



HEADING TOWARDS SUSTAINABLE MINING

BENEATH THE SURFACE : EXPLORING THE ESG DYNAMICS IN THE MINING INDUSTRY

SEIZING STRATEGIC OPPORTUNITIES IN AN EVER-CHANGING LANDSCAPE

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AT A GLANCE

- The mining industry's positioning in the global ESG landscape remains highly ambiguous. On one hand, the industry is perceived as a laggard when it comes to ESG stewardship. On the other, mining companies solely carry the hopes of an entire generation to supply a continuously growing need for the "green transition minerals".
- Rising pressure from investors, governments, downstream industries, and society is driving mining companies to improve their ESG performance. However, the challenge lies in moving from ambitions to tangible and actionable initiatives.
- Multiple opportunities lie in the green transition, and ESG should no longer be perceived as a sacrifice of financial returns but rather as a significant catalyst for value creation.
- CVA has developed and implemented proprietary methodologies that help mining players identify the right opportunities, deploy the right initiatives and maximize their returns while playing a leading role in the green transition.



60 elements

are vital to modern society
today

Source : (1) Coalition for Eco Efficient Comminution (CEEC)

Chapter 1

SIGNIFICANT ESG-RELATED EFFORTS ARE NEEDED IN THE MINING INDUSTRY

THE MINING INDUSTRY FACES CHALLENGES IN ALIGNING ITS PRACTICES WITH GLOBAL ESG STANDARDS

With the advance of technology, our reliance on a broader spectrum of metals has increased. Today, about 60 elements are vital to modern society. However, the exploitation of these elements has given rise to a variety of environmental, social and governance challenges.

Processing and extraction of minerals and metals contribute to a quarter of global carbon emissions, driven largely by electricity consumption and fuel usage. Due in part to declining resource quality as demand rises, refining activities are becoming particularly electricity-intensive. The comminution process is estimated to consume up to 3% of all the electricity generated worldwide¹.

Mining operations also result in substantial changes to land cover, significant water usage, and landfills of hazardous waste. Furthermore, these operations carry contamination risks through acid mine drainage, wastewater discharge, and tailings disposal. These factors have the potential to trigger notable environmental consequences, as exemplified by the Brumadinho dam collapse in Brazil.

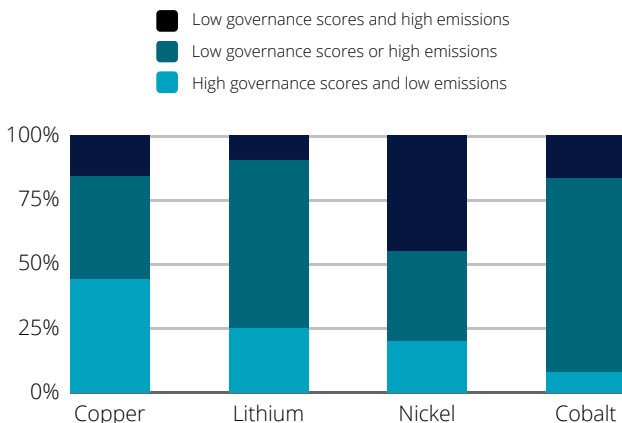
Alongside environmental concerns, significant governance and social challenges are yet to be overcome, since critical elements like lithium, nickel, and cobalt are mainly produced today in regions with low governance and high emissions

(Figure 1), which has historically impacted public support for mining projects leading sometimes to local and international resistance to mining investments and criticisms related to ESG topics.

Figure 1

Only a minority of mining output comes from regions with a high governance score and low emissions intensity*

Distribution of production of selected minerals by governance and emissions performance, 2019



Source : World Bank, IEA

DESPITE EXTERNAL GROWING PRESSURES, DISPARITIES BETWEEN MINING PLAYERS PERSIST

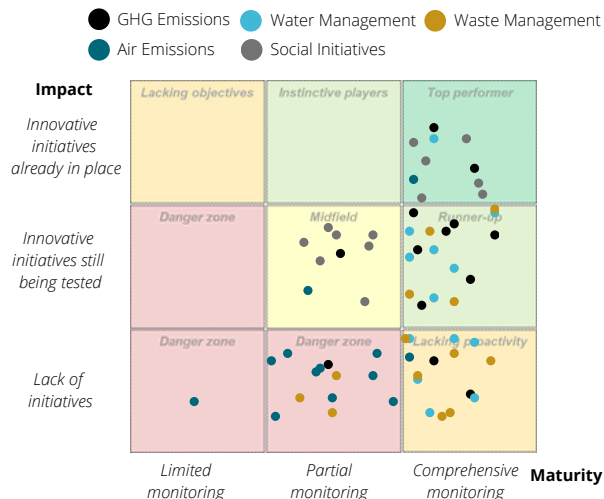
The mining industry has deployed significant efforts to overcome its historical ESG challenges, but notable disparities continue to separate mining players when it comes to their readiness for the sustainability transition.

While climate change and ESG are consistently ranked as the most important topics on the C-Suite agendas of mining players, Figure 2 illustrates that the level of maturity in terms of communication and monitoring on “basic” indicators such as greenhouse gas (GHG) emissions, water and waste management, air emissions, and social initiatives still varies widely among industry players. A recent survey of mining industry leaders reveals that ~40% of players have not yet managed to deploy proper processes and roadmaps to identify, quantify and respond to ESG-related challenges and threats.

Figure 2

There is a notable inhomogeneity in the market regarding environmental and social performance

Ranking of firms according to the level of maturity regarding environmental and social topics



Source : CVA analysis

A significant **disparity** exists within the market regarding environmental and social performance

Note : (*) Analysis done using the World Bank Worldwide Governance Indicator (as a proxy for governance) and electricity CO₂ intensity (as a proxy for emissions performance). Composite governance rank / scores below 50 were classified as low governance; electricity CO₂ emissions intensity above 463 g CO₂/kWh (global average value in 2019) was classified as high emissions intensity.

Due to the growing scrutiny from investors, governments, downstream industries, and civil society, industrial players are simultaneously facing increasing pressure to prioritize the sourcing of responsibly produced minerals :

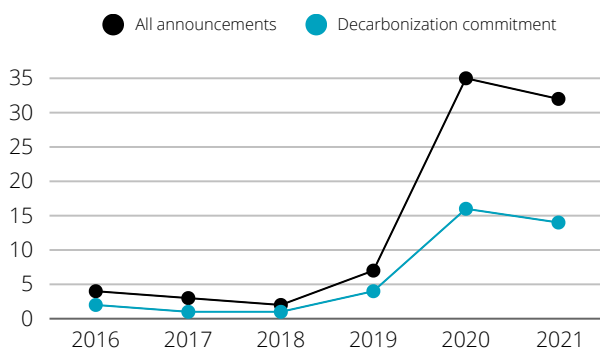
- Investors prioritize decarbonization, with increasing pressure on reducing GHG emissions and having a positive social impact on indigenous communities.
- Political pressure is accelerating the transition towards achieving net-zero mining operations and mineral supply chains, i.e. the EU is using a carbon tax to incentivize cleaner energy adoption.
- The decreasing attractiveness of the mining industry among students and job seekers, primarily due to heightened ESG expectations, is leading to a skills shortage: Three mining executives out of four believe the talent shortage is holding them back from delivering on production targets¹.

COMPANIES ARE ANNOUNCING THEIR ESG STRATEGIES WITH DEFINED LONG-TERM TARGETS

Figure 3

Rising number of stand-alone decarbonization announcements in the mining sector

An increasing number of mining companies are committing to reduce emissions (mainly scope 1 & 2)



Source : Annual reports

Source : (1) CVA Database. (2) World Business Council for Sustainable Development

Due to the increasing stakeholder pressure, a growing number of mining companies are committing to reduce emissions, which has resulted in a recent surge in decarbonization announcements over the last 5 years (**Figure 3**), with a large array of miners committing to achieve net-zero emissions by 2050. Companies that have not set 2050 targets are still aiming to reduce carbon emissions, primarily through scope 1 & 2 abatement efforts. Despite such efforts, the most significant challenge lies in controlling scope 3 emissions, which account for 95% of the mining industry's overall output². Mining companies are also aligning their commitments with their portfolios by:

- Forming strategic alliances to lower the value chain's overall carbon footprint (such as BHP and POSCO joint development of steel-decarbonization technologies in 2021), or alliances with downstream companies, such as automakers, to lock-up supply of minerals required for the energy transition (such as Tesla and Prony Resources, securing a multi-year nickel-supply agreement for battery production).
- Reviewing their portfolios to focus on energy transition and include climate-friendly minerals. BHP for instance is divesting its oil and gas business, and Rio Tinto has recently added scandium and tellurium to its portfolio.
- Rethinking traditional value chains through new circular business models, which are focused on metal reprocessing, recycling, and urban mining. In certain scenarios, with dwindling ore grades in traditional mines and rising extraction costs, these models might become not only environmentally but also economically preferable.

THE CHALLENGE LIES IN TRANSITIONING TOWARDS CONCRETE INITIATIVES: ESG AS A VALUE DRIVER

Fulfilling ESG obligations and transitioning towards concrete initiatives will require full integration of

ESG into long-term business strategies as a value-adding component.

- The key focus is to initiate a cultural shift where ESG considerations are embedded in every decision-making process.
- The challenge is to make these considerations environmentally and financially beneficial.

Mining companies that develop a strategy combining these two aspects, alongside a solid governance structure, will be better equipped to meet progressively stringent ESG targets and achieve higher valuations, thus attracting more capital investment to support their growth.

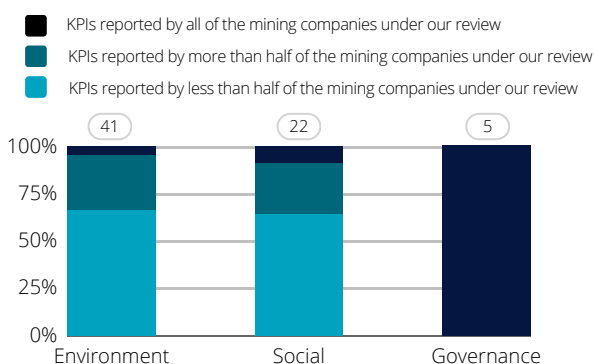
IT IS CRUCIAL TO ADDRESS THE LACK OF ALIGNMENT ON REPORTING STANDARDS AND BEST IMPLEMENTATION PRACTICES

Mining companies have all embarked on the ESG transformation journey but are yet to align on the way forward. Clear initiatives are yet to be defined, along with implementation strategies and key success indicators. Governance is currently the only ESG pillar with alignment.

Figure 4

In terms of ESG initiatives, the mining industry has potential for improvement on multiple fronts

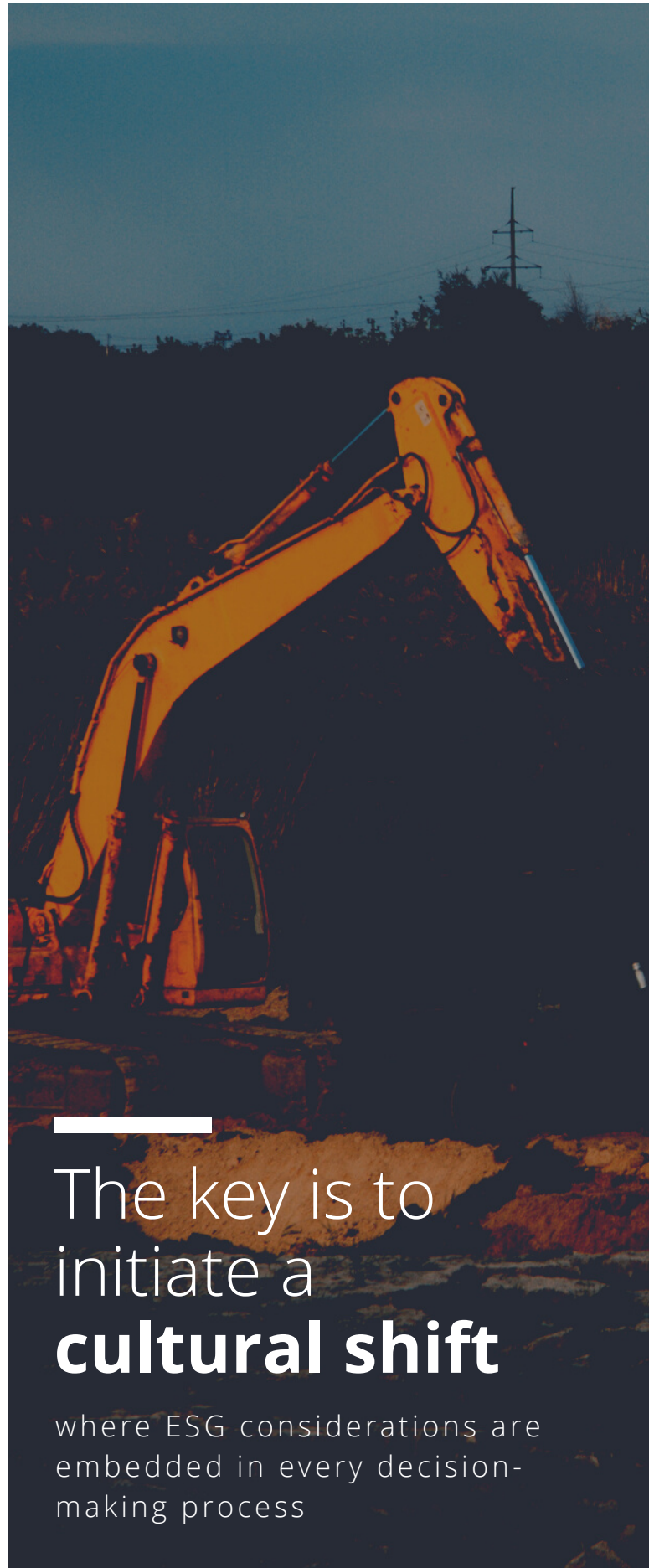
Lack of consistency in reporting of ESG KPIs across the mining industry



Legend : Total of mapped ESG KPIs
Source : Annual reports. CVA analysis

The key is to
initiate a
cultural shift

where ESG considerations are
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Strong performance expectations generate undifferentiated actions

Full alignment on what "good governance" means is the most striking observation among the panel of 13 mining companies we have analyzed. The entirety of the panel has implemented the same initiatives consisting of:

- Creation of CSR-dedicated executive positions
- Creation of official charters on human rights
- Monitoring of controversies
- Creation of data protection policies
- Implementation of Tax Transparency policies

Such solutions will address higher expectations of most stakeholders. However, the effectiveness of these initiatives is yet to be confirmed. In a favorable market context and historically high prices, temptations not to abide by the rules are reduced. However, as the market returns to lower price levels, it will be important to see how impactful these initiatives will be in enforcing sustainable good governance practices.

Social initiatives are yet to be shaped

The mining industry has always operated in challenging social conditions, which require a delicate balance between efficient mining operations, employee safety, and protection and empowerment of local communities.

In recent years, there has been a growing emphasis on the need for mining companies to demonstrate commitment to social responsibility in order to be granted a license to operate. Social initiatives have become integral components of mining projects, with a focus on investing in communities, empowering women and ensuring safety for all employees. Initiatives like the Initiative for Responsible

Mining Assurance (IRMA) aim to offer a comprehensive standard for responsible mining, encompassing environmental and social criteria.

However, **Figure 4** highlights that, even if all mining players are approaching social impact through the same prism, KPIs used for monitoring their performance vary widely. Differences of jurisdictions and geographies explain a large part of the witnessed discrepancies, largely owed to local communities having specific expectations.

The environment will be the most challenging yet also the most rewarding dimension to consider

Despite some relative maturity in monitoring GHG emissions, significant challenges remain. Many companies still lack concrete initiatives, making it challenging to quantify their progress in addressing their reduction objectives. Some players only display an "on track" or "under monitoring" status, while reported numbers linked to emissions indicate stalling decreases or even increases in amounts of CO₂ emissions. Two reasons can explain the gap between challenges faced and solutions offered:

- ESG scorings, by giving an equivalent weight between the three E-S-G dimensions, clearly do not favour environmental initiatives that are more costly, complex to implement and have uncertain long-term returns.
- Many potential solutions rely on technologies that either need to be invented, or are not yet sufficiently mature or cost-effective.

It should be noted that some organizations recognize companies that report transparently and meet their sustainability objectives: The CDP (Carbon Disclosure Project) scores companies based on their transparency and action, allowing stakeholders to discern which companies are leading in their efforts.

The energy transition entails a shift from a

fuel-intensive to a material- intensive

energy system

Chapter 2

A LOW-CARBON FUTURE IS MINERAL INTENSIVE, AND ACHIEVING AMBITIOUS CLIMATE CHANGE GOALS REQUIRES A LARGER MATERIAL FOOTPRINT

The mining industry, often perceived as a low performer in the context of environmental sustainability, is now being seen as a crucial contributor to the solution. Stakeholders are increasingly recognizing the industry's role, not only as a primary source of emissions, but also as a supplier of essential raw materials necessary for the global energy transition.

THE MINING INDUSTRY WILL BE AT THE CORE OF ENABLING THE ENERGY TRANSITION

Achieving emission reductions in line with the Paris Agreement requires a significant increase in the deployment of clean energy technologies.

- In the Sustainable Development Scenario*, the annual installation of solar photovoltaic (PV) cells, wind turbines, and electricity networks must triple by 2040, and sales of electric cars need to grow by 25 times over the same period.
- To reach global net-zero emissions by 2050, a substantial acceleration of the deployment of clean energy technologies is required.

Such clean energy technologies require larger quantities of minerals and metals compared to their fossil fuel-based counterparts. The energy transition entails a shift from a fuel-intensive to a material-intensive energy system. For instance,

Note : (*) The Sustainable Development Scenario (SDS) outlines a clear trajectory that completely aligns with the global objectives of addressing climate change in accordance with the Paris Agreement. This scenario is dependent on countries and companies achieving their stated targets of achieving net-zero emissions, mostly by 2050, within the specified time frame and without any deviations. Some nations or regions have adopted policies that are in line with the SDS. For instance, the European Union's Green Deal aims to make Europe the first climate-neutral continent by 2050, aligning with the SDS's objectives.

On the other hand, the Stated Policies Scenario (STEPS) offers an insight into the potential outcomes of existing policy measures and plans in the energy sector.

an Electric vehicle (EV) requires six times the mineral inputs of a conventional car, while an onshore wind plant requires nine times more mineral resources than a gas-fired plant¹.

As the world transitions towards net-zero emissions, the rapid adoption of these technologies is expected to drive a significant surge in demand for various minerals (**Figure 5**):

- Lithium, nickel, cobalt, manganese, and graphite are crucial for battery performance, longevity, and energy density.
- Rare earth elements are essential for the production of magnets used in wind turbines and electric vehicle motors.
- Copper and aluminium are extensively required for electricity networks.

Figure 5

By 2040, several miners will play a role in facilitating the energy transition for major industries

Demand evolution of iron ore, copper, aluminium and other minerals in a sustainable scenario by 2040



Source : IEA. CVA analysis Steady demand ● ● ● High demand increase

Up until the mid-2010s, the energy sector represented a small portion of total demand for most minerals. However, as energy transition accelerates, clean energy technologies will become the fastest-growing segment of demand, and with that the demand for critical minerals will very likely outstrip supply in the near term, pushing mining

Source : (1) IEA

companies to expand their activities. In scenarios aligned with the Paris Agreement goals, the share of total demand of mining companies would rise over two decades to :

- Over 40% for copper and rare earth elements
- 60-70% for nickel and cobalt
- 90% for lithium

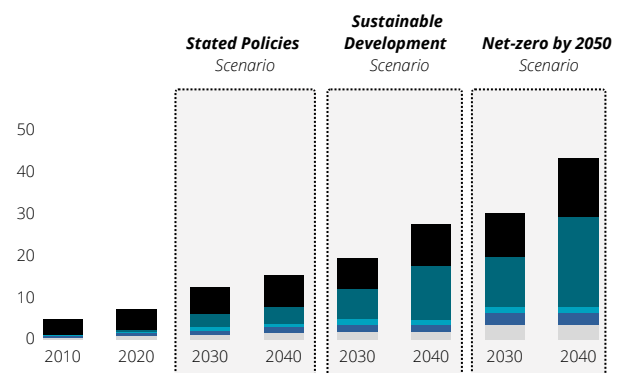
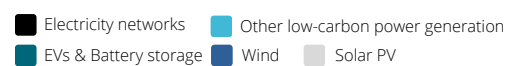
For instance, EVs and battery storage have already become the largest consumers of lithium, surpassing consumer electronics, and are projected to surpass stainless steel as the largest end-user of nickel by 2040.

Under the IEA Stated Policies Scenario, the world is currently on track to double overall mineral requirements for clean energy technologies by 2040 (**Figure 6**). However, meeting the goals of the Paris Agreement would necessitate a fourfold increase in mineral requirements for clean energy technologies by 2040. To reach global net-zero emissions by 2050, mineral inputs in 2040 would need to be six times higher than current levels.

Figure 6

Total mineral demand from clean energy technologies is set to double under STEPS and quadruple under SDS by 2040

Total mineral demand (in Mt) for clean energy technologies by scenario



Source : IEA

IT IS THEREFORE CRUCIAL TO INVEST IN ENERGY TRANSITION MINERALS AND DEVELOP A GREEN OFFER

Energy-transition critical minerals represent a global playing field for mining players with Africa, South and North American seen as driving regions for the future of the mining industry. Combined, these regions represent around 50% of the global reserves of aluminium, cobalt, copper and lithium. Best-in-class mining players will manage to generate a portfolio of ESG-friendly investments and mining activities that will allow them to seize all the potential from these regions as enablers of the global energy transition.

Such an investment in energy transition involves substantial initial capital expenditures. Nevertheless, these costs can be mitigated by:

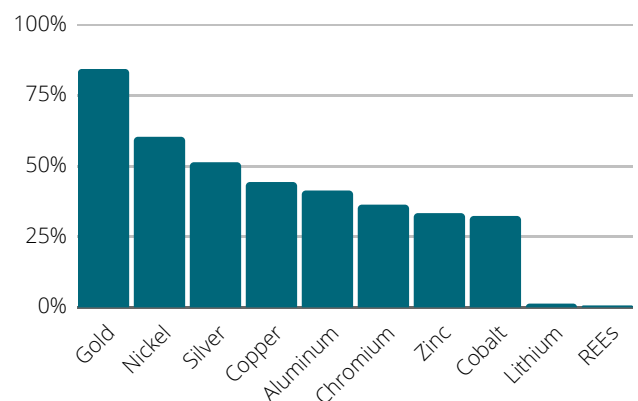
- Taking advantage of tax incentives and favorable financing conditions.
- Enhancing efficiency, given that decarbonization initiatives encourage the implementation of efficient equipment and processes, which leads to reduced operating expenses and increased profit margins.
- Optimizing the value of end-of-life materials through recycling, thereby shifting positions on the cost-curve, resulting in lower supply costs and protection against fluctuations in raw material prices.

Currently, there is room for improvement for recycling best practices (**Figure 7**). The recycling capabilities for lithium and REEs, for instance, are relatively limited on a global scale. This is partly due to technical constraints (lithium reactivity in thermodynamic and metallurgic recycling), limited collection infrastructure, and higher cost compared to mining new reserves, especially if the latter is subsidized or if environmental externalities aren't priced in. It's important to note that recycling practices vary regionally, with the EU relying heavily (50%) on secondary production using recycled metals compared to other global regions (18%).

Figure 7

Today's recycling rates vary by metal and depend on the ease of collection, price levels and market maturity

End-of-life recycling rates (%) for selected metals



Source : Henckens, UNEP (for aluminium), OECD (for nickel and cobalt)

The recycling rate of Rare Earth Elements (REEs) and Lithium today is

< 1%



Ultimately, establishing strong and innovative governance strategies remain crucial in proactively addressing the energy transition. It is important to maintain ESG as a prominent item on the board's agenda and at the center of decision-making. Moreover, social impact should not be overlooked in favor of financial benefits, particularly for minerals located in challenging areas, as companies pursue expansion to address the significant demand-supply gap for critical minerals.

EXAMPLES OF GREEN COMMODITIES OFFERS

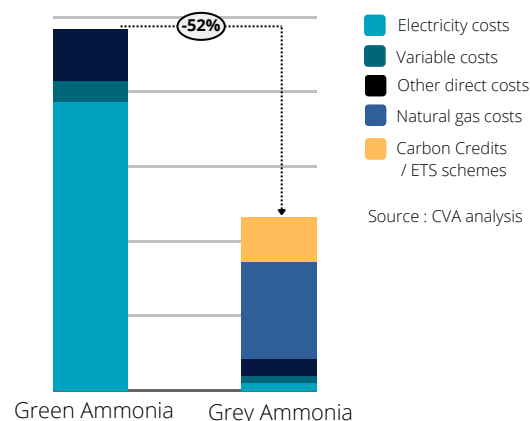
- Green steel:** CO₂ balance and eco-compatibility are becoming determinant elements in mobility, with several trends reshaping the mobility market, thereby impacting the volume of steel sold, specs and prices. Green steel is one solution to address the new paradigm. For instance, as steel represents a limited share of car production costs, the impact of a green-steel price premium on the overall car cost would be marginal although it would represent an interesting marketing rationale for OEMs toward their end-users. It could present value for other stakeholders such as OEMs to reduce their overall CO₂ emissions and for authorities to develop a green industry. In a scenario where steel volumes may be on the decline, focusing on green steel for product differentiation is an attractive strategy.
- Low-carbon fertilizers:** The low-carbon fertilizer transition is underway driven by carbon price increase, growingly challenging legislation on GHG emissions and ambitious hydrogen/ammonia plans:
 - Green ammonia: Fertilizer companies are shifting to low-carbon fertilizers derived from green ammonia to comply with regulations and minimize exposure to growing costs.

As green ammonia production increases, adoption of low-carbon fertilizers will grow, offering room for expansion after 2030. By 2035, the costs of green ammonia may become competitive compared to grey ammonia and the current gap is expected to be bridged as a result of declining green electricity costs arising from the development of green energy (economies of scale), improved technological efficiency, evolution of carbon credit schemes, and increasing natural gas prices (**Figure 8**).

Figure 8

Green ammonia vs grey ammonia : a significant OPEX gap today, that can be bridged by 2035

Grey and green ammonia direct costs estimates (USD/t), Europe average in 2020

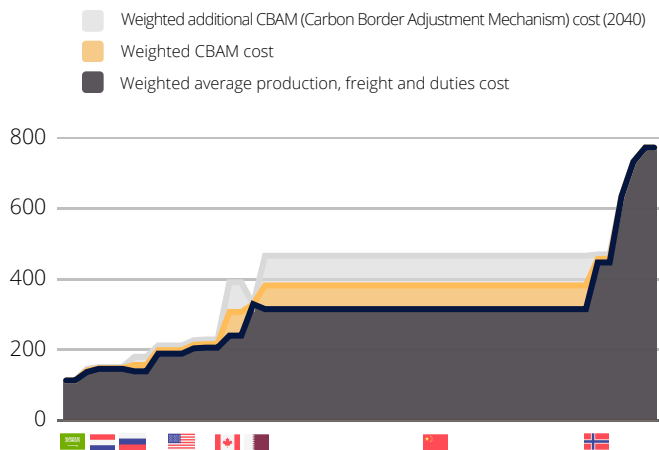


- Green hydrogen: Financial incentives, such as public investments in green hydrogen through initiatives like the EU's COVID stimulus package, as well as the expansion of large-scale green hydrogen plants, are accelerating the progress toward achieving hydrogen adoption targets.
- Nitrogen (Urea): Reduced utilization of urea due to increased awareness of fertilizers' environmental impact (notably conventional N and K-fertilizers) and stricter regulations impacting the competitiveness of N-suppliers (**Figure 9**).

Figure 9

Carbon pricing and taxation is expected to impact the competitiveness of international N-suppliers in Europe

Nitrogen (urea) cost curve for Europe, in USD/t



Source : CVA analysis

It should be noted that CBAM implications are numerous, ranging from encouraging global industries to adopt greener practices, to promoting a culture of corporate responsibility by providing a competitive advantage to ESG-compliant businesses within the EU.

- **Green cement** : Buildings are the number one source of carbon emissions globally and ~60% of construction emissions are due to cement production¹. Restrictive environmental regulations, like France's ER2020 and the Housing, Development & Digital Development Law (ELAN), require the assessment of a building's carbon footprint and therefore the adoption of low-carbon construction solutions.

Previous examples are not exhaustive, and serve to illustrate the potential opportunities for mining companies and to emphasize the importance of developing a green offer.

Source : (1) CVA Database

Chapter 3

BUILDING A COMPREHENSIVE ESG-ENABLED STRATEGY

Merely addressing new ESG regulations with small-scale initiatives to meet minimal expectations does not give a lot of space for additional benefits. On the contrary, implementing a proactive approach through ambitious ESG initiatives will eventually give mining companies the ability to:

- Identify relevant value pools.
- Focus their core business to activities with significant added value.
- Differentiate and capture generated added value with a long-term perspective.

Hence, the key element that mining firms critically need to thrive from both an economic and ESG-friendly perspective is identifying and constructing a holistic strategy. CVA has developed a specific expertise in this field and has designed a customized methodology that allows firms to not only thrive but to stand out in front of competitors, illustrated by **Figure 10**.

In order to succeed in the coming decades, mining companies will need to understand various dynamics:

- In the short-term: the state of their core business activities.
- In the mid-term: the nature and extent of ESG dimensions' impact on these core business activities.
- In the long-term: mining market and macroeconomic trends that will be fully integrating ESG requirements.

Some materials, such as nickel, are certainly

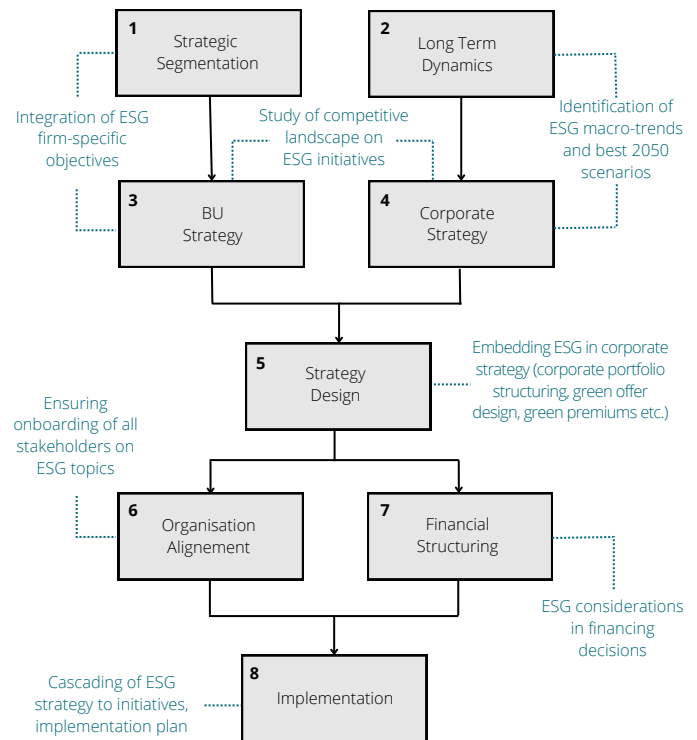
critical for the energy transition “as we conceive it today”, but their scarcity raises the question of whether there won't be a paradigm shift in the short/medium term towards alternative green solutions that utilize different, more abundant minerals.

Therefore, conducting a thorough analysis of their activity portfolio will allow companies to deconstruct their business, perform a strategic segmentation (#1 in **Figure 10**) and get a better understanding of where their true assets and liabilities appear. Contrarily, performing some extensive analysis of mining long term dynamics (#2) will allow mining companies to move from a risk-mitigating stance to a proactive one when dealing with ESG expectations related to the whole industry.

Building up on such a future-oriented ambition will force mining companies to carefully select their core strategies per Business Unit (#3), thereby requiring significant preparedness to identify the most relevant corporate strategy (#4) and the best way to design it (#5) that will provide access to the most compelling value pools.

Once the strategy is chosen and properly designed, best-in-class mining companies will get alignment from all internal stakeholders (#6). Financial structuring (#7) will be the final tangible lever that will set the whole strategy of such mining companies in motion towards full implementation (#8), fostering differentiation and ultimately generating value for the company, its shareholders, and to society overall.

Figure 10
CVA LEAD® Methodology



The key element is to identify and construct a proper

holistic strategy

Chapter 4

CVA AS YOUR PARTNER IN THIS FAST-CHANGING INDUSTRY

With three decades of experience in the mining industry, CVA brings profound knowledge of the minerals market. Over the years, a dedicated Mining & Metals platform has been established, and various projects were conducted for diverse key players along the value chain. Leveraging its extensive database and expert network, CVA has been able to deliver strategic advice on a wide range of topics to its clients.

Players wishing to take advantage of one of the numerous opportunities in the mining industry would need to adapt their strategic roadmap for the upcoming months. **Figure 11** showcases which methodology CVA would apply as your strategic partner for each opportunity. From corporate portfolio and sustainability strategies to green offer design and everything along the way, CVA is ready to mobilise a team of experts to provide top tier support to its partners.

Figure 11

The CVA methodology used to implement the relevant strategy



ABOUT US

- Founded in 1987, Corporate Value Associates (CVA) is a global strategy consulting firm with 17 offices around the globe, that combines business mindset and technical expertise
- CVA has developed a unique expertise through its dedicated Mining & Metals platform through 30+ years serving the mining industry. CVA has worked with multiple key players throughout the value chain on a wide array of topics (strategy, growth, M&A, operational excellence, and more)
- By bringing together experts from both upstream and downstream segments, CVA ensures a comprehensive understanding from the mine to the end users, which necessary to provide a custom-made solution for every challenge
- CVA combines mining expertise, innovation, distribution and retail skills, to position itself as trustful partners to explore new opportunities in the mining industry
- CVA works together with clients to seize strategic opportunities and achieve breakthrough improvements on their top-line and bottom-line
- CVA is committed to customer satisfaction, delivery of tangible results and sustainable business impact



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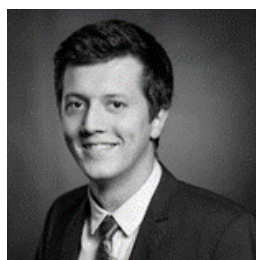
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