



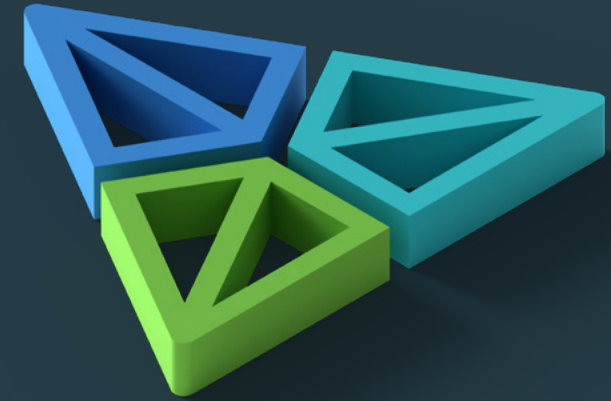
Report No. 1
November 2024

SHAPING THE FUTURE OF MINERALS

Unlocking Mineral
Supply for Global
Development and the
Energy Transition

www.futuremineralsforum.com





03
Executive Summary

04
Introduction

08
Building Shared Value Propositions in the
Minerals Industries

21
From Vision to Reality: Understanding the
Role of Collaboration in our Transition to a
Low-carbon Future

30
Value Creation in a Decarbonising World

35
Investment in Exploration, Infrastructure
Development, and Processing

38
Targeting Opportunities for Mineral Value
Addition

46
Shared Value and the Role of Government
and Industrial Policy

52
AI-Driven Sentiment Analysis of Critical
Minerals: Global Trends in Public Perception

60
Conclusion

Table of Content

WELCOME TO THE FUTURE MINERALS FORUM'S 2024 REPORT



Since its inauguration in January 2022, the Future Minerals Forum (FMF), convened in Riyadh by Saudi Arabia, has become the world's premier gathering of government and industry leaders with the ambition of shaping the future of minerals. For us the supply of minerals is a vital cause for furthering human development and the FMF the spark igniting a movement.

Our current and future success is based on a strategy that seeks to lead the global conversation on minerals through our Ministerial Roundtable; engage by bringing together decision makers; deliver positive impact through action, partnerships and investment; influence by taking the Riyadh conversations to the rest of the world; and inform by providing a thought leadership platform, as well as producing authoritative reports that tackle the tough issues facing mineral supply and spark debate on the way forward.

The 2024 Report makes a case for the value minerals can bring to countries and communities and the importance of supplying minerals in a responsible way to secure societal support. The Report also highlights the need to significantly increase investment through partnerships to achieve development, prosperity and the energy transition, both across our Super Region, as well as all supplier and customer countries.

These perspectives are not presented in isolation, rather contribute to the broader Future Mineral Forum's strategic direction. The topics covered in the Report will be the focus of discussion and debate at FMF25, as well as serve to inform three Ministerial Roundtable initiatives under development that aim to enable global collaboration, build capacity and enhance transparency in mineral supply.

I wish to acknowledge and thank all the report contributors including Mark Cutifani and Dr Michelle Foss, two leading thinkers and advocates for the minerals industry, as well as CRU, Wood Mackenzie, Clareo-DPI and Global AI for their thought provoking and evidence-based analysis. Some of these organizations are competitors in the commercial space, however, they have come together to develop a Report that will play an important part in the global discussion.

I also wish to thank McKinsey & Company for providing technical input to this report.

I invite you to read the Future Minerals Forum 2024 Report and join the conversation.

Ali Al-Mutairi
Executive Director
Future Minerals Forum

November 2024

EXECUTIVE SUMMARY

Despite considerable progress in the fight against climate change, further advancements are imperative to meet critical climate targets. This reality underscores the necessity for a more robust and sustained collaborative approach to accelerate the pace and scale of efforts.

In response to evolving global dynamics, countries and companies are increasingly reevaluating the physical locations where goods are produced to secure and protect strategic supply chains. A shift is underway from merely exporting raw materials to producing higher value-add midstream or downstream products. This transformation aims to enhance economic resilience and generate greater value within local economies. Historically, investments have predominantly focused on mining assets. However, the future landscape necessitates a greater emphasis on processing due to the intricate refining requirements of materials. As mining projects venture into more remote areas, the need for reliable and cost-effective infrastructure—such as power, roads, and ports—becomes critically important.

The industry faces multifaceted challenges, including resource depletion, project cycle times, and geopolitical tensions. These issues must be addressed to sustain long-term profitability. Traditionally, the "extract-and-ship" mindset has led to tensions and a lack of investment in regional growth and infrastructure. Nevertheless, the industry now stands at a pivotal juncture, with companies beginning to embrace their role in fostering shared prosperity.

Governments also play a vital role in this transformation. Establishing enabling environments for collaboration and value-sharing is essential to support these new strategic directions. By working together, governments and industry can create sustainable, resilient supply chains and drive forward the global agenda for economic and environmental sustainability.

INTRODUCTION

This report offers a comprehensive exploration of key challenges in today's energy transition raw materials, including the need for investment, collaboration and responsibilities between government and industry, value addition, social and economic shared value, and societal perception of the minerals sector. The contributors offer a broad range of perspectives that will serve to inform leadership dialogues at the Future Minerals Forum (FMF).

The transition to a low-carbon future is a multifaceted endeavor that cannot be achieved by a single entity or nation. It is a global challenge that requires the concerted effort and strategic collaboration of multiple stakeholders, including governments, industries, and communities. Frameworks such as the United Nations Framework Convention on Climate Change (UNFCCC) and The Paris Agreement highlight the critical need for multinational cooperation in addressing the climate crisis. While these agreements have been instrumental in setting the net-zero targets, further progress is needed to meet key climate targets¹. This underscores the necessity for a more robust and sustained collaborative approach to accelerate the pace and scale of decarbonization efforts.

Minerals for Development

The ongoing energy transition and traditional drivers such as population growth are significantly boosting demand for key materials in the mining and metals industry. To meet this growing demand, substantial investment is needed in mining, refining, and supporting infrastructure, with an estimated US\$5.4 trillion required by 2035. This investment is crucial not only for ensuring the availability and affordability of materials but also for producing them sustainably, which requires advanced processing technologies and robust public-private partnerships. By channeling investments into key areas, there is an opportunity to foster socio-economic growth locally and build resilient supply chains, ensuring a steady and reliable supply of critical materials for the global economy.

¹ CRU group, 2024

The minerals industry plays a crucial role in nation-building by providing raw materials and driving infrastructure expansion. It stands at the forefront of the energy transition, balancing the reduction of emissions while supporting local socioeconomic development in supplier countries. Value creation in this context often involves downstream processing and value chain integration, which can enhance economic value and market access. Despite a common belief that downstream integration always results in added value, the impact of such investments varies across industries.

Countries and companies are increasingly reconsidering the physical locations where goods are produced, to secure and protect strategic supply chains. In this context, mineral value addition has reemerged as a key focus for resource-rich countries. Rather than only exporting raw materials, these nations aim to produce higher value-add midstream or downstream products. This strategy is particularly pertinent for minerals used in clean energy technologies, which are essential for the global energy transition. Policies promoting value addition have been enacted worldwide, from emerging markets in Africa, Asia, Latin America, and the Middle East, to advanced economies like Australia and Canada. Policymakers are considering value addition opportunities based on benefits, competitiveness, and market dynamics, ensuring that investments lead to substantial economic gains and sustainable growth.

Meeting the growing demand for transition materials essential for low-carbon technologies requires substantial investment in mining, refining, and infrastructure development. While past investments have primarily focused on mining assets, the future necessitates a greater emphasis on processing due to the complex refining needs of materials like nickel and lithium. Additionally, as mining projects move into more remote areas, investments in reliable and low-cost infrastructure, such as power, roads, and ports, become increasingly crucial. Addressing these needs is vital for ensuring the availability and affordability of essential materials, thereby supporting the global transition to a low-carbon economy and driving sustainable industrial growth.



Minerals' Contribution to Society

Mining significantly contributes to societal and economic development by providing raw materials, creating jobs, and driving infrastructure expansion, but its success relies on establishing shared value propositions and robust commercial frameworks that incorporate sustainability. The industry's operational and financial performance, influenced by fluctuating commodity markets and regulatory environments, underscores the need for innovation and efficient resource management. Challenges such as resource depletion, project cycle times, and geopolitical tensions must be addressed to sustain long-term profitability. Creating shared value in the mining industry can benefit from a multi-stakeholder approach that includes governments, companies, and communities. Historically, the "extract-and-ship" mindset has led to tensions and a lack of investment in regional growth and infrastructure. However, the industry is now at a turning point, with companies taking on the responsibility of fostering shared prosperity.

Partnership is Fundamental

Governments also have a crucial role in establishing enabling environments for collaboration and sharing value by providing access to capital, investing in infrastructure, and developing regional hubs to mobilize ecosystems of the Super Region of Africa, Western, and Central Asia. Clear roles can help create a shared vision and roadmap that benefits all parties involved, contributing to overall prosperity. Ultimately, a shared vision built on durable partnerships, clear accountabilities between government, industry

and communities are crucial for achieving sustainable growth and meeting stakeholder expectations.

The resource-rich Super Region of Africa, Western and Central Asia has the potential to significantly benefit from a collaborative approach to mining and processing. The Super Region is a term used to describe 79 countries geographically located between the Eastern and Western hemispheres, a 9,000km corridor stretching from South Africa to Kyrgyzstan, that will play an important role in supplying minerals for the energy transition and global development, as well as being a future source of demand.

The region covers 33 per cent of the world's land mass and expected to account for more than 50 per cent of the world's population by 2024.

The Future Minerals Forum's (FMF) ambition and vision is to become the premier global gathering for shaping the future of minerals, focussed on turning discussion into action through government leadership. We believe that only through collaboration can the Super Region leverage its vast mineral endowment to develop and prosper sustainably while building trust through demonstrating responsible action.

By adopting a multistakeholder approach FMF aims to be an inclusive forum that brings together a range of perspectives to find solutions and build trust among all stakeholders, including local communities. Through this platform FMF aims to achieve its purpose of enabling the creation of resilient and responsible mineral value chains for development and the energy transition.

Economic growth is 40 per cent faster than the global average and it had vast renewable energy resources. The Super Region is underexplored containing untapped mineral resources, including 89% of global platinum, 80% of phosphate, 67% of bauxite, 62% of manganese and 59% of cobalt.

By embracing a multi-stakeholder approach, the Super Region can achieve shared value and sustainable development, ensuring collaboration between governments and markets to deliver prosperity for local stakeholders including Indigenous communities before, during and after a mine closes.

The FMF supports this by fostering partnerships that address the key challenges. The FMF's initiatives on developing a regional critical

minerals framework, building capacity through centers of excellence, and developing regional expectations for responsible critical minerals supply aim to highlight opportunities to harness the region's vast natural resources, financing mechanisms, and emerging technologies to drive economic growth, create jobs, and position the Super Region as a leader in clean energy and sustainable development.

The Reputation Challenge

A sentiment analysis² was completed, assessing public opinion from diverse sources, reducing self-reporting bias and highlighting the perceived impacts of critical minerals like cobalt, copper, and lithium. This analysis, covering January 2023 to September 2024, provides valuable insights for policymakers, investors, and industry stakeholders, highlighting significant variations in sentiment across different minerals and regions. The FMF Super Region generally exhibits better overall sentiment for mining compared to the global average, with positive views particularly linked to investment in infrastructure and community engagement. Sustainable practices, transparent governance, and addressing environmental and social concerns are crucial for maintaining positive public perception and ensuring long-term success in the mining sector. Addressing the industry's reputation is essential to enable a reliable supply of critical minerals, and this sentiment analysis helps understand societal views and identify key issues that need to be addressed. This report offers strategic insights to guide discussions, decision-making and policy formulation in the rapidly evolving critical minerals sector.

² AI-Driven Sentiment Analysis of Critical Minerals and Mining: Global Trends in Public Perception across the FMF Super-Region



BUILDING SHARED VALUE PROPOSITIONS IN THE MINING INDUSTRIES

Mark Cutifani, Chairman, Vale Base Metals

Michelle Michot Foss Ph.D., fellow in energy and minerals, Baker Institute, Rice University

THE VALUE PROPOSITION

Mining can create value for societies and their economies. This is a known, and recognized, fact, throughout the experience of human development. Indeed, the earliest human uses of metals defined civilizations. Human progress can be mapped against evolving sophistication in metals for tools and implements that enabled humans to adapt, survive, and prosper.

As a basic industry, mining operators harvest natural resources for beneficial use and contribute to "nation building" by providing both raw materials and spurring expansions of infrastructure. That infrastructure supports not only the mining industry itself but also local, regional, and broader economies. Along the way, mining creates employment and provides building blocks for overall industrial and economic growth and opportunity while injecting billions in direct and indirect payments into private and public coffers. Mining also fosters trade by creating comparative advantages.

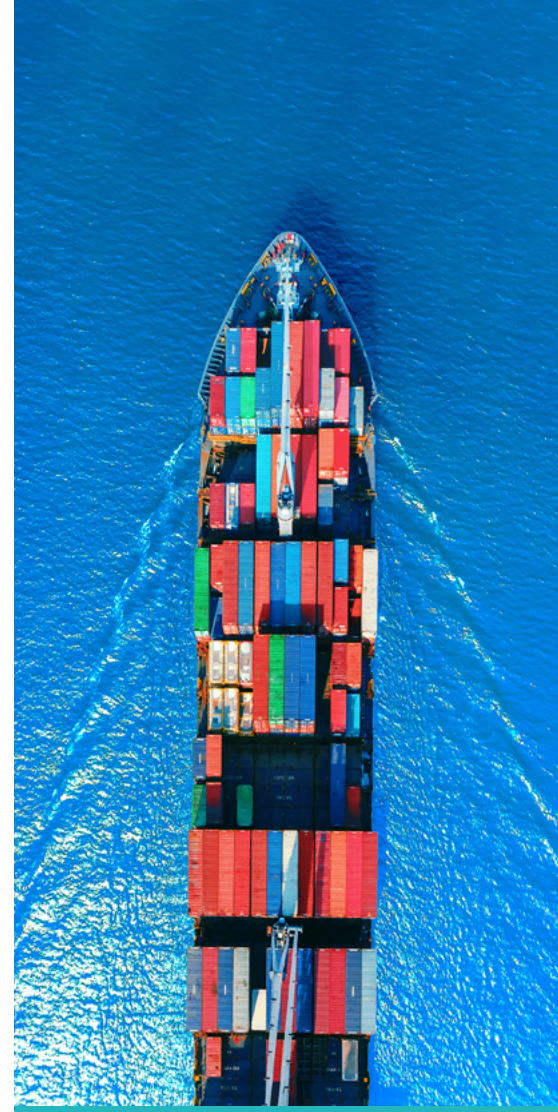
The value proposition is alluring, but none of what has been achieved thus far in human experience has come easily nor will the path forward be any less demanding or risky. Clearly, the potential rewards are worth the effort. However, the size and scope of the ultimate prize is contingent on the level of effort made to ensure and preserve optimal value realization and distribution. This means a shared value proposition – an alignment of interests that fosters durable success, supported by robust commercial frameworks that incorporate broad-based sustainability concepts and effective allocation and distribution of fiscal benefits.

Consistent with the concept of broader social value, we also must be mindful of how the mining industry helps minimize our human footprint by concentrating human activities to help preserve natural and biodiverse communities. This specific contribution is substantial and not universally appreciated.

DEFINING COMMERCIAL FRAMEWORKS

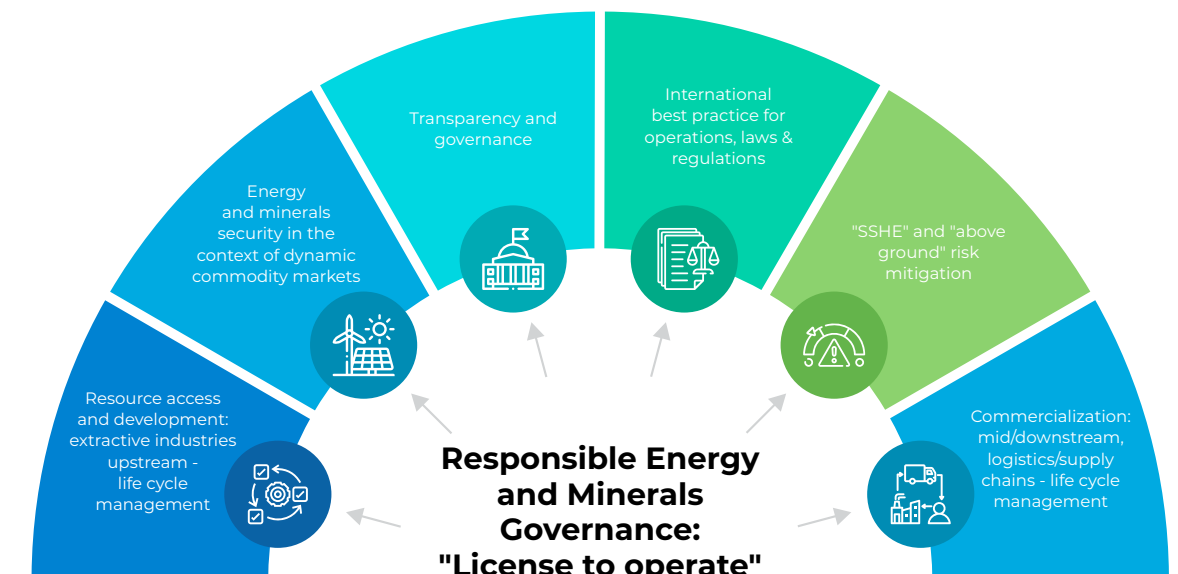
One truth stands out: **All value chains begin upstream.** Overall, value creation occurs at various stages of project development and various supply chain segments, all with varying risk profiles. From a minerals resource owner point of view, the enormous economic rents unleashed from the upstream value proposition are huge. Self-funded prospectors are motivated by expected prices to search for minerals – metallic and non-metallic, fuel and non-fuel. If exploration is successful, latent wealth is realized as discovered resources are exposed to markets. Commercialization can proceed only once resources are demonstrated to be technically recoverable at prevailing prices. The demands of processing and logistics associated with reaching often distant markets are considerable and easily can undermine projects and/or deplete returns, especially given volatility in commodities prices. These realities mean a high degree of confidence within capital markets if investment downstream is a distinct goal.

The mining ecosystem entails complex and linked functions. If any one of these cannot or does not perform and deliver, the entire ecosystem becomes fragile and value realization suboptimal. Lack of access to evaluate resources and potential mineralization disrupts the project development pipeline. Commodity markets are dynamic and unforgiving, and easily weakened if market power is unreasonably asserted. Transparency and governance rest



on confidence in institutions which implies common understanding of practices. While often critiqued, concepts like "rule of law" and "contract sanctity" bear meaning and enable transactions to proceed. The mining industry – no industry – can be successful without adherence to requirements for safe and secure operations, often a first indicator of potential deal-killing problems on down the road. Logistics are the bane of commercialization, usually dictating whether projects can ever deliver profitability on acceptable terms. Looked at through the lens of these linked functions, "license to operate" ought to be a logical outcome if energy and minerals governance are "responsible". That said, defining "responsibility" across the ecosystem can be a loaded concept, subject to interpretation across locations, operations, and societies.

LINKED FUNCTIONS IN THE MINING ECOSYSTEM



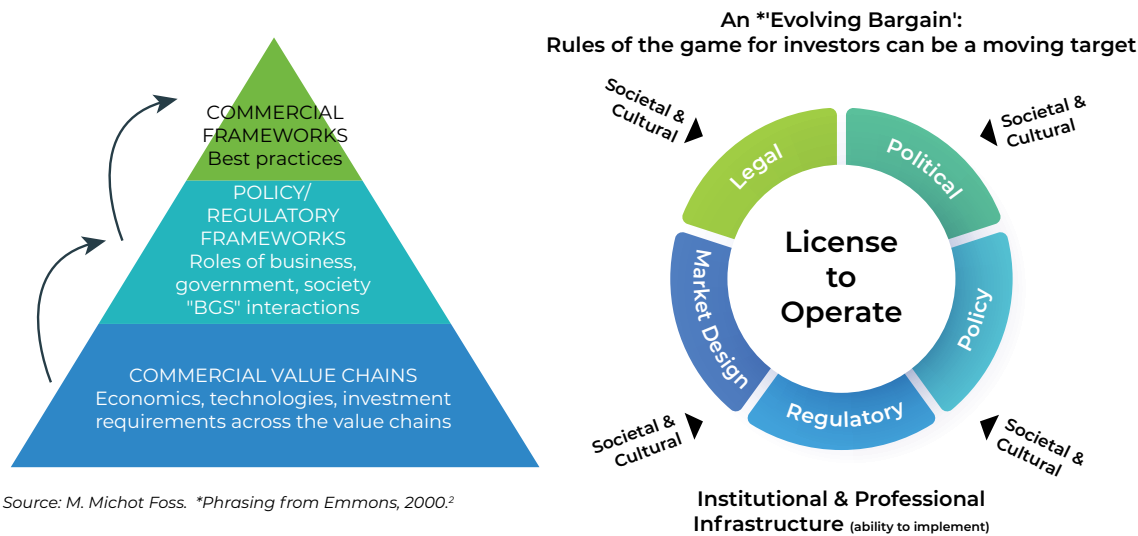
Developed by author, used with permission. 'SSHE' is safety, security, health, environment.

Source: M. Michot Foss, 2022.¹

Executing on the linked functions further requires the building blocks of "commercial frameworks", the combination of sound commercial fundamentals and workable policy and regulatory frameworks that accommodate the range of interactions business, government, and societal interactions that increasingly dominate and can encumber the project development cycle. These building blocks and the resulting commercial framework architecture are themselves the product of constantly "evolving bargains" that reflect political, societal, and cultural dynamics and

pressures. These occur, to some degree, in every nation state. Risks and uncertainties emanate from each interacting domain, raising any number of considerations as mining companies and their investors weigh the potential to achieve some balance that facilitates "license to operate". Institutional and professional "infrastructure" dictate what can get done and how quickly. A commercial framework, no matter how ideal in the eyes of beholders, will only be implemented to the extent that institutional and professional capacity allows.

COMMERCIAL FRAMEWORKS BUILDING BLOCKS AND "EVOLVING BARGAINS"



In today’s world and given expectations about the future, commercial frameworks increasingly must incorporate "sustainability" concepts. But what are these? Too often, sustainability is meant to only include environment, or, even more narrowly, only concerns about emissions. "ESG", environment, social, and governance are replete with poorly defined indicators and metrics.³ Yet sustainability is so much more, not least commercial and financial.⁴ Indeed, without commercial and financial sustainability, not much else can be achieved. Yes, they are deeply intertwined with notions of best practice and responsible governance, but **ability and flexibility to deepen the mining value proposition hinges on establishing sustainability as an economic concept.**

BALANCING SUSTAINABILITY



A proposition is that sustainability for successful mining and minerals development entails seven "pillars".⁶

- Safety and health (SSHE in the mining ecosystem).
- Environmental protections.
- Social performance, with the industry seen as a partner.
- Talent pools to support the industry.
- A resource and production base with replenishment to sustain the business.
- Unit operating cost, preferably in the bottom half of cost curves in order to withstand commodity price ructions.
- Strong balance sheets, conservatively managed to ensure optionality.

In practice, miners and other natural resource industries often go beyond minimum requirements on many fronts, such as mine land reclamation, social performance, and work force development. **Overall, with mining viewed as a partner this means alignment of interests between industry, resource owners and other stakeholders to achieve durable success.**

WHERE IS VALUE CREATED?



Given the preconditions inherent in the mining ecosystem and supporting commercial frameworks, resource owners should focus attention on the key ingredients for upstream value creation – where the highest returns are earned in mining life cycle. This implies laser-like attention to commercial frameworks that best support upstream risk taking and value creation, effective capture of economic rents, and deployment of rents toward most effective development uses. Taken together, these efforts can support the mining industry for nation building.

Source: R.A. Meidl, 2024.⁵

An important consideration is achieving full understanding of mining industry operational and financial performance to build commercial frameworks that can accommodate variations in technical, operational, and market conditions. The mining businesses are distinguished across commodities, over time horizons as supply-demand fundamentals and price signals shift, as innovations unfold, and as new technologies and methods are adopted.

Key mining metrics such as free cash flow, reinvestment, returns to shareholders, revenues to resource owning interests, and return on capital employed are more easily attained and sustained when the value proposition is fully shared.

The industry faces many challenges, of which nine are likely to define the mining businesses going forward.⁷

Minerals occurrences. Technology cannot alter underlying geology, but it can stretch the boundaries of commercial recoverability.

Commercialization. Wide variabilities in mineral concentration and purity have implications for commercialization along with logistics.

Maturity of assets. Mines are built to last decades or more but ageing of the current mining and minerals processing fleet is a particular concern.

Project cycle times. If attention has been galvanized by anything when it comes to ambitions for minerals and metals — as well as the status of the mining industry — it is the length of time that it takes to reach "paid metal" **from new investment.**

Supply chain dominance. China's role as both materials' supplier and "factory to the world" stems from its rapid industrialization and substantial domestic resource base that supports its manufacturing.

Competitiveness. A primary concern in the "new minerals world order" is whether the United States and other major Western economies can regain "mojo" in their mining and minerals processing segments to support domestic initiatives.

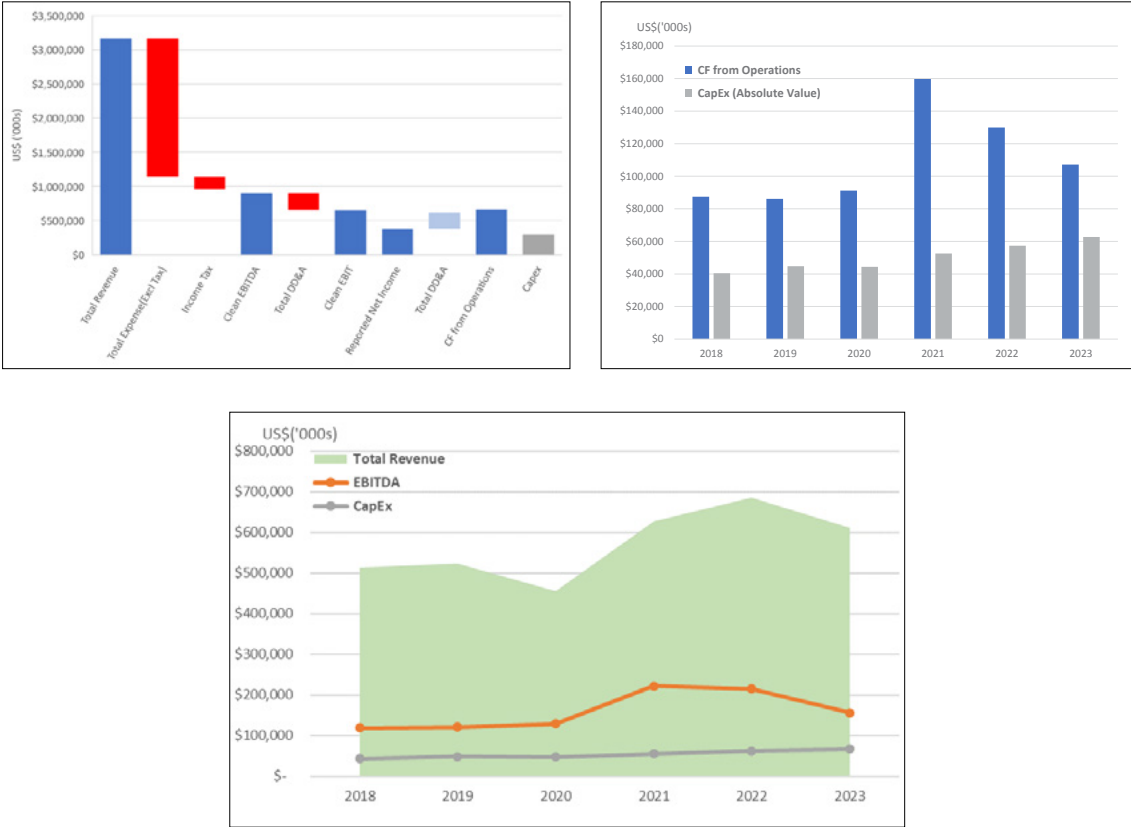
Sustainability in the mining industry. Transitioning from fossil fuels to metals-centric alternative energy technologies ("green" energy technologies) has intensified scrutiny of metals and minerals supply and value chains.

Markets. Metals have a long history of formal trading, but metals trading remains far smaller, with less liquidity than commodities such as oil and natural gas, despite recent growth.

Old and new insecurities. A range of factors — including pressures for access, geopolitical competition, sustainability aspirations, fluctuating markets and prices, and more — are combining to add complexities that will test governance skills and heighten geopolitical and trade tensions.

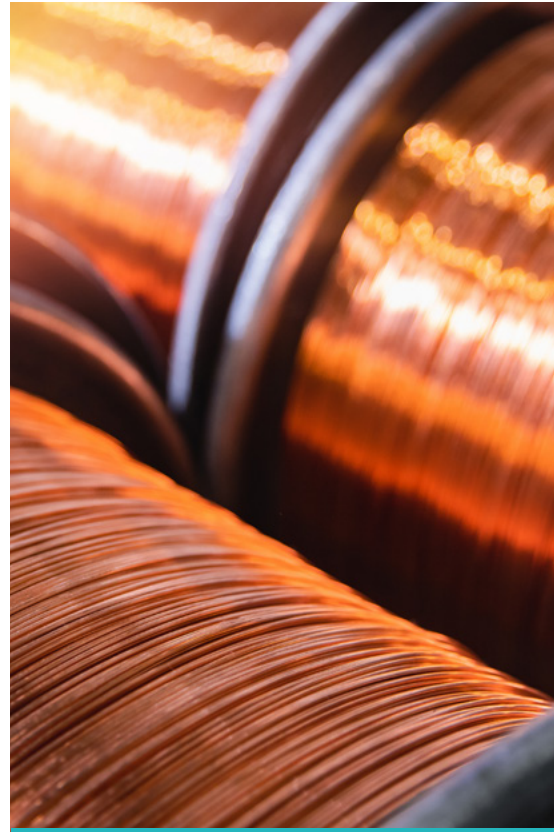
Against this backdrop, the performance of the mining industry in recent years is notable for its ability to maintain capital expenditures while total revenue, cash flows from operations, and earnings came under pressure from lower commodity prices. In truth, the industry funds much capex organically, in particular, for exploration and appraisal to establish mineralization and to ultimately define ore bodies. The same holds for other "mining" businesses such as oil and gas. Capital markets tend to disfavor exploration, with institutional investors preferring to participate in development phases once exploitable resources are confirmed. For the mining industries, this often means less funding available for exploration and replenishment, especially during periods of softness in prices.

A View of Mining Industry Financial Performance, 2018-2023

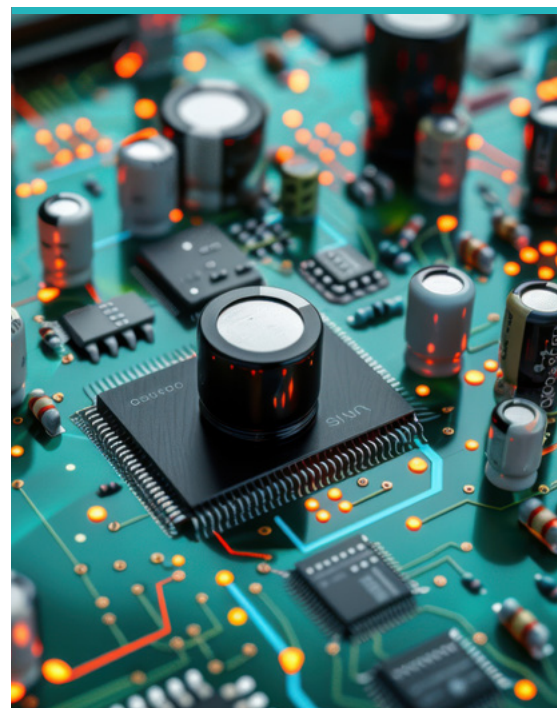


Source: M. Michot Foss and Ishmael Eshun, 2024.⁸ Based on financial reports and other information for 16 companies, worldwide operations. Excludes pure coal producers but includes legacy coal assets for some companies. EBITDA is earnings before interest, taxes, depreciation, amortization. DD&A is depreciation, depletion (tax allowances for produced minerals) and amortization.

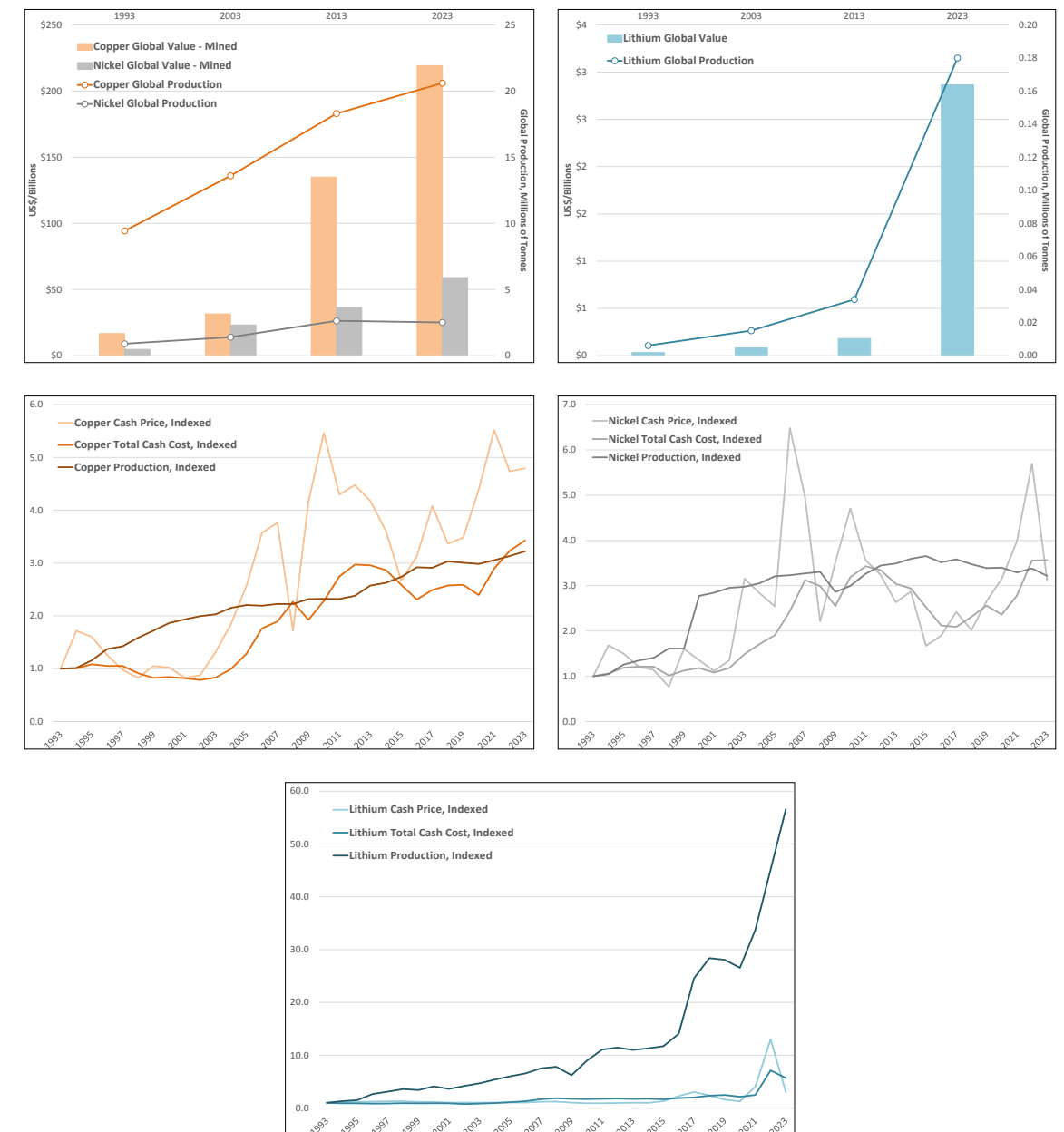
As noted, the mining businesses differ across commodities and their respective markets. Using copper, nickel, and lithium to illustrate these contrasts, over the past three decades, global production and the market value of production have increased for all three. The pace of production growth for copper and nickel slowed while lithium accelerated – lithium is almost purely an "energy storage" play while copper and nickel have many diverse end uses and customers. Total operating expenses (opex or cash costs) have risen for copper and nickel. While overall costs tend to follow, and lag, changes in price, the increases in recent years are not expected to diminish. They reflect the gamut of challenges faced by the industry, as lined out above, including the key indicators embedded in those challenges, such as falling ore grades (with maturity of assets, lack of exploration, and lengthening project cycle times along with the various issues that burden the project development cycle).



Nickel production has been influenced by the pursuit of lower grade resources, such as the laterites that are common in southeast Asia, along with the commensurate higher processing costs associated with HPAL (high pressure acid leaching). The need to achieve large scale output to accommodate these costs has pushed nickel prices down. The same has been true of lithium, a processing-heavy commodity. Lithium processing can include additional costs associated with form (the preference for lithium hydroxide over lithium carbonate for certain battery chemistries). The surge in production and proposed projects along with tension in electric vehicle sales set up a roller coaster in lithium prices in recent years. Lithium tends to be the most volatile among traded commodities. Lithium also serves as an example of the impact on total cash costs if commercial framework regimes change sharply.⁹



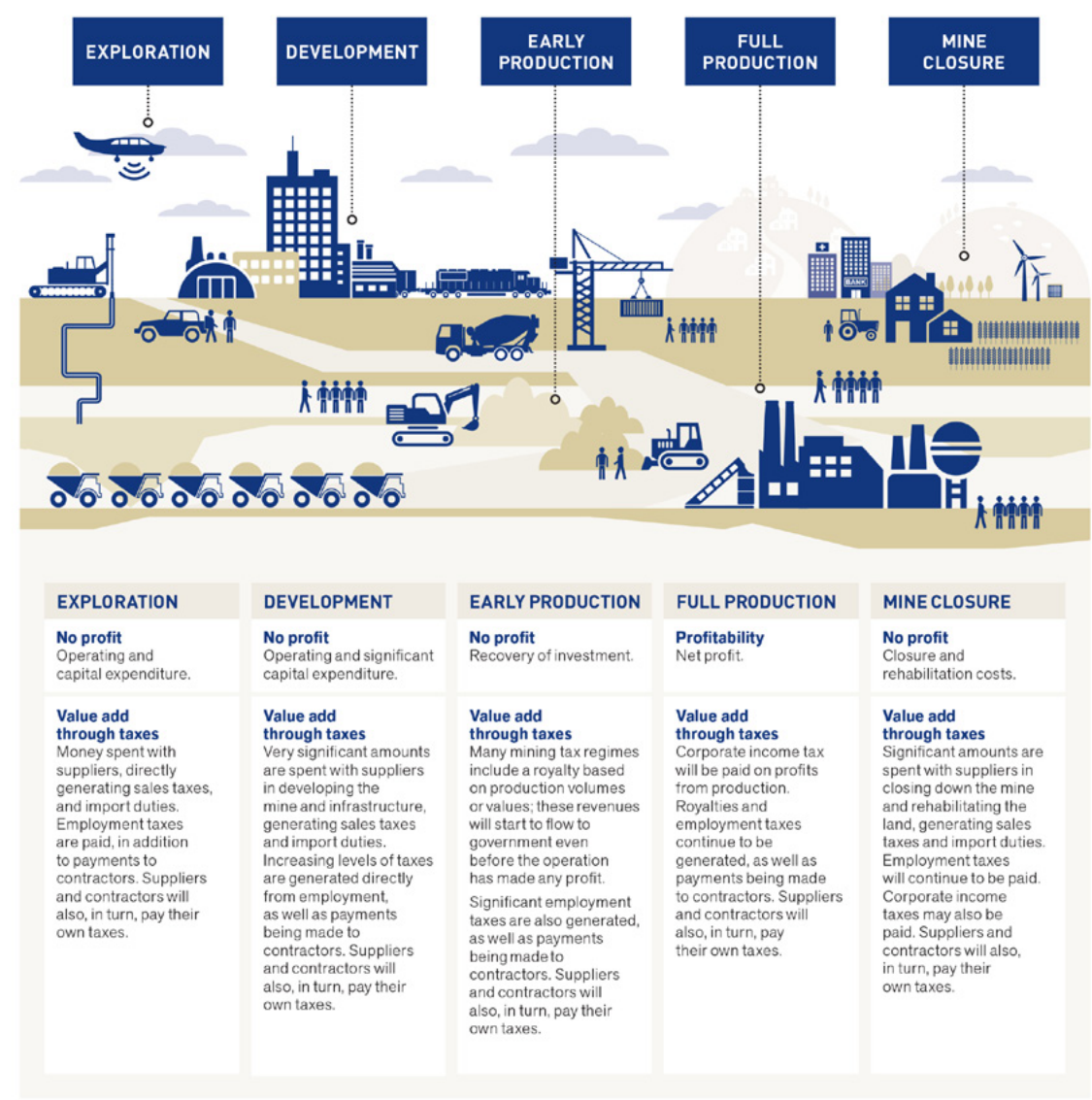
A View of Mining Industry Operational Performance (Copper, Nickel, Lithium), 2023-1993



Source: Michot Foss, using data accessed from SPG via license and public domain sources such as U.S. Geological Survey.

Host governments and societies – be they sovereign nations, territories including tribal and indigenous lands, provinces, counties, municipal jurisdictions – that do a good job of building and offering enabling, derisking commercial frameworks will help their operators to become and remain successful. Mindful of the mining project development life cycle and business dynamics, those jurisdictions can reap the rewards from economic rents and then invest and deploy investment proceeds for economic development to broaden the benefits from mining industries in their countries.

Value Add Through Taxes Throughout the Life of a Mine



From Anglo American, <https://www.angloamerican.com/-/media/Files/A/Anglo-American-Group-v5/PLC/investors/annual-reporting/2015/anglo-tax-report-web.pdf>

THE INDUSTRY CANNOT DO IT ALONE

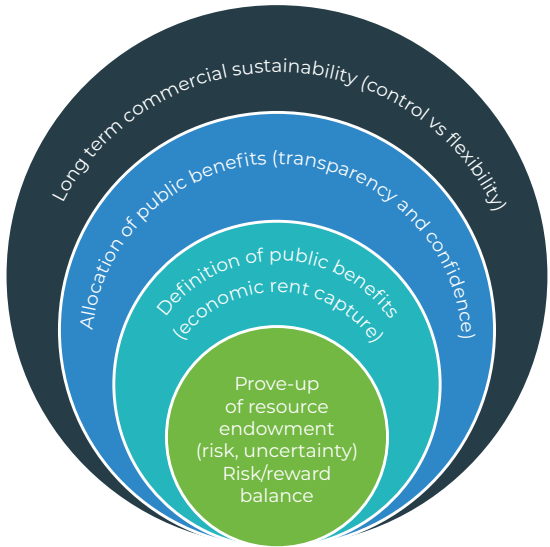
Research demonstrates that public acceptance of mining can be positive and broad based, and that mining can be transformative for economic development. When public support and results fall short, they tend to be in those locations where distribution of benefits is perceived to be inefficient and/or perceived to be inequitable, in particular with respect to interests of local and regional stakeholders most proximal to operations. While the mining industry can do much to help build and boost local and regional benefits,

responsibilities lie with government jurisdictions to ensure that benefits linked to economic rents – revenue streams from taxes and royalties – are allocated in ways that build trust. Transparency and confidence go a long way toward resolving concerns and stemming conflicts. Indeed, opinions are that in many locations, it is not so much a matter of additional economic rent capture to assuage public concerns as improving and optimizing allocations of benefits and effective use of rents.¹⁰

Many examples and case studies exist of initiatives by the mining industry to engage with local and regional interests along with national governments. The approaches taken in the best examples reflect locational attributes that have bearing on operations and associated logistics. For instance, decisions on whether to ship bulk ores as opposed to higher grade concentrates are dictated by transportation considerations. Local and regional context in terms of economic structure (whether economies are based on agriculture, tourism, manufacturing and how these drive other needs for water, energy, roads, rail and other infrastructure assets) is an important consideration in determining engagement and how benefits can best be utilized for long term economic development.

In the end, partnerships for shared, durable value creation and commitment to supporting commercial frameworks can go a long way toward meeting and exceeding key stakeholder expectations.

"Hill of Value"
Achieving Durable Commercial Sustainability



Source: Michot Foss, 2024.¹²

1. Michelle Michot Foss, Defining the ‘Minerals Heartland’ of the Future — From Africa to Central Asia, Center for Energy Studies, Energy, Minerals, and Materials Research Paper, Rice University’s Baker Institute for Public Policy in partnership with Future Minerals Forum, December 20, 2022, <https://www.bakerinstitute.org/research/defining-minerals-heartland-future-africa-central-asia>.
2. Willis Emmons, The Evolving Bargain, 2000, Harvard Business School Press, <https://www.hbs.edu/faculty/Pages/item.aspx?num=17920>.
3. Michot Foss, Mining, Minerals, and Materials in the Age of Sustainability and Alliances, Center for Energy Studies, Energy, Minerals, and Materials Research Paper, Baker Institute in partnership with FMF, February 8, 2024, <https://www.bakerinstitute.org/research/mining-minerals-and-materials-age-sustainability-and-alliances>.
4. Rachel A. Meidl, Toward Sustainability: Understanding the Challenges, Center for Energy Studies Report, Baker Institute, June 18, 2024, <https://www.bakerinstitute.org/research/toward-sustainability-understanding-challenges>.
5. Meidl, 2024.
6. Mark Cutifani, CIM Conference: Keynote Address on Health and Safety – Moral Obligation or Business Imperative. October 2024.
7. Michot Foss, Minerals and Materials Challenges for Our Energy Future(s): Dateline 2024, Center for Energy Studies, Energy, Minerals, and Materials Report, Baker Institute, September 20, 2024, <https://www.bakerinstitute.org/research/minerals-and-materials-challenges-our-energy-futures-dateline-2024>.
8. Michot Foss and Ishmael Eshun, unpublished work in progress, Center for Energy Studies/Baker Institute minerals finance dashboard, based on company filings and other sources.
9. See Michot Foss, 2024 for details on commodity price volatility and the shift in fiscal regime for lithium in Chile, a key factor in cost increases.
10. See Lenin H. Balza, Lina Diaz, Nicolas Gomez-Parra, and Osmel Manzano, The Unwritten License: The Social License to Operate in Latin America’s Extractive Sector, Inter-American Development Bank (IDB), August 18, 2022, https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4188882. Also see Manzano, Diaz, Augusto Chavez, Leandro Gaston Andrian, Daniela Valdivia, and Balza, The extractive sector, as a lever for productive transformation, IDB, 2023, <https://publications.iadb.org/en/extractive-sector-lever-productive-transformation>. Comment made during a CES/Baker Institute workshop on Latin America resource politics, September 7-8, 2023.
11. Mining reference for project value optimization – used by Mark Cutifani to capture social dimensions in mine value creation. Various references in key industry forums.
12. See Michot Foss, 2024.

FROM VISION TO REALITY

Understanding the role of collaboration in our transition to a low-carbon future



Ionut Lazar, Principal Consultant, CRU and
Senanee Abeyawickrama, Consultant, CRU

It is evident that the energy transition and push for a decarbonised future cannot be achieved by a single entity. It is a global, multi-stakeholder challenge that requires strategic forms of collaboration, especially if we want to move at pace and achieve the desired scale. Frameworks such as UNFCCC and The Paris Agreement acknowledge the severity of the climate crisis at a multinational level.

These instruments, which are early forms of collaboration, have helped

form consensus on setting net zero targets around and beyond 2050. However, emissions forecasts show progress has been underwhelming in most countries, including some of the major emitters such as the US, India and China. There has been dissatisfaction and frustration among key stakeholder groups, ranging from governments struggling to match measures with targets, all the way to consumers who must absorb high power and goods costs with little evidence of early progress. Measures taken so

far have had limited impact – it is, of course, too early to tell in most cases, but the momentum started by target-setting worldwide has not been sustained. Unsurprisingly, it is proving extremely difficult to remove emissions while sustaining economic growth.

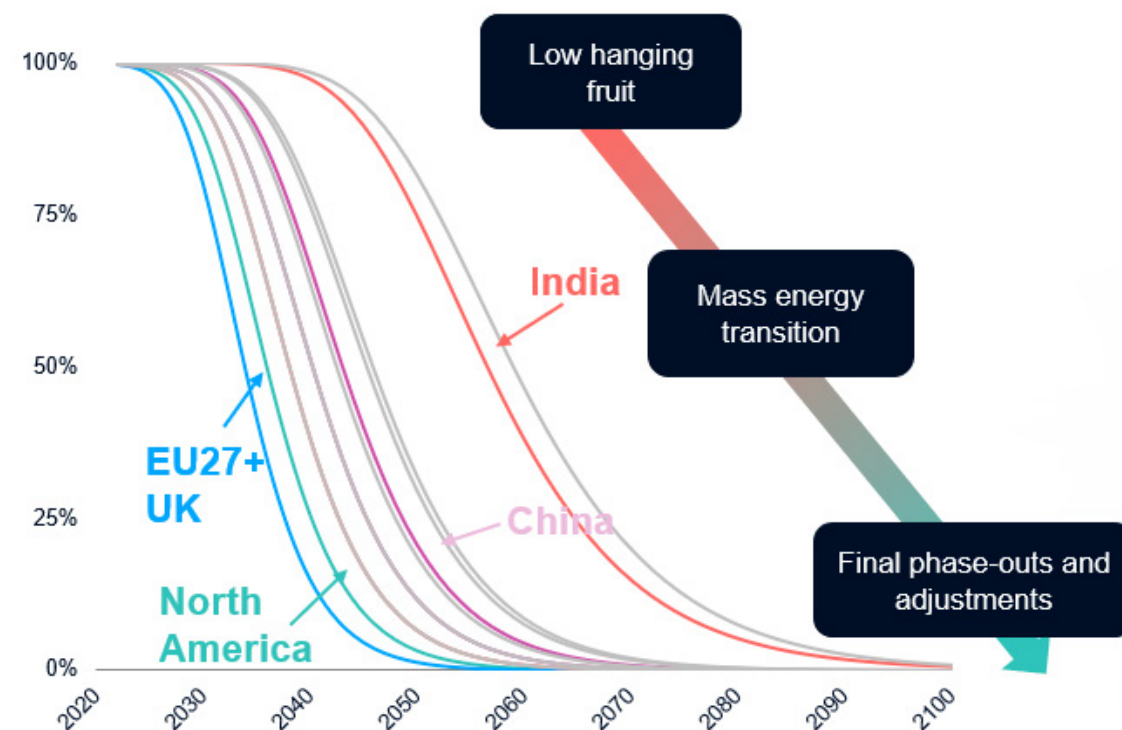
The commodities sector exemplifies how difficult it is to use decarbonisation as a lever for economic growth. Despite sustained efforts to decarbonise value chains, cumulative emissions over the next decade are expected to grow in key sectors like steel and aluminium. After all, these emissions-intensive sectors are critical to the energy transition. This relates to another key source of frustration: the lack of commitment to high-impact measures. Ambitious targets, climate conferences and global governance may set expectations, but the multi-stakeholder commitment required to make this a reality is still severely lacking and remains arguably superficial. Pathways to targets may be theoretically available, but multi-

stakeholder commitment remains centred around sharing cost and risk in a balanced way. In most cases, we are still looking for the right balance.

Isolated success stories have proven that collaboration can set important precedents at the local level, but this does little to accelerate the global pace of change. For instance, Uruguay has managed to successfully deploy renewables over the last decade, now sourcing 90-95% of its power from clean energy. The government was at the forefront of this evolution, having launched energy policies and a wind energy programme backed by the academic community, investors and industry alike. With a stable economy, Uruguay was able to attract US\$5.6 billion in clean energy investments in a span of just six years. A combination of competitive auctions, feed-in tariffs and long term PPAs (Power Purchase Agreements) created a dynamic environment for renewables deployment. Local infrastructure also adapted to feed renewables into the grid. These are commendable achievements at a national level but are forecast to add only around 4GW of renewable energy capacity by 2030. Even with significant improvements, Uruguay's overall GHG emissions are marginally higher than 2008 levels, with agriculture accounting for 70%. This reinforces the point that localised successes do not always achieve the scale required to a) meaningfully reduce global GHG emissions or b) encourage larger-scale initiatives elsewhere.

This is one of the key challenges the US Inflation Reduction Act (IRA) strives to address: to bridge the gap between successful precedent and the hope for future mass implementation. In terms of

Figure 1: Targeted emissions intensity profile by region, %



commitment, the US tried to signal that it is willing to invest at the scale required to deliver transformative change. In its first year, the IRA attracted US\$224 billion worth of investments into solar, wind, critical minerals and EVs. In addition to activating the private sector, it targets consumer behaviour by allocating US\$43 billion in incentives towards households that purchase energy-efficient appliances, rooftop solar panels and EVs. The IRA's impact also extends internationally in that it has influenced countries like Canada and South Korea to implement similar green subsidies programmes. In this way, the IRA has helped unite government, private sector, consumer and international forces towards a common front. There are inevitable teething issues: grid connection bottlenecks reduce the efficiency of deployed renewables, and the overall emissions impact is still limited. To this point, CRU has quantified the impact of IRA subsidies using a carbon abatement curve analysis. This has revealed that IRA subsidies do not match the carbon price of ~\$105/tCO₂ required to meet US climate targets. As such, some form of carbon taxation will have to prevail over and above the existing IRA measures to keep up with the required pace of change.

State-led agendas facilitate collaboration

Successful cases of collaboration are few and far between, but the common thread is evident: state-led agendas have often facilitated coordination and motivation. However, there are a multitude of stakeholders and actors, who are an integral part of the network, making this implementation possible. In this context, it is important to understand the key players involved and the underlying mechanics of stakeholder collaboration.

The key players in a collaborative environment are those who take on specific roles that contribute to successful implementation and change. Collaboration necessitates the participation of most of these stakeholders, who each bring specific capabilities and interests to the table. In the context of the energy transition, the key stakeholders and their roles can be identified as in Figure 1 below. Matching of stakeholders to specific roles is based on pre-existing linkages, mandates and skillsets. However, there may be instances where these relationships do not map out easily on a one-to-one basis. Considering these nuances, for collaboration to be effective, stakeholders must understand their roles and mutually



accept them to be able to work together as a cohesive group.

Collaboration typically entails some form of pooling knowledge, skills and resources. This is easy to execute in a more controlled or localised environment, but when dealing with transformative change there is an even bigger onus on stakeholders to actively share not just the benefits but, crucially, the responsibility, and especially the cost and risk associated.

Instances of multiple stakeholders competing for roles are actually few and far between. State actors have driven much of the early movement. In industrially focussed environments, industry associations have also had success imposing some standards, even if adoption has been uneven. The GHG definitions of Scope 1, 2 and 3 emissions are an example of an imperfect but widely adopted logic that has helped industries move forward with their strategies. Technological innovation has predictably been embraced by different levels of industry and academia. Some industry sectors, such as seaborne freight and automotive, have voluntarily instituted targets and premia for the use of low-carbon materials and increased circularity, well ahead of regulatory developments. Stakeholders have been willing to share roles, and even, in some cases, responsibility. What has been lacking, at this early stage, is enough sharing and commitment to risk and cost.

Sharing the risk

The willingness to pool risk is a major issue in commodity markets and supply chains. Particularly from a financing perspective, project risks continue to be evaluated from a traditional due diligence lens – with limited regard for the long-term impacts on decarbonisation. Graphite projects, as an example, are struggling to secure financing to progress – even though the commodity is officially regarded as a "critical mineral" by the US, EU and Canada. Graphite plays an important role in the production of EV batteries and wind turbines. Long-term market fundamentals are very strong, with demand expected to triple in the next 15 years, and supply from synthetic (oil-based) feedstock set to reduce as oil consumption and production decreases with the energy transition. However, from a traditional due diligence lens, graphite is still largely seen as a risky investment due to the uncertain nature of future demand and current Chinese overcapacity.

Banks are not willing to finance projects without necessary fallback options and shared risk. Governments and multi-national institutions are not actively filling this gap, even though they acknowledge criticality and state their support for resilient value chains. Between regulators or governments unwilling to shoulder major risks and consumers unlikely to pay premiums or, sometimes, even allow assets to be built next door, strategic markets acknowledged as critical to the energy transition risk remaining undersupplied and undercapitalised. Traditional, unimaginative financial due diligence methods are often blamed for this, but the underlying cause remains limited commitment to share risk.

Dealing with conflicting interests

Failure in collaboration can also arise due to conflicting interests among stakeholders. Carbon Capture and Storage (CCS) technologies, for example, have encountered significant bottlenecks in terms of implementation due to high costs, insufficient scale, and technical risks that need to be addressed by multiple stakeholders. The interplay of conflicting interests has led to a stalemate where CCS deployment is either delayed or never fully realised. This has been the case in Europe, where CCS developers are still waiting on regulatory frameworks and more clearly spelt-out incentives to financially de-risk projects. Similarly, delays in the UK have meant that the CCS fund allocation of US\$25 billion



might become costlier for the government as inflation and borrowing costs increase. Despite securing the technology, Canada-based Capital Power recently cancelled a major CCS project worth US\$1.8 billion, also citing issues of financial feasibility. In essence, technological innovation needs to meet government approval and industrial willingness (supported by robust regulatory incentives) to bear costs for CCS technology to be implemented effectively and at scale. Conflicting priorities have obstructed successful CCS deployment.

When high-level attempts at collaboration fall short or break down due to lack of commitment, responsibility or willingness to share risk – the tendency is to revert to smaller-scale isolated decarbonisation levers. This is not an issue on its own, as it can help bring industries closer to interim targets. However, there is an opportunity cost attached to diverting efforts and resources away from high-impact measures that can help achieve the energy transition at a much faster pace, and, crucially, allow lessons to be

learned that can improve efficient deployment at scale.

In the absence of necessary support and incentives to help industry bear costs and navigate regulations, actions have tended towards decarbonisation levers that require less collaborative effort and are, at least initially, lower in cost. These include carbon offset programmes, measures to optimise energy efficiency, and low-carbon feedstock use (including scrap) as shown in the lower-left quadrant of Figure 4.

Figure 3 CCS: an illustration of how multi-stakeholder cooperation breakdown can delay or prevent deployment

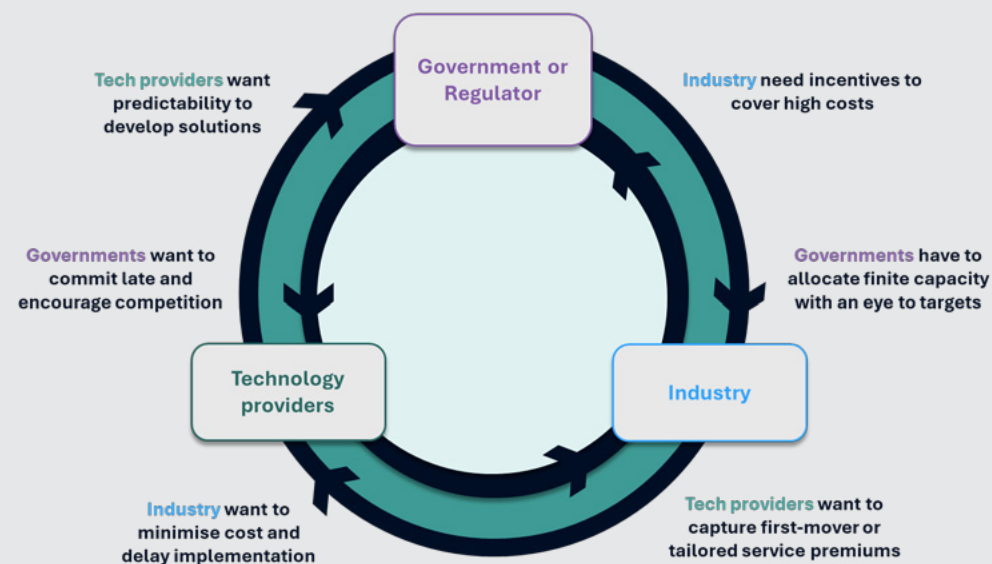
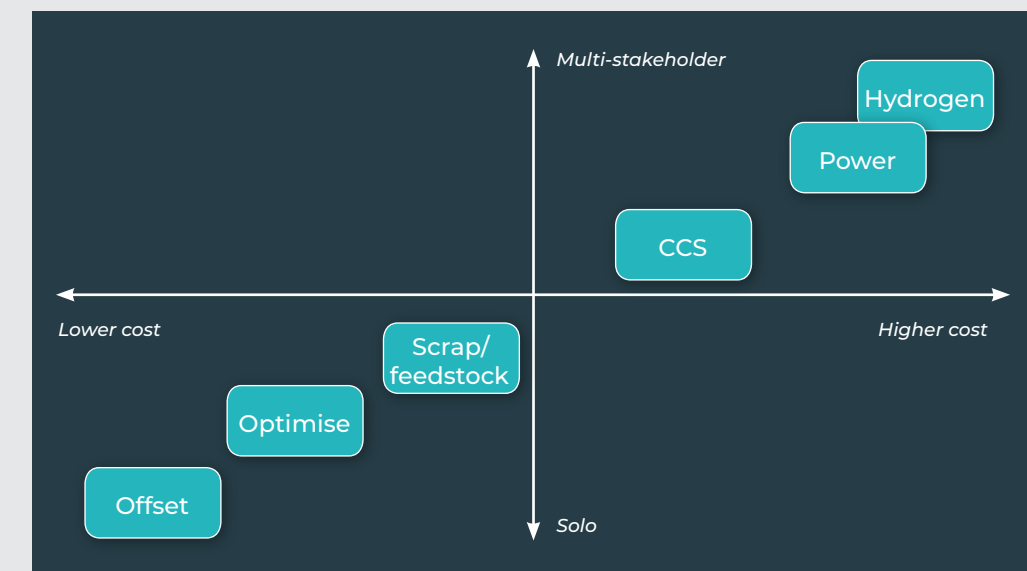


Figure 4: Decarbonisation matrix: understanding levers from a collaboration and cost perspective





A tendency towards less ambitious, less costly projects is a commonly observed phenomenon in the commodities sector – especially in energy-intensive industries like aluminium, silicon, and magnesium smelting, where power is the primary source of emissions. Conventional wisdom would dictate that these industries switch to low carbon or renewable sources of power, but due to breakdown in stakeholder collaboration and failure to share costs and risks, these industries are settling for smaller-scale, low impact changes first. This is a substantial setback for the pace of transition, and it delays the impact that meaningful changes can be shown to have. In the case of aluminium, for example, ~70% of emissions originate from power consumed during the primary smelting process. This suggests that a plant utilising a low-carbon energy source for even 30% of its power needs could benefit from an immediate emissions cut that brings it closer to at least an interim emissions target. At the same

time, it could ascend part of the learning curve on how to tackle key challenges around clean energy use; these are lessons that are necessary for widescale implementation.

The cost of cleaner energy

Government support for such initiatives is robust at the policy level, but with actual implementation, conflicting priorities and competition for clean energy among multiple stakeholders leaves the energy transition at the back of the sustainable strategy queue. Incentives are dampened further in many of the metal sectors by the reluctance of consumers to pay a sizeable premium for low-carbon material, especially at a time when the commodity prices are already high. Unsurprisingly, neither industry nor consumers are willing or able to shoulder the full capital cost of cleaner energy. Smaller-impact measures that require minimal external participation are taken instead; these are valuable, but most often they merely convert capital spend into operational improvements that have neither the scale nor the impact to substantially affect the pace of global change.

Targets to share cost and risk

Overall, collaboration can play a significant role in terms of manoeuvring incentives and mobilising the right stakeholders to effect change. The land, technology, finances, and regulatory frameworks exist to speed up the pace of decarbonisation. The crux of the issue is that targets need to be followed up with greater commitment to share risk and cost. The cumulative capital intensity of two capital-hungry sectors, energy and industry, requires a collaborative approach. State actors and multi-national organisations, including banks, have gone to school on local-scale projects, hoping to learn the lessons needed to cope with large-scale transition. It is time - or past time – for them to step up.

To take on cost and risk across multiple stakeholders, a common

structure and logic is needed to convince more stakeholders to fully understand, and hopefully take on, risk. Certainty is hard to come by in the early stages of structural change, and much of the perceived risk stems from widely different perspectives of possible future outcomes, backed by

Collaboration can play a significant role in terms of manoeuvring incentives and mobilising the right stakeholders to effect change

precious little early data as a starting point. Objective observation, assessment and advice become hugely important to demystify and improve precision in cost and risk assessment, and the consulting

community take this role extremely seriously. Ultimately, however, risk can be clarified, but certainty remains a challenge. The deficit in collaboration remains fundamentally a deficit to shoulder risk for enough time to allow large-scale transition to prove itself successful. How the major stakeholders do this will determine whether decarbonisation accelerates or stalls.



VALUE CREATION IN A DECARBONISING WORLD

CHALLENGES AND OPPORTUNITIES IN THE MINING INDUSTRY

Kaitlin Gebbie, Senior Consultant, CRU

Josefa Carrere, Principal Consultant, CRU

The evolution of value creation

Often materialising as investment in downstream processing and integration, value addition plays a pivotal role in increasing economic value and accessing wider markets. It can also manifest as positive externalities through both indirect benefits to a region and certainty of supply. With the introduction of global decarbonisation targets, the pace and form of value creation has evolved. Collaboration, state actor engagement, geographical competitiveness and the ongoing trade-off between reducing emissions and reducing costs are critical success factors. Creating value whilst decarbonising is a serious challenge and raises questions around cost prioritisation with regards to making choices between targeting emissions reduction or investing downstream and whether the two beneficial actions are mutually exclusive in a mineral supply chain

Across commodities, the creation of value through the addition of further processing steps is directly linked to relative competitiveness, and the characteristics of competitiveness change when moving through the value chain. At the mine level, competitiveness is driven by factors such as the quality of the deposit and access to infrastructure, which ultimately determine CAPEX & OPEX

requirements. For manufactured products, capital and operating costs play a relevant role and geographical proximity to consumer markets becomes a key consideration.

There is a general misconception that downstream integration always equals added value and thus investments in processing and manufacturing activity in mining countries will lead to attractive levels

Government incentives and state actor involvement can have a fundamental role when shaping value chains

of additional profit. However, the magnitude of the measurable impact of these investments is industry-dependent. Chile, for example, is the largest producer of mined copper material, yet exports most of its concentrate to smelters in China. China has an overcapacity in smelting and downstream processing which puts downwards pressure on the price smelters globally can charge, and as such, there is less incentive for Chilean producers to add value through downstream integration and investment.

Alongside beneficial geographies and relative sources of competitiveness, government incentives and state actor involvement can have a fundamental role (for better or worse) when shaping value chains for different commodities. As an example of this, the Indonesian government introduced a ban on the export of unprocessed ores. This was the instigating event for major domestic downstream investment in the nickel industry and as a result,



Indonesia – formerly a miner and exporter of nickel laterite ore – has successfully incorporated several stages of lucrative downstream nickel processing. Indonesia is not only the largest miner of nickel but now has a large, highly competitive finished nickel and stainless-steel production industry. While these changes were prompted by strict regulatory adjustments, the scale and success of these investments has only been possible due to Indonesia's relative competitive position in the associated processing steps. At the mining stage, Indonesian laterite ore is high quality, and drivers of processing costs such as coal and power are relatively low. The development by major Chinese investors of large-scale industrial parks, at which various facilities can be co-located, has increased efficiencies and lowered infrastructure costs. Capital costs for processing plants are far lower than greenfield facilities elsewhere in the world due to the use of Chinese EPCM companies. Interestingly, the uptake of downstream processing for copper ores has had a slower uptake than in nickel as copper smelting capacity availability in China serves as a deterrent to further investment.

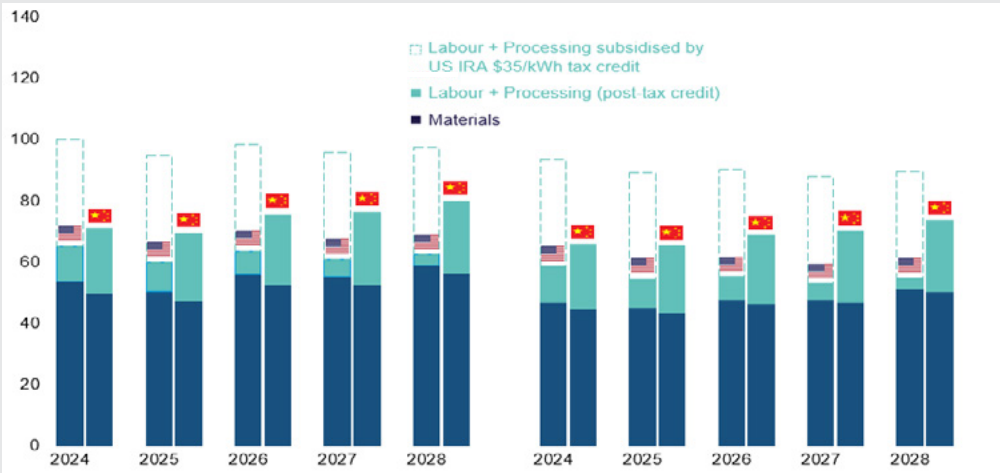
Government incentives for value-related investments

While governmental action can drive downstream integration for the sake of increasing value generation at a country level, the addition of downstream facilities in the wrong location can, at a global level, (1) affect the industry's cost competitiveness and, more importantly, (2) inhibit the development of raw materials supply chains that have the required scale and robustness to address value chain bottlenecks effectively. Government incentives are often pivotal for value related investments as well, particularly in critical minerals where aid is linked to strategic decarbonisation objectives. In the US, the introduction of the Inflation Reduction Act (IRA) engendered the development of battery gigafactory plans and onshoring of domestic lithium production, amongst plans to expand value in other critical minerals. Specifically, the IRA's 45X Advanced Manufacturing Production Tax Credit (AMPC) offers up to \$35/kWh for battery cell production in the US, to offset the cost of labour and processing. This demonstrates the opportunity for US manufacturers

to add value and reach cost-parity with Chinese counterparts. Figure 2 demonstrates the effects of US policy on supporting domestic cost competitiveness in battery

production. Without government tax credits and related incentives, downstream investment and consequential value addition would be significantly lower.

Figure 2: NMC 811 battery cell production cost for US vs. China (LHS); LFP battery cell production cost for US vs. China (RHS), real 2024 \$/kWh



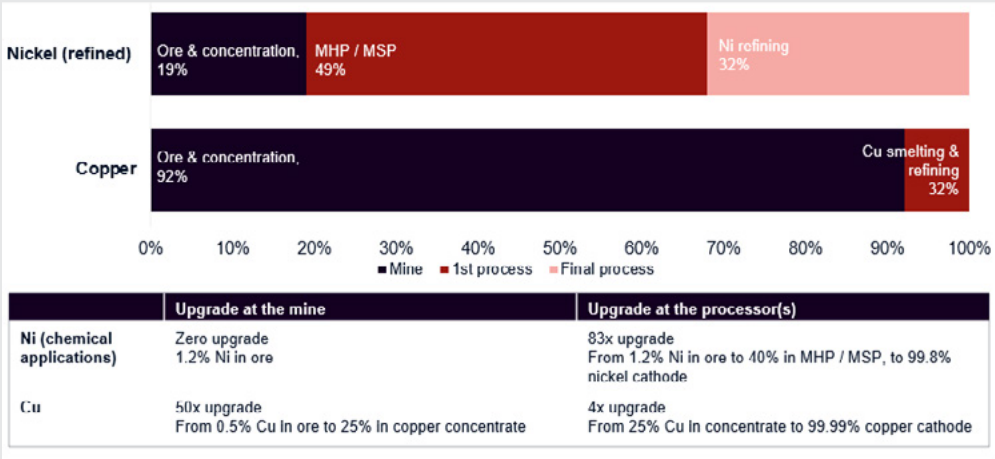
DATA: CRU. As per latest policy guidance, IRA 45X Manufacturing Tax Credit applies only to labour and processing, not materials. Modelled cells are prismatic with synthetic graphite anode. Forecast includes inflation.

In China, the approach to decarbonisation and creating value through downstream investment has been bullish. Driven by domestic regulation and a unique acceptance of overcapacity in several mineral markets, China's approach to vertical integration has been a pivotal enabling factor in China becoming the lowest cost producer or processor for several critical minerals. This more aggressive strategy to secure complete value chains in renewable energy and related commodities has thus successfully supported the development of 1TW of domestic renewables capacity. In recent years, China has developed a full solar value chain domestically with capability to export solar panels. This has allowed for a dominant presence on the export market and has created a ripple effect of indirect value addition through local employment, patents and expertise. The caveat to this

success is the dominance from China has crashed solar module prices with most producers selling below cash cost. Despite this, the phenomenon is expected to continue with EVs on the horizon as the next export target, building downstream value into China's existing dominance in battery manufacture. The strategic objective is clear: add value to the upstream entities to secure the value chain and industrial sector presence.

This more aggressive strategy towards decarbonisation has a mixed impact on risk. Whilst risk has been reduced through domestic mineral supply chains and decreased reliance on non-Chinese owned foreign supply, it has simultaneously increased the breadth of risk whereby revenue is reliant on strong demand from the export market. Nonetheless, with control of the supply chain, China has the tools

Figure 1: Indicative value addition between mining & processing of nickel & copper, 2023



to mitigate risk. With ownership of several components of a supply chain, China can respond to market conditions more easily, not least as the strategy allows for control of both patents and expertise. Such a high-risk, high-reward strategy is unseen elsewhere, and the question remains whether this could truly be replicated outside of China, and if not, whether there is intrinsic value in avoiding China when securing value chains.

Geographical and legislative drivers

Both geographical and legislative drivers give rise to a crucial underlying aspect of value addition: certainty of supply and securing access to specific industrial sectors, evidenced through efforts in the US and China respectively. It is difficult to off-set potential cost disadvantages, particularly if a monopoly of supply exists in high-risk regions. In time, CRU expect a more concrete green premium to develop to support value addition globally. The investment case for building nickel outside of Indonesia

is founded on the significance of nickel as a critical mineral in the energy transition. Many assets outside of Indonesia are less competitive, and hence the investment case hinges on

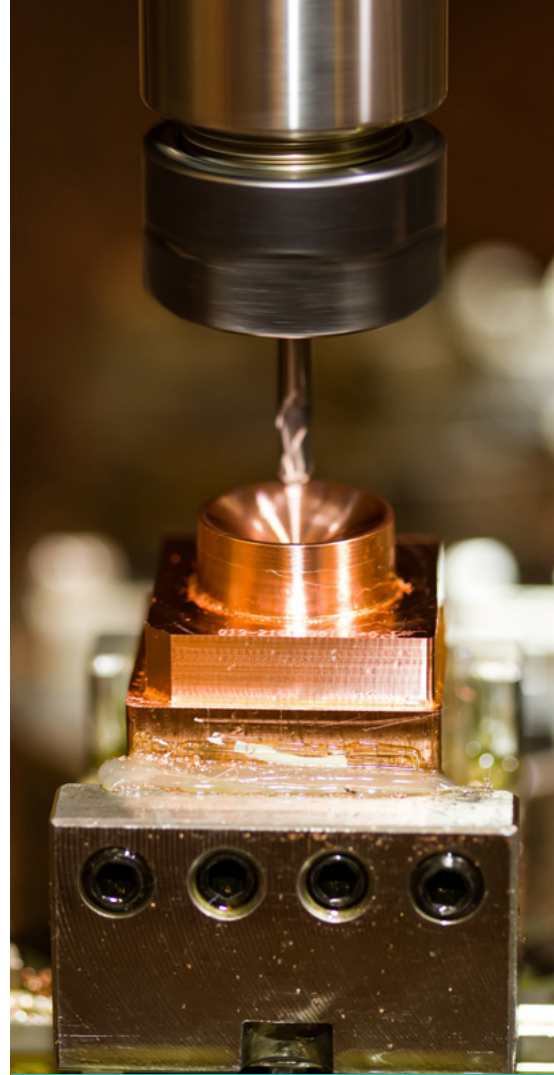
a potential 'green' premium for a product which is either (1) lower carbon than Indonesian material, or (2) non-Chinese. However, such a premium is voluntary in nature and yet to fully materialise. It is ultimately the market who determines the true value of ex. Indonesian nickel through provision of a tangible

A collaborative approach is required with ongoing commitment to provide the level of scale and funding needed to realise value

premium in the absence of an enforcing regulatory mechanism. A general unwillingness to pay such a premium has led to the closure of several ex. Indonesian assets over the last two years who cannot secure

higher achieved prices. For a green premium to exist in critical minerals, regulation must be enforceable with serious incentives to decarbonise. A collaborative approach is required with

ongoing commitment to provide the level of scale and funding needed to realise value. Allowing for improved valuations for new assets and technologies will ensure due diligence can recognise the benefits of value addition against the backdrop of decarbonisation and green premium.



INVESTMENT IN EXPLORATION, INFRASTRUCTURE DEVELOPMENT, AND PROCESSING



The ongoing energy transition, along with traditional drivers, is significantly driving the demand for key materials in the metals and mining industry. As the global push for net-zero emissions grows, there is a noticeable shift towards transition materials like copper, lithium, nickel, rare earth elements (REEs), graphite, and cobalt, which are essential for low-carbon technologies (e.g., battery electric vehicles, renewable power). Simultaneously, traditional drivers – population and middle-class growth – continue to support the materials industry's growth through for instance steel and aluminum demand.

The industry faces the dual challenge of ensuring the availability and affordability of materials, while also producing them sustainably. This is not only changing investment priorities but also increasing the need for more exploration, better infrastructure development, and advanced processing, including through innovative technologies and partnership models.

To meet the growing materials demand, significant investment unlocks will be required in both mining and refining, as well as in the development of supporting infrastructure. While ~70% of past investments have primarily been in mining assets, i.e., coal, iron ore, copper and gold, the future will likely require more processing due to the nature of minerals that need to be extracted and processed for usage in low-carbon technologies. This shift is essential because many of the transition materials, such as nickel and lithium, are relatively easy to mine but require complex refining processes. Additionally, as projects move into more remote areas, investments in reliable and low-cost infrastructure—such as power, roads, and ports—become increasingly important.

To meet the projected demand for minerals and metals by 2035, an estimated US\$5.4 trillion in capital will be required to sustain and expand mining and processing facilities, according to McKinsey's latest estimates¹. This increase represents only a US\$500 billion increase compared to the previous decade (2012-2023 vs. 2024-2035) when adjusted for inflation.

Today, over 90% of the mass moved involves coal, iron ore, copper, and gold mining. Therefore, most of today's capital requirements are in these value chains. Going forward, over 70% of total capital will be needed for these four commodities, with roughly 75% of it dedicated to sustaining existing assets. This high need for sustaining capital expenditure is due to high production levels but limited expansion in coal and steel (the steel value chain alone is estimated



to require about US\$1.6 trillion in sustaining capital expenditure)¹.

Project capital expenditure, covering the cost of building new mining and processing assets, will be mainly needed for copper, nickel, and lithium.

The industry's financing capacity is theoretically sufficient to meet the scale-up needs. However, two primary barriers must be addressed to unlock capital deployment:

01 There must be enough profitable and attractive projects

02 Investments need to be aligned with the right regions, players, and projects

¹ McKinsey 2024 Global Materials Perspective

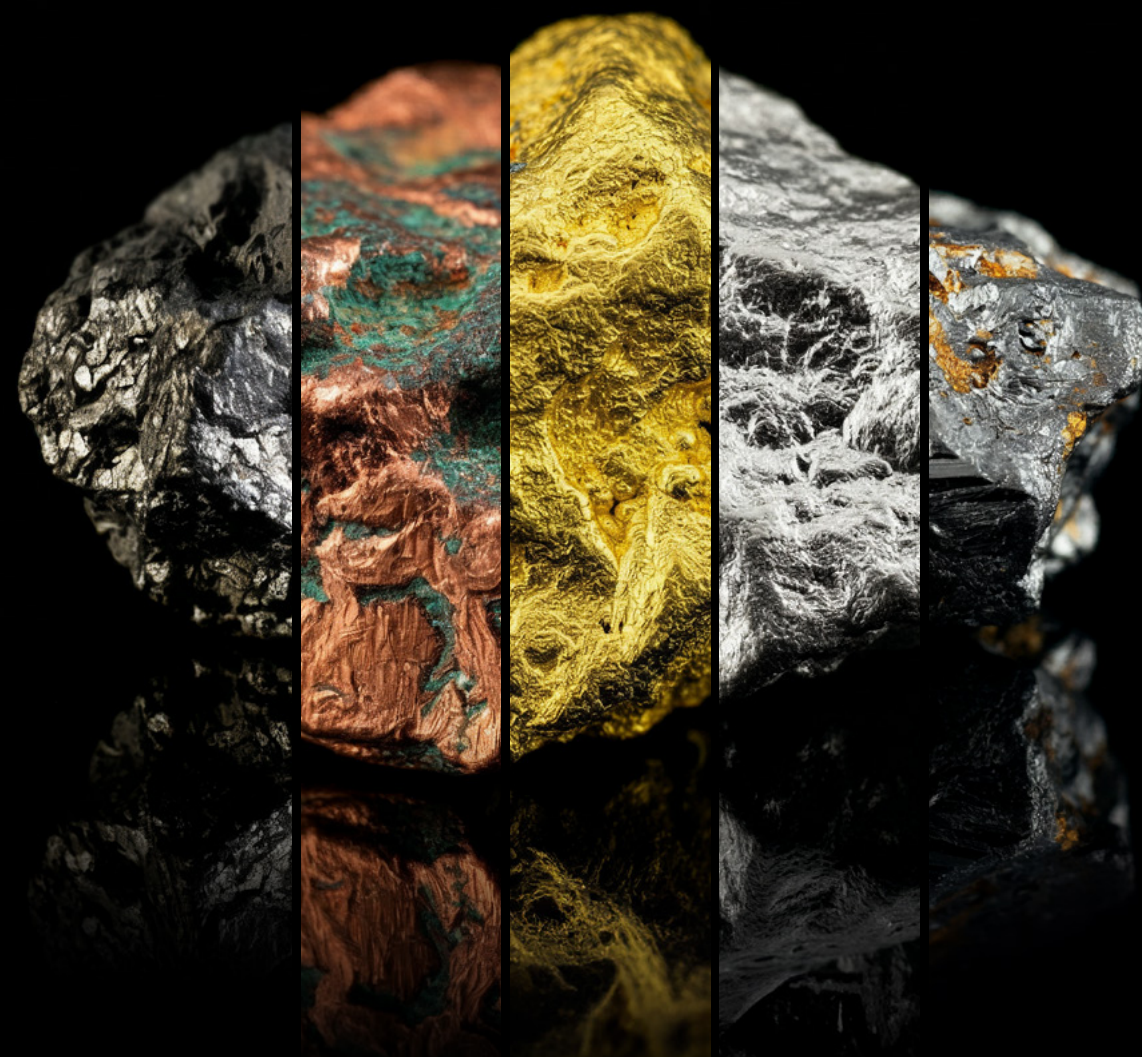
Several announced investments are in the southern hemisphere which includes resource-rich areas and holds vast untapped resources of minerals that are critical for the energy transition. As such, the Super Region stands to benefit from the transition.

By channeling investments into key areas, the Super Region has an opportunity to foster socio-economic growth locally. This approach will help build resilient supply chains, ensuring a steady and reliable supply of critical materials for the global economy.

Overcoming barriers to investments will be critical. These include clear demand signals, skilled labor, and securing debt financing for junior miners. Enabling the necessary capital to scale up supply would require a focus on cost efficiency and public-private collaboration and partnerships. Governments have a role to play in minimizing infrastructure costs, such as energy and logistics, by promoting regional clusters for extraction and processing. Companies and governments could also work

together to streamline administrative processes and shorten project timelines. Private companies should leverage technology and innovation to primarily facilitate brownfield expansion and improve operational performance, and mining productivity. Increased exploration spending is essential to secure projects with optimal prerequisites. Finally, given the capital-intensive nature of the mining industry, companies should emphasize capital excellence to minimize project cost overruns.





TARGETING OPPORTUNITIES FOR MINERAL VALUE ADDITION

Patrick Barnes, Global Head of Metals and Mining Consulting, Wood Mackenzie

Cina Vazir, Managing Consultant, Wood Mackenzie

Introduction

We live in a world of rapidly shifting supply chains. Countries are competing with increasing intensity to protect strategic supply chains for commodities like steel, become leaders in innovative supply chains for products like advanced semiconductors, and attract new supply chains for emerging industries like clean energy technologies. Amid rising geopolitical tension, countries and companies are increasingly reconsidering the physical locations in which goods are produced. Everyone wants a bigger slice of the pie.

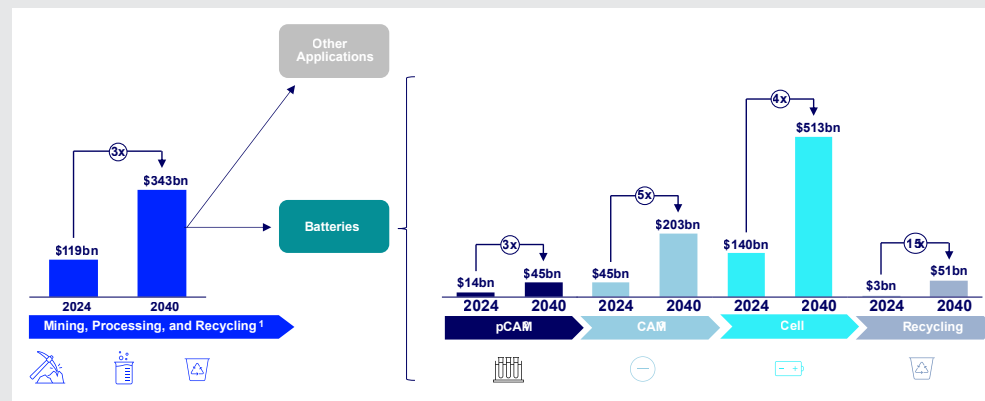
Within this context, value addition has reemerged as a key topic in mineral-rich countries. The idea of value addition is not itself new. Mineral producing countries have often sought to "add more value" to their minerals by moving further down the value chains of economic products. In short, mineral value addition refers to producing higher value-add midstream (processed) or downstream (manufactured)

products, rather than exporting upstream products like ore and concentrate. Mineral-rich countries across the world are enacting policies to promote more value addition. These include emerging markets and developing economies (EMDEs) in Africa, Asia, Latin America, and the Middle East. They also include advanced economies like Australia and Canada. Many recent value addition policies are focused on minerals used in clean energy technologies. Supply chains for clean energy technologies, like lithium-ion batteries, are evolving and mineral-intensive. The nascency of these supply chains and their mineral intensity creates a window of opportunity for mineral-rich countries to pursue value addition.

Value addition for certain clean energy technologies can provide a path for countries to expand domestic economic activity. For example, production of cathode materials, battery cells, and battery recycling could produce around US\$800 billion in annual revenue by 2040.

Amid rising geopolitical tension, countries and companies are increasingly reconsidering the physical locations in which goods are produced. Everyone wants a bigger slice of the pie

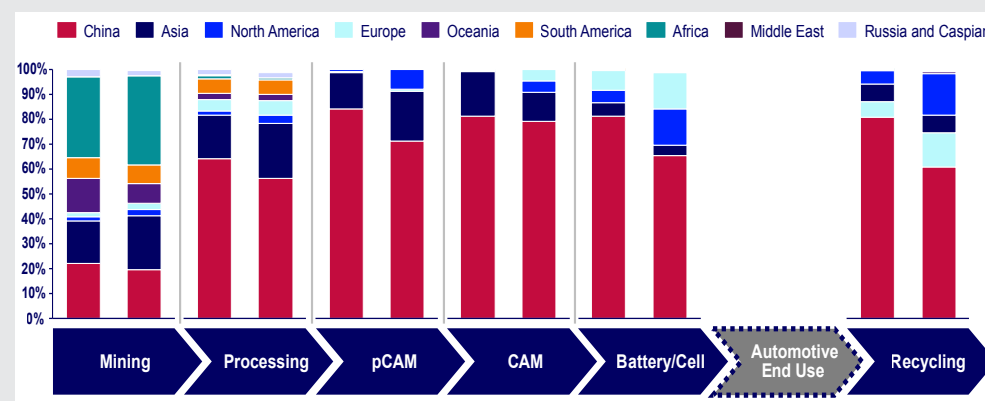
Figure 1: Annual Revenue of Lithium-Ion Battery Value Chain (US\$ Billions)



Note: All values in real (2024) USD [1] For cobalt, lithium, natural graphite, nickel, and manganese [2] For Ni-based cathodes [3] For Ni- and Li-based cathodes
Source: Wood Mackenzie

Despite EMDEs' recent policies to move further downstream in clean energy supply chains, most of the midstream and downstream project pipeline for these technologies remains in China and advanced economies. In the battery value chain, for example, Africa, the Caspian, the Middle East, Oceania, and South America combine for less than one percent of forecast pCAM, CAM, cell, and recycling capacity by 2040.

Figure 2: Market Share of Lithium-Ion Battery Value Chain, by region



Note: Mining and processing represent the average market share for lithium, nickel, cobalt, manganese, and natural graphite; recycling consists of global black mass feedstock supply; battery/cell is in GWh terms
Source: Wood Mackenzie

Policies to promote value addition are struggling and have also faced similar obstacles in the past. How can public policy be more successful this time around? If countries want to attract more value addition, it is clear they will have to act more aggressively and decisively. But they will also need to be more efficient given limited fiscal space, particularly in many EMDEs. It will therefore be key for policymakers to target value addition opportunities based on three key criteria: benefits, competitiveness, and market dynamics.

Prioritizing Benefits

Value addition can provide countries with a range of different benefits. Some of the most obvious benefits are increased GDP and more fiscal revenue from a larger tax base. Along with this, countries can increase their export earnings as they export higher value products. In certain cases, this can also lead to a more stable balance of payments if the price of manufactured products is less volatile than that of primary raw materials.

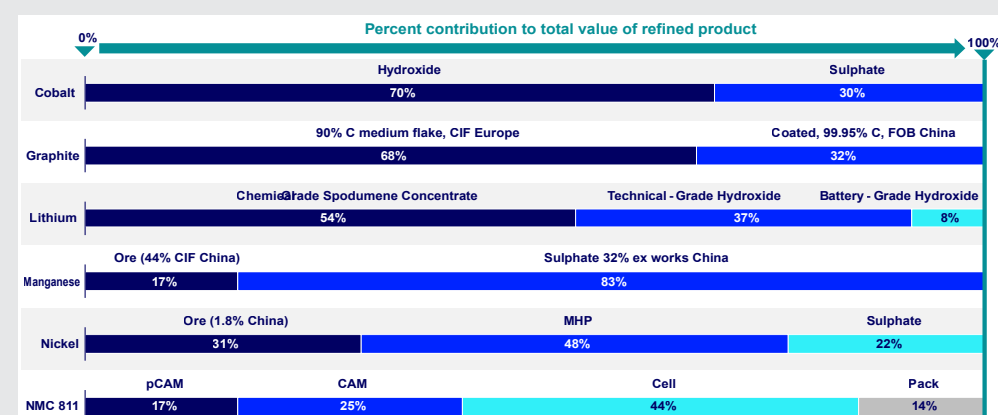
More domestic value addition often leads to the creation of direct and indirect jobs. The impact on employment depends on factors including a production processes labor intensity, wage structure, and split of low-, medium-, and high-skilled employment. Additionally, countries can use value addition to acquire new capabilities and know-how within the domestic economy. This can then help induce economic diversification into other value chains that require similar capabilities.

As countries pursue value addition, they will need to prioritize between potential benefits. This prioritization can help guide which value chains, and stages of those value chains, to target. For example, if a country prioritizes fiscal revenue, it may not be worthwhile to incentivize manufacturing of copper semi-fabricated products (semis) like rods and wires given that these are often low-margin products. However, if a country's priority is to develop a manufacturing base, producing copper semis could be an effective way to create industrial hubs and lead to more complex manufacturing of products like high-voltage cables.

More domestic value addition often leads to the creation of direct and indirect jobs

The same applies to mineral processing. Most countries that target mineral processing prioritize fiscal revenue and export earnings. But the level of value-add is not equal across all minerals. Smelting and refining of base metals like copper and zinc often has relatively low value-add below 20 percent of the refined product price. Value-add can be higher for other base metals and battery raw materials. For example, countries could gain significant value from moving from exports of manganese or nickel ore into intermediate or refined products.

Figure 3: Percent of Total Refined Product Price, by stage of value chain



Note: All prices for commodities are on a contained ton basis; NMC 811 on a kWh basis; 2024 prices; coated graphite price adjusted to account for yield loss
Source: Wood Mackenzie

As countries pursue value addition, they must first ask: why are we doing this to begin with? That question should lead to a frank conversation around which potential benefits to prioritize. And once policymakers can agree on their priorities, they can then evaluate which value addition opportunities are worth pursuing.

Assessing Competitiveness

Competitiveness and comparative advantage play a decisive role in countries' ability to attract investment, sustain projects, build scale, and achieve their stated objectives. Competitiveness therefore constitutes the second key consideration for policymakers targeting value addition.

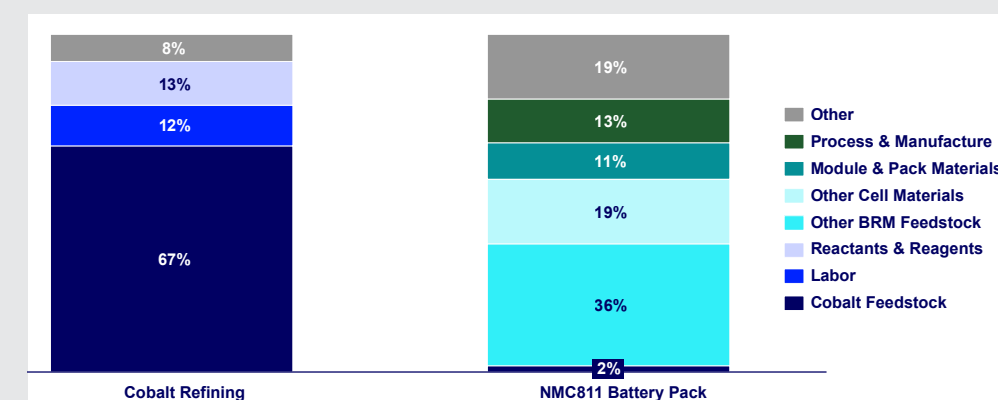
Countries can begin by assessing their current competitive positioning. This can then be followed by a gap analysis. If value addition is not already occurring, there is likely a gap in competitiveness. Countries can identify these gaps and evaluate policies to "bridge" the gap to make domestic industry competitive. The difficulty and amount of capital needed to provide this bridge will depend on existing comparative advantage.

Competitiveness and comparative advantage play a decisive role in countries' ability to attract investment, sustain projects, build scale, and achieve their stated objectives

Competitiveness assessments must differentiate between the key capabilities required across and within different mineral value chains. For example, the capabilities required to produce refined cobalt are far different than those required to make lithium-ion batteries. Cobalt feedstock can usually comprise 60-80 percent of the cost of producing refined cobalt. In

contrast, cobalt feedstock comprises an average of only 2 percent of the cost of making an NMC811 battery pack. A country with cobalt could therefore potentially have a strong comparative advantage for making cobalt sulphate if it leverages integrated feedstock. But integrated cobalt feedstock would offer a far less compelling competitive advantage for making an NMC811 pack.

Figure 4: Cost Structure, by stage of value chain (Percent of Total Production Cost)



Note: Cobalt refining costs are for an example non-integrated asset and NMC811 costs are industry average
Source: Wood Mackenzie

After assessing gaps in competitiveness and identifying opportunities, policymakers will also need to think about efficient tools to induce domestic value addition. Policy options can generally be categorized as subsidies, enablers, or coercive measures. Subsidies include direct grants, concessional loans, and tax holidays. Enablers aim to decrease capital and operational costs, often through investment in supporting infrastructure.

Coercive measures, in contrast, increase the costs of not undertaking value addition. These include bans or high taxes on exports of unrefined products.

Value addition policies should seek to increase a country's short-term, and eventually long-term, competitiveness. Efficient policies must seize on comparative advantages, have sensible phaseout timelines, and have adjustment mechanisms to react to changing conditions.

Evaluating Market Dynamics

Global market dynamics can often determine the success or failure of value addition. This is particularly true as the energy transition and geopolitics insert high levels of uncertainty into global markets. Policymakers must make sure to stress-test and periodically reevaluate core assumptions around supply, demand, offtake, and prices throughout the value addition journey.

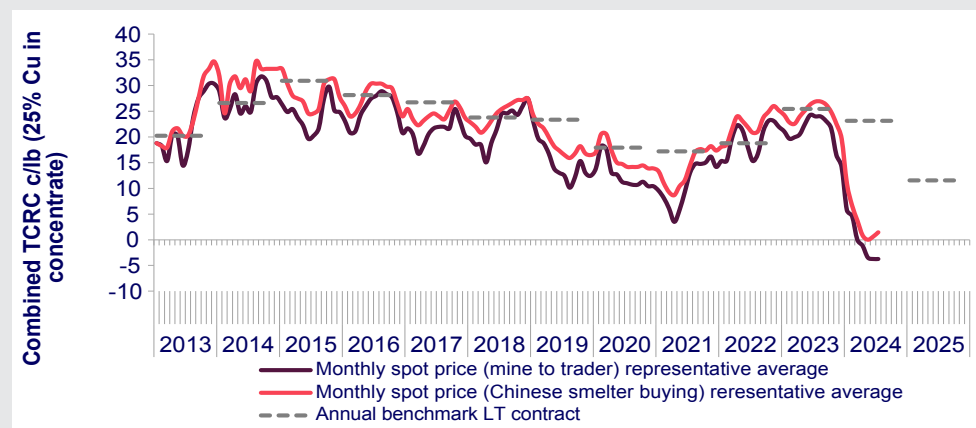
Demand is closely linked to uncertainty around technology and policy in clean energy value chains. This has recently been evident in the nickel market. Over the last few years, nickel has seen tremendous internal technological change through the commercialization of high-pressure acid leaching (HPAL) which has altered the mining and processing landscape. At the same time, the rise of lithium-iron-phosphate (LFP)

Demand is closely linked to uncertainty around technology and policy in clean energy value chains

is cannibalizing demand for nickel sulphate in batteries. Meanwhile, a potential slowdown or acceleration in government policies around electric vehicles casts uncertainty around demand for nickel chemicals.

Global supply dynamics can also influence value addition. For instance, massive Chinese investment in copper smelting has created overcapacity and plunging treatment and refining charges in the last year. Low margins for smelters degrade the viability of projects seeking to add value to copper concentrate.

Figure 5: Copper Treatment and Refining Charges



Source: Wood Mackenzie

Market dynamics present two core threats to value addition. The first is the short-term threat of low prices or high costs during initial startup years, which could significantly degrade a project's net present value. The second is the long-term threat of demand destruction and oversupply,

which would result in implications for finding markets and, ultimately, receiving preferential prices. Policymakers will need to carefully weigh these considerations as they evaluate different value addition opportunities.



Conclusion

Successful value addition will look different for every country, but all countries will benefit from embracing a set of realities. For one, competitiveness cannot be ignored. Policymakers cannot just "wish" for value addition; they must identify gaps in competitiveness, and then enact policies that will bridge those gaps and ensure value addition is competitive. As they do this, countries will also need to find partners that are willing to share risk across the duration of a multidecade, and often volatile, investment. These partners can be private companies and investors. They can also include other governments. As [we wrote](#) ahead of last year's Future Minerals Forum, increased cooperation between countries in Africa, the Caspian, the Middle East, and South Asia could help pool comparative advantages and lead to greater participation in mineral value chains.

Mining and finance ministers around the world today are under pressure to increase local value addition and position their countries favourably for the energy transition. The rationale for pursuing value addition is clear and attractive. But countries cannot afford to proceed blindly. Ineffective policies can lead to failure and impose more costs on taxpayers than they do benefits. In some cases, misguided policies could even jeopardize investment in mining, threatening countries' economies and decarbonization targets. Without proper planning, there is a risk that chasing value addition will actually result in value destruction.

This does not need to be the case. Mineral producers have a variety of tailwinds behind them that provide a new window of opportunity to move further down value chains. Now, policymakers need to engage in hard conversations around benefits, competitiveness, and market dynamics. This can lead to more clarity on where to focus value addition and whom to partner with. From there, policymakers will be in a far stronger position to act boldly and in the best interest of their constituents.



SHARED VALUE AND THE ROLE OF GOVERNMENT AND INDUSTRIAL POLICY

CATALYZING GROWTH AND MUTUALLY
BENEFICIAL OUTCOMES IN THE SUPER REGION

Peter Bryant, Co-Founder and Board Chair,
Development Partner Institute and Board Chair, Clareo

The super region of Africa, Western and Central Asia is full of resource-rich nations that rely on mining as a key industry and a major contributor to GDP. Historically there has been tension between industry, governments and communities, as many of these countries have experienced an "extract-and-ship" mindset that did not invest in growth or infrastructure outside of mine demands. To date, the minerals industry has not prioritized shared prosperity effectively, resulting in a breakdown of trust with governments and local communities. However, the industry is at a turning point. Companies are taking on the responsibility of creating shared value, collaborating with new partners and at a deeper level, in response to downstream, government, and community demands and increased transparency across the value chain. Mining has a massive opportunity to grow prosperity both through and beyond the life of the mine for resource-endowed communities and countries.

[illegible]

Mining provides multiple value streams and can have an investment multiplier effect on prosperity at the individual country level and the super region at large. We can divide mining-led prosperity into three categories – during the life of the mine, bridging to the future, and beyond the life of the mine. In terms of shared value, mining has focused heavily on prosperity during the life of the mine for obvious reasons. Job creation, supply chain development and efficiency, and sourcing goods and services in-country serve as a temporary boon to local economies.

Bridging to the future means investing in infrastructure development – power, water, digital technologies, transportation, etc. – that brings both short- and long-term benefits to the region. Social and economic development in the region around development projects are equally key pieces of this. Setting up structures to encourage and enable investment into the region and building up education and healthcare systems are examples of this.

Steps to build prosperity

Taking these steps to build out systems leading up to and during the life of the mine will naturally lead to prosperity beyond the life of the mine itself, enabling the development of new economic sectors with emerging companies and investors, robust digital, education, and health systems, and well-maintained infrastructure. Mauritania, the second-largest producer of iron ore in Africa, credits the mining industry with its above-average economic growth over the last several years. Proactive reforms and mining policies have encouraged investment in the industry, and the 6% growth in GDP over just one year and 30% contribution to the

national budget has encouraged further investment in infrastructure and logistics to support more development. The country is coupling this with initiatives like the Desert-to-Power project, focused on increasing energy production, promoting solar energy, and improving access to electricity. The African Development Bank has been an important partner in addressing development challenges, ranging from environmental compliance to skill development. SNIM (the Mauritanian iron ore producer) is also a member of the Extractive Industries Transparency Initiative, demonstrating a commitment to ensuring the benefits of mining are equitably shared.

Co-creating a shared vision and roadmap

The path to achieving shared value requires co-creating a shared vision and roadmap. This in turn necessitates a multi-stakeholder, multi-sector approach in order to create a universally adopted set of principles. The Kingdom can create an enabling environment and foster a triangle of trust between government, communities, and mining companies. It's important that there are clear roles outlined for government, mining companies, communities, and downstream companies, and that there is clear representation across all of the stakeholder and owner groups. Government can put forth the appropriate guardrails, so that discussions account for nuance and uniqueness of individual projects while still adhering to a co-created set of accepted principles. It's important that there is a baseline of mutual respect and understanding, avoiding any tendency to preach or impose country-specific values upon others. Designating time and effort to creating that set of principles ahead of ongoing dialogues is key to achieving this.



A pathway to responsible sourcing

One successful example of how this has been activated in the region is the Development Partner Institute's (DPI) Responsible Sourcing Coalition (RESCO), launched in late 2019 in partnership with The Rockefeller Foundation. In a special session, DPI brought together a multi-stakeholder group – including communities and Indigenous perspectives that had been notably absent from conversations to date – to discuss a vision for responsible sourcing, deepen the understanding of each sector and stakeholder's priorities and issues, learn from attempts at standardizing sustainability efforts in other sectors and commodities (such as The Global Platform for Sustainable Natural Rubber), and collectively outline a pathway to accelerate the move towards responsible sourcing. They broke down different stakeholder motivations and expectations, encompassing mining companies, government, investors, Indigenous communities, refiners, downstream companies, and consumers, and had stakeholders from each group share perspectives. The outcome of this session was alignment on workstreams that would develop a Vision and a set of Principles for Responsible Sourcing that provides flexibility to allow for the variations of commodity and jurisdiction. This example is specific to the goal of responsible sourcing, but the method can be applied to many other initiatives and objectives.

Government's role

Government also plays a key role in creating shared value by providing the springboards to invest and develop in the super region. Making

it easier to create new businesses by providing access to capital, investing in infrastructure development, and creating regional hubs to mobilize ecosystems around new challenges are ways they can do this. Anglo American's Sustainable Mining Plan is a successful example of a co-created roadmap that encompasses environmental, economic, and social factors. They utilize a model called Collaborative Regional Development (CRD), which focuses on establishing cross-sector partnerships with organizations from different sectors, governments, communities, academia, financial development institutions, and NGOs to work together on projects of mutual interest. To do this, they establish a regional organization that acts as their "partnership engine" in collaboration with government and other stakeholders. They gauge the viability of opportunities via spatial and economic analysis, testing opportunities and exploring market prospects and local stakeholder views. They then collaborate with different stakeholder groups – business, government, civil society – to manage and co-fund mutually beneficial projects. They currently have five active partnership programs across Africa and South America.



Leveraging networks and resources

The Impact Catalyst South Africa, anchored in the principles of DPI's award-winning Development Partner Framework, is another great example. This development initiative is a multi-partner, cross-sector, impact-driven development effort founded by Anglo American, the South African Council of Scientific & Industrial Research (CSIR), Exxaro, Zutari and World Vision South Africa. In partnership with the Government of South Africa, it designs and delivers large-scale socio-economic development projects in Limpopo, Mpumalanga, and the Northern Cape, utilizing a unique approach where the mining sector is used as the anchor for broad-based regional development. The Impact Catalyst focuses on leveraging the networks and resources of each partner to design public-private initiatives aligned with provinces' and municipalities' Integrated Development Plans. These partners are brought together by a common problem or opportunity, contributing to the notion of what each partner considers shared value in the first place. Government plays a key role in aiding with planning, risk management, decision-making and delivery. The function of government within the Impact Catalyst has been to help understand where the challenges are, what the policy constraints are, and how best to navigate them.

Important to note is the issue of resource nationalism. The concept of shared vision is especially key here, as it requires investing in the time and dialogues necessary to build the mutual understanding and trust needed to buy into a regional approach, versus the standard "country-only" perspective. Establishing trust and aligning on mutual benefit is the biggest weapon against resource nationalism, which is

A demonstrated commitment to collaborative, multi-stakeholder engagement and investment beyond the development of a specific resource project – to the development of a nation's prosperity as a whole – will beget greater value for all involved

often politically popular but may leave jurisdictions with long-term liabilities. Both Uganda and Zimbabwe have engaged in multi-stakeholder dialogue and made changes to their mining codes, balancing national interests and investor needs.

Success will look different on a country-by-country basis based on regional development goals, but there are some collective indicators. From a social and economic standpoint, increased capability across sectors – shown by the emergence and/or strengthening of specific sectors is a key indicator. Strong diplomatic ties, achieved via government-to-government engagement and the effort to create a shared set of principles ahead of project implementation, will help insure against political risk. Providing tax and royalty certainty can help contend with resource nationalism risks, resulting in more investment into the super region. Above all, a demonstrated commitment to collaborative, multi-stakeholder engagement and investment beyond the development of a specific resource project – to the development of a nation's prosperity as a whole – will beget greater value for all involved.



AI-DRIVEN SENTIMENT ANALYSIS OF CRITICAL MINERALS AND MINING: **GLOBAL TRENDS IN PUBLIC PERCEPTION ACROSS THE FMF SUPER-REGION**

Richard Rothenberg, Chief Executive Officer,
Global AI Corporation

This report presents a comprehensive analysis of critical minerals and mining sentiment, leveraging advanced AI-driven techniques to gauge public perception. Covering the period from January 2023 to September 2024, our study focuses on the Future Minerals Forum (FMF) super-region while also providing global context and regional comparisons. The analysis delves into sentiment trends across various critical minerals, revealing generally positive perceptions of lithium, graphite, and nickel, in contrast to more negative sentiments surrounding cobalt. Notably, the FMF super-region demonstrated a more favorable overall mining sentiment compared to global averages. Our research highlights significant investment trends in critical minerals infrastructure and underscores the

crucial role of Environmental, Social, and Governance (ESG) factors in shaping public opinion. The report offers a nuanced exploration of regional sentiment breakdowns and examines how ESG considerations and investment factors influence perceptions within the mining industry. By synthesizing vast amounts of multilingual data from diverse sources, including news articles, social media, and industry reports, this analysis provides a more current and unbiased perspective than traditional reporting methods. The findings presented here have far-reaching implications for policymakers, investors, and stakeholders in the critical minerals sector, offering valuable insights to guide strategic decision-making and policy formulation in this rapidly evolving industry.





Introduction

The critical minerals sector plays a vital role in the global economy and technological advancement. Understanding public perception and sentiment regarding mining activities and specific minerals is crucial for policymakers, investors, and industry stakeholders. This report utilizes AI-driven sentiment analysis to assess public opinion on critical minerals and mining across the FMF super-region and globally, with a particular focus on investment trends and infrastructure development.

Our AI-driven sentiment analysis measures the overall sentiment of critical minerals from large amounts of sources associated with critical minerals. The data includes news items, social media, and reports in dozens of languages, providing up-to-date information beyond what is in unaudited annual firm reports or firms' marketing efforts. Thus, our big data approach significantly reduces self-reporting bias and 'greenwashing' and can show which critical minerals are effectively having a positive or a negative sentiment. The higher the sentiment score, the more positive the text is in relation to a given topic - whether it is

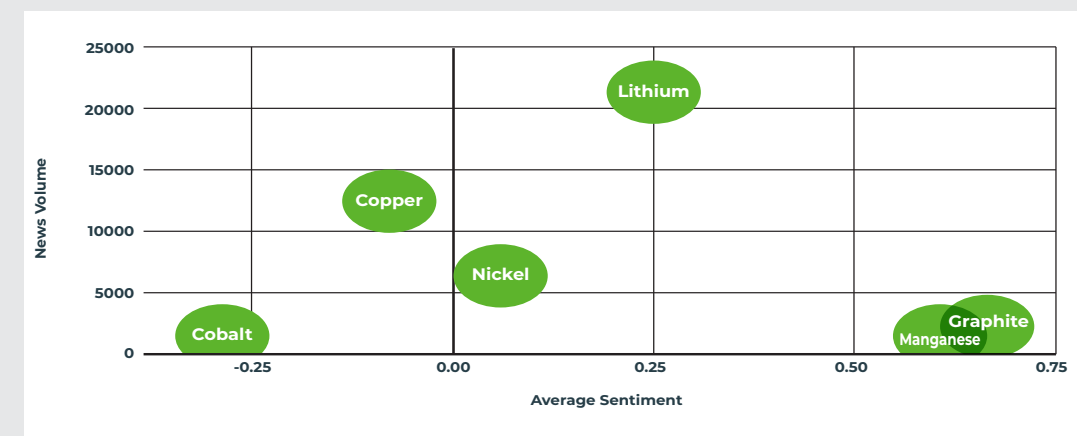
about investment or sustainability-, and vice versa. For example, a company would get a more negative score after a chemical spill that pollutes an entire ecosystem than a company that increases its carbon emissions by a small percentage, thus reflecting different levels of impact or sentiment 'footprint'. While our technology provides a data-driven proxy for perception on critical minerals, it's important to acknowledge its limitations, particularly in scenarios involving fake news or significant discrepancies between self-reported and third-party data. Despite these challenges, our sentiment analysis remains a powerful tool for understanding the complex landscape of critical minerals and their perceived impacts on society and the environment.

The analysis covers the period from January 2023 to September 2024, focusing on six critical minerals: cobalt, copper, granite, lithium, manganese, and nickel. By examining over 40,000 news items related to mining and these specific minerals, the study provides insights into sentiment trends, regional variations, and factors influencing public perception and investment decisions.

Global Sentiment Trends

The sentiment analysis reveals distinct patterns for different minerals and regions. Globally, the average sentiment and total news volume varied significantly across the six critical minerals. Key observations from the global data include the following: Lithium and copper had the highest data availability, while manganese and graphite had less information available globally. Graphite, nickel, and lithium showed positive average sentiment. In contrast, cobalt demonstrated notably negative sentiment.

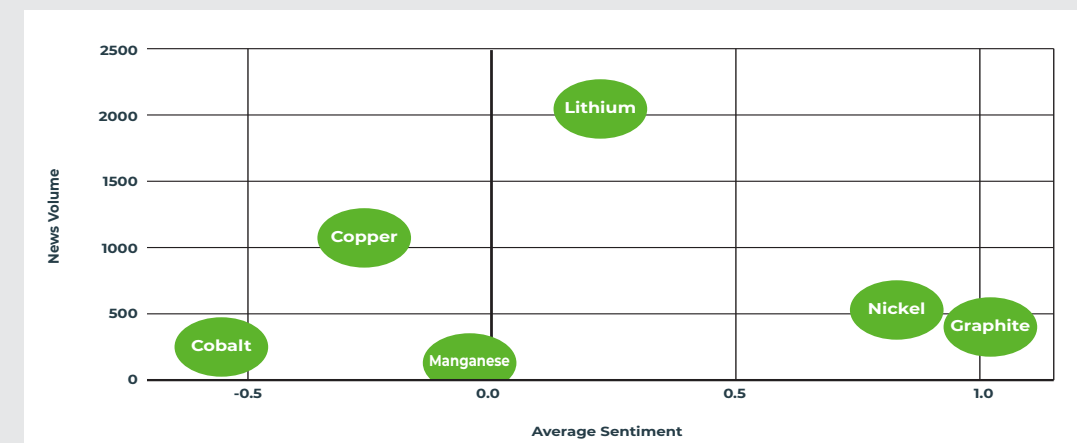
Global: Average Sentiment & Total News Volume



FMF Super-Region Sentiment Analysis

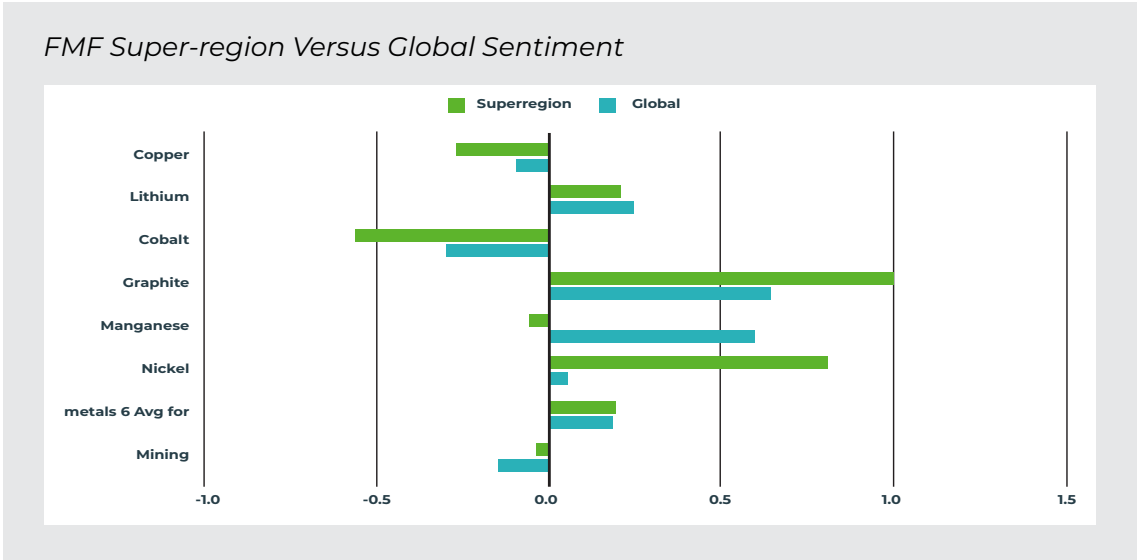
For the FMF super-region, the sentiment analysis revealed some differences compared to the global trends. Notable findings for the super-region include positive sentiment for lithium, graphite, and nickel. Cobalt showed negative sentiment, similar to the global trend. There were variations in sentiment and news volume compared to global data.

Super-region: Average Sentiment and News Volume



Comparison of Global and Super-Region Sentiment

A direct comparison of sentiment scores between the global sample and the FMF super-region reveals interesting insights. Key findings from this comparison include: The average sentiment for mining is noticeably better in the super-region than globally. There is no significant difference in the average sentiment for the six critical minerals combined. Graphite and nickel show better sentiment in the super-region. Copper, lithium, cobalt, and manganese have more positive sentiment globally than in the super-region.



Investment Sentiment Trends in Mining Infrastructure

Analysis of news and reports indicates growing investor interest in critical minerals projects within the FMF super-region. Investment in mining infrastructure showed a significant increase in 2023 compared to the previous year, focusing on modernizing existing facilities and developing new projects for critical minerals. Sentiment towards foreign direct investment (FDI) in mining was generally positive, with a majority of analyzed articles expressing favorable views on international partnerships and technology transfers. Cross-border collaborations and joint ventures in the mining sector were frequently mentioned in positive sentiment articles, highlighting the importance of international cooperation in developing critical mineral resources. Several countries within the FMF super-region have announced major investment plans for critical minerals exploration and extraction, reflecting a growing recognition of the strategic importance of these resources. Investments in sustainable mining technologies and practices were associated with notably higher positive sentiment scores, suggesting a strong public interest in environmentally responsible mining operations.



Regional Breakdown of Sentiment

The sentiment analysis reveals significant regional variations across the FMF super-region. In the Middle East and Africa, there was the highest overall positive sentiment towards mining, particularly for copper and lithium projects, with shared value initiatives and local employment opportunities frequently cited as positive factors. In Europe, sentiment was mixed, showing strong support for critical minerals needed for clean energy technologies but also concerns about the environmental impacts of mining operations. Asia and Oceania generally exhibited positive sentiment, especially for nickel and lithium projects, with cross-border collaborations and technology transfers viewed favorably. In the Americas, sentiment varied widely, with strong support for mining in some countries contrasted with environmental and social concerns in others.

ESG and Sustainability Perceptions

Environmental, Social and Governance (ESG) factors, including those from the UN Sustainable Development Goals (SDGs), play an increasingly important role in shaping public perception of the mining industry. Environmental concerns are a significant focus of negative sentiment articles, particularly regarding water usage and biodiversity loss. In terms of social responsibility, articles that highlight community development initiatives and local employment opportunities generate substantially more positive sentiment than those focusing solely on economic benefits. Governance issues, such as transparency in licensing processes and revenue sharing, are associated with higher positive sentiment scores. Additionally, news about the adoption of sustainable mining practices, including renewable energy in mining operations and water recycling technologies, correlates with higher positive sentiment scores.



REFLECTIONS

The AI-driven sentiment analysis of critical minerals and mining provides valuable insights for policymakers, investors, and industry stakeholders. Key conclusions indicate that sentiment varies significantly across different minerals and regions, with minerals like lithium and nickel generally viewed more positively than cobalt. The FMF super-region exhibits better overall sentiment for mining compared to the global average, though this varies by specific mineral and country. Investment in mining infrastructure and critical minerals projects is viewed positively, particularly when accompanied by community engagement and benefit-sharing mechanisms. Cross-border collaborations and international partnerships are increasingly important in the development of critical mineral resources. ESG factors, especially environmental concerns and social responsibility, play a crucial role in shaping public perception of the mining industry and influencing investment decisions. Sustainable mining practices and transparency in governance are associated with significantly higher positive sentiment scores.

This sentiment analysis approach offers numerous benefits for the mining sector, including trend identification, uncovering hidden patterns, providing real-time insights, informing policy formulation, enhancing understanding of public perception, and improving communication strategies. By leveraging these insights, stakeholders can work towards more sustainable and socially acceptable mining practices, ultimately contributing to the responsible development of critical mineral resources in the FMF super-region and beyond. The findings underscore the importance of balancing economic development with environmental and social considerations in the mining sector. As the demand for critical minerals continues to grow, policymakers and investors should prioritize sustainable practices, community engagement, and transparent governance to ensure long-term success and positive public perception.

CONCLUSION

The transition to a low-carbon future requires global collaboration among governments, industries, and communities. Frameworks like the UNFCCC and The Paris Agreement emphasize multinational cooperation, yet significant progress is still needed to meet climate goals. The mining industry must balance emission reductions, economic growth, and enabling key transition projects, leveraging value creation through downstream processing and integration. For instance, resource-rich countries stand to benefit significantly from mineral value addition, particularly for clean energy technologies, which can support sustainable economic gains through initiatives targeting benefits, competitiveness, and market dynamics.

The minerals industry plays a crucial role in nation-building by providing raw materials and driving infrastructure expansion. Maximizing the benefits of nations' mineral endowments has been a historic challenge but can be addressed through a shared value proposition that aligns interests and fosters durable success. The energy transition is driving increased demand for materials like copper, lithium, nickel, rare earth elements, graphite, and cobalt. This shift necessitates both increased mining and processing investments. Ensuring the availability and affordability of these materials sustainably is reshaping investment priorities, requiring more exploration, better infrastructure, and advanced processing technologies.

Significant investments—estimated at US\$5.4 trillion required by 2035—are needed in mining, refining, and infrastructure to meet the growing materials demand. Countries are focusing on value addition to produce higher value midstream and downstream products, especially for clean energy technologies. However, most midstream and downstream projects remain concentrated in a few countries, including China and advanced economies such as North America and Europe. Emerging markets face challenges due to limited access to funding, underdeveloped mineral extraction capabilities, and infrastructure gaps. Policymakers must prioritize value addition based on benefits, competitiveness, and market dynamics to bridge these gaps effectively.

The energy transition requires robust, risk-sharing collaborations among stakeholders to accelerate progress. Enhanced cooperation between public- and private-sector players, as well as international partners is essential to overcome financial and operational barriers, ensuring that decarbonization efforts are effective and scalable. The Super Region, rich in resources, has historically suffered from an "extract-and-ship" mindset but is now at a turning point. Companies are increasingly focusing on creating shared value through deeper stakeholder collaboration.

The minerals industry is at a crossroad of technological transformation and societal expectations for greater responsibility, while maximizing local benefits.

A test for the sector will be how it responds to these demands, particularly delivering prosperity to local and Indigenous communities beyond the life of a mine.

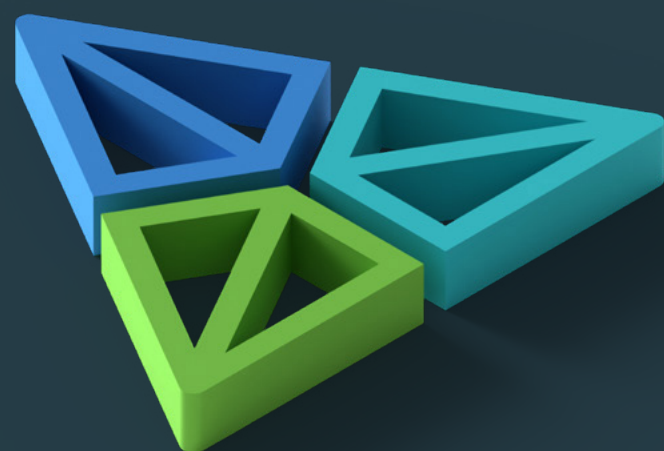
The Super Region has significant untapped potential in mining and metals that can drive the global

energy transition. By facilitating partnerships, the FMF is working to enhance the region's contribution to global mineral supply chains, particularly in key materials needed for renewable energy technologies.

Looking ahead, practical steps to unlock the Super Region's potential include increasing investment in infrastructure, improving access to project financing, and utilizing advanced technologies to enhance mineral production. Policymakers could engage in thorough assessments of competitive positioning, implement targeted policies, and foster partnerships to ensure long-term success in value addition efforts. Mining companies could adopt and communicate sustainable practices, such as renewable energy use and water recycling technologies, to address environmental concerns and improve public perception. By focusing on strategic collaborations and leveraging the region's vast resource base, the Super Region can drive sustainable economic growth, job creation, and play a crucial role in the global energy transition.









[Futuremineralsforum.com](https://futuremineralsforum.com)

#FMF #FMF25 #FutureMineralsForum

