IGF INTERGOVERNMENTAL FORUM on Mining, Minerals, Metals and Sustainable Development

WHAT MAKES MINERALS AND METALS 'CRITICAL'?

A practical guide to the attention of governments to build resilient supply chains

DRAFT FOR CONSULTATION

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1.0 Introduction

Minerals and metals are the backbone of our modern society. These crucial elements are the building blocks that drive economic, social, and technological advancement. They serve as vital feedstocks for our food systems and are indispensable inputs for our industrial development.

Global trends and calls to action, such as the imperatives to address climate change, notably by moving away from a fossil-fuels based economic model and the increasing digitalization of our society, will require a rapid adoption of a suite of technologies that are highly mineral intensive. As recent analysis suggests (see IEA, 2023, World Bank, 2019), these systemic changes in our industrial and societal models have led to an exponential rise in demand for minerals and metals and forecasts predict that the upward trend in demand is likely to continue at an accelerated pace.

Forecasts however indicate that the increasing demand for minerals and metals is unlikely to be met by a corresponding pace in mineral supply, at least in the short- to medium term.

It is therefore expected that in the years to come, production of and access to minerals and metals that are essential to the manufacturing of digital, decarbonization and energy transition technologies will be at the top of the political and economic agenda of many governments and influence strategic decisions and alliances at various levels, namely at bilateral, regional and global levels. These will fundamentally reshape the markets for minerals and metals that are essential for the energy and digital transitions, indistinctly impacting all supply chain actors, albeit in different ways.

2.0 Objectives

This practical guide provides a series of questions that may guide governments when considering the design of strategic policies and roadmaps with respect to minerals and metals they produce and/ or need for resilient industrial supply chains.

The aim is to support governments in crafting their own definitions and lists of what should be considered as 'strategic' or 'critical', based on their mineral endowments, on their national development objectives and priorities, on their decarbonization and industrialization pathways, and on their importance (and role) in global supply chains.

This practical guide provides a (non-exhaustive) set of questions and indicators that governments may want to consider when conducting a thorough assessment of the risks associated with their critical or strategic minerals and metals. While criticality assessments are mainly aimed at identifying risks, indicators provided in this practical guide are also aimed at identifying strategic opportunities that can be leveraged to maximize the benefits from the rising demand for minerals and metals.

3.0 How do we assess whether a mineral or a metal is critical (or not)?

Minerals and metals are not equally distributed in the Earth's crust, which means that some minerals are highly concentrated in a handful of countries. This physical characteristic of mining is at the source of several potential risks and challenges that may, in turn, impact mineral value chains and their related supply chains. Risks differ across producing and destination countries and across different industries or sectors that require minerals and metals as inputs in their production.

The rising demand related to the energy and digital transitions, the growing complexity of global supply chains and the geopolitical tensions these dynamics have generated have exacerbated the risks. To manage the growing risks associated with access to, and production of, minerals, countries and industries who are most vulnerable to supply disruptions have undertaken risk assessments (also called *'criticality assessments'*) to better identify sources of vulnerabilities, understand pinch points along mining production value chains as well as related weaknesses in the global supply chains.

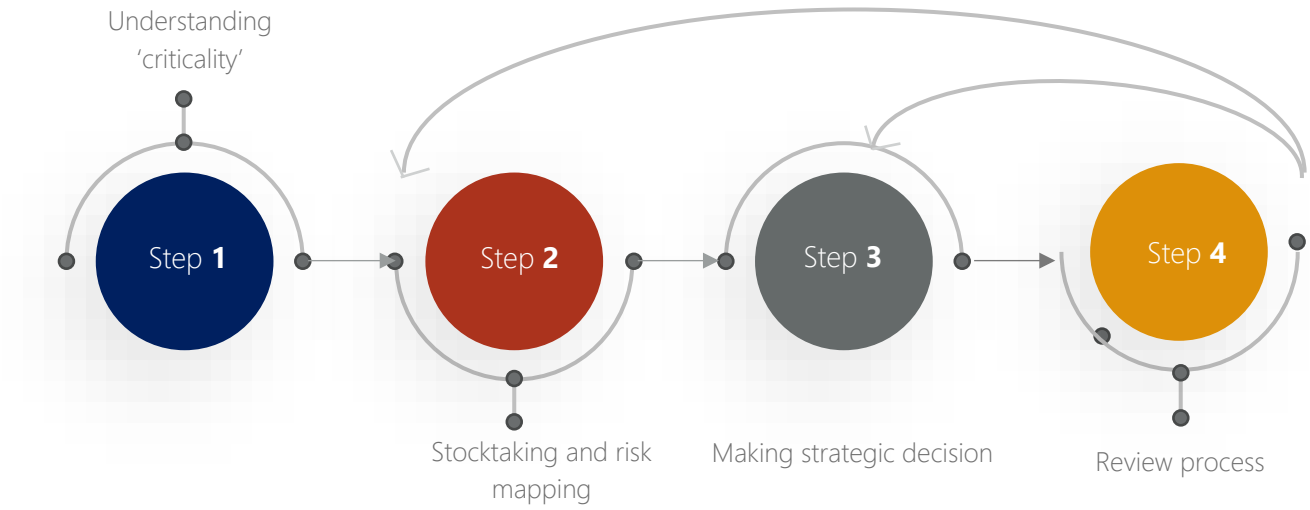
In the meantime, countries with a dominant position as producers of minerals and metals in high demand are increasingly taking a strong stance to position themselves as strategic partners. Cognizant of their bargaining powers and of their geopolitical strengths, many have also developed critical or strategic minerals policies. Objectives differ from those who are vulnerable to supply shocks and are instead aimed at strengthening their positions and protect interests. Arguments for a greater control over the supply of minerals vary from developing resilient domestic industrial capacities and supply chains, to political positioning to become suppliers of choice. In some cases, strong nationalistic positions are a response to retaliate over measures taken by competing countries.

3.1 Key steps to define the mineral scope for strategic considerations

The following section provides a **4-steps approach** that include a series of key questions and indicators aimed at providing policymakers with a toolbox to assess the extent to which minerals and metals are 'critical' or 'strategic', based on what they consider as national priorities and global responsibilities. To fully assess the criticality or the strategic importance of minerals and metals, governments are advised to undertake a thorough assessment of risks and opportunities of the entire mineral supply chain.

The approach proposed in this section is a dynamic one. When there are changes in circumstances, whether at domestic, regional or global levels, policymakers need to take a step back and re-assess their priorities accordingly. It is also advisable for policymakers to review the criticality assessment on a regular basis (on average every three years).

Figure 1: A four steps approach to identify indicators to assess criticality and define strategic interests.



Source: Authors

3.2 Step 1: Understanding criticality

The first and perhaps the most important step before making any policy choices is to define which minerals and metals should be considered critical and/ or strategic. This step is key for producing and destination countries alike.

While the rationale is well understood, there is however no universally agreed definition of what is 'critical' or 'strategic' or what minerals and metals should be considered as such. Nonetheless, there are common denominators to keep in mind when determining what is 'critical' and/or 'strategic', and these include economic importance, demand and supply risks, and dominant suppliers.

Terminologies | Critical or strategic: Are these terms synonymous?

In the prevailing discourse, the term "critical minerals" has been commonly and widely used by countries with significant industrial capabilities to manufacture energy and digital technological solutions, but with important deficits in domestic mineral production. For these countries, the use of the term "critical minerals" refers to those elements that are needed for their key industries. Given their (over)reliance on external markets, their policies are driven by security of supply to overcome vulnerabilities and risks of shortages or supply disruptions.

On the other hand, countries that produce or extract these minerals often prefer to refer to them as "strategic minerals", because these minerals are of crucial importance to their domestic economies and can potentially confer them with a position of strength as suppliers of choice to destination countries. In some countries (in the US for example), the term 'strategic' refers to minerals essential for the defense industry. In this case, both terminologies are used, and strategic minerals are a subset of critical minerals.

While there are significant overlaps in the scope of critical and strategic minerals, there are major differences in approach, which reflect national priorities, industrial competitiveness and choice of global partners.

Acknowledging that each country assigns different characteristics to the terms strategic and critical, in this report, we will use the term 'critical' since it is the most commonly and widely used term.

In the current literature, 'criticality' assessments are mainly driven by downstream supply chain actors[1]. They are aimed at identifying and evaluating risks associated with the supply of minerals that are needed by countries that have a deficit in production and for specific industries or applications (Schrijvers et al. 2020; DOE, 2023). Motivations and perspectives may vary if the stakeholder is a company, a specific industry (such as renewable energy and digital technologies), a country, or a region (Schrijvers et. Al, 2020).

The outcomes of these assessments are generally the adoption of critical minerals strategies associated with a mineral scope[2], which are then used as important levers for policymakers and industrial players to make informed decisions regarding current and future investment plans, strategies to negotiate trade and global partnership agreements, and engagements in global policy agenda, among other things.

[1] For detailed literature reviews on critical minerals see Helbig & el. 2006; Achzet & Helbig. 2013; Viebahn et al. 2015; McCullough & Nassar, 2017; Hayes & McCullogh, 2018; Schrijvers et al. 2020; Takuma et al. 2020; McNutty & Joewitt. 2021.

[2] See Annex I for a comparative list of critical minerals as identified by the EU, US, Canada, Australia and the UK.

3.2.1 Key characteristics that define criticality include:

(i) Demand and supply risks

Assessing risks associated with the demand of critical minerals, such as industrial demand related to the energy and digital transitions, or potential changes in technologies that may affect future demand as well as risks associated with supply, such as social and environmental risks, geopolitical tensions and resource nationalism are key factors in defining criticality.

(ii) Production volume

Minerals and metals may be critical because they are only produced in low volumes, while the demand is high. In fact, it is estimated that more than 60% of minerals and metals considered as 'critical' by the US, EU, Canada or Australia[3] are not mined for themselves. They are minor metals, mainly extracted as co- or by-products of other major minerals and metals (IGF, 2023) and therefore are available in smaller volumes. They are considered as having higher levels of risk because their supply is generally quite inelastic in the short term because their production is highly dependent on the technical feasibility and/or economic sustainability of the host metal extraction processes[4].

(iii) Uses and Applications

It is important to note however that the criticality of a mineral or a metal does not refer only to the latter's availability. It is also linked to specific technologies (*see Annex II for a mapping of digital and energy transition technologies against critical minerals*), and to the pace of technological development, and hence used when stakeholders want to call for (political) attention about the security of access to the supply of the mineral in question.

(iv) Time factor

Criticality also depends on *the time dimension*: the indicators of criticality evolve over time and is assessed differently in the short term and long term. What is critical today might not be critical in a few years, because new sources of production may emerge, including at the national level, substitution can be found, or technology may change, requiring different volumes of the mineral in question or different sets of minerals altogether, hence potentially reducing the risks associated with supply for some minerals or increasing risks for others.

[3] For example, associated with Lead-zinc-silver there are 75% of indium, 65% of germanium; almost 100% of gallium is associated with Aluminium; and 50% of cobalt and palladium is co-produced with Nickel.
[4] For a more comprehensive overview of how metals are produced and associated together, see IGF, 2023.

Criticality: Time matters

Technological evolution is illustrated by the historic change of mobility vehicles at the beginning of the 20th century. In 1900, there were practically no motor vehicles but the rapid deployment of the first cars meant that within a span of 20 years, horse-driven carriages were almost wiped out from large cities in the US. This historic change has drastically affected entire industries, their supply chains and subsequently the demand for minerals and metals.

Mineral intensity in various technologies can also evolve spectacularly, and the move towards e-mobility is more copper-intensive. For instance, with current technologies, a conventional internal combustion engine car requires on average, 25 kg of copper. For an equivalent size of vehicle, a hybrid car requires on average 50 kg of copper, while an electric vehicle needs 75 kg of copper (IEA, 2021[5]).

(v) Stakeholders' position in the supply chain

The understanding of the notion of criticality can vary, depending on where stakeholders are positioned in the mining supply chain at a point in time. Midstream and downstream stakeholders and destination countries generally consider criticality from the security of supply of minerals and metals they do not produce or produce only in limited quantity. Recent developments have shown that countries are increasingly ramping up efforts to explore domestic mineral reserves and identity potential areas for the discovery of mineral deposits. Examples of countries increasing their exploration activities include France, Saudi Arabia, Laos PDR, and the Philippines. Criticality assessment from this particular security of supply perspective will consider issues such as the degree of import dependency, economic importance for industrial use, risks of supply shortages, the expected mix of clean energy technologies that the country will develop or adopt and geopolitical challenges, amongst others.

For *upstream* stakeholders, such as mineral producing countries and related domestic industries, criticality assessment is both a strategic and a risk consideration. From a *risk management* perspective, mineral producing countries and domestic industries will consider issues such as their degree of dependency on and concentration of export markets, the degree of fiscal revenue reliance, the risks related to changes in demand due to, for example technological changes, availability of substitutions to replace the mineral or policies from import-dependent countries to diversify away from their markets, as well as social and environmental impacts of mining, overall. Criticality assessment will consider the types of minerals available, the type and quality of deposits, and the economic viability of developing the resources.

Mineral producing countries have a *strategic* role to play as key suppliers to countries and industries that are further downstream. Arguably, mineral producing countries can leverage

[5] "The Role of Critical Minerals in Clean Energy Transitions." International Energy Agency, 2021, 6.

their mineral resources as bargaining power to develop their own industrial and value addition capacities, notably through investments and partnerships. Currently, very few producing countries have conducted similar criticality assessments. Few exceptions include Australia and Canada, who are both major producers and industrial actors, and who are positioning themselves as partners of choice with key midstream and downstream stakeholders.

Criticality assessment from mineral producing countries: debunking a misconception

Among developing countries who are major critical minerals producers, it is often (wrongly) perceived that criticality assessments are not necessary if countries are well endowed with minerals or are net exporters thereof.

In fact, risk assessments are equally, if not more important for mineral producing countries for several reasons. First, economies are globally interdependent, and therefore measures taken to mitigate risks by destination countries will necessarily have implications for mineral producing countries. If not well understood, analyzed and anticipated, risks mitigation strategies may create new challenges and vulnerabilities for producing countries which may eventually have repercussions on their mining sectors and on their policy choices.

In addition, many mineral producing countries, in particular those with relatively undiversified economies and high dependencies on few mineral exports, are less resilient to external policies and shocks and therefore are likely to be disproportionately impacted by policies aimed at managing risks elsewhere.

Finally, while the demand for minerals needed for the energy and digital transitions is likely to continue to grow, the risks associated with supply shortages or disruptions may eventually be managed and addressed. The focus on their 'critical' nature are therefore likely to change, which may impact the ability of mineral producing countries to leverage their geopolitical strengths to become suppliers of choice. Criticality assessment therefore can provide strategic insights in that regard.

4.0 Step 2: Know your resources and their uses and assess the associated risks

For policymakers, in mineral producing countries in particular, having a strategic vision for their mining industry is important, irrespective of whether they are planning to identify or classify certain minerals as strategic or critical, or not, or develop another category (e.g., Brazil). In that context, it is crucial to conduct criticality assessments to inform the country's long-term strategic objectives.

The exercise will allow countries to identify opportunities to leverage the benefits from minerals in high demand for the energy transition and digital technologies and for their wider development needs. It will also help countries improve their mineral policies and address bottlenecks that may prevent the implementation of domestic industrial policies and global commitments with key buyers and trading partners.

As a foundation for strategic decision-making, the second step therefore is to **take stock** of various factors that impact the demand and supply of minerals to get a deep understanding of the availability and accessibility of mineral resources, of their industrial uses (domestic and global), and of trends in global markets and geopolitical dynamics surrounding these minerals. The main outcome of the stock-taking and risk mapping exercise is to identify a comprehensive list of minerals and metals, which will then inform the strategic decision (Step 3) about the scope and list of critical minerals that a country wants to adopt.

4.1 Key questions to guide the criticality assessment

To conduct the stock-taking exercise, governments need to gather as much data and information as possible, from multiple sources, to get a deeper understanding of their mineral resources, their use and applications and global trends driving the demand for their resources. Information gathered should be disclosed to ensure transparency and accountability.

Based on the information gathered, governments should define a preliminary set of minerals that they may want to further investigate and monitor more closely.

The importance of conducting the assessment despite possible data gaps

This section provides a comprehensive list of questions. While this might seem complex and time consuming, the objective is for governments to gather as much information as possible on their mining sector to be able to conduct an informed risks assessment.

We acknowledge however that data and information may not always be available or up-to-date or may be incomplete. Also, some countries may not have systems in place to collect and process the information gathered or may not have historical data in a format that can be easily exploited or made available. Other countries may have smaller or nascent mining sectors, and therefore may not have sufficient historical data to inform longer-term policies. In that case, we encourage countries to collect the basic information they may have, and work towards improving their database, to ensure they can improve their analysis in the future.

Despite these challenges, governments should nonetheless attempt to conduct the stock-taking exercise to the best of their ability and improve on the assessment as data gaps are filled.

This section is organised in 5 sub-sections, as follows:

(i) **Geological considerations**: Identifying the sources and geographical location of mineral production, notably by mapping the geological ore bodies and occurrences for major and minor minerals, in terms of resources, reserves and production at the domestic level and assessing global supplies and potentials.

(ii) **Economic, market, and fiscal considerations**: Assessing actual and forecasted industrial needs, by mineral, by sector and by application[6]. The analysis should take a holistic approach across the value chain and supply chain, to identify potential bottlenecks and weaknesses at all levels. It should also consider how demand can affect by- and co- products differently (see IGF, 2023), and whether the current fiscal regime is fit for purpose.

(iii) **Social and environmental considerations:** Assessing the impacts of current (and future) mining activities on the social fabric and on the environment. These should inform the subsequent question of what policies to prioritise based on the strategic mineral list.

(iv) **Geopolitical considerations** with a focus on global trade tensions, pinch points in the global supply chains and other countries' critical minerals assessments and de-risking strategies.

(v) **Governance, legal and regulatory issues**: national policy frameworks and instruments that may impact mineral production and trade, global standards (such as responsible sourcing obligations), industry standards and requirements (such as ESG

[6] This should include current and estimated future domestic and global demand, potential changes in demand due to changes technologies, substitutions or availability of new sources of supplies, potential changes in domestic or global supply, key market considerations such as price volatility, levels of investments; government incentives; trade restrictions.

reporting requirements), that may have an impact on demand and supply of minerals and on specific countries/ regions.

Each sub-section highlights the main questions that are relevant to the stock taking and risk mapping exercise. Annexes III – VII, organised according the 5 sub-sections mentioned above, provide a comprehensive checklist of information and data that are relevant to inform the exercise. The Annexes also provide a set of performance indicators that can be used to measure risks that may impact the design and implementation of the strategic policies that governments may consider adopting.

4.1.1 Geological considerations.

Information gathered under this section allows governments to determine the importance of their geological potential, by type of minerals and by grade and hence gauge the potential strength in the upstream part of the mineral value chain. It is important to make sure potential of co-products and by-products are well documented, as a significant number of minerals and metals needed for the energy transition and digital technologies are minor elements.

1. What minerals are available in my country?

This question is aimed at conducting a detailed assessment of domestic mineral production capacity. Geological consideration informs how deposits are exploited, which in turn allows for a better understanding of the potential future risks.

Information gathered should include detailed geological information on mineral occurrences, estimated reserves and resources with details about their sub-national locations. Geological data should be classified by types of minerals.

Geological information should include quality of ore bodies, associated elements in the ore bodies, (whether in commercially exploitable quantity or not), minerals associated with problematic elements.

Governments should map out the location of resources that may overlap with biodiversity hotspots and conservation areas, water bodies, or land of indigenous people etc.

Annex III provides a checklist of information that are needed to get a good understanding of the geological potential of a country and provide a set of indicators to conduct the assessments.

Possible risk factors to consider:

- ✓ Depletion time of reserves
- ✓ Risk of temporary scarcity, due to technical feasibility; political issues (sanctions); geopolitical issues
- ✓ Levels of risk in country, including political risks; risks of corruption and risk of conflict that may impact decisions to invest.

4.1.2 Production, macroeconomic and market considerations

Besides maintaining an updated geological knowledge, it is necessary to keep track of historical exploration and production data, by value and volume. This will allow governments to have a deeper understanding of the country's position in the upstream mineral value chain, compared to other producing countries, and to assess the associated risks. The analysis is needed to develop strategic plans on the use of minerals resources domestically and determine what is needed to develop downstream capabilities.

2. How much do I produce?

Information gathered on domestic production will help identify a preliminary list of minerals for further investigations. Information should cover all size of mining activities and all minerals identified above. It should consider all minerals associated together, as co-products and by-products. The analysis should be done in comparison to other global producers.

Information should include mineral production by size of mining activities and by types of commodities (in volume and in value). Governments need to estimate the importance of each mineral produced in total mining in-country and globally. All potential sources of supply should be considered, including production from artisanal and small-scale mining (ASM), where relevant from reprocessing of waste rocks or tailing; and from recycling of end-product wastes.

Measuring the importance of the mining production in the national economy and on the global scene is key to inform national development programmes as well as diversification strategies. Particular attention should be given on minerals that contribute significantly to the national income (in terms of fiscal or export revenues) and governments may want to further investigate how strategic they may be for the country.

Annex IV provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Possible risk factors to consider:

- ✓ Price volatility
- ✓ (Non-transparent or absence of) pricing of minerals (including for minor elements)
- ✓ Risks of substitutability
- ✓ Technological change
- ✓ Risks associated with informality or illegal mining.
- ✓ Stockpiling strategies of third countries

3. How important is the mining sector to my country?

Information gathered about the domestic mining sector will help provide a macroeconomic overview on how the mining sector contributes to the income of the nation, either through fiscal revenues, export revenues, investments and/or employment.

Information should include:

Economic contribution of the mining sector to national income, fiscal revenues, export revenues, employment. This will help governments assess how dependent they are on the mining industry, and take the necessary measures to manage associated risks and vulnerabilities. Data on investment flows into the production and value chain of specific minerals are important to assess the strategic interests of global mining actors. Governments also need to assess how much resources they invest domestically in R&D and innovation, which are key to supply chain development. They may also want to incentivise private sector investment in R&D, including through public - private research partnerships to foster innovation. In that regard, they may need to reinforce their domestic intellectual property regulations to protect innovation and industrial designs.

Detailed information on producing companies as well as refining and smelting companies, whether domestic or foreign. This information is necessary to assess in-country capacity to beneficiate mineral production. Historical data on exploration budgets, number and types of companies involved as well as types of transactions conducted (such as M&As; JVs etc.) must be tracked and analysed. Importantly, ownership structures of foreign mining companies should be understood as they may have geopolitical implications.

Detailed information on trade flows and trade measures in place are essential to assess the importance of specific markets, identify key partners and assess the level of dependency (import and export), which may be a source of risk and vulnerability, both for the producing country and the importing partner country. The presence of trade measures on specific minerals also signals some level of strategic importance and these should be examined in details, particularly in terms of their implications on the domestic economy or the foreign market.

Annex IV provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risk factors to consider:

- ✓ Degree on mineral trade dependency (imports and exports)
- ✓ Impact of trade barriers on country's competitiveness
- ✓ Impact of trade barriers on fiscal revenues
- ✓ Impact of trade barriers on production costs
- ✓ Impact of third countries' trade barriers on domestic value chains
- ✓ Investment risks for related to price volatility; fiscal policies; trade barriers

4.1.3 Industrial development considerations

Data gathered in this section provides the basis to assess existing and potential industrial capabilities based on domestic mineral production when available, as well as an indication of the country's reliance on external sourcing when there is a gap in domestic supply.

This analysis allows governments to design risk mitigation and management policies to properly and timely address domestic and external risks. For instance, countries that are highly dependent on mining face higher risks if there are significant changes in global demand, in technologies requiring the minerals they export, or in investment decisions.

Gathering a holistic picture of the mining landscape from an industrial perspective is also relevant for strategic thinking about ownership of key mining assets. Even if countries do not yet have significant industrial production capabilities, based on their endowments, it is important nonetheless to assess potential future use against mineral production and accessibility.

4. Which minerals are essential to my country's strategic objectives?

Information gathered in this section is crucial to assess current industrial capacities and the extent and degree of self-sufficiency or of reliance on third sources, which is a necessary preliminary analysis when defining criticality.

Information should include industrial policies and roadmaps, with a focus on how the mineral sector will contribute to industrial activities. These plans should include which priority sectors have been identified for the use of domestic mining production and the level of domestic demand (current and forecasted) anticipated for an agreed period of time.

Information should also include an assessment of the current demand of minerals and metals, to fulfill the needs of current industrial sector. Considerations should be given to expected development plans and is anticipated in national industrial strategies.

If the country has significant mineral production, analysis should identify existing downstream capabilities as well as future plans by type of minerals. When capabilities exist already, data on existing and forecasted production volumes by type of minerals should be collected. Historical information about plans that may not have succeeded must be collected and reasons for failures need to be examined. Any plans to build new facilities should be identified.

Annex IV provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risks factor to consider:

- ✓ Technological changes that may impact on mineral intensity or mineral needs.
- ✓ Geopolitical risks related to sourcing of inputs not produced domestically.
- ✓ Bottlenecks that may negatively affect investment plans and downstream industrial plans.
- ✓ Level of dependence on parts of the supply chains not present in the country.

Recent years have put forward vulnerabilities in mineral supply chains, resulting from several factors which are often interdependent. Geopolitical tensions over access to mineral feedstocks, pinch points in supply chains, and strategic needs have all contributed to design, implementation and financing of 'critical minerals' strategies. Led initially by advanced economies, an increasing number of emerging economies that want to position themselves across various parts of the global supply chains for energy and digital technologies have announced similar strategies. More recently, producing countries have joined the bandwagon.

5. Are there any minerals that I do not produce (or not sufficiently produce) but are key to my domestic industries?

Information gathered about minerals not or insufficiently produced will help inform a preliminary identification of which minerals are available domestically, and therefore could be considered as 'strategic' for various reasons and which ones are not sufficiently available (or not available at all), and therefore could be considered as 'critical'.

Information should include the analysis of mineral feedstocks needed for domestic industrial development and how much countries produce locally and/or need to import. For minerals available locally, it is important to assess whether those minerals are likely to be sufficiently available over time both for domestic needs and to meet international demand.

As countries seek to build their capabilities for local value chains, they may start importing mineral feedstocks as inputs for local manufacturing. Governments therefore need to have a good understanding of their levels of dependency on minerals and metals that are not available locally (or available in insufficient amount), to be able to assess, anticipate and manage any risks associated with security of supply. Methodologies used by the EU, the US, the UK, Australia or Canada provide good examples for conducting such assessments.

Annex IV provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risk factors to consider:

- ✓ Level of concentration of minerals production not produced in country.
- ✓ Level of dependency on imports
- ✓ Geopolitical risks associated with the supply of minerals not produced in-country.
- ✓ Regulatory frameworks in third countries.
- ✓ Conflicts such as those linked to war or political stability.

4.1.4 Fiscal considerations

Within the context of the surging demand for the minerals and metals necessary for the energy and digital transitions, these set of questions will help examine whether – and to what extent – current fiscal approaches and policies are fit for purpose or require adjustments to ensure that resource rich countries collect an appropriate share of the financial benefits arising from the extraction of their critical minerals. The information can also inform whether (or not) and what types of fiscal policies and incentives can be given to support the development of midstream and downstream supply chains.

6. Will current fiscal approaches and policies ensure that producing countries collect an appropriate share of the financial benefits arising from the extraction of their critical minerals? Are current financial tools sufficient to incentivise local industrial development?

Recognizing the importance of critical minerals to advanced manufacturing, renewable energy, the future of transportation and the future of technology, this set of questions tests the extent to which existing fiscal instruments and administrative practices remain fit for purpose.

While the fundamentals of fiscal policies are likely to remain largely the same, including with respect to critical minerals, governments may want to reflect on whether the rising demand for critical minerals require a recalibration of existing financial benefit sharing systems and instruments. And if so, what types of instruments would be relevant in that context.

Governments are recommended to examine current practices regarding pricing and valuation, with regards to specific minerals or to mine wastes and tailings that may contain commercially exploitable concentrations of critical minerals. Current fiscal regimes will need to be assessed on that basis.

To optimise financial benefits that may be derived from higher demand for some critical minerals, governments may want to give higher consideration to issues such as ringfencing, tax incentives, state participation, ownership of mining rights by large end users in the value chain, and administrative capacity for tax administration, amongst others.

To support the development of local industrial capabilities and foster R&D and innovation, government may want to assess what types of incentives would be required to stimulate investments in supply chains. Incentives could take the form of fiscal instruments or non-fiscal instruments such as concessional access to finance for local firms, duty-free imports of inputs and equipment or the creation special economic zones.

Annex IV provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risk factors to consider:

- ✓ Undervalued minerals production affects government revenues
- ✓ Under-priced or lack of transparency in pricing mechanisms affects government revenues.
- ✓ Risks of base erosion profit shifting
- ✓ Risks of transfer pricing
- ✓ Missed opportunity to leverage the benefits of rising demand.
- ✓ Corruption
- ✓ Market distortions as a result of incentives

4.1.5 Social and environmental considerations

Companies that fail to consult and engage with communities will face backlash from mining affected communities. Acquiring and maintaining the so-called ''social licence to operate'' should therefore be a key aspect of any criticality assessment and of any mineral strategy to secure mineral production. As demand for critical minerals increase, unresolved tensions may be exacerbated, posing risks to mining projects.

7. What are the key social issues I need to consider to constructively engage with mining communities and ensure benefits for society at large?

Information gathered in this section provide an overview of the social landscape and issues that are relevant to secure the mining social license to operate, provide a platform to consult local communities for ownership of mining projects and manage relationship with indigenous communities, ensure local community development and build resilience.

Information should include detailed and historical databases and geographical maps of mining projects that coexist with local communities. Particular attention should be placed on potential overlap between mining projects and community-owned land, including indigenous and ancestral land, where applicable. Where required by law and to the extent possible, governments should ensure they maintain a repository of community development agreement plans as well as projects executed under those plans. They must ensure they keep track of conflicts with communities over time, as ownership of companies change hands.

When relevant, implementation of local content policies, such as requirements for local employment; business opportunities and shared infrastructure, need to be monitored and assessed (disaggregated by gender where possible).

Annex V provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risks factors to consider:

- ✓ Historical tensions/ conflicts with local communities
- ✓ Tensions with communities over land rights
- ✓ Human rights abuses and gender-based violence

Likewise, should there be significant environmental risks, producing countries will not be able to develop or expand mining projects without or against the consent of their population, and in particular of communities that live close to mine sites.

Mining is the industrial sector that generates the biggest volume of wastes. It is a highly energy and water intensive activity, usually associated with negative externalities such as water and air pollution. The sector already faces growing oppositions from communities, which are sometimes linked to human rights abuses. Expansion of mining activities can increase potential conflicts over access to water and land use with local communities. There

are real concerns that measures to fast-track mineral development projects may be conducted at the expense of appropriate consultations, further antagonizing relationships with local communities.

8. What environmental issues are essential for the sustainability of my mining sector?

It is key to make sure sufficient and appropriate safeguards are in place to avoid creating or exacerbating environmental challenges. Information gathered in this section will help governments monitor the sustainability of the mining sector from an environmental perspective.

Assessing the impacts of mining activities on the environment, as well as the interconnected effect of climate change on mining activities, would enable governments to put in place the necessary safeguards to address the environmental impacts of mining activities. Data gathered should include historical account of impacts of mining activities on the environment, water quality, availability, use and access to water rights, impact of mining on air quality, as well as potential overlaps between mining activities and biodiversity amongst others.

Assessing the extent to which climate change that induces new environmental conditions (more frequent and more intense climatic events), is expected to impact mining operations and surrounding communities, is necessary to implement mitigation measures to build resilient mining operations and supply chains.

Annex V provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risk factors to consider:

- ✓ Externalities such as water, soil and air pollution
- ✓ Tensions with other stakeholders over water rights
- ✓ Biodiversity sensitivity
- ✓ Environmental risks associated with technologies used to process ore grades[7].

4.1.6 Geopolitical considerations

Analysis of the information regarding the types of policies and strategies being deployed elsewhere (e.g., industrial policies to develop local capabilities; trade policies to secure access to minerals; political alliances amongst groups of third partners), will provide a better understanding of how they can or will have impacts on producing countries.

[7] For example, the High-Pressure Acid Leach (HPAL) technology used in Indonesia, although necessary to process low grade laterite ore, might appear as an environmental ticking bomb that could ultimately disrupt nickel supply.

9. Which minerals are considered as 'critical' for my main trading partners and what are their key industrial uses in those markets?

Information on criteria used by destination countries to define 'criticality' will provide a good understanding of challenges linked to different aspects of supply chains and the associated geostrategic implications.

Global policies will significantly impact demand and supply of critical minerals and reshuffle supply chains. Governments therefore need to assess the implications of global strategies on critical minerals on their mining sector.

Information gathered must cover the following issues:

Understanding criticality as defined by main trading partners, assessing the mineral scope of their definitions, the industries and technologies for which they are relevant, and measures taken by partner countries to manage and mitigate risks.

The role of the country in global supply chains, i.e., what is the share of the country's exports of critical minerals to partner countries that have critical minerals strategies and in global demand, more generally. Governments also need to get data on other sources of supplies, to assess their bargaining power.

Understanding global needs, i.e., having a good understanding of major technologies that require such critical minerals are important to find alternative markets in case measures taken to address criticality leads to a switch to other 'less risky' minerals.

Annex VI provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risk factors to consider:

- ✓ Without a clear domestic strategy, pressure from international partners to sign bilateral agreements.
- ✓ De-risking policies in partner countries to mitigate risks may have unintended consequences on producing countries.
- ✓ Search for alternative sources can impact producing countries.
- ✓ Orientations in R&D to de-risk supply chain vulnerabilities may accelerate technological changes, with different mineral feedstock needs

4.1.7 Governance, legal and regulatory considerations

As countries design or review their policies to consider the rising demand for minerals and metals, it is important to have a good overview of how regulatory frameworks evolved over time, and ensure coherence and consistency, in particular, with regards to future development plans. Domestic regulations give important signals to foreign partners (investors, trading partners, etc.) and therefore must be in line with national development ambitions, while remaining consistent with their international commitments.

Most countries have legal obligations at the international level, through agreements signed over the years, with investors and/or with trading partners. As development ambitions evolve, domestic measures taken may not always be compatible with bilateral and multilaterals agreements already in place. Governments may therefore have to design other types of measures (with similar effects) or engage their partners to avoid legal disputes.

Furthermore, there could also be several industry-to-industry agreements in place, such as off-takes or long-term supply contracts, or even deals such as infrastructure financed by external partners in exchange of natural resources. These deals may have already committed a large share of minerals production to trading partners. Governments should track and monitor these agreements and assess their implications, namely on the availability of mineral resources for domestic uses, and on other issues such as revenue collection.

10. What policies, legislations, regulations have an impact on my mining sector?

This question is aimed at taking stock of policies and obligations at various levels – national, regional and international.

Governments need to map out all existing domestic policies[8], measures and instruments that can impact the mining sector, covering the entire life cycle of the mine. In particular, gaps must be identified so that plans to explore, produce, reprocess tailings etc. are not held back by regulatory bottlenecks and that there is no trade-off regarding sustainable mining practices.

It is recommended that governments gather information regarding ESG policies and performance indicators from mining companies, to ensure a level playing field in terms of sustainable mining practices from all industrial actors, including from state-owned companies, operating in their territories.

With regards to international agreements and partnerships, it is necessary to keep track of all bilateral and international agreements that could be relevant for critical minerals. These include for example trade and investment agreements, scientific and technical cooperation or infrastructure for resource deals. The impacts of those agreements for the mining sector and on national or regional development goals must be regularly assessed.

Governments are advised to regularly assess domestic policies and incentives aimed at supporting industrial development.

Where possible, governments need to take stock of other types of agreements, such as long-term supply contracts and off-take agreements that mining companies may have signed with trading partners or with supply chain actors. The nature and time frame of these deals need to be understood as they may impact the ability of local industries to access critical minerals, when required for domestic manufacturing industries.

Annex VII provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risk factors to consider:

- ✓ Regulatory bottlenecks impact on the ability to start mining operations.
- ✓ Pressure to mine more may have unintended negative consequences due to gaps in regulations.
- ✓ Trade and investment agreements limit policy space of governments to meet development goals.
- ✓ Restrictive domestic trade and investment instruments impact on global supply chains.
- ✓ Industry-to-industry agreements limit the ability of local industries to access critical minerals

[8] Examples of policies include mining codes; environmental regulations; mining contracts; local content policies; beneficiation strategies; regulations that already identify specific types of minerals for specific purposes.

Governments need to make sure that regulatory frameworks are in line with good governance practices at the global level. Global frameworks exist to address corruption, human rights abuses and transparency and accountability, amongst others in the mining sector. At the same time, mining companies are also engaged in voluntary sustainability standards.

11. What global governance frameworks are applicable to my mining sector?

This question is aimed at understanding how global sustainability governance frameworks impact mining activities and whether global processes are owned and implemented at national level.

Sustainability initiatives in the mining sector, including voluntary standards, play a key role in advancing good practices and in informing governments, consumers and investors how minerals are explored and sourced. They have been used to attempt to provide solutions to mitigate impacts on the local communities, society, and the environment. The rise in demand for critical minerals is likely to lead to more mining activities. It is recommended that Governments promote and enable responsible and sustainable mining practices to minimize the potential negative impacts and avoid unintended consequences for local communities and the environment, associated with increased activities.

In countries where challenges associated with risks of conflicts exist, governments need to engage actively in global discussions related to conflict minerals given that some critical minerals may be mined together with conflict minerals.

Annex VII provides more details on types of information that governments may want to collect to inform their policy documents and provide a set of indicators to conduct the assessments.

Risk factors to consider:

- ✓ Local mining actors like ASM are excluded from supply chains.
- ✓ The lack of coherence between discussions around conflict minerals and critical minerals.
- ✓ Lack of implementation of global frameworks because producing countries are not actively involved on global discussions.

Some critical minerals are mined in regions where governance challenges have been observed, such as regions prone to conflicts or to human rights violations. For instance, tin, tantalum and tungsten (3Ts) are considered as potential 'conflict minerals' when they are mined from Conflict-Affected or High-Risk Areas (CAHRAs). The sourcing of 3Ts is regulated by law at the global level by importing countries, industrial sectors or by stock markets if mined in CAHRAs. However, tin, tantalum and tungsten are also considered as 'critical' by a few countries, as *Annex VIII* highlights. It therefore raises the question of the extent to which criticality assessments consider risks related to conflict and therefore what safeguards are in place to ensure that the heightened attention given to those minerals (because of their strategic nature), do not unintentionally fuel more conflicts in already fragile jurisdictions.

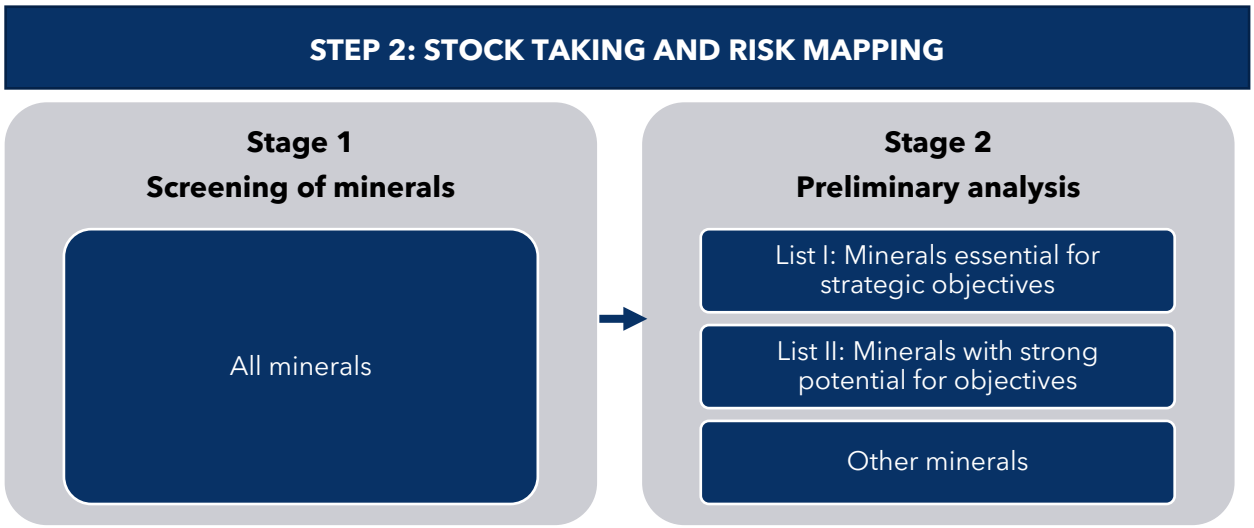
Governments need to make sure to monitor the evolution of conflict and critical minerals regulations concurrently, given that there does not seem to be a clear connection across those policy instruments.

In cases where critical minerals are mined as by-products of conflict minerals, producing countries must anticipate how responsible sourcing policies may evolve so they are able to take the necessary measures to address potential weaknesses in their mineral supply chains.

Summary of outcome expected from Step 2.

Based on this stock-taking exercise, governments should outline a preliminary comprehensive list of the minerals and metals to be considered for further investigations.

Figure 2: A two-stage approach to knowing your resources and assessing their associated risks



Source: Authors, based on Viebahn et. Al (2015)

5.0 Step 3: Strategic considerations.

Once Steps 1 and 2 are completed, governments need to decide what types of policies, tools and instruments are most suitable to attain their objectives. This section highlights 3 complementary strategic orientations that governments need to consider **before** designing the critical minerals policies and associated lists.

5.1 National priorities

Based on the assessments made in Step 2, governments must clarify the role that their mining sector plays in national development plans. Minerals that have been identified as a result of step 2 must be classified according to a nationally agreed taxonomy, based on domestic needs, industrial trajectories and global demands.

To guide policy implementation and engagement with industry stakeholders and global partners, Governments need to clearly outline national priorities. The definition of these priorities should be informed by other national policies and by consultations with national stakeholders, such as other government departments, industry actors and representatives of local communities. National policies should also consider regional initiatives as well as commitments made at the global level to support resilient supply chains, notably for the energy and digital transitions.

Key drivers of a critical minerals' strategy
Beneficiation in mining value chain
Development of local critical minerals supply chains
Securing higher revenues from critical minerals
Strategic positioning as *suppliers* of choice
Strategic positioning as *investors* of choice
Ensuring a more socially responsible and inclusive mining sector
Application of recycling and circularity principles to produce critical minerals from existing sources.
Partnerships with supply chain actors (such as OEMs; specific technology companies etc.)
Managing geopolitical tensions, while balancing response to global demands and growing risks of trade wars.
Potential scope of a critical mineral strategy
New regulatory instruments specifically focused on those minerals (including contracts and environmental laws)
Higher forms of state participation such as joint ventures with mining companies; or creation of state-owned companies.
Revision of fiscal policies and other financial benefit sharing mechanisms
Provision of incentives to local supply chains industries

Domestic regulations and trade measures to limit exports of unprocessed minerals.
Greater role for artisanal and small-scale mining sector in critical minerals
Reprocessing of tailings and mining wastes
National joint ventures, bilateral agreements with other producing and value-chain countries, partnerships with industry players, and regional cooperation.
Potential risks to consider
Lack of geological data.
Insufficient industrial capabilities and related skills.
Lack of access to finance to stimulate industrial development.
Insufficient access to infrastructure and high cost of energy.
Price volatility and market uncertainty for minor metals.
Change in technologies that may impact demand for some critical minerals.
Lack of applicable legal and regulatory framework, alongside environmental and social concerns.
Social tensions and lack of trust from local communities.
Lack of a coherent vision and objectives, information asymmetry, and capacity constraints.

5.2 Regional initiatives

Complementary to their national priority orientations, governments need to work collaboratively with their neighbours to build on each others' strengths and comparative advantages. In many cases, domestic markets are small and nascent, and for industrial activities to become competitive and thrive, there is a need to secure economies of scale and larger markets. Regional initiatives must therefore be encouraged and supported.

Such regional initiatives, if harnessed, can support the development of resilient regional value and supply chains to feed into priority sectors, such as e-mobility, renewable energy solutions or other electronic industries, that are significant consumers of critical minerals.

Some elements to consider when designing regional initiatives:

- The importance of having coherent discussions on national critical minerals plans and lists.
- Identification of priority regional value and supply chains, with clear roles defined for each regional partner.
- Fiscal regime harmonization to avoid race to the bottom.
- Coordination and knowledge sharing across countries.
- Regional investment mechanisms to facilitate investment across countries.
- Trade agreements, with rules of origin that facilitate supply chain development.

- Regional industrial policies, where standards are harmonized and technical barriers to trade eliminated.
- Trade facilitation protocols that have removed cross-border trade challenges impacting on movement of goods and services across countries.
- Coordinated shared regional infrastructure to facilitate cross-border transportation.

Bilateral initiatives across neighbouring countries are also important levers. An interesting example is Zambia and the Democratic Republic of Congo (DRC), who signed an agreement in 2022 to set up a Special Economic Zone for the joint development of electric battery manufacturing capacity, notably using both countries' mineral wealth. The DRC is the world's largest cobalt producer. Zambia also produces cobalt. Both countries have copper. In addition to cobalt, lithium, nickel and manganese are also required for the production of basic batteries. While the DRC have these resources, they are currently not being mined.

Discussions are ongoing with other regional partners, such as Gabon, Madagascar and Zimbabwe. A recent study by Bloomberg NEF estimated that building a battery precursor manufacturing plant in in the DRC could cost only a third of an equivalent plant in China or the US. Compared to Poland, the cost is just under two-thirds.

5.3 Global responsibilities

While producing countries have the duty to optimise the benefits from their mineral resources, including by adding more value at the national and regional levels, they also play a key role in supplying global markets. In recent months, several countries have entered into negotiations to sign bilateral agreements and Memorandum of Understanding (MOUs) to secure access to critical minerals. Producing countries need to ensure that the terms of these agreements and MoUs are fair and that benefits are mutually shared.

As countries commit to achieving net-zero emissions and as digital technologies take more prominence, the demand for critical minerals and metals will only surge. Mid-stream and downstream industrial sectors and countries who host them, are particularly concerned around supply shortages and/ or disruptions. These challenges may affect the competitiveness of industries and plans to build larger industrial capacities in cutting-edge technologies, needed to embrace the energy and digital transition.

Given the complexity of global supply chains, no countries will be able on its own to provide every technological solution to the energy transition and for digital technologies. In that regard, global partnerships are crucial. Countries therefore need to have clear objectives defined as to what should be the scope of global partnerships, to ensure they are able to position themselves in global supply chains as 'suppliers' of choice, while benefiting from the critical mineral demand windfalls in a fair manner. This would help buyers diversify their

sources of supply away from potential choke points, hence addressing political risks associated with market over-concentration.

Furthermore, there is therefore a strong case to be made to attract investors to new industrial locations, closer to critical minerals production centres and stimulate the development of value-added activities to widen the choice. Having other industrial hubs for key parts of supply chains is a de-risking strategy, both for producing countries and for destination countries.

Commitments to lower greenhouse gas emissions also require developing countries to produce their own energy transition solutions. In many countries, clean energy and transportation is key because demand is set to grow in decades to come, namely due to population growth. Being part of global supply chains is part of the learning curve to develop industrial capabilities domestically or at regional level.

6.0 Step 4: Review

Designing a policy is not an end in itself. It must be administered, enforced and progress must be measured against realistic benchmarks, preferably in the form of goals to be achieved. In the case of critical minerals, risks associated with criticality is a factor of time, which may impact the mineral scope attached with the policy. The objective of the review process is to evaluate whether the initial assessment is still valid after a period of time and whether the administrative and enforcement tools efficiently delivered on the stated objectives. The exercise allows governments to revise the strategy to reflect new realities and changes in circumstances and adjust the tools in place (critical minerals strategy, critical minerals list…) to meet the overall objectives in a changing landscape.

Key elements of the review process are:

- Clear objectives outlined when designing of the critical and/ or strategic minerals policy.
- Measurable targets agreed against the policy objectives, that can be assessed on an annual basis.
- A list of minerals considered as 'critical' and or 'strategic, with indicators and benchmarks that allows periodic reviews.
- Strong systems for collecting data on various elements that inform the policy design and the list of critical and/ or strategic minerals.
- A multistakeholder committee in place, with a mandate for a specific period of time, tasked to review the list, against the goals that governments have identified.
- A time frame set to revisit the policy objectives and the targets, with the aim of making recommendations to adjust the policy objectives and the mineral scope accordingly.

Common reporting frameworks allow governments to:

- Gather and aggregate data on various aspects of the mining value chain and on the regulatory, geological, geopolitical, economic, social and environmental considerations.
- Obtain a holistic picture of the sector's progress toward building resilient supply chains.
- Design realistic critical minerals policies, and strengthen domestic capabilities, skills and technological knowledge to achieve mid- to longer term development objectives.

7.0 Next Steps

Once the four steps are completed, governments would have identified the minerals that are essential for their country's strategic objectives. The next step is to design **a critical minerals strategy, accompanied by a roadmap** and related policy instruments, incentives and mechanisms to leverage the potential opportunities from their critical mineral wealth, while properly and effectively managing risks identified in the assessment conducted under Steps 1 and 2.

The critical minerals strategy and the roadmap need to provide the strategic direction, priorities, and timelines with regards to a set of well-defined objectives. The critical minerals strategy and the roadmap should include the following key elements:

- **Clear goals and objectives**: The roadmap should articulate the overarching goals and objectives of governments regarding their development pathways. Goals must be specific, measurable, achievable, relevant, and time bound.
- **Identified short- medium and long-term priorities**: The roadmap must clearly outline the key initiatives and activities that need to be undertaken to achieve the stated goals. These initiatives should be prioritized based on factors such as mineral resource availability, strategic importance for industrial development, and market demand, amongst others. Timelines must also be identified.
- **Risks and constraints**: Governments must identify any constraints that may impact the implementation of the roadmap. This could include domestic factors such as industrial capabilities, technical skills, financial resource limitations, regulatory requirements, or external risks, such as potential geopolitical shifts and changes, as well as differing or potentially contentious critical mineral policies of partners.
- **Availability of resources**: The roadmap should provide a clear indication of financial, human, and technical resources required to implement the strategy.
- **Geological data transparency**: National geological surveys should collect and publish more systematic geological information from exploration and from producing companies.
- **Flexibility and adaptability**: While the roadmap provides the milestones to implement the critical minerals strategy, it should also allow for flexibility and adaptability, as circumstances may change, new opportunities or challenges may arise, requiring adjustments to be made.
- **Implementation and measuring performance**: The roadmap should include key performance indicators (KPIs) to measure the progress, success, and failures of the policies outlined. Tracking performance and evaluating the effectiveness of policies is an important element for the periodic review of the list of critical minerals and of the associated strategy overtime.
- Finally, countries should make a plan to **review the assessment on a regular basis** to ensure they remain relevant over time.

8.0 Conclusions

It is important to underscore that critical minerals are in the spotlight because of major risks associated with potential supply bottlenecks or disruptions. Key industries and countries that rely on those minerals for their strategic industries are deploying every effort to minimize those risks, including looking for alternative sources of supply (through recycling for example) or alternative materials, altogether. Significant investments are made in R&D to find potential substitutes for problematic minerals.

What does it mean for producing countries?

It means that the window of opportunity to leverage those minerals – because all attention is currently on de-risking supplies – is small and is narrowing. As solutions are found to de-risk supply chains, the spotlight will fade. It does not mean that demand will fall. On the contrary, the energy and digital transitions will continue to drive demand and at a growing rate. But when or if risks are contained, these attention to the critical minerals will shift and these commodities will normalize. As a result, opportunities to leverage investors and access to finance, as well as the potential to attract industries seeking new locations to reduce risks, may wane.

It is therefore important for producing countries need to seize the moment to position themselves as suppliers of choice across the value chains, and not necessarily as providers of unprocessed minerals. Producing countries in a position to do so, should become investors of choice, notably by entering into joint ventures with industry players and/or with trading partners, and taking a stake in various complementary assets and interests.

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Annex I: List of Critical Minerals in the European Union, United Kingdom, United States, Canada, and Australia

	EU critical raw materials, 2023	US critical minerals, 2021	Canada critical minerals 2021	Australia critical minerals, 2020	UK critical minerals, 2022
Aluminum	■	■	■		
Antimony	■	■	■	■	■
Arsenic	■	■			
Baryte	■	■			
Bauxite	■				
Beryllium	■	■		■	
Bismuth	■	■	■	■	■
Borates	■				
Cerium		■	■		
Chromium		■	■	■	
Cobalt	■	■	■	■	■
Coking coal	■				
Copper	■		■		
Fluorspar	■	■	■		
Gallium	■	■	■	■	■
Germanium	■	■	■	■	
Graphite	■	■	■	■	■
Hafnium	■	■		■	
Helium	■		■	■	
Indium		■	■	■	■
Lithium	■	■	■	■	■
Magnesium	■	■	■	■	■
Manganese	■	■	■	■	*
Molybdenum			■		

	EU critical raw materials, 2023	US critical minerals, 2021	Canada critical minerals 2021	Australia critical minerals, 2020	UK critical minerals, 2022
Nickel					*
Niobium					
Phosphate rocks					
Phosphorus					*
Potash					
Rare-earth elements					
Rhenium					
Silicon metal					
Tantalum					
Strontium					
Tellurium					
Rubidium					
Tin					
Titanium					
Tungsten					
Vanadium					
Uranium					
Zinc					
Zirconium					
Platinum Group Metals (PGMs) - 6 metals					
Ruthenium					*
Rhodium					
Palladium					
Osmium					
Iridium					*
Platinum					

* UK watch list

Annex II: Mapping selected minerals and metals against energy transition and digital technologies

	ENERGY TRANSITION TECHNOLOGIES						DIGITAL TECHNOLOGIES		
	Solar PVs	Wind Turbines	EVs			Hydrogen			
			Li-ion batteries	Fuel cells	Electric Tractor motors	Electrolysers	Smartphones, tablets & laptops	Data transmission networks	Data storage servers
Copper	X	X	X		X	X	X	X	X
Cobalt		X	X	X		X	X		
Nickel	X	X	X	X		X	X	X	X
Manganese		X	X	X		X	X	X	X
Lithium			X	X			X	X	
REEs		X	X	X	X	X	X		X
Chromium		X		X	X	X	X		X
Zinc	X	X				X		X	X
PGMs				X		X	X	X	X
Aluminium	X	X	X	X	X	X		X	X
Vanadium						X			
Molybdenum	X	X		X	X	X			
Graphite			X	X		X	X		
Silicon	X	X	X		X		X	X	X

	ENERGY TRANSITION TECHNOLOGIES						DIGITAL TECHNOLOGIES		
	Solar PVs	Wind Turbines	EVs			Hydrogen			
			Li-ion batteries	Fuel cells	Electric Tractor motors	Electrolysers	Smartphones, tablets & laptops	Data transmission networks	Data storage servers
Niobium		X	X						
Iron	X	X		X	X	X		X	X
Gallium	X						X	X	X
Germanium	X	X	X	X			X	X	X
Titanium			X	X		X			
Gold			X	X		X	X	X	X
Potassium						X			
Silver	X			X			X	X	X
Tin	X		X					X	X

Source: Author, based on IEA: 2023; OECD: 2023; JRC: 2023

Annex III: Data checklist and key indicators of risks regarding geological consideration

1. What minerals are available in my country		
Factors to consider	**Data to be collected**	**Unit/ indicators**
Geological and sub-national considerations		
Geological data	a. Geological Mapping	✓ Percentage of territory covered by geological mapping. ✓ Geophysical maps
	b. Mineral occurrences	✓ Maps of mineral occurrences
Mining potential	a. List of deposits	✓ Map of mines and identified deposits ✓ Database of existing projects
	b. Comprehensive information for each deposit	✓ Location ✓ Commodity ✓ 3D model ✓ Volume of ores and grade of mineralisation ✓ Resources estimates ✓ Reserves estimates ✓ Mineral processing pathways ✓ Last feasibility study and all previous technical reports

	C. Mineral associations	✓ Multi-element geochemical composition of each deposit ✓ By-production potential for mineral and metals ✓ By-production potential in percentage of mineral value in the deposit ✓ List of main elements in deposits expected to end-up in tailings ✓ List of potential radioactive elements in the deposit (Uranium, Thorium, Radium…) ✓ List of potential heavy metals in the deposit (Lead, Zinc, cadmium…)
	d. Access to infrastructures	✓ Map of transportation network (roads, rails, rivers, airports, ports…) ✓ Map of electricity network ✓ Map of water resources
Land use	a. Potential overlap with environmentally sensible areas	✓ Map of world Heritage Sites ✓ Map of conservation areas and biodiversity hotspots
	b. Potential overlap with human usages	✓ Map of community developments

Possible information sources:

- ✓ National geological surveys, statistics and cadastral information
- ✓ Foreign geological surveys
- ✓ Companies' exploration Reports
- ✓ Pre-feasibility and feasibility studies
- ✓ National geophysical and geological campaigns
- ✓ Other experts' reports

Annex IV: Data checklist and key indicators of risks regarding production, economic and market considerations

Factors to consider	Data to be collected	Unit/ indicators
2. How much do I produce? Geological and sub-national considerations		
Reserves data	a. Reserves by commodity	✓ See Annex III
Production data	b. Production by commodity; by size of mining activities	✓ In volume ✓ By value ✓ Estimated growth in production by commodity in-country ✓ Production growth for similar commodities in other producing countries
	c. Depletion time of reserves	✓ Years
	d. The degree of mineral concentration in-country	✓ Herfindahl-Hirschman Index (HHI)
	e. Mineral production in total mining production (by mineral).	✓ % share of national mining production ✓ % share of global production
	f. Minerals produced as co-product and by-products.	✓ % share of national mining production ✓ % share of global production
	g. Minerals exported, by volume and by value.	✓ Types of minerals exported ✓ Exports by volume ✓ Exports by value ✓ % Minerals exports as a share of total exports ✓ % share of country's minerals exports in global exports (by commodity)
	h. Share of minerals produced by Artisanal and Small-Scale Mining (ASM)	✓ Production by type of commodity ✓ Production by value ✓ Production by volume

	i. Alternative sources of supply, by source: • Recycling • Reprocessing of mining of wastes and tailings • Any potential minerals from deep seabed mineral resources	✓ types of minerals and metals recycled domestically. ✓ Share of recycled products as a share of total product ✓ Projected supply growth from recycling ✓ Types of minerals produced from mine wastes/ tailings. ✓ Share in total mineral produced. ✓ Projected supply growth from reprocessing of tailings ✓ Estimated volume
Demand for minerals	a. Domestic demand by commodity	✓ Estimated domestic demand by commodity in-country. ✓ Types of minerals by industrial need ✓ % share minerals sold to domestic industries ✓ Estimated growth in demand by commodity ✓ Elasticity of mineral demand
	b. Domestic demand by applications and by sectors	✓ Estimated growth in domestic demand by application ✓ Estimated growth in domestic demand by sector ✓ Elasticity of demand for specific applications ✓ Elasticity of demand by sector
	c. External demand by commodity by application and by sector	✓ Estimated growth in global demand by application ✓ Estimated growth in global demand by sector
	d. Likeliness that technological changes will affect minerals demand	✓ New technologies by application ✓ Critical minerals mix by technology

Possible information sources:

- ✓ National statistics
- ✓ Mining companies' reporting

3. How important is the mining sector to my country?		
Contribution of the mining sector to the economy	a. Overall economic contribution of mining	✓ % Share of mining sector to national income ✓ % Share of mining sector to GDP ✓ Contribution of mining to foreign revenues
	b. Contribution of mining to employment	✓ % share of direct mining employment in total employment, by gender ✓ % share of indirect mining employment in total employment, by gender
	c. Public sector investment in mining sector	✓ Share of public investment in mining sector to total public investments (by type of activity from exploration to closure). ✓ Share of public expenditure on R&D and innovation on mining and mineral-related activities. ✓ No. of patents, industrial designs filed (related to mining value chains).
	d. Private investment in mining	✓ Share of domestic private investments in mining to total domestic private investments (in exploration; in production; in refineries and smelting). ✓ Share of FDI in mining to total FDI.
Information on producing companies	a. Prospection and exploration phase	✓ Number of prospection and exploration permits delivered ✓ Exploration budgets by commodities, by stage and by company type. ✓ Growth in exploration budget over time by commodities, by stage and by company ✓ Investment projects in the pipeline
	b. Production phase	✓ Number of exploitation permits delivered by location and by commodity ✓ Number of producing companies by mine site. ✓ Number of producing companies by commodities (including by- and co- products identified in feasibility studies but not necessarily produced). ✓ Number of producing companies by size.

		✓ Number of investment projects in the pipeline by types of investment (greenfield, brownfield, extension, M&A) ✓ M&A history and planned. ✓ Ownership structures of producing companies (and nationality of owners) ✓ In-country geographical distribution of producing companies, by commodities and by size.
	c. Mining and refining capacity	✓ Types of minerals and metals refined/ smelted in-country ✓ Volume and value of minerals and metals refined and smelted in-country ✓ Share of refined and smelted production sold to domestic industries ✓ Share of refined and smelted production exported ✓ Planned mining and refining projects
Trade data	a. Exports	✓ List of export trading partners for mining ✓ Key exports by commodities in volume ✓ Key exports by commodities in value ✓ Share of exports by commodities in total mining exports ✓ Key exports by trading partner in value ✓ Key exports by trading partner in volume ✓ Share of mining exports by trading partners on total mining exports
	b. Imports	✓ List of importing trading partners for mining ✓ Key imports by commodities in value ✓ Key imports by commodities and in volume ✓ Share of imports by commodities in total mining exports ✓ Key imports by trading partner in value ✓ Key imports by trading partner in volume ✓ Share of mining imports by trading partners on total mining imports

	c. Trade balance	✓ Overall trade balance for mining ✓ Export dependency ratio on mining ✓ Import dependency ratio on mining ✓ Time series change in share of trading partners in mining imports and exports
	d. Share of country in global trade	✓ % share of country in global trade by commodity ✓ Herfindahl-Hirschman Index (HHI)
	e. Trade measures in place	✓ By commodity, if applicable (e.g., export licensing; export restrictions etc.) ✓ Performance requirements, if applicable ✓ Restrictions on sectors or specific minerals for investment ✓ Incentives to stimulate mining-related industrial development or development of mining activities
4. Which minerals are essential to my country's strategic objectives?		
Industrial development considerations	a. Country's industrial roadmap (current and future plans)	✓ Scope of industrial policies where mining is relevant ✓ Key technological and industrial sectors in-country and globally for which 'critical minerals' are indispensable.
	b. Beneficiation and mid-stream capabilities	✓ *(See also information in Annex 2)* ✓ Number of refiners/ smelters in operation. ✓ Investment pipeline in refining/ smelting ✓ Share of minerals produced domestically supplied to local refiners / smelters. ✓ Production by type/ volume/ value of refiners/ smelters. ✓ Plans to build refineries/ smelters and their expected capacity (timeline projections) ✓ Share of country's exports of refined/ smelted products ✓ Share of country's imports of refined/ smelter products

	c. Downstream capabilities	✓ List of sectors / industries that *currently* require mineral resources produced domestically. ✓ List of (critical) mineral-intensive sectors/ industries identified as potential drivers for *future growth*. ✓ % share of domestic demand for critical minerals mined in my country (current and projected) by sector/ industry. ✓ % share of global demand for critical minerals mined in my country (current and projected) by sector/ industry.
5. Are there any minerals that I do not produce (or not sufficiently produce) but are key to my domestic industries?		
Domestic availability of critical minerals	a. Reliance on imports and vulnerability of supply chains	✓ Key domestic industries that rely heavily on imports of specific minerals in high demand. ✓ Key minerals imported for specific industries, by type, volume and value. ✓ Top importing partner countries. ✓ Degree of concentration of mineral production by producing countries. ✓ Import dependency ratio by mineral and by country. ✓ Top producing countries of minerals imported and their share in global production.
6. Will current fiscal approaches and policies ensure that producing countries collect an appropriate share of the financial benefits arising from the extraction of their critical minerals?		
Fiscal considerations	a. Current fiscal contribution of the mining sector	✓ Types of fiscal instruments in place relevant to mining ✓ Contribution of mineral resources to government fiscal revenues by type of instrument ✓ Contribution of mineral resources to export revenues.
	b. Pricing models	✓ Types of mineral pricing methods and practices (inc. any specific commodity pricing methods)
	c. Benefit sharing tools	✓ Types of financial benefit sharing systems and instrument

	d. Future fiscal considerations	✓ *Guiding questions for policy discussions:* ✓ Are there alternative financial benefit sharing models that would be more appropriate for 'critical minerals' considering governments' broader policy goals? ✓ Are there gaps to consider in the valuation of mine tailings and how they are considered in mining and / or tax legislation? ✓ Do current fiscal regimes capture potentially valuable by-products and co-products? ✓ Are there benefit sharing opportunities along the critical minerals value chain that require further consideration (tools such as ringfencing, tax incentives, valuation of minerals; and practice issues such as state participation, ownership of mining rights by large end users in the value chain, administrative capacity for tax administration)?

Annex V: Data checklist and key indicators of risks regarding social and environment considerations

Social and environment considerations		
Factors to consider	**Data to be collected**	**Unit/ indicators**
7. What are the key social issues I need to consider to constructively engage with mining affected communities and ensure benefits for society at large?		
Social considerations	a. Existing mining-neighbor communities	✓ A database of mining projects that coexist with local communities. ✓ A map that identifies potential overlap between mining projects and local communities' land (and indigenous people's land where applicable)
	b. Community participation and a repository of community development agreement plans and their scope, where relevant	✓ Agreements with Indigenous people ✓ Local employment as a share of employment at mine site, by gender ✓ Local procurement as a share of operational expenditures at mine site, disaggregated by gender where available ✓ Social services provided by mining companies
	c. Community consultations and engagements	✓ grievance mechanisms, where applicable. ✓ Conflicts history with communities ✓ Case law on conflicts with communities
8. What environmental issues are essential for the sustainability of my mining sector?		
Climate change	Climate change vulnerability	✓ Qualitative ✓ Assessment of the country's vulnerability to climate change, where available
Energy	Energy intensity	✓ kJ / tonne of ore extracted ✓ kJ / tonnes metal processed ✓ kJ / tonnes of metal refined

Air	GHG emissions	✓ tonnes of CO2 / tonne of ore extracted ✓ tonnes of CO2 / tonnes metal processed ✓ tonnes of CO2 / tonnes of metal refined ✓ Level of GHG emissions of the mining industry in total country's GHG emissions
	Air quality	✓ Emission of particulate matter
Water	Water intensity	✓ Water consumption by mining operation / T produced
	Water quality	✓ Number of sample results above national or WHO recommendations
Biodiversity	Biodiversity sensitivity	✓ Existence of protected Fauna and Flora in the vicinity of the mining project (IUCN Conservation list)

Annex VI: Data checklist and key indicators of risks regarding geopolitical considerations

Geopolitical considerations		
Factors to consider	**Data to be collected**	**Unit/ indicators**
Which minerals are considered as 'critical' for my main trading partners and what are their key industrial uses in those markets?		
Market intelligence of third countries	a. Understanding criticality of main trading partners: ✓ A mapping of domestic minerals production against key partners' critical minerals lists ✓ Identification of minerals in partners' CM strategies already exported ✓ Identification of industries and sectors in partner countries that have the highest demand for 'critical minerals' ✓ Identification of key policies and instruments of partner countries to secure access to their 'critical' minerals	✓ List of countries that have a critical minerals strategy. ✓ Scope of (partners) critical minerals strategies. ✓ List of minerals that are covered on these lists. ✓ Partners CM exports by type, by volume, by partner, by share ✓ List of industry players in partner countries ✓ List of relevant policy instruments of partner countries.
	b. Mapping domestic and global demand for partners' critical minerals	✓ A mapping of domestic sectors and applications that use minerals in CM lists. ✓ A mapping of global demand and supply (current and forecasted) of (partners') critical minerals production. ✓ Share of domestic production in global production. ✓ What other technologies need critical minerals (other than RE and digital)

	c. Understanding global supply chains ✓ A mapping of global supply chains for (partners') 'critical minerals' produced domestically ✓ Mapping geographical locations of key parts of supply chains	✓ Critical minerals produced in partner countries, by sectors and by application. ✓ Depth of supply chains by sector and by industry. ✓ Share of specific countries in key parts of supply chains by sector and by industry. ✓ Identification of potential choke points in global supply chains.
	d. Understanding global competition	✓ Key producing countries of 'critical minerals': by name and by share of global production. ✓ Geographical location of global reserves by 'critical minerals'. ✓ Political landscape surrounding key producing countries (i.e., political instability; governance challenges; conflicts; human rights issues)

Annex VII: Data checklist and key indicators of risks regarding governance, legal and regulatory issues

Factors to consider	Data to be collected	Unit/ indicators
10. What policies, legislations, regulations have an impact on my mining sector?		
Regulatory frameworks	a. Domestic policies[9] ✓ Plans to elaborate policies for specific minerals, or for specific sectors. ✓ Plans to develop industries that require mineral feedstocks produced locally.	✓ Mapping of policies by type and scope ✓ List of existing policies/ measures/ instruments that have implications on exploration projects. ✓ List of existing policies/ measures/ instruments that have implications on mining production and processing activities. ✓ List of existing policies/ measures/ instruments that have implications on international trade of specific minerals, by type of measure. ✓ Documentation of plans, and analysis of scope of application and of feasibility ✓ Timeline estimated for their implementation
	b. ESG policies and performance indicators of mining companies	✓ If available, policies of mining companies regarding ESG. ✓ When published, mining companies' ESG performance indicators.

[9] Examples of policies include mining codes; mining contracts; local content policies; beneficiation strategies; regulations that already identify specific types of minerals for specific purposes.

	c. International agreements	✓ Types of agreements and their legal status ✓ Scope of trade agreements with partner countries (with relevant for minerals) ✓ Scope of investment agreements with States (such as BITs) or with companies (mining contracts) that cover mineral production and conditions of exports. ✓ Other trade and investment frameworks particularly focused on minerals (such as MOUs, Framework Agreements)
	d. Other relevant agreements/ contractual obligations:	✓ Existence and content of resource swap deals, that is, agreements to exchange mineral resources for infrastructure or for loans. Offtake agreements (by commodities and relevant industry; length and nature of agreements) ✓ Long-term supply contracts (by commodities and relevant industry; length of contracts, nature of contracts).
11. What global governance frameworks are applicable to my mining sector?		
Global governance frameworks	a. Global frameworks around responsible supply chains	✓ Extractive Industries Transparency Initiative (EITI) ✓ OECD Due Diligence Guidance on Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas. ✓ Section 1502 of the 2010 US Dodd-Frank Act. ✓ European Regulations, such as 2017 EU Conflict Minerals Regulation; 2022 Battery Regulation; 2023 EU Critical Raw Materials Act.
	b. A mapping of host metals and their co-products and by products with partners' conflict minerals and critical minerals lists.	✓ Assessment to be conducted by countries that are in CAHRAs

Risks	Country risk	✓ Corruption Perception Index (Transparency International) ✓ Resource Governance Index (NRGI) ✓ EITI Standards Reporting ✓ World Governance Index (WB) ✓ Global Political Risk Index (Eurasia Group) ✓ Policy Potential Index (Fraser Institute) ✓ Human Development Index (UNDP) ✓ Global Peace Index (Institute for Economics & Peace) ✓ Civic space (WGI Voice and accountability)

Source: adapted from https://opus.bibliothek.uni-augsburg.de/opus4/frontdoor/deliver/index/docId/44156/file/Postprint_AchzetHelbig2013-SupplyRisks+(1).pdf

Annex VIII: Where critical and conflict minerals overlap

It should be relevant to highlight that the 'conflict minerals' listed below are mined alongside other critical minerals, either as co-products or as by-products of host (conflict) minerals. A case in point is lithium, which is a by-product of tin, and currently being explored in some CAHRAs. Although associated with (and therefore mined with) tin, lithium is however currently not classified as a high-risk or conflict mineral in those CAHRAs. This raises the question about policy inconsistencies and of the potential of risk spillovers not being adequately addressed.

Table 1: What other minerals are associated with 'high-risk' and 'conflict' minerals?

'Conflict' minerals	Associated 'critical' minerals	Countries that listed conflict minerals on critical minerals lists[10]	Comments
Tin[11]	Arsenic, Copper, Tungsten, Zinc, Bismuth Lithium[12]	Canada, UK and US	Tin is not on EU and Australia critical minerals list
Tantalum[13] (Columbite-Tantalite)	Niobium, REEs, Lithium, tungsten, Beryllium, Tin Lithium[14]	Australia, Canada, EU, UK, US	
Tungsten[15] (Wolframite)	Copper, molybdenum, zinc, Tin, Antimony	Australia, Canada, EU, UK, US	
Gold[16]	Arsenic, Copper, Zinc, Antimony, Tungsten, Molybdenum	None	Gold is not considered a critical mineral by any country

[10] See Annex 1 for a comparison of critical minerals lists.
[11] Source : https://www.mindat.org/min-52525.html
[12] Source : https://www.mindat.org/min-52473.html
[13] Source : https://www.mindat.org/min-52510.html
[14] Source : https://www.mindat.org/min-52473.html
[15] Source : https://www.mindat.org/min-52513.html
[16] Source : https://www.mindat.org/min-52454.html

'Conflict' minerals	Associated 'critical' minerals	Countries that listed conflict minerals on critical minerals lists[10]	Comments
Cobalt[17]	Copper, Nickel, Gold, Zinc, Chromium	Australia, Canada, EU, UK, US	Cobalt is not considered a 'conflict mineral' in any legislations. However, mining practices from ASM in regions of the DR Congo prone to armed conflict and human rights violations confer similar governance challenges to those observed for Tin, Tantalum, Tungsten and Gold. Rising demand for batteries makes it a critical mineral, and hence subject to regulatory pressures for responsible sourcing[18].

[17] Source : https://www.mindat.org/min-52440.html
[18] Source : https://infraglob.eu/2022/12/20/cobalt-as-conflict-mineral-on-the-opportunities-and-limits-of-new-supply-chain-laws/

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