critical minerals projects and processing.	The IRA provides a 10% annual tax credit on production costs for critical minerals that are mined or produced in the US.	The IRA establishes US$500 million in incentives for critical minerals mining and processing in the US. Consistent with the Defense Production Act, actions may include building a critical minerals stockpile.
Electric vehicle tax credits	**Research and development grants**	**Support for manufacturing**
The IRA extends tax credits to electric vehicle manufacturers that meet requirements for final assembly in the US and for sourcing battery components from the US or its key trade partners.	The CHIPS and Science Act offers grants to advance research into critical minerals mining strategies and technologies.	The Bipartisan Infrastructure Law allocates US$8.6 billion for manufacturing and for workforce development in supply chains for clean-energy technologies.

Funding

Another recent trend has seen governments establish funds to invest in critical minerals projects and supply chains. For example, Australia's export credit agency, Export Finance Australia, set up the Critical Minerals Facility to fill gaps in private financing for critical minerals projects. In 2022, the agency agreed to lend Australia miner Iluka Resources US$1.05 billion to build a fully integrated rare earths separation facility in Western Australia. The Australian Government is also directing a portion of its US$15 billion National Reconstruction Fund to critical minerals companies that build processing, refining or manufacturing capacity in the country.

The US Government, too, is providing significant funding for critical minerals projects. The Department of Energy's Loans Program Office, for example, has extended a US$2 billion conditional commitment to US battery recycler Redwood Materials for the construction of a battery materials campus in the state of Nevada, a conditional offer of US$700 million to US mining company ioneer for the development of the Rhyolite Ridge lithium and boron project in Nevada, and US$102 million to Syrah Resources for the development of a graphite processing facility in the state of Louisiana.

Implications for miners

These moves by governments are rapidly changing the competitive landscape for critical minerals companies, and miners more broadly, in five main ways. Miners must adjust now to stay ahead of their rivals.

1. **Greater demand for critical minerals.** As more governments try to secure supplies of critical minerals in tightening markets, we are seeing countries emerge as buyers. The concept of a strategic reserve has precedent in materials that are essential for traditional energy systems; examples include the United States' strategic petroleum reserve and uranium reserve. As governments consider their future needs for critical minerals, they may seek to establish strategic stocks of these resources, too, as evidenced by government-backed procurement activity in the EU and India.

Noteworthy critical-minerals supply moves

European Union	India
As part of the Critical Raw Materials Act, the EU announced its intention to establish a central purchasing agency for critical minerals. The act outlines preliminary plans to 'aggregate demand' and establish a purchasing system for critical minerals end users within the EU bloc.	The Indian Ministry of Mines established a joint-venture company, Khanij Bidesh India Ltd. (KABIL), to ensure the supply of critical minerals for India's domestic economy. KABIL has been actively seeking offtake agreements and has already signed with Argentina and Australia to procure select critical minerals.

2. **A changing financial picture.** Due to lower interest rates on government borrowings, the financing cost available to the public sector is lower than that available to the private sector, even for companies with the highest credit ratings. Government-backed funds are likely to have nominal (or inflation-linked) return requirements that are lower than the usual expected returns on investment for a mining company or its shareholders. As more governments use their capital to finance critical minerals and supply chain projects, miners may need to lower their target rates of return to compete.

3. **Higher investment risk.** Government interventions in critical raw materials markets are steadily increasing in the form of export restrictions and, in some cases, resource nationalism. This development mirrors a larger trend: the Organisation for Economic Co-operation and Development (OECD) has observed a fivefold increase in export restrictions on industrial raw materials over the past decade. But in critical minerals, government actions have been especially pronounced. Uncertainty about future government action will likely require miners to reassess country risk profiles, which may affect investment and deal activity.

   Developments in Canada and Chile highlight the risks that companies can face. In 2022, Canada's Government announced restrictions on investments by foreign state-owned companies in its critical minerals sector and stiffened its criteria for whether a transaction is of 'net benefit' to Canada. The Government is also forcing some foreign state-owned entities to divest their critical minerals assets. And in April of this year, Chile announced intentions to nationalise its lithium industry. Given that Chile is the world's second-largest lithium producer and hosts the largest lithium reserve base, the proposed interventions would likely affect global supplies of lithium. The Chilean Government has also indicated that any private company must partner with the state to mine lithium.

4. **More competition.** Over the past year, we've seen more original equipment manufacturers (OEMs) and end users partnering with miners and processors through joint ventures, partnerships and offtake agreements to secure supplies of critical minerals. And as governments offer incentives for the production and processing of critical minerals, we expect OEMs to make more direct investments in mining and processing assets, vying against mining companies for growth assets and mergers and acquisitions. Overall, these trends amount to a power shift away from buyers of critical minerals and to sellers.

Cross-industry partnerships: OEMs and miners

Volkswagen plans to construct its first North American battery plant in Canada and has partnered with mining operations there to secure supplies of raw materials. Thomas Schmall, CEO of Volkswagen Group Technology, said, 'The bottleneck for raw materials is mining capacity, which is why we need to invest in mines directly.'

Mercedes-Benz opened a raw materials office in Canada to manage sourcing efforts and signed a battery materials cooperation agreement with the Canadian Government. Like Volkswagen, Mercedes-Benz has indicated that it's willing to invest directly in mines, if necessary, to secure resources.

General Motors is making a US$650 million equity investment in Lithium Americas Corp., accelerating the development of the Thacker Pass lithium project—the largest known lithium resource in the US, which is expected to support the production of nearly 1 million electric vehicles annually.

LG Energy Solution announced a plan to collaborate with China's Sichuan Yahua Industrial Group to produce lithium hydroxide in Morocco. Because Morocco has a free-trade agreement with the US and the EU, the company expects to be able to comply with both the US's Inflation Reduction Act and the EU's Critical Raw Materials Act.

5. **Stricter environmental standards.** Climate policy in major markets such as the US and the EU should give operators ever greater incentives to decarbonise. So far, we've seen little evidence that mineral buyers are willing to pay a "green premium," a price premium for products made with comparatively low or net-zero carbon emissions. But government legislation is creating new financial incentives—and penalties—for mining companies to achieve carbon reduction or environmental, social and governance (ESG) benchmarks. For example, the EU has introduced the Carbon Border Adjustment Mechanism (CBAM), a border tariff on imports of carbon-intensive goods such as aluminium, iron and steel. Legislation of this nature will force companies to meet carbon standards if they want to compete in a given market. And as we explain below, advances in technology are giving miners more options to meet ambitious climate goals.

Chapter III

Decarbonisation: A fresh source of value

Even as they increase output of critical minerals to support the energy transition, miners know they must reduce their carbon emissions to avoid risks such as market barriers, fines and loss of social licence to operate. But decarbonisation can also help miners create value. By accelerating their decarbonisation plans and extending them to their supply chains, mining companies can realise cost savings, partnership opportunities and favourable financing terms.

Because many mining operations are in hot, dry, remote environments, mining leaders know the pressure that climate change can create. In PwC's 26th Annual Global CEO Survey, 35% of mining CEOs said their companies are highly or extremely exposed to climate risks arising in the next five years. It's also clear that mining and metals production, as practised today, results in substantial carbon emissions.

At the same time, leaders recognise that mining plays a crucial role in the energy transition by providing commodities for renewable-energy and climate technologies. Indeed, achieving global emissions-reduction targets will require more mining products, according to the International Energy Agency (IEA): more steel for wind turbines, more copper for transmission lines and electrical components, more lithium for batteries, more rare earth materials for electronics.

As a result, mining companies face a dual imperative: to increase output of conventional and critical minerals while decarbonising mining, refining and production processes. And progress towards that imperative is underway. Existing technology and methods can already decarbonise a significant proportion of mining, processing and production activity. Still better news is that these technologies and methods can be applied across the mining and metals value chain to unlock greater cost-savings and value-creation opportunities.

The decarbonisation toolkit

Mining processes account for 4 to 7% of global greenhouse-gas emissions, according to GlobalData. Mineral and metal production adds significantly more; for example, steel manufacturing accounts for around 7% of global emissions and aluminium manufacturing for around 2%. Miners and processors have access to a range of lower-emissions technologies and methods to help them decarbonise. Among the most cost-efficient options are direct electrification,

35%

of mining CEOs said their companies will be highly or extremely exposed to climate risks in the next five years.

Source: PwC's 26th Annual Global CEO Survey

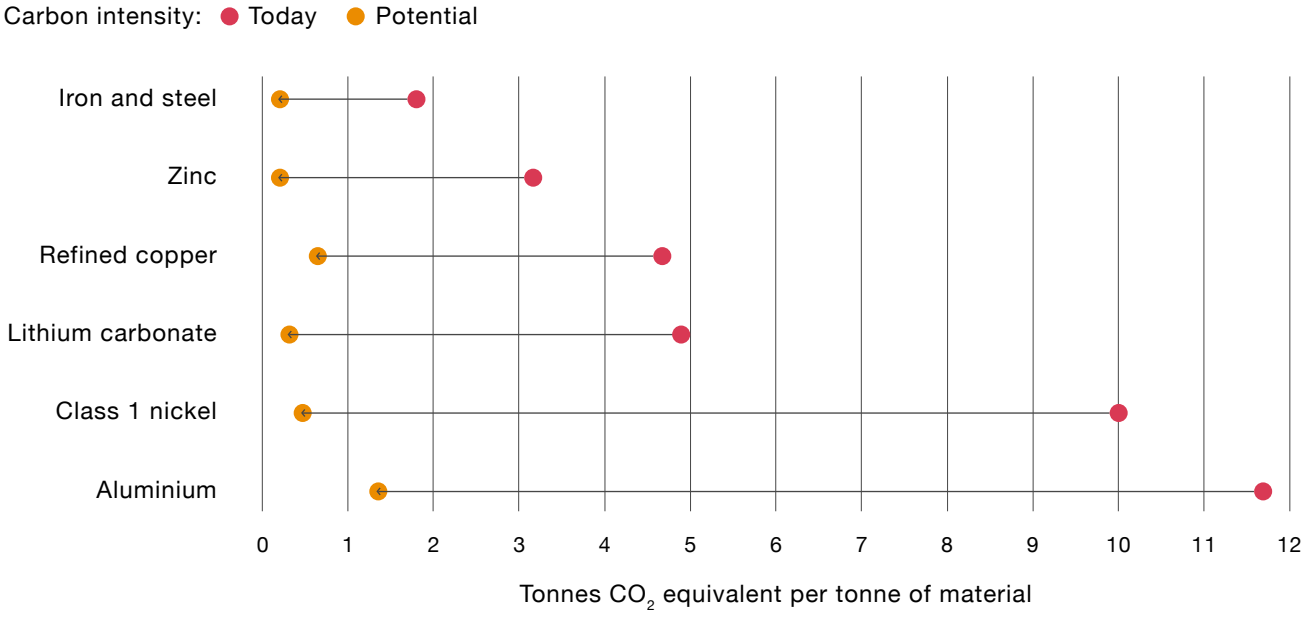
efficiency improvement and renewable energy, followed by hydrogen power for applications that can't be electrified. The following examples show how companies are using some of these options.

Efficiency improvement. The Sibanye-Stillwater mine, in South Africa, has cut the energy consumption of its ventilation systems by 62% by better controlling fan speed and air circulation. Rio Tinto's Gudai-Darri mine in Western Australia has introduced driverless vehicles, which have been shown to increase output by 15 to 20% while reducing costs and fuel consumption.

Renewable energy. The falling costs of solar and wind power have made renewable energy one of the most reliable ways for miners to decarbonise while also reducing their energy costs, which tend to be higher than average. Installing renewables near mine sites, which are usually remote, also helps improve their energy security. For example, Chilean copper miner Codelco is reducing emissions by 15,000 tonnes of CO_2 and saving US$2 million per year by using solar power. As the costs of batteries and electrolysers continue to fall, we should see rapid growth in the use of renewables and hydrogen in mining in the near future.

Hydrogen-powered transport. Anglo American's Mogalakwena mine in South Africa has begun using hydrogen-powered trucks, which can reduce CO_2 emissions by more than 2,000 tonnes per vehicle per year. By replacing its diesel trucks and using hydrogen produced onsite, the mine is on track to significantly reduce its direct (Scope 1) emissions.

New technologies and methods can help decarbonise mining, processing and refinement



Source: International Energy Agency, PwC analysis

Hydrogen-powered steelmaking. The standard method of processing iron ore relies on coal or other fossil fuels and produces significant CO_2 emissions. A new technique being tested in Sweden, direct reduction of iron, uses hydrogen as the reducing agent instead, eliminating 60 to 90% of CO_2 emissions per tonne of iron. Applied at full scale, the technology could help Sweden reduce its total CO_2 emissions by 10%. Saarloha, a steel producer based in India, used the same technique to produce the country's first commercial low-carbon steel in December 2022, achieving emissions from the refining process that are 80% lower than traditional methods.

Partnerships with processors

By partnering with processors, miners can share project-related risks, gain economies of scale and ensure quality control from the mine to the finished product. The hydrogen-powered approach to steelmaking mentioned above is one example of such a partnership. Called Hybrit, it is a collaborative effort among mining company LKAB, steel producer SSAB and power utility Vattenfall to produce green steel for automotive OEM Volvo. The project touches all segments of the value chain and is expected to produce fossil-free steel at commercial scale by 2026.

Another example is Rio Tinto's ISAL aluminium smelter in Iceland. Through a partnership with the local power company Landsvirkjun, the plant uses 100% renewable electricity to produce 202,000 tonnes of aluminium annually at one of the lowest carbon footprints in the world. Such efforts help mining and metals companies not only to meet their emissions targets but also to command higher prices. S&P Global Platts's green aluminium index, for example, shows that low-carbon metals are priced higher than conventionally produced metals.

For Top 40 miners, opportunities like this can be found around the world. One example is the proposed collaboration between the Republic of Zambia and the DRC Battery Council to use hydroelectricity in producing low-carbon cobalt. Leading miners will scope these opportunities now, for lead times can be long and competition is rising.

Green finance

When it comes to accessing capital, the energy transition is creating both opportunities and risks for big mining companies. On the downside, as investors divest fossil-fuel assets, miners may find it hard to obtain capital from traditional sources. But on the upside, the volume of sustainability-related bonds and other financing mechanisms is rising—providing miners with new, attractively priced sources of capital. Globally, green bonds grew from around US$150 billion in 2017 to US$450 billion in 2022 and are expected to grow a further 30% in 2023. In 2021, Newmont issued US$1 billion of sustainability-linked bonds, and in 2022, Anglo American issued €745 million (US$741 million).

Multilateral organisations are also getting involved. In 2019, the World Bank launched the Climate-Smart Mining Initiative, a fund dedicated to supporting sustainable mining practices. As the Top 40 miners seek to decarbonise their activities and expand mines to meet the world's future minerals needs, sustainable capital can help them meet their financing requirements.

US$450bn

green bonds issued in 2022

Source: S&P Global

Capturing the decarbonisation opportunity

The economics of decarbonisation will drive business decisions in mining for decades to come, as mining executives come to grips with significant challenges and opportunities. To create value, leading companies are focusing their decarbonisation strategies on initiatives that help them save costs and access new end markets. Our experience suggests that the fundamentals of such strategies include the following.

The next five years

- Set and communicate targets for reducing emissions within your control (Scope 1 and 2), and engage with customers and suppliers to reduce Scope 3 emissions.
- Implement mature renewable-energy technologies at mine sites, and pilot new, lower-carbon solutions for processing.
- Evaluate emissions-reductions partnerships with customers, and begin to engage them.

Through 2035

- Partner with processors in efforts to cut downstream value chain emissions (e.g., by using renewable energy to produce low-carbon aluminium or hydrogen to reduce iron ore for steelmaking).
- Scale up renewable technologies at mine sites.

Beyond 2035

- Scale new mine operations as well as low-carbon refining processes.
- Commission full-scale co-located mining and refining plants.
- Integrate renewables in power and transport applications, and phase out remaining fossil fuel–powered equipment.

Chapter IV

Financial analysis: Uncertainty ahead

In 2022, the Top 40 mining companies once again reported strong financial results. Their revenue remained near the high point of 2021, and their 2% increase in market value exceeded the gains of benchmarks such as the S&P 500. However, softening commodity prices and rising operating costs hurt cash flow and margins. Amid continued economic uncertainty, big miners should consider using their strong balance sheets to seize the growth opportunities afforded by increasing demand.

The Top 40's total revenue of US$711 billion in 2022 was broadly consistent with last year's top-line result. However, the share of revenue from different mining commodities changed. For the first time since 2010, coal was the largest contributor to total revenue across the Top 40, rising from 23 to 28%. This increase was largely price-driven, with average spot prices in some cases doubling across the year. Copper revenue remained largely the same, with increasing volumes offset by a slight decrease in price. Iron ore saw declining volumes and prices, as economic uncertainty and covid restrictions across China pushed down global steel demand. Gold prices held relatively steady, but gold revenue fell due to a decline in the number of gold companies in our Top 40. Critical minerals other than copper account for a small share of our Top 40's revenue, with increasing production volumes but volatile prices.

Top 40: 2022 financial snapshot

Revenue

US$711bn

-1% from 2021

EBITDA margin

29%

-3 percentage points from 2021

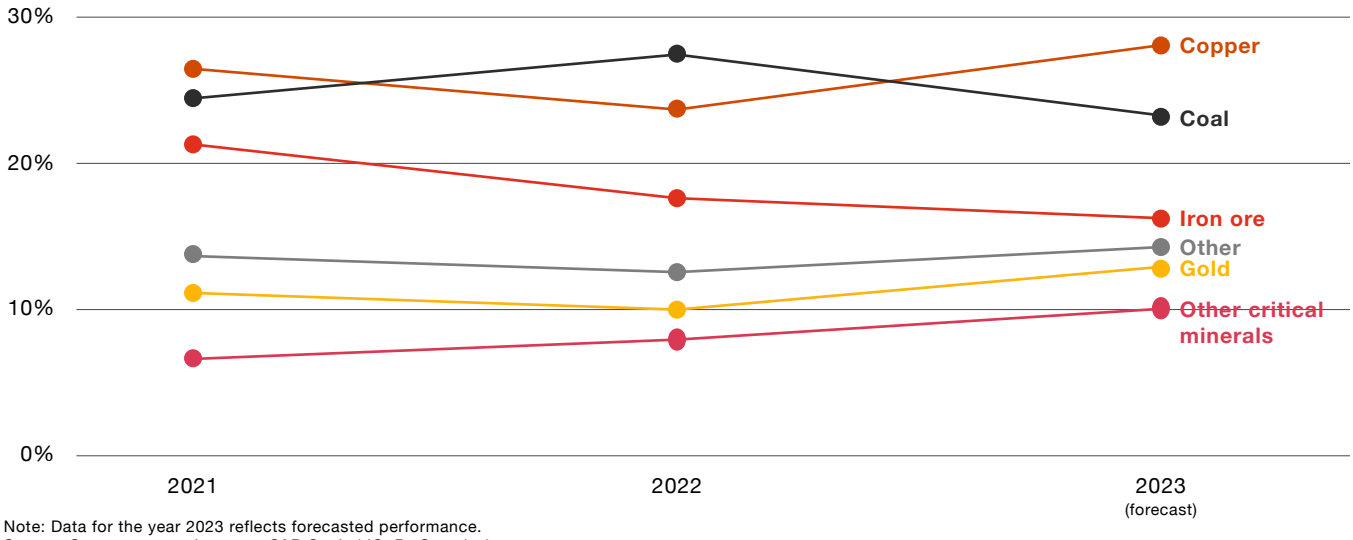
Market cap

US$1.2tn

+2% from 2021

A changing mix of revenue

Top 40 mining companies: Share of revenue by commodity

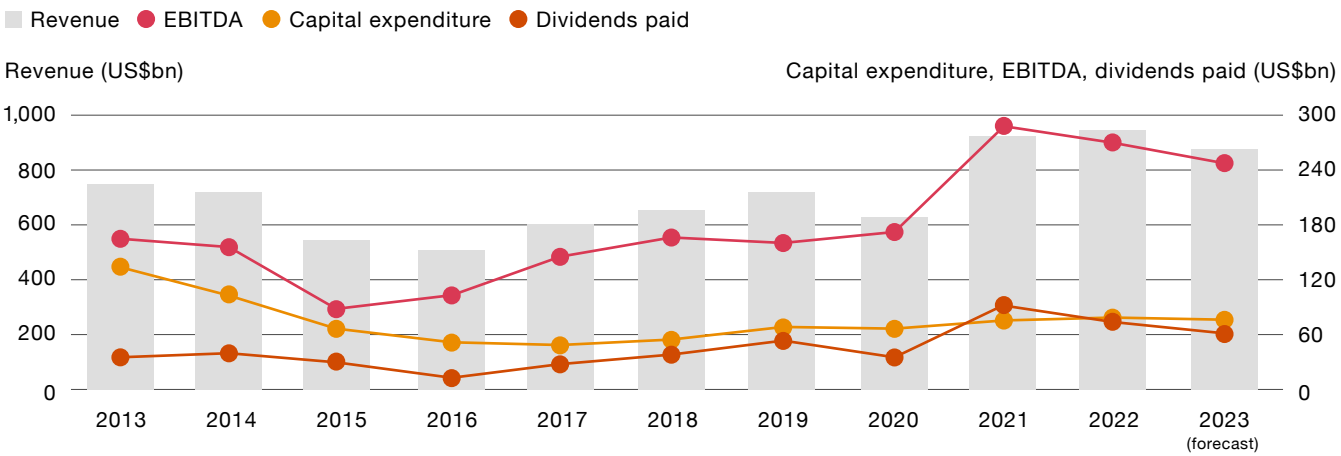


Note: Data for the year 2023 reflects forecasted performance.
Source: Company annual reports, S&P Capital IQ, PwC analysis

As predicted in *Mine 2022,* rising costs took a toll on the Top 40's financial performance. A 6% increase in operating expenses over the year, combined with slightly lower revenue, lowered EBITDA margins from 32% to 29%. This result would have been worse if not for increased trading revenue. Nevertheless, balance sheets remained strong overall. Net debt across the group remained low at US$93 billion (down from US$104 billion in 2021), with positive working capital and net assets. Given their minimal debt, the Top 40 were largely insulated from the impact of rising interest rates in 2022 and recorded only a small increase in borrowing costs.

Rising costs take a toll on results

Top 40 mining companies: Financial performance



Note: Data for the year 2023 reflects forecasted performance.
Source: Company annual reports, S&P Capital IQ, PwC analysis

Top 40 mining companies: Income statement extract (US$bn)

	2023 (forecast)	2022	2021	% change 2022–23 (forecast)	% change 2021–22
Revenue (excluding trading revenue)	649	711	719	-9%	-1%
Trading revenue	238	232	206	2%	13%
Operating expenses	(642)	(670)	(633)	-4%	6%
EBITDA	**245**	**274**	**292**	**-11%**	**-6%**
Depreciation and amortisation	(52)	(49)	(52)	4%	-5%
Impairment reversal/(expense)	(9)	(9)	(6)	0%	48%
Net finance costs	(7)	(5)	(7)	42%	-33%
Profit before tax	**177**	**211**	**226**	**-16%**	**-7%**
Income tax expense	(54)	(57)	(67)	-6%	-14%
Net profit	**123**	**153**	**159**	**-20%**	**-4%**

Profitability measures			
EBITDA margin	28%	29%	32%
Net profit margin	14%	16%	17%
Return on capital employed	17%	21%	21%
Return on equity	19%	24%	26%

Note: Intersegment revenue has been excluded from the trading revenue figures. Totals may not equal sums due to rounding.
Source: Company annual reports, S&P Capital IQ, PwC Analysis

Top 40 mining companies: Balance sheet extract (US$bn)

	2022	2021	% change
Current assets			
Cash	141	156	-9%
Inventories	98	98	0%
Accounts receivable	53	45	19%
Other	94	71	32%
Total current assets	**386**	**370**	**4%**
Non-current assets			
Property, plant and equipment	676	647	4%
Goodwill and intangible assets	78	73	7%
Investments and loans granted	78	76	2%
Other	68	69	-1%
Total non-current assets	**899**	**865**	**4%**
Total assets	**1,286**	**1,235**	**4%**
Current liabilities			
Accounts payable	95	82	16%
Borrowings	45	49	-8%
Short-term lease liabilities	2	2	0%
Unearned revenue	12	11	6%
Other	83	90	-8%
Total current liabilities	**238**	**234**	**2%**
Non-current liabilities			
Borrowings	189	211	-10%
Long-term lease liabilities	12	12	0%
Environmental provisions	68	66	3%
Unearned revenue	13	11	14%
Other	97	86	13%
Total non-current liabilities	**378**	**386**	**-2%**
Total liabilities	**616**	**620**	**-1%**
Net assets	**670**	**614**	**9%**
Total shareholders' equity	**670**	**614**	**9%**

Note: Totals may not equal sums due to rounding.
Source: Company annual reports, S&P Capital IQ, PwC Analysis

The outlook for coal

In 2022, coal accounted for more of the Top 40's revenue than any other mining commodity, as governments chose to add coal-powered generation capacity amid a global energy crisis. According to the IEA, coal-fired power generation increased in 2022, which suggests that the world may struggle to achieve a steady reduction in the use of coal despite the many commitments by governments and businesses to reduce carbon emissions.

To achieve emissions-reduction targets set by signatories to the Paris Agreement, many countries have declared they will reduce their use of all fossil fuels, including thermal coal. However, the IEA has forecast that the reduction will not be even. It expects that global coal-fired power generation will level off from 2023 to 2025, with increases in Asia-Pacific and decreases in the Americas and Europe playing out as global power generation from renewables goes up. This pattern would imply a continued need for thermal coal until alternative energy sources are reliably embedded in the global energy grid. Metallurgical coal, too, will continue to be the primary energy source in steel and cement production until suitable substitutes can be implemented at scale.

Governments and businesses will likely continue to seek a balance between environmental protection and energy security. The market dynamics of 2022 indicate that coal miners still have a role to play in meeting energy demand as the world makes uneven progress towards net zero.

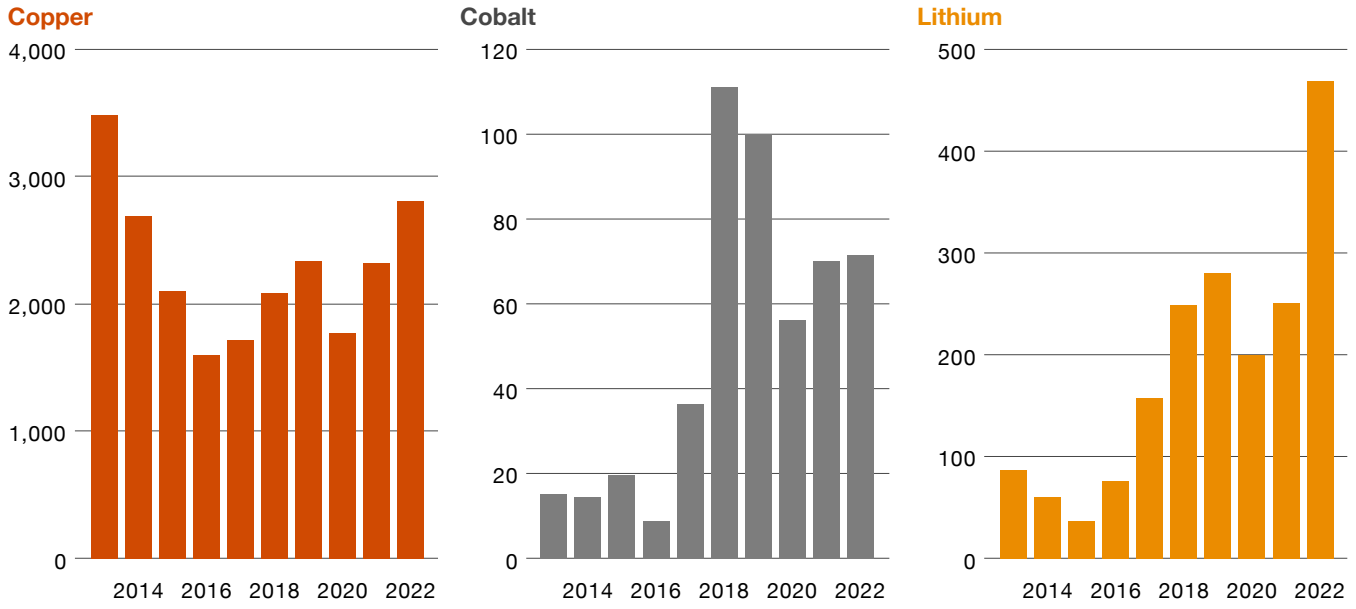
Exploration for growth

Amid surging demand for minerals and metals, the Top 40 reported higher spending on exploration than at any point since 2013. In 2022, gold topped exploration spending globally, and spending on the search for critical minerals such as copper, lithium and cobalt also grew significantly. Given projected supply shortfalls of critical minerals, continued investment to discover these deposits will be essential to sustain the energy transition.

Larger mining companies accounted for most of the total exploration spending, and we expect this trend to continue through 2023 as juniors struggle to obtain financing in challenging capital markets. This will make it all the more important for miners to meet criteria for government incentives. We expect total exploration spending to decline through 2023 as earnings soften. Though smaller exploration budgets could exacerbate shortages of critical minerals, spending on exploration should grow over the long term as miners seek to meet increasing demand.

A growing emphasis on discovery

Exploration spending on three key commodities (US$m)



Source: Company annual reports, S&P Capital IQ, PwC analysis

The coming year

The outlook for the Top 40 in 2023 is mixed. We expect softening prices for many key mining commodities and, as a result, we forecast a 9% fall in revenue. Revenue from coal is expected to fall by at least 20%, and the commodity is unlikely to be the industry's main revenue source next year, which could lead to a change in the composition of the Top 40.

We expect the 2022 trend of rising costs to stabilise through 2023, as lower shipping and fuel costs offset some inflation pressures. Our outlook—higher costs and lower revenue—points towards a decrease in EBITDA margins, from 29% in 2022 to 28% in 2023, and towards negative net cash flow. Given the challenging economic conditions, we believe overall capital spending will also decline, though spending on critical minerals and decarbonisation should increase. Payment of dividends is still expected to be high, although down from 2022 levels.

To ensure longer-term resilience, the Top 40 should focus on responding to evolving trends even as they temper spending. With continued free cash flow and strong balance sheets, these miners are well-positioned to take advantage of new opportunities.

Top 40 mining companies: Summarised cash flow (US$bn)

	2023 (forecast)	2022	2021	% change 2022–23 (forecast)	% change 2021–22
Net operating cash flows	157	180	225	-13%	-20%
Purchase of property, plant and equipment	(75)	(75)	(72)	0%	4%
Free cash flow	**82**	**105**	**153**	**-22%**	**-31%**
Dividends paid	(66)	(74)	(85)	-11%	-13%
Share buybacks	(9)	(10)	(11)	-10%	-9%
Total shareholder returns	**7**	**21**	**57**	**-67%**	**-63%**
Net repayments of debt	(7)	(6)	(7)	17%	-14%
Other	(10)	(34)	(16)	-71%	113%
Net cash flow	**(10)**	**(19)**	**34**	**47%**	**-156%**

Note: Totals may not equal sums due to rounding.
Source: Company annual reports, S&P Capital IQ, PwC Analysis

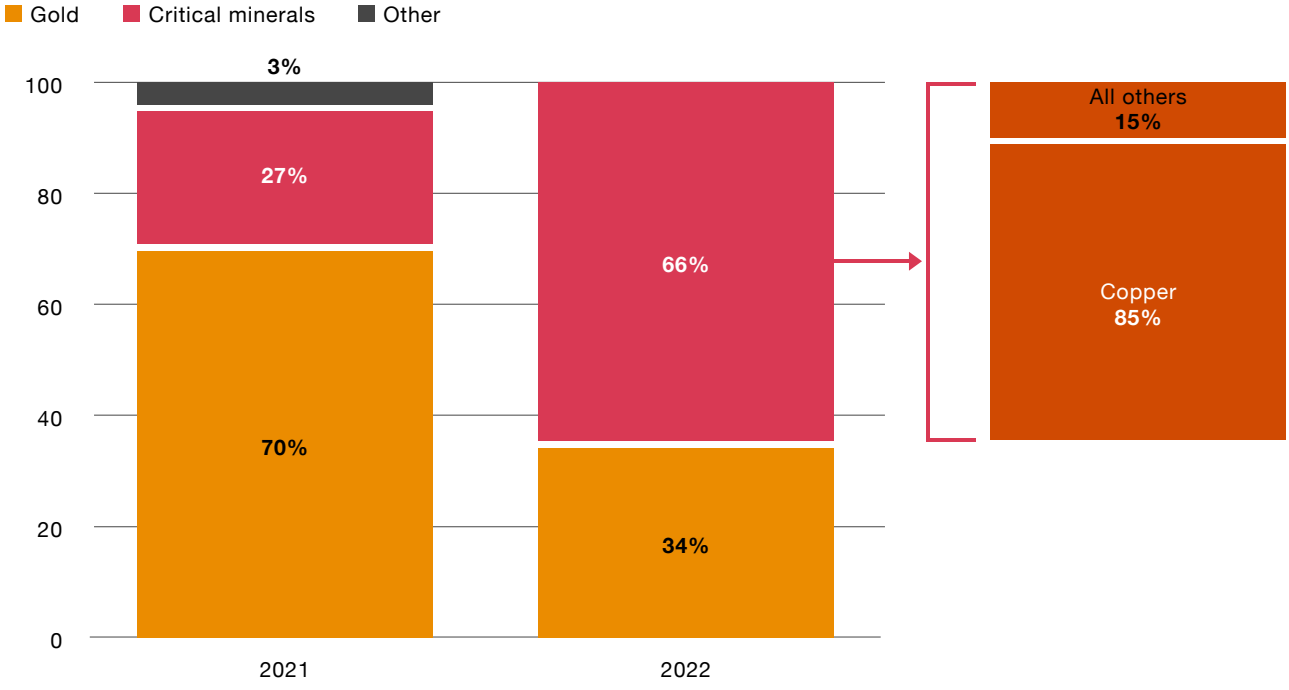
Chapter V

Deals: The race for critical minerals

Critical minerals transactions dominated deal activity in 2022 as miners big and small raced to reposition themselves for the energy transition. Miners now face an intensely competitive environment for critical minerals assets. As opportunities dwindle, mining leaders must act with urgency to acquire the assets that will power their companies' future growth.

Critical minerals deals surge

Top 40 mining companies: M&A activity



Source: Company annual reports, S&P Capital IQ, PwC analysis

Though the total value of Top 40 M&A activity was steady in 2022 compared with the previous year, the composition of those deals changed significantly. The value of critical minerals deals increased by an impressive 151% from 2021, accounting for 66% of all deal value in 2022. Gold deals, on the other hand, fell by 50%, marking the end of the precious metal's dominance of M&A for the past several years. Copper was the year's hot commodity, representing 85% of all critical minerals transactions and 56% of the Top 40's M&A activity. As a key metal that enables electrification and renewable energy, copper should be in high demand during the years ahead.

The Top 40's major moves

It's no surprise that companies with critical minerals businesses have become acquisition targets, given the substantial demand for these commodities and the long lead times required to bring new mines into production. Among the Top 40, several trends in critical minerals deal-making have emerged in the past several years. The first is a preference for outright ownership rather than joint ventures, illustrated by Rio Tinto's full acquisition of Canada-based Turquoise Hill Resources in December 2022.

The second trend is an increasing appetite for transformational deals, as the largest members of the Top 40 seek to unlock value within existing portfolios, acquire strategic assets, achieve operational efficiencies and improve resilience. An example is Glencore's US$22 billion-plus offer for Teck Resources. The offer, which was rejected, would have reshaped the mining industry—first combining the companies, and then splitting them into two mining powerhouses, one focused on base metals and the other on coal and carbon steel materials.

Another example is Vale's effort to sell a 10% stake in its base metals business before carving out the entire base metals unit. Though these deals don't always work out as contemplated—and face some scrutiny from investors, governments and other stakeholders—they indicate that Top 40 companies are looking to reinvent themselves.

Top 40: Critical minerals transactions in 2022

US$6.4bn

BHP's takeover of Oz Minerals marked a significant move to strengthen its position in copper and nickel. The deal included Oz Minerals' Carapateena copper mine (which is near BHP's Olympic Dam copper mine) and the West Musgrave nickel project in Western Australia.

US$3.3bn

Rio Tinto acquired the portion of Turquoise Hill Resources that it did not already hold, giving it a 66% stake in the expansion-stage Oyu Tolgoi copper mine in Mongolia. Oyu Tolgoi is expected to become the world's fourth-largest copper mine, with a projected output of 500,000 tonnes per year.

Other entrants in the race

Though the Top 40 accounted for more than half of the value of all critical minerals deals in 2022, other mining companies also made moves to reshape their portfolios for the future. Key deals outside of the Top 40 include Lundin's US$950 million offer for 51% control of the Caserones Copper Mine in Chile and Albemarle's US$3 billion-plus bid for Liontown Resources, which owns one of the largest and highest-grade lithium deposits in the world. More recently, lithium producers Allkem and Livent announced that they would merge, in a deal that would form a US$10.6 billion company and create the world's third-largest lithium producer.

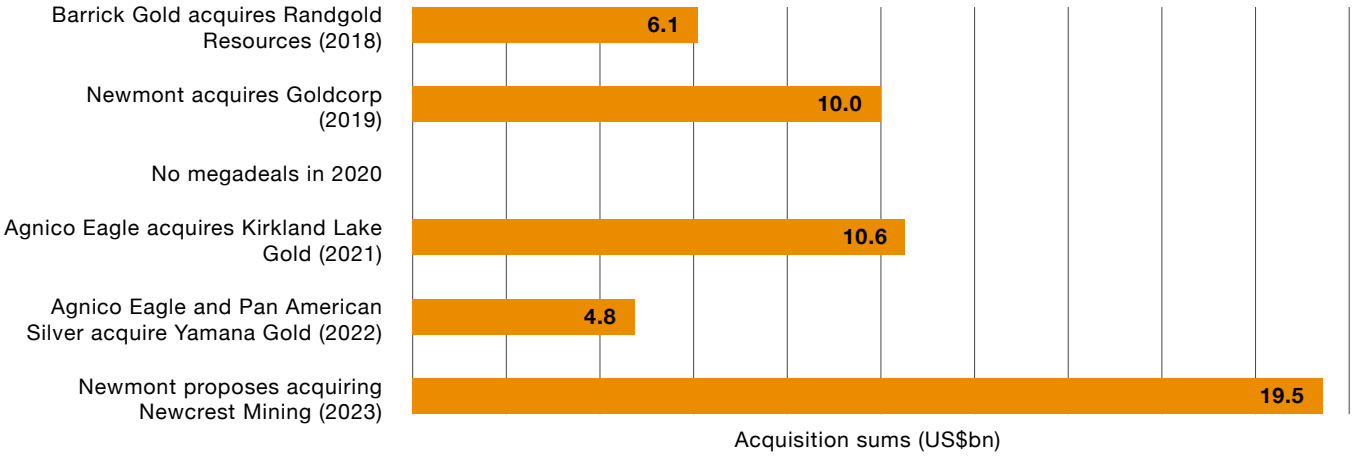
Mining companies aren't the only players in the race for critical minerals. Sovereign wealth funds and pension plans have shown increasing interest in critical minerals companies. And, as noted above, OEMs—particularly those in the automotive sector—have been entering into strategic partnerships with miners.

Gold's continued consolidation

Although the value of gold M&A fell between 2021 and 2022, the sector still saw plenty of deal activity. The largest transaction, worth US$4.8 billion, was Agnico Eagle Mines and Pan American Silver's acquisition of Yamana Gold. The deal closed in March 2023 at the end of a long process that began in May 2022, when Yamana paid a US$300 million termination fee to Gold Fields, the original announced buyer. The Yamana Gold deal, which will significantly expand Pan American Silver's operations in Latin America, demonstrates that gold miners are capitalising on current market conditions to author the next chapter of the industry's consolidation story.

M&A in the gold sector continues

Top 40 mining companies: Largest gold megadeals by year



Note: Newmont's proposed acquisition of Newcrest Mining could be valued at up to US$20 billion. The figure listed above is an estimate made at the time of publication.
Source: Company annual reports, S&P Capital IQ, PwC analysis

And gold miners show no signs of slowing down their deal-making. The beginning of 2023 brought news of a potential megadeal that could go down in history as the industry's largest: Newmont's attempt to reunite with Newcrest after almost a quarter of a century apart. The proposed acquisition, which could be valued at up to US$20 billion, would provide Newmont with assets in familiar locations, potentially leading to greater efficiency and resilience. As gold miners navigate a complex, changing market, M&A still offers a means of building scale, optimising portfolios and unlocking synergies. We expect to see continued M&A activity in the gold sector, including mid-tier consolidation and a megadeal every few years.

An ESG mindset

Emissions regulation and the energy transition mean that coal assets are under increasing scrutiny, with investors exiting the sector and mining companies reorganising portfolios. Some large investors, including BlackRock and Fidelity Investments, have publicly committed to phasing out their stakes in thermal coal producers, underscoring the challenges that miners with coal assets can face. Teck Resources' initial plan to separate its base metals and coal businesses, and Glencore's subsequent proposal to merge with Teck and then divide their combined holdings into a base metals company and a coal company, both resemble recent portfolio overhauls by other Top 40 mining companies.

Whether through M&A or decommissioning, coal assets will remain at the forefront of change, and Top 40 miners will likely continue to reorganise their operations in line with the shift to a low-carbon economy.

The time to act is now

As demand for critical minerals grows, miners will face continued pressure to establish competitive positions with respect to geographic footprint and asset balance. We also anticipate that stakeholders' expectations on sustainability will shape the future of the critical minerals segment, as buyers across all sectors look to demonstrate responsible sourcing. For miners, finding the right value-chain partners will be important, whether through partnerships, acquisitions or consolidation. When assessing deals, the world's large mining companies should plan for:

- further consolidation in the critical minerals space
- more efforts by miners and non-miners to secure supply through strategic partnerships
- increased price volatility in the near to medium term as inflationary and demand pressures continue
- additional government action through regulations and tax changes, alongside deals scrutiny.

Deal strategy will be central to the Top 40's long-term success. Large miners must closely monitor deal opportunities and value propositions as the M&A market becomes more competitive. Those that act now will reap the benefits in the next five to ten years.

Chapter VI

Talent: Preparing for the future

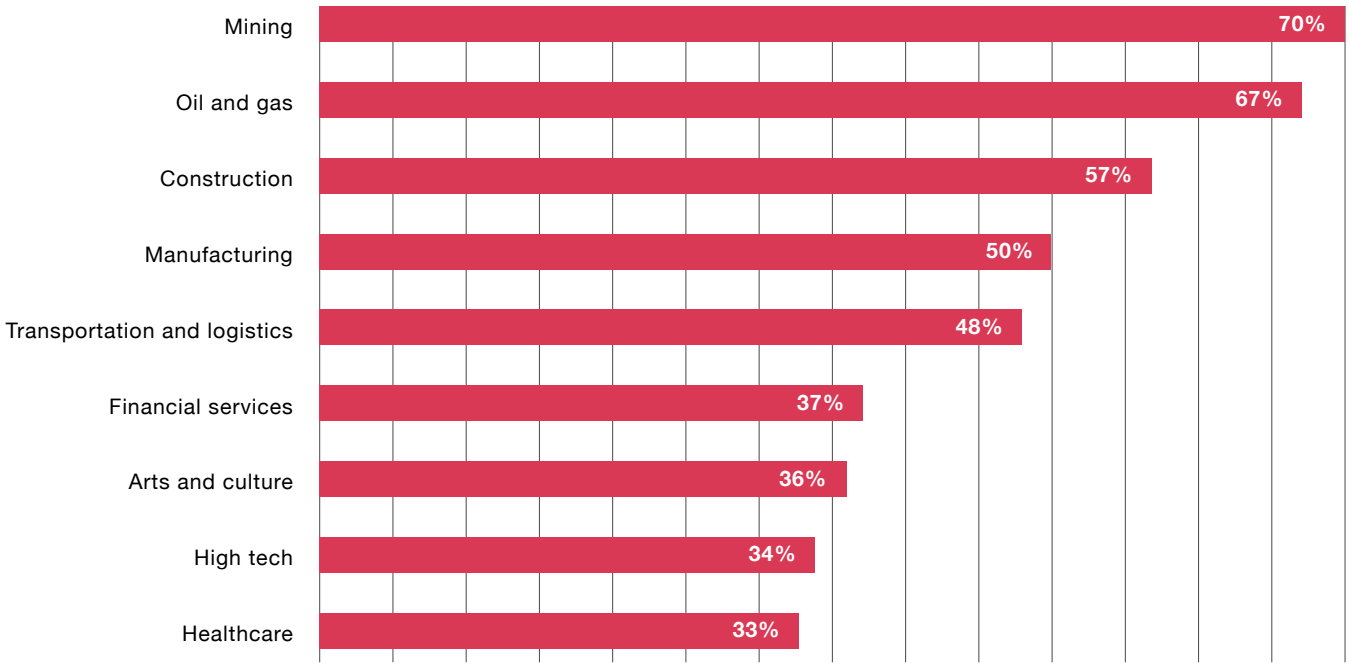
For mining companies, the talent shortage is becoming a nearly existential challenge. Miners must attract more workers, including those with coveted technology skills, to achieve their strategic objectives. Yet many of the most sought-after workers do not see the industry as attractive. The Top 40 need to rethink their workforce strategies to appeal to a wider range of employees.

The world's big miners have a talent problem. Mining companies need talent to meet the growing demand for minerals and metals. They especially need talent who can work with the advanced technologies that are integral to modern mine operations. But many workers don't want mining jobs. Young workers are emblematic of this. In a survey by the Mining Industry Human Resources Council of Canada, 70% of 15- to 30-year-olds said they probably or definitely would not consider a career in mining, the highest proportion of all industries. The mining workforce also exhibits wide gender gaps: according to the International Labour Organization (ILO), approximately 14% of mining jobs are held by women.

The talent problem is complex, and there are no straightforward solutions. Nevertheless, miners must act quickly to avoid the long-term consequences of a growing shortfall in skills. According to PwC's 26th Annual Global CEO Survey, almost two-thirds of mining CEOs believe that skill shortages will have a large or very large impact on profitability over the next ten years.

Young workers are less interested in mining than in other fields

Percentage of respondents who chose ‘definitely would not’ or ‘probably would not’ consider jobs in mining and other sectors



Note: In December 2020, 3,000 Canadians aged 15-30 were asked, ‘How likely, if at all, would you consider working in these sectors?’
Source: Mining Industry Resources Council

Targeting tech

Just as mining workers at large companies no longer work with picks and shovels, the workers of the future will not be driving trucks and loaders. (Between May 2021 and May 2022, the number of autonomous haul trucks in operation globally grew from 769 to 1,068, an increase of 39%.) Rather, their skills will be in robotics, automation and data analytics. Indeed, when a 2020 World Economic Forum survey asked mining executives which skills are in high demand at their organisations, respondents named technology-use skills more often than any other kind. Meeting the need for workers with technology skills won’t be easy; after all, companies in every industry want to hire them, too. Besides recruiting beyond the traditional mining talent pool, leaders must also retrain existing workers.

Some mining companies have tried to reach tech workers through graduate programmes and other incentives, but the sector has struggled to bring in the necessary talent. In the World Economic Forum survey noted above, 57% of the surveyed companies said that they see the inability to attract specialised talent as the biggest barrier to the adoption of new technology. A more formidable problem may be the availability of such workers: 73% of the surveyed companies named skills gaps in the local labour market as the biggest barrier to adopting new technology. With many mine sites operating in remote locations, successful retraining of local workers is likely to be critical.

73%

of mining companies see local skills gaps as the biggest barrier to adopting new technology.

Source: World Economic Forum

As it is, though, some workers lack confidence that even their *current* employers are training them in the use of technology. In PwC's Global Workforce Hopes and Fears Survey 2022, 38% of workers at metals and mining companies said that they're concerned about not getting sufficient training in digital and technology skills from their employer.

To attract the talent they'll need at tech-enabled mining sites, miners should consider the following approaches.

- Invest in education at the site and community level to attract and retain talent who can be trained, reskilled or transferred.
- Collaborate with governments, industry and peers on policy advocacy for issues such as the migration of skilled workers and support for remote mining communities to attract talent and fulfill workforce requirements.
- Invest in communications to highlight the industry's role in the energy transition and its use of technology to change the way miners mine, which could help address the perception of mining as environmentally harmful, physically demanding, hazardous and remote.

Championing DE&I

A strong diversity, equity and inclusion (DE&I) culture is critical for attracting talent. A recent US study by CNBC showed that 80% of respondents find inclusion important when choosing an employer. What's more, inclusive companies benefit from diversity of experience and diversity of thinking—two valuable qualities in an industry undergoing change. In the mining industry, though, diversity is lacking across a wide range of workforce characteristics. Here, we focus on gender imbalance, which continues to be an issue.

The case for gender diversity in mining is solid. One recent study by BHP showed that teams composed of both men and women were more productive and more engaged, and that they operated more safely. Such teams delivered an average of 67% lower total recordable-injury frequency and saw improved company culture, with a 21% greater sense of company pride, than teams composed solely of men. What's more, the Top 40 mining companies are largely aligned around the idea of increasing gender diversity. In a review of the most recent sustainability reports published by the Top 40, we found that around two-thirds had set targets for the representation of women at some level of the organisation.

Nevertheless, significant gender gaps persist at all levels of many mining organisations. According to S&P Global, women hold only 14% of executive positions and 12.3% of board positions at mining companies worldwide. And though focusing on the executive level is important to shift the industry's gender imbalance, so is increasing women's participation at an operational level, given that operational roles represent the bulk of the mining industry workforce.

But strengthening DE&I in the workplace isn't as simple as setting hiring quotas. As mine workers know from their long experience in prioritising physical health and safety by setting targets, reporting against goals and holding management

14%

of mining jobs worldwide are held by women.

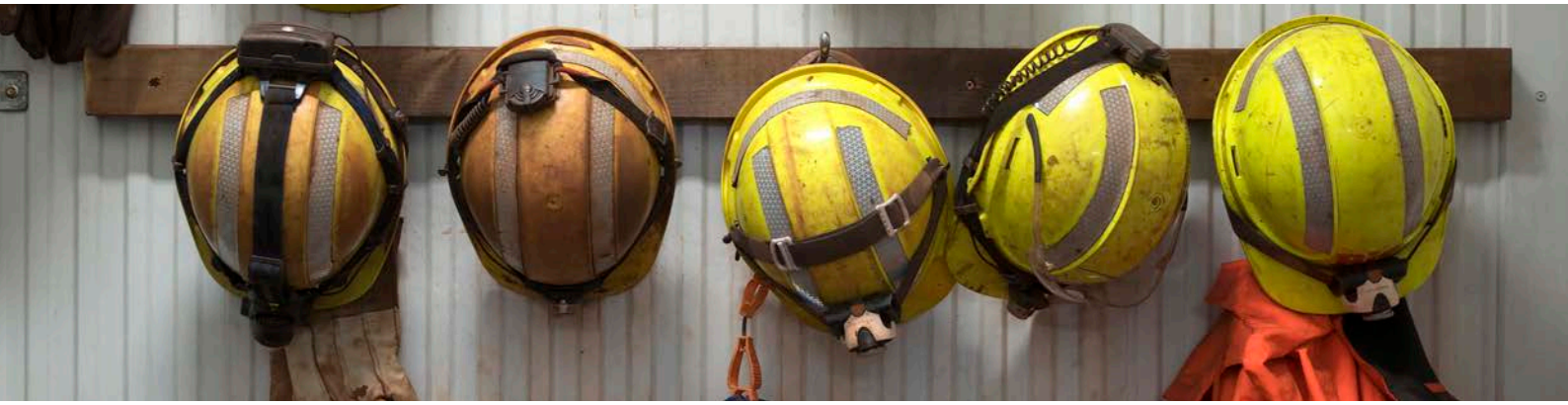
Source: International Labour Organization, *Women in mining*

accountable, changing workplace practices and culture requires policies, incentives and long-term strategies. Mining companies among the Top 40 have taken such steps as establishing requirements to seek diverse candidates during recruiting and tying executive compensation to diversity targets.

Some have also established training programmes to raise awareness of discrimination and harassment and to promote a more inclusive and open work environment. According to PwC's Global Workforce Hopes and Fears Survey 2022, almost two-thirds of workers at metals and mining companies said they frequently or sometimes have conversations at work about social and political issues. They were also more likely to say that these conversations have a positive impact than a negative one.

To attract diverse talent and achieve the benefits of an inclusive workforce, miners should consider these action steps.

- Understand the state of DE&I in your business by gathering data and creating transparency with stakeholders.
- Embrace technology to remove barriers brought about by the remote location of many mine sites and allow a more accessible working environment.
- Build a strategy that highlights DE&I as a priority and embeds it throughout the organisation; communicate how it directly affects the bottom line.
- Generate buy-in from leaders throughout the business; ensure that the tone at the top is aligned with the stated purpose.



Top 40 global mining companies

2023 rank	2022 rank	Change from 2022	Company	Country	Commodity focus
1	1	-	BHP Group Limited	Australia	Diversified
2	2	-	Rio Tinto Group	Australia / UK	Diversified
3	4	1	Glencore plc	Switzerland	Diversified
4	3	-1	Vale S.A.	Brazil	Diversified
5	5	-	China Shenhua Energy Company Limited	China	Coal
6	6	-	Freeport-McMoRan Inc.	United States	Diversified
7	7	-	Anglo American plc	UK / South Africa	Diversified
8	New	New	PT Bayan Resources Tbk	Indonesia	Coal
9	10	1	Fortescue Metals Group Limited	Australia	Iron ore
10	14	4	Saudi Arabian Mining Company (Ma'aden)	Saudi Arabia	Diversified
11	11	-	Zijin Mining Group Company Limited	China	Diversified
12	8	-4	Newmont Corporation	United States	Gold
13	13	-	Barrick Gold Corporation	Canada	Gold
14	12	-2	Grupo México, S.A.B. de C.V.	Mexico	Diversified
15	17	2	Shaanxi Coal Industry Company Limited	China	Coal
16	27	11	Agnico Eagle Mines Limited	Canada	Gold
17	24	7	Yankuang Energy Group Company Limited	China	Coal
18	22	4	Teck Resources Limited	Canada	Diversified
19	19	-	Antofagasta plc	UK	Copper
20	15	-5	Tianqi Lithium Corporation	China	Lithium
21	29	8	Coal India Limited	India	Coal
22	18	-4	Hindustan Zinc Limited	India	Diversified
23	23	-	The Mosaic Company	United States	Potash
24	32	8	China Coal Energy Company Limited	China	Coal
25	21	-4	First Quantum Minerals Limited	Canada	Copper

Top 40 global mining companies (continued)

2023 rank	2022 rank	Change from 2022	Company	Country	Commodity focus
26	20	-6	CMOC Group Limited	China	Diversified
27	25	-2	Newcrest Mining Limited	Australia	Gold
28	26	-2	South32 Limited	Australia	Diversified
29	28	-1	Shandong Gold Mining Company Limited	China	Gold
30	30	-	Impala Platinum Holdings Limited	South Africa	Platinum group
31	New	New	Mineral Resources Limited	Australia	Diversified
32	38	6	Cameco Corporation	Canada	Uranium
33	34	1	Ivanhoe Mines Limited	Canada	Diversified
34	35	1	Gold Fields Limited	South Africa	Gold
35	New	New	Northern Star Resources Limited	Australia	Gold
36	40	4	AngloGold Ashanti Limited	South Africa	Gold
37	37	-	Fresnillo plc	Mexico	Diversified
38	New	New	Pilbara Minerals Limited	Australia	Lithium
39	39	-	Sibanye-Stillwater Limited	South Africa	Diversified
40	36	-4	Jiangxi Copper Corporation Limited	China	Copper

Source: S&P Global Market Intelligence, PwC analysis

Constructing the report

Our analysis includes major companies from all parts of the world whose primary business is assessed to be mining. The results aggregated in this report have been sourced from the latest publicly available information, primarily annual reports, and from financial reports available to shareholders. Our report also expresses PwC's point of view on topics affecting the industry, developed through interactions with our clients and other industry leaders and analysis.

Companies have different fiscal year ends and report under different accounting regimes, including International Financial Reporting Standards (IFRS), United States Generally Accepted Accounting Principles (US GAAP) and others. Information has been aggregated for the individual companies, and no adjustments have been made based on different reporting requirements. As far as possible, we have aligned company financial results to be as at, and for, the year ended 31 December 2022. For companies that do not have December year ends, we added and deducted reviewed results to reflect the comparable 12-month period. The aggregated financial information of the Top 40 includes the results of the Top 40 mining companies as reported in each respective edition of PwC's *Mine.*

All figures in this publication are reported in US dollars (US$), except where specifically stated. The balance sheets of companies that report in currencies other than US dollars have been translated at the closing US dollar exchange rate, and the cash flow and financial performance were translated using average foreign exchange rates for the respective years.

Some diversified miners undertake part of their activities outside the mining industry, such as parts of the Rio Tinto aluminium business and Glencore's marketing and trading revenue and costs. We have not excluded these activities from the aggregated financial information, except where noted. Where their primary business is outside the mining industry, companies have been excluded from the Top 40 listing.

All royalty companies and metal streamers are excluded. Entities that are controlled by others in the Top 40 and consolidated within their results have been excluded, even where minority stakes are listed.

2023 outlook methodology

Income statement. We have forecast revenue from the sale of commodities based on the critical inputs of commodity price and production volumes. Foreign exchange has been considered in various aspects of expenses; however, a wide variety of functional and operating currencies is used by the Top 40, and therefore estimates are subject to judgment.

For commodity prices, we have used the latest consensus economic data available for each of the major commodities mined by the Top 40, coupled with the latest available production estimates for the 2023 financial year from annual reporting or, where available, more recent public information releases made before this publication was finalised.

Taxes are forecast with reference to the average effective tax rate over the past eight years, with the exception of notable anomalies.

Cash flow statement. Cash flow from operations was forecast with reference to movement in EBITDA. The drivers of working capital balances are expected to move in line with their historical tendencies, and no material movement in working capital adjustment is expected.

Investing cash flows include capex and have been forecast based on guidance issued by our Top 40 at the date of the report.

Dividends are forecast with reference to amounts declared at the date of the report. Net debt repayments are expected to remain consistent with historical trends.

Share buybacks are based on history and announcements made at the date of the report.

Top 40 mining companies: Ten-year financial trends (US$bn)

	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
Aggregate market capitalisation	1,225	1,203	1,120	898	757	926	714	494	791	958
Aggregated income statement										
Revenue	943	925	656	692	683	600	496	539	690	719
Operating expenses	(670)	(633)	(482)	(524)	(518)	(454)	(390)	(448)	(531)	(554)
EBITDA	274	292	174	168	165	146	106	91	159	165
Impairment charges	(9)	(6)	(11)	(14)	(12)	(4)	(19)	(53)	(27)	(57)
Amortisation, deprecation and impairment	(49)	(52)	(50)	(50)	(47)	(41)	(44)	(42)	(48)	(42)
Net finance cost	(5)	(7)	(10)	(14)	(13)	(11)	(9)	(19)	(15)	(16)
Profit before tax	211	226	102	89	93	90	34	(23)	69	50
Income tax expense	(57)	(67)	(32)	(29)	(27)	(29)	(15)	(4)	(24)	(30)
Net profit/(loss)	153	159	70	61	66	61	19	(27)	45	20
EBITDA margin	29%	32%	26%	24%	24%	24%	21%	17%	23%	23%
Aggregated cash flow statement										
Operating activities	180	225	142	130	134	119	89	92	127	124
Investing activities	(85)	(71)	(56)	(69)	(63)	(46)	(40)	(69)	(93)	(125)
Financing activities	(114)	(117)	(51)	(66)	(70)	(63)	(44)	(31)	(31)	(3)
Dividends paid	(74)	(85)	(37)	(55)	(43)	(36)	(16)	(28)	(40)	(41)
Share buybacks	(10)	(11)	(1)	(7)	(15)	(7)	(4)	(7)	(6)	(4)
Free cash flow	105	153	81	69	77	71	40	23	24	(6)
Aggregated balance sheet										
Cash	141	156	123	88	101	102	86	82	83	168
Property, plant and equipment	676	647	653	649	610	663	616	579	745	712
Total assets	**1,286**	**1,235**	**1,163**	**1,139**	**1,080**	**1,129**	**1,063**	**1,047**	**1,231**	**1,256**
Total liabilities	**616**	**620**	**588**	**576**	**540**	**573**	**563**	**569**	**630**	**624**
Total equity	**670**	**614**	**575**	**563**	**540**	**556**	**500**	**478**	**601**	**632**

Note: The information above includes the aggregated results of the Top 40 mining companies as reported in each edition of PwC's *Mine*.
Source: Company annual reports, PwC analysis

Glossary

Term	Definition
AI	Artificial intelligence
Battery minerals	The raw materials used in the production of batteries, including lithium, nickel, cobalt, manganese and graphite
CBAM	Carbon Border Adjustment Mechanism
CEO	Chief executive officer
CO_2	Carbon dioxide
Critical minerals	Critical minerals may be defined differently depending on location. For the purposes of this report, we have considered the commodities needed to generate low-emission energy: elements such as lithium, nickel and cobalt for energy storage; copper and aluminium for energy transmission; and silicon, uranium and rare earth elements for energy generation such as solar, wind and nuclear.
DE&I	Diversity, equity and inclusion
DRC	Democratic Republic of the Congo
EBITDA	Earnings before interest, taxes, depreciation, amortisation and impairments
EBITDA margin	EBITDA divided by revenue
ESG	Environmental, social and governance
EU	European Union
Free cash flow	Operating cash flows less purchases of property, plant and equipment
Green bonds	Debt securities issued to fund projects with a positive environmental impact and/or climate benefits
Green premium	Price premium for products that meet the highest ESG operating standards and have comparatively low or net-zero emissions

Term	Definition
GRI	Global Reporting Initiative
IEA	International Energy Agency
ILO	International Labour Organization
IRA	Inflation Reduction Act
M&A	Mergers and acquisitions
Market capitalisation	The market value of the equity of a company, calculated as the share price multiplied by the number of shares outstanding
Net assets	Total assets less total liabilities
Net debt	Total borrowings less cash
Net profit margin	Net profit divided by revenue
Net zero	The state at which greenhouse gases produced are equal to greenhouse gases removed from the atmosphere
OECD	Organisation for Economic Co-operation and Development
OEM	Original equipment manufacturer
Return on capital employed	Net profits excluding impairment, divided by capital employed
Return on equity	Net profits divided by equity
Scope 1 emissions	Direct emissions that occur from sources that are controlled or owned by an organisation
Scope 2 emissions	Indirect emissions created by the production of energy that an organisation purchases
Scope 3 emissions	Indirect emissions generated by customers using a company's product and/or generated by suppliers of the company in making the inputs that the company uses
Top 40	The world's 40 largest mining companies by market capitalisation, as of 31 December 2022
Working capital	Inventory plus trade receivables less trade payables

S&P Capital IQ waiver

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Mine 2023: 20th edition

The era of reinvention

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