Special Report 1

FUTURES: CRITICAL MINERALS

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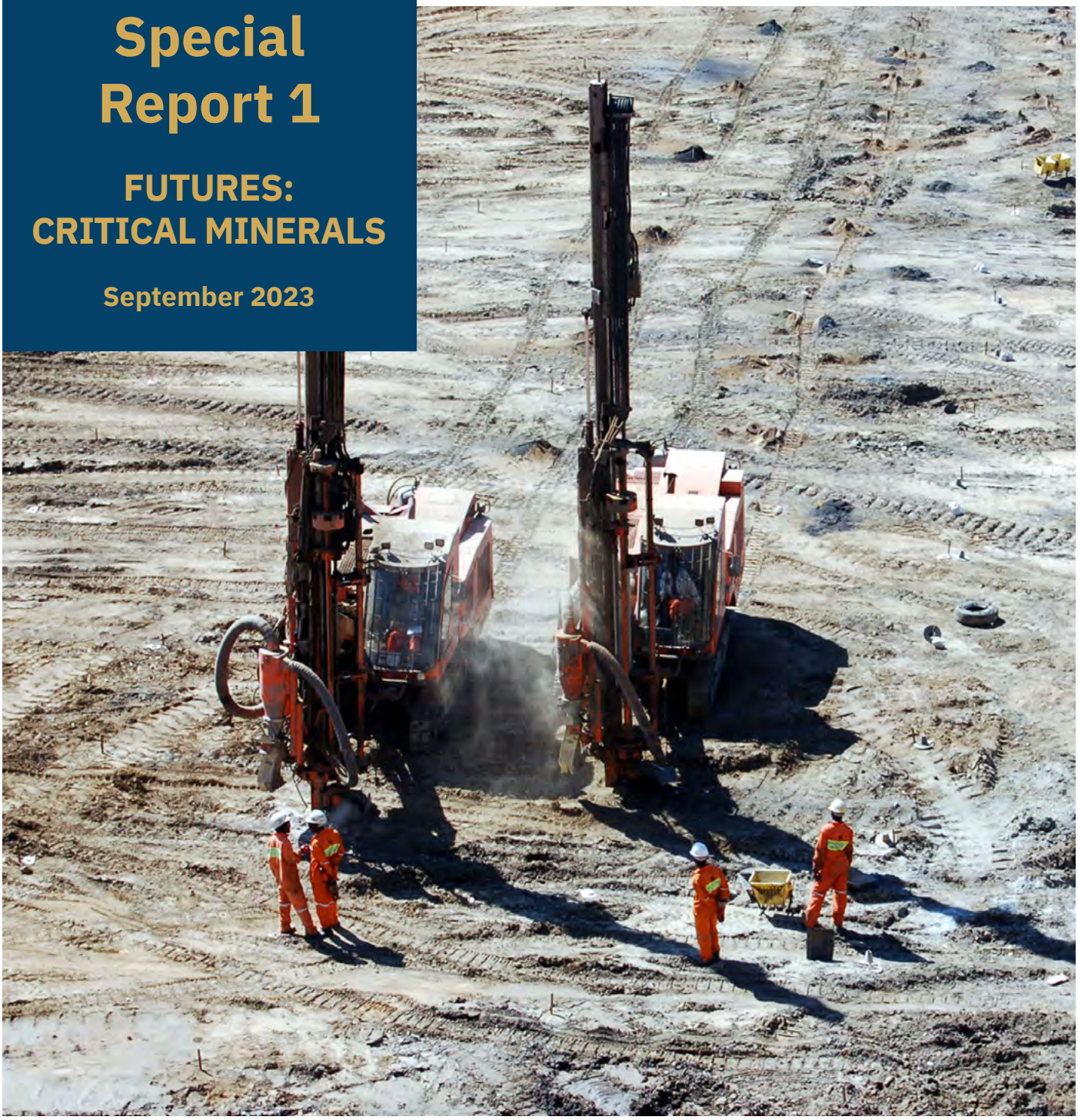

Exploring the Critical Minerals Ecosystem in SADC

Country Barriers and Enablers

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African perspectives
Global insights

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Executive summary

According to the International Energy Agency, there will be a fourfold increase in demand for minerals essential to green energy technologies by 2040. Additionally, the World Bank forecasts a potential 500% surge in the production of minerals such as graphite, lithium and cobalt by 2050. If the trajectory towards global climate neutrality by 2050 accelerates, demand could escalate further, possibly necessitating up to six times more minerals in 2040 than current levels. This shift towards renewable energy sources is expected to lead to a substantial increase in the demand for minerals and metals, highlighting the significance of the African continent due to its wealth of natural resources and its strategic importance in the decarbonised economy.

The amplified need for these critical minerals, often termed 'low carbon', 'green' or 'transition' minerals, creates a new era for mining jurisdictions, especially Southern Africa. The main immediate concern of SADC policymakers is the current lack of policy and governance measures to enable the region to transition from suppliers of raw minerals. The main share of value will still be retained in major manufacturing centres situated elsewhere. In addition, enhanced governance concerning mining practices is lacking and can have catastrophic implications, such as increased pollution.

This special report is part of a series of four reports on the 'Futures of Critical Minerals in SADC: Building Anticipatory Governance'. The special reports are:

- **Special Report 1**
  Exploring Critical Minerals in SADC: Country Barriers and Enablers
- **Special Report 2**
  Navigating the SADC Critical Minerals Transition: Towards Preferred Futures
- **Special Report 3**
  Re-imagining the Critical Minerals Ecosystem in SADC: Building Anticipatory Governance
- **Special Report 4**
  Systemic Innovations Toward the SADC Draft Critical Minerals Strategic Framework

This report provides a critical review of the Southern African critical minerals ecosystem, exploring what is meant by critical minerals and what are the main critical minerals. It also considers the geostrategic machinations by China, the US and Europe in the context of current governance challenges in the SADC region in terms of the environment, socio-economic conditions and sub-regional mineral frameworks. Further, the contextual assessment analyses the region's barriers to and enablers of resource-led industrialisation. Renewable energy sources, particularly clean energy technologies, require significantly more minerals than fossil fuel-based energy sources. It is estimated that the mining industry needs to invest $1.7 trillion over the next 15 years to supply enough metals for renewable energy.

Many of these critical minerals play a significant role in geopolitics, especially in the growing competition between the US and China, given China's current control over global critical mineral supply chains. The increased demand can exacerbate conflicts and environmental tensions as different actors compete for a greater supply chain share in the race for decarbonised economies.

The report concludes by focusing on country case studies of copper, lithium, cobalt, graphite, manganese, nickel and rare earth elements in the Democratic Republic of Congo, South Africa, Zambia, Zimbabwe, Mozambique, Madagascar and Tanzania.

By understanding the key dimensions of the critical minerals mining ecosystem, policymakers can push beyond conventional thinking on balancing mining supply and demand dynamics within the geopolitical landscape and better anticipate future events by applying strategic foresight. Understanding past dynamics and forecasting trends has a place, but it is limited because it focuses on past events. Although change is always present, the rate of change is much faster, necessitating the need to discover the underlying shifts and opportunities to unearth systemic value and contextual relevance within the SADC region.

Abbreviations & acronyms

AfDB	African Development Bank
AMDC	African Minerals Development Centre
AMV	African Mining Vision
AU	African Union
CLA	Causal Layered Analysis
DRC	Democratic Republic of Congo
EBA	European Battery Alliance
EITI	Extractive Industries Transparency Initiative
EU	European Union
IEA	International Energy Agency
IGF	Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development
IRA	Inflation Reduction Act
MSP	Minerals Security Partnership
OECD	Organisation for Economic Co-operation and Development
REE	rare earth element
RMI	European Raw Materials Initiative
SADC	Southern African Development Community
SAIIA	South African Institute of International Affairs
UK	United Kingdom
UN	United Nations
US	United States
USAID	United States Agency for International Development

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About SAIIA

SAIIA is an independent, non-government think tank whose key strategic objectives are to make effective input into public policy, and to encourage wider and more informed debate on international affairs, with particular emphasis on African issues and concerns.

SAIIA's special reports are fairly lengthy analytical papers, usually reflecting on and analysing the findings of field research.

Cover image

Zambian open pit copper mining
Getty Images/mabus13

Please note that all currencies are in US$ unless otherwise indicated.

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CHAPTER 1

Introduction

The World Bank estimates that the production of minerals and metals such as graphite, lithium and cobalt could increase by nearly 500% by 2050, spurred on by the scaling of low-carbon energy generation and storage technologies.[1] The surge in demand for these green minerals (also referred to as 'low carbon', 'critical' or 'transition' minerals) provides new opportunities for the mining jurisdictions in which they occur. Yet, without appropriate policy and governance measures, mining jurisdictions could remain locked in as raw mineral suppliers for green technology value chains, with most of the value captured in major manufacturing centres elsewhere. Enhanced governance is also needed to ensure that the expansion of mining activities for these green minerals does not lead to pollution, habitat destruction, corruption, illicit financial flows and other deleterious environmental and social impacts. Such impacts undermine the potential contribution of the mining sector to the sustainable and inclusive development of mineral-rich economies.

For most countries in Southern Africa, mining contributes a significant part of foreign exchange earnings and gross domestic product while also being a major employer. Therefore, the demand, use and trade landscape of these commodities is an important economic driver of these economies. Roughly 70% of the world's cobalt – used for batteries in mobile phones and electric cars – comes from the Democratic Republic of Congo (DRC), and a significant percentage from Madagascar. Zimbabwe and Namibia have among the largest reserves of lithium globally. As key global producers of these commodities, Southern African economies are well positioned to benefit from rising demand for critical minerals.

At present, however, the region faces low levels of industrialisation, high commodity dependence, regional fragmentation and high levels of social inequality. The changing minerals and metals ecosystem spurred by the global drive towards decarbonisation is a unique opportunity for Southern African countries to stimulate a paradigm shift away from a development model anchored on extraction. Instead, they can move towards one in which mineral resources are harnessed to accelerate regional broad-based development and build resilient, diversified and competitive economies.

This report seeks to address critical questions:

- What are the intricacies of the SADC critical minerals ecosystem that stand to shape the region's destiny in a carbon-constrained world?
- How can SADC member states harness their mineral endowments to drive economic progress and technological advancement while navigating the complex geopolitical forces at play?

1 World Bank, *Minerals for Climate Action: The Mineral Intensity of the Clean Energy Transition* (Washington DC: World Bank, 2020).

- What strategies intersect with Africa's aspirations in the renewable energy regional value chain that complement the needs of global stakeholders, including China, the US and Europe, in securing their energy transitions through their respective critical minerals strategies?
- What are the barriers to sustainable and equitable mineral extraction and trade within the region?
- How can policy frameworks be designed to foster mineral-driven development while mitigating environmental degradation and social conflict?
- Which countries have significant deposits of critical raw materials that could be on the radar of geostrategic ambitions, experience governance challenges and lack regulations at regional and national levels?

Simultaneously, the report delves into the pressing governance challenges associated with mining. Balancing the economic opportunities of resource extraction with environmental protection and social well-being requires robust governance frameworks. As mineral-rich countries contemplate downstream value addition, they must confront the lessons of history: resource extraction does not necessarily translate into inclusive prosperity. The analysis examines the barriers and enablers of resource-led industrialisation within the SADC context, considering the role of local procurement policies and diversification initiatives and the potential pitfalls of downstream processing. Case studies from around the world illuminate the complex interplay of factors that determine the success of these policies, from economic drivers to infrastructure to good governance.

This report provides a critical review of the Southern African critical minerals ecosystem, exploring what is meant by critical minerals and what are the most critical minerals. It also considers the geostrategic machinations by China, the US and Europe in the context of the current governance challenges in the SADC region regarding the environment, socio-economic conditions and sub-regional mineral frameworks. Further, the contextual assessment analyses the barriers and enablers of resource-led industrialisation in the region. The report concludes by focusing on country case studies of copper, lithium, cobalt, graphite, manganese, nickel, and rare earth elements (REEs) in the DRC, South Africa, Zambia, Zimbabwe, Mozambique, Madagascar and Tanzania.

Ultimately, this report seeks to provide insight into the multifaceted realm of SADC's critical minerals ecosystems, offering a comprehensive overview that spans economic, environmental and geopolitical dimensions. By shedding light on the intricacies of critical minerals, the report aims to equip policymakers, stakeholders and readers with the knowledge necessary to navigate the complex landscape of sustainable development in the era of the global energy transition. The subsequent sections delve into each facet with precision, facilitating a deep understanding of the challenges, opportunities and strategic choices that lie ahead for the SADC region.

CHAPTER 2

The SADC critical minerals ecosystem

Critical minerals

In 2015, states agreed to a global goal of keeping global warming to no more than 1.5°C above pre-industrial levels. This target was part of the Paris Agreement, a key milestone in international climate negotiations under the auspices of the UN Framework Convention for Climate Change. Achieving this target will require a massive ramping up of green technologies such as renewable energy generation, battery storage and electric vehicles (EVs). These trends are already apparent and are likely to accelerate further in the years ahead. Installed solar capacity has undergone a more than 20-fold increase since 2010.[2] In 2010, EVs represented about 0.01% of the global automotive market; in 2022, this had increased to 10%, with researchers indicating it could double or even quadruple by 2030.[3] Targets set out in national commitments under the Paris Agreement, known as Nationally Determined Contributions, as well as national economic policies and regulations such as the European Green Deal, the US Inflation Reduction Act and China's series of five-year plans for a modern energy system outline ambitious plans for ramping up renewable energy technologies. This is also reflected in private sector commitments, such as those issued by major automotive manufacturers to switch production towards EVs.

The International Energy Association (IEA) has highlighted that the economic nature of a country fuelled by traditional energy sources differs radically from that of a country whose economy is fuelled by clean energy technologies.[4] Renewable energy sources, particularly clean energy technologies, require significantly more minerals than fossil fuel-based energy sources. Reaching the goals of the Paris Agreement would quadruple mineral demand by 2040. It is estimated that the mining industry has to invest $1.7 trillion over the next 15 years to supply enough metals for renewable energy.

The mining sector will play a crucial role in the transition toward a low-carbon future, and the various green technologies required to achieve this transition all need substantial mineral and metal resources. An increased demand for low-carbon technologies will result in greater demand for the component minerals and metals that comprise these technologies. Modern economies rely on a wide variety of resources, but they are not seen as critical because some are available in abundance or can readily be substituted. It is, therefore, important to note that certain materials have been used for decades without facing supply constraints, due to their wide distribution and abundance. For example, while

2 Laura Cozzi et al., *World Energy Outlook 2020* (Paris: International Energy Agency, 2020).

3 Jacob Zinkula, 'Electric Vehicles Accounted for 10% of Global Auto Sales Last Year – This Could Quadruple by 2030', *Business Insider*, January 16, 2023.

4 IEA, *The Role of Critical Minerals in Clean Energy Transitions* (Paris: IEA, 2022).

the increase in demand for certain green technologies might cause increases in demand for both cobalt and aluminium, only cobalt is considered a critical mineral, due to the relative abundance of aluminium and the relative scarcity of cobalt.[5] Hence, it is essential to acknowledge the difference between green minerals – simply minerals needed for green technologies – and critical minerals. While there is a less than perfect consensus on which minerals are deemed critical, certain minerals are included in most lists, namely copper, cobalt, nickel, lithium and rare earth metals.[6] While many different resources might be required to facilitate the green transition, only a specific subset of minerals directly applying to the energy transition is considered critical.

Competition for access to these critical minerals will increase notably, ultimately placing Africa at the centre of the green transition in both environmental and geopolitical terms. This increased competition will spur new conflicts over which countries can gain access to these resources and how these resources are best managed

Generally, critical minerals have been understood as those minerals and metals that require significant extraction effort, where the reserves or production are geographically concentrated and where a notable increase in supply will be needed.[7] Another important characteristic of critical minerals worth highlighting is the combination of factors that pose severe risks to their reliable supply. For instance, many of these minerals are highly concentrated in politically unstable regions, are produced in comparatively small volumes or have few substitutes in their applications. Moreover, many of these critical minerals play a larger role in geopolitics, especially in the growing competition between the US and China, given China's existing control over global critical mineral supply chains.[8] Inevitably, the security of critical mineral supply chains is an emerging geopolitical issue and is likely to remain relevant for the foreseeable future, given the exponential growth in demand for green technologies. Competition for access to these critical minerals will increase notably, ultimately placing Africa at the centre of the green transition in both environmental and geopolitical terms.[9] This increased competition will spur new conflicts over which countries can gain access to these resources and how these resources are best managed. Therefore, these minerals can also be understood as critical because increased demand for them

5 Papa Daouda Diene et al., *Triple Win: How Mining can Benefit Africa's Citizens, Their Environment and the Energy Transition*, Research Report (New York: Natural Resource Governance Institute, 2022).

6 Dolf Gielen, "Critical Materials for the Energy Transition" (Technical Paper 5/2021, IEA, Abu Dhabi, 2021).

7 Antonio Adreoni and Simon Roberts, "The Geopolitics of Critical Minerals in Renewable Energy Supply Chains" (Policy Brief, The African Climate Foundation, Cape Town, 2022).

8 Jane Nakano, *The Geopolitics of Critical Minerals Supply Chains*, Report (Washington DC: Centre for Strategic and International Studies, 2021).

9 Ben Chandler, "Africa's Critical Minerals: Africa at the Heart of a Low-Carbon Future" (Policy Brief, Mo Ibrahim Foundation, London, 2022).

could exacerbate existing conflicts and environmental tensions as different actors compete for a more significant share of the supply chain.[10]

Also worth noting is that these green technologies have different degrees of dependence on a range of critical minerals, which are, in turn, influenced by external factors such as price volatility and supply constraints. Each critical mineral demonstrates a different demand risk depending on whether it is needed for various green technologies or its use is concentrated in one particular kind of green technology.[11] In addition, due to the rapid pace of technological advancement and the potential for metal substitutions, these critical minerals are subject to changes in demand.[12] In short, due to the accelerated rate of technological development and the potential for substitution, demand for these critical minerals will likely shift under different transition scenarios. Nevertheless, given that green technologies are generally more resource-intensive, overall demand for these minerals will still increase even if the exact mix and distribution of minerals is unknown. Hence, there is a need for African policymakers to maintain flexibility when designing critical minerals lists, as the advent of new technological or geopolitical events may affect the composition of minerals required to facilitate the green transition.

In response, many governments worldwide have established critical minerals lists to highlight what they consider essential resources for meeting their climate commitments or securing their vital industries. For example, according to a recent paper by the African Development Bank (AfDB), the criteria include:[13]

- minerals that are required in green technologies;
- minerals that maximise the benefits of Africa's large mineral endowment; and
- minerals that are used in the industrialisation of clean energy industries.

There are evident parallels between the lists of core minerals proposed by different governments. Still, Africa and SADC member states need to define their lists of critical minerals, given the strategic reserves of many of these minerals and the unique socio-economic contexts. In summary, a critical mineral is best understood as one that is:

- likely to experience increased demand in the immediate future due to its role in the green technologies needed to realise the green transition;
- subject to geopolitical risks such as high geographic concentration in politically fragile regions; and

10 Clare Church and Alec Crawford, *Green Conflict Minerals: The Fuels of Conflict in the Transition to a Low-Carbon Economy*, Report (Winnipeg: International Institute for Sustainable Development, 2018).
11 Nakano, "Geopolitics of Supply Chains".
12 Church and Crawford, "Green Conflict Minerals".
13 African Natural Resources Management and Investment Centre, African Development Bank, "Approach Paper to Guide Preparation of an African Green Minerals Strategy" (AfDB, Abidjan, 2022).

- influenced by accelerated technological developments that could affect its demand profile in unforeseen ways.

Tables 1 and 2 present the list of 13 core minerals and 19 'watch-list' minerals identified by the AfDB in its approach paper on an African Green Minerals Strategy.

TABLE 1 CORE MINERALS FOR THE AFRICAN GREEN MINERAL STRATEGY

Mineral	Solar PV	Hydrogen & fuel cells	Energy storage	Electric vehicles
Aluminium	■		■	
Chromium				■
Cobalt		■	■	
Copper	■		■	■
Graphite			■	■
Iron – Steel	■		■	
Lithium		■	■	■
Manganese			■	
Nickel	■		■	■
Platinum group metals		■		■
Rare earth elements		■		
Vanadium			■	■
Zinc	■			

Source: Compiled by authors

TABLE 2 WATCH-LIST MINERALS FOR THE AFRICAN GREEN MINERAL STRATEGY

Mineral	Main green technology uses
Arsenic	PV semi-conductor
Boron	EVs
Cadmium	PV semi-conductor
Gallium	PV semi-conductor
Germanium	PV semi-conductor
Indium	PV semi-conductor, coating anodes, chemical catalyst
Lead	Lead acid batteries and PVs
Magnesium	Steel alloys
Molybdenum	Steel alloys for geothermal plants
Niobium	Steel alloys
Selenium	PV semi-conductor
Silicon	PV semi-conductor
Silver	PV semi-conductor
Tantalum	Steel alloys
Tellurium	PV semi-conductor
Tin	Protective coating
Titanium	Lithium-ion batteries
Tungsten	Water resistant steel alloys
Zirconium	Hydrogen electrolysers alkali process

Source: Compiled by authors

BOX 1 CONCEPTS: CRITICAL MINERALS, GREEN MINERALS, TRANSITION MINERALS, LOW-CARBON MINERALS

Critical minerals

US Government

A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals (E.O. 13817):

'A "critical mineral" is a mineral identified by the Secretary of the Interior pursuant to subsection (b) of this section to be (i) a non-fuel mineral or mineral material essential to the economic and national security of the United States, (ii) the supply chain of which is vulnerable to disruption, and (iii) that serves an essential function in the manufacturing of a product, the absence of which would have significant consequences for our economy or our national security.'[a]

US Agency for International Development (USAID)

'Critical minerals are defined by current dependence on foreign imports of minerals necessary for security and economic prosperity. By definition, this includes a wider array of minerals used in defence and other industries. In addition, critical minerals tend to have limited domestic sources and therefore dependence on one or [a] few trading partners.'[b]

EU Critical Minerals List

'The EU's list of Critical Raw Materials is a list of raw materials, mostly minerals, that are considered strategic to the EU's' economy and that have high supply risk... [These are] raw materials that are both crucial to maintaining a healthy economic system, and whose supply may be at risk, because of – but not limited to – geopolitical, geographical, and geological factors.'[c]

World Bank

'Based upon what we call the demand risk matrix, we know that aluminium, copper and nickel are "critical" minerals that will play a strong role in the transition to a low-carbon future, as they will be needed for a wide variety of technologies. Graphite and lithium are also "critical", but their outlook depends on the extent to which battery storage is deployed between now and 2050.'[d]

International Renewable Energy Agency

'Generally, attention has focused on minerals and metals that require a significant extraction effort, where the production is concentrated in a few countries, where the quality of natural resources is declining, where a massive ramp-up of supply will be needed and where prices have shown large fluctuations that reflect supply-demand imbalances.'[e]

BOX 1 CONCEPTS: CRITICAL MINERALS, GREEN MINERALS, TRANSITION MINERALS, LOW-CARBON MINERALS CONT...

UK Critical Minerals Strategy

'Modern economies rely on countless raw materials. Many minerals have important uses but, by dint of plentiful supply, functioning markets or an ability to substitute them, do not warrant the focus that others may at this stage. By necessity of focus, only some are defined as "critical". These "critical minerals" are not only vitally important but are also experiencing major risks to their security of supply. These risks can be caused by combinations of factors including but not limited to rapid demand growth, high concentration of supply chains in particularly countries, or high levels of price volatility. Many of these critical minerals are produced in comparatively small volumes or as companion metals (ie, produced as by-products of other mining activities), are non-substitutable in their applications and have low recycling rates.'[f]

PricewaterhouseCoopers Mine 2022: A Critical Transition

'Critical minerals are needed at all stages of the low-carbon energy cycle. They include silicon, rare earth elements and uranium for energy generation; copper, aluminium and steel for distribution networks; and "battery minerals" such as nickel, lithium and cobalt for energy storage. Many governments around the world have established critical minerals lists to highlight what they see as essential resources for meeting their net-zero commitments and for applications in high tech, defence and other vital industries. But it's the subset of critical minerals with direct application to the energy transition that will experience the greatest growth and dominate the mining industry of the future.'[g]

Green minerals

AfDB

'Criteria for defining the scope for minerals to include in the [African Green Mineral Strategy] are proposed as follows: (1) minerals that are used in clean energy technologies and green industries; (2) minerals that maximise the benefits of Africa's mineral endowment; (3) minerals that are feedstocks for resource-based industrialisation of clean energy industries.'[h]

Transition minerals

Natural Resource Governance Institute

'For instance, battery EVs require twice the metal of a standard internal combustion engine car. Solar and wind plants respectively require three and four times the metal needed for an energy-equivalent gas fired power plant. This increases demand for both

BOX 1 CONCEPTS: CRITICAL MINERALS, GREEN MINERALS, TRANSITION MINERALS, LOW-CARBON MINERALS CONT...

rarer "critical minerals" like cobalt as well as relatively abundant metals such as copper and aluminium. All these metals and minerals required in the "transition industries" that produce technology for the energy transition we call "transition metals and minerals".'[i]

a Government of the US, Executive Office of the President, *A Federal Strategy to Ensure Secure and Reliable Supplies of Critical Minerals*, Executive Order 13817 (Washington DC: Executive Office of the President, 2017).

b Government of the US, US Agency for International Development, *Mining and the Green Energy Transition: Review of International Development Challenges and Opportunities* (Washington DC: USAID, 2021), 3.

c EU, European Commission, *Critical Raw Materials Resilience: Charting a Path Towards Greater Security and Sustainability* (Brussels: European Commission, 2020), 1.

d World Bank, "The New Kids on the Block: Redefining "Critical" Minerals Essential for a Clean Energy Future", May 11, 2020.

e Dolf Gielen, "Critical Materials for the Energy Transition" (Technical Paper 5/2021, International Renewable Energy Agency, Masdar City, 2021), 10.

f UK Government, Department for Business, Energy and Industrial Strategy, *Resilience for the Future: The United Kingdom's Critical Minerals Strategy* (London: Department for Business, Energy and Industrial Strategy, 2022), 10.

g PricewaterhouseCoopers, *Mine 2022: A Critical Transition* (London: PWC, 2022), 9.

h African Development Bank, "Approach Paper Towards Preparation of an African Green Minerals Strategy" (AfDB, Abidjan, 2022), 23.

i Papa Daouda Diene et al., *Triple Win: How Mining can Benefit Africa's Citizens, Their Environment and the Energy Transition, Research Report* (New York: Natural Resource Governance Institute, 2022), 10.

Geostrategic considerations

Due to the pace of clean energy technology development, supply chain security for these critical minerals has become an arena of geopolitical contestation. The rapidly growing markets for these critical minerals needed to supply the clean energy transition could be subject to price volatilities, supply disruptions and geopolitical influences. In addition, the high geographical concentration of production and processing operations for many energy transition minerals has made global energy markets more susceptible to increasing geopolitical instability.[14] The US and the EU have become increasingly concerned about China's dominance in critical mineral value chains and green technology production.[15] Furthermore, the Covid-19 pandemic and the Russian invasion of Ukraine have highlighted the vulnerability of global supply chains and the risks associated with a reliance on imports, including green technologies. As the US and EU increasingly seek to compete with China in securing critical mineral supplies and onshoring green technology value chains, Africa risks

14 Nakano, "Geopolitics of Supply Chains".

15 Danielle Marais, "Africa's Mineral Resources are Critical for the Green Energy Transition", South African Institute of International Affairs, November 15, 2022.

having its interests sidelined and becoming locked in as a supplier of critical minerals to other parts of the world.

China

China has become the dominant stakeholder in global supply chains for critical minerals and clean energy products and is rich in multiple mineral resources key to green energy technologies.[16] It has some of the largest global reserves of lead, selenium, tellurium, tin and zinc, critical to solar technology, and graphite, lithium and titanium, vital for EVs and energy storage technologies.[17] China is also a strategic participant in the later stages of the supply chain and an essential player in refining critical minerals required for green technologies such as battery cell components. For example, it is the most significant actor in the cobalt mining industry and the world's leading consumer of cobalt, with over 80% of its consumption going towards the rechargeable battery industry. In lithium-ion battery manufacturing, China has most of the processing capacity for key components (such as cathodes, anodes, separators and electrolytes) and almost 80% of global battery cell manufacturing capacity. This vast mineral wealth and processing capacity place it in a unique global position, allowing the state to exert a quasi-monopoly on several critical minerals.[18] China's leverage exposes other countries to supply chain disruptions and reduces the ability of governance actors to ensure that minerals are extracted and processed according to environmental standards. In short, no discussion about critical minerals can be complete if it does not grapple with China's commanding position in critical minerals production and processing.

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US

Shortly after the inauguration of US President Joe Biden, his administration issued an executive order on US supply chains and called for an immediate review of critical minerals'

16 Rodrigo Castillo and Caitlin Purdy, *China's Role in Supplying Critical Minerals for the Energy Transition*, Report (Washington DC: The Brookings Institution, 2022).
17 Church and Crawford, "Green Conflict Minerals".
18 Nakano, "Geopolitics of Supply Chains".

vulnerabilities in these supply chains.[19] The Biden administration is eager to meet its carbon neutrality commitment. It has highlighted the connection between supply chain security and its ability to lead the green energy transition as a serious issue. To this end, one of the relatively recent initiatives of the US State Department is the Minerals Security Partnership (MSP). The MSP is a helpful starting point for understanding how the US intends to disentangle itself from Chinese supply chains by improving its cooperation with other strategic regions.[20] Announced in 2022, the MSP seeks to promote investments for securing critical mineral supply chains from extraction to processing and export between the US and its allies. The MSP is part of a sustained effort by US policymakers to reduce dependence on China and ensure that critical minerals are mined and processed in a way that supports the responsible development of a country's resources.[21] The US-led partnership is a work in progress. Still, the idea seems to be that member countries will support their firms in delivering mining projects that will meet international best practices in terms of environmental and social requirements.[22] While a renewed emphasis on responsible mining is positive, it is unclear to what degree the MSP will help support local value addition in regions such as Africa, where local policymakers are looking for ways to leverage the continent's mineral wealth.

Another noteworthy policy initiative for developing critical mineral supply chains is the Inflation Reduction Act (IRA). Diversification of the critical minerals supply chain is essential, and the IRA provides an important step for this process through its EV consumer tax credit mechanism.[23] The credit mechanism aims to make EVs more accessible. Still, the more significant impact lies in the requirement that a portion of the battery minerals in qualifying vehicles be extracted or processed in the US or its trusted trading partners. In this way, the mechanism connects increased future demand for domestic EV sales with investments in alternative critical mineral supply chains to source these battery metals.[24] Furthermore, the US engages with the critical minerals arena through its diplomatic actions, which include bilateral agreements with critical mineral suppliers. For instance, the US recently signed memorandums of understanding with officials from the DRC and Zambia, two of Africa's largest cobalt producers, signalling its desire to import greater amounts of cobalt and other minerals for EV manufacturing.[25] In addition, USAID works extensively with key developing country producers to improve governance, environmental protection and community welfare.[26]

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19 Government of the US, Presidency, *Securing a Made in America Supply Chain for Critical Minerals* (Washington DC: Presidency, 2022).

20 Ryan Berg and Henry Ziemer, "The Indispensable Industry: Mining's Role in the Energy Transition and the Americas", Centre for Strategic and International Studies, January 24, 2023.

21 Government of the US, *Securing Supply Chains*.

22 "How America Plans to Break China's Grip on African Minerals", *The Economist*, February 28, 2023.

23 Morgan Bazilian and Gregory Brew, "The Missing Minerals", *Foreign Affairs*, January 6, 2023.

24 Reed Blakemore and Paddy Ryan, "The Inflation Reduction Act Places a Big Bet on Alternative Mineral Supply Chains", Atlantic Council, August 8, 2022.

25 Christian Byamungu, "The US-Zambia-DRC Agreement on EV Batteries Production: What Comes Next?", Centre for Strategic and International Studies, March 6, 2023.

26 Terah De Jong, Titus Sauerwein and Ludivine Wouters, *Mining and the Green Energy Transition: Review of International Development Challenges and Opportunities*, Report (Washington DC: USAID, 2021).

Europe

Diversifying and strengthening supply chains have become a priority for the EU, as supply chain resilience is closely linked to the renewed emphasis on industrial policy in Europe. More specifically, the European Commission focuses on emphasising the need for intelligent reshoring to relocate industrial production in sectors of strategic value for the EU.[27] For its part, the UK government has reviewed its vulnerability in supply chains for critical minerals and has released a critical minerals strategy that lays out the government's plans to improve the security of its supply chains.[28] To realise its ambition of securing the supply of critical minerals, the European Commission has launched two key initiatives: the European Raw Materials Initiative (RMI) and the European Battery Alliance (EBA).[29] The RMI aims to build resilience and strategic autonomy for Europe's critical mineral supply chains by identifying investment opportunities and addressing sustainability impacts. For example, the European Commission decided to modernise EU battery legislation to underpin the sustainability and circularity of battery consumption to facilitate their collection and recycling. The EBA is another major EU policy initiative that aims to enhance its independence in the green transition. The EBA was established as part of the EU's new industrial strategy, which aims to localise the value chain of lithium-ion batteries, given the EU's overreliance on China.[30] The EU hopes to mobilise public and private investment through the EBA to help re-shore industries key to lithium-ion battery production.

Governance challenges

Mining has long been central to society. Modern transport, communication, urban development and even food production have been and remain highly reliant on a range of minerals and metals provided by the mining industry, and, in this sense, mining has been closely tied to growth and development. Yet mining is also associated with various negative social and environmental impacts. While the global economy benefits from the products and infrastructure derived from minerals and metals, those closest to the mining activities often bear the brunt of negative social and environmental impacts.[31] Mining activities can affect social and environmental systems in direct and indirect ways. Mine exploration, construction, operation and maintenance may result in land-use change, leading to deforestation, erosion, contamination and alteration of soil profiles, contamination of local streams and wetlands, and an increase in noise level, dust and emissions. Mine abandonment, decommissioning and repurposing can also result in significant environmental impacts, especially soil and water contamination. The infrastructure that supports mining activities, including roads, ports, railway tracks and power lines, can affect

27 Kjeld Van Wieringen, "Securing the EU's Supply of Critical Raw Materials" (Policy Brief, European Union, Brussels, 2022).
28 Government of the UK, Department for Business and Trade, *Resilience for the Future: The United Kingdom's Critical Minerals Strategy* (London: Department for Business and Trade, 2022).
29 Nakano, "Geopolitics of Supply Chains".
30 Marianne Schneider-Petsinger, "US and European Strategies for Resilient Supply Chains: Balancing Globalisation and Sovereignty" (Research Paper, Chatham House, London, 2021).
31 Jennifer Bansard and Mika Schröder, "The Sustainable Use of Natural Resources: The Governance Challenge" (Policy Brief, International Institute for Sustainable Development, Winnipeg, 2021).

the migratory routes of animals and increase habitat fragmentation. Mining is also known to affect the traditional practices of Indigenous peoples living in nearby communities and conflicts in land use are also often present, as are other social impacts, including those related to public health and human wellbeing. In addition, mineral riches have been the source of violent conflict and have helped sustain these conflicts, as attested by the literature on conflict minerals.

Nevertheless, the mining industry will play a central role in the transition towards a low-carbon future as the technologies needed to realise this transition require significant mineral resources. How all these minerals are sourced and processed will ultimately determine whether the green transition contributes to sustainable socio-economic development or perpetuates pre-existing social and environmental governance failings. While the critical mineral wealth of many countries has the potential to promote development, there is also the possibility that the dramatic increase in demand for these critical minerals may unleash a wave of new social and environmental abuses.[32] In other words, there are real risks of diverse tensions and grievances around the emerging or continued extraction of these critical minerals. This is compounded by the fact that many significant reserves of these critical minerals are concentrated in African states perceived as fragile and corrupt as defined by Transparency International's Corruption Perceptions Index.[33] While many of these issues are not new to the mining sector, a failure to address these challenges in the critical minerals sub-sector could lead to major supply disruptions, undermining the pace of the green transition. Considering these challenges, Africa's crucial role in the global green transition should not inadvertently contribute to widespread environmental degradation and the deepening of longstanding socio-political challenges.[34]

How all these minerals are sourced and processed will ultimately determine whether the green transition contributes to sustainable socio-economic development or perpetuates pre-existing social and environmental governance failings

The global energy transition requires more minerals, as clean energy technologies usually require more significant minerals than their fossil fuel counterparts. While increased circularity in mineral supply chains is important, recycled materials are insufficient to meet

32 Elsa Dominish, Nick Florin, and Sven Teske, 'Responsible Minerals Sourcing for Renewable Energy', Report prepared for Earthworks (University of Technology Sydney: Institute for Sustainable Futures, 2019), https://earthworks.org/wp-content/uploads/2019/04/Responsible-minerals-sourcing-for-renewable-energy-MCEC_UTS_Earthworks-Report.pdf.

33 Church and Crawford, "Green Conflict Minerals".

34 African Natural Resources Management and Investment Centre, AfDB, "Approach Paper".

this burgeoning demand.[35] New mines must come online in much shorter timeframes than the present average project lead time. This increased demand for these critical minerals could create additional opportunities for corruption and, in turn, threaten to derail the energy transition.[36] On the one hand, for countries that host substantial reserves of the minerals needed for the energy transition, increased demand could present an opportunity to build a highly profitable and responsible mining sector. On the other hand, without adequate governance these countries face the risk of revenue losses and widespread corruption. Failure to properly manage these governance risks may expose governments and mining companies to increased ethical scrutiny as public resistance to the adverse effects of these mining projects builds.[37] In short, increased demands for minerals needed in the energy transition create governance risks and opportunities for various stakeholders.

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Failure to address corruption in mineral supply chains could also slow and disrupt supply, breed an unpredictable regulatory environment and expose governments and companies to long-term liability. Previous commodity booms have shown how corruption can delay responsible production, undermine the mining sector's contribution to sustainable development and increase the risk of societal and environmental harm.[38] Historically, many resource-rich countries have experienced a 'resource curse' where they fail to benefit from their mineral wealth for various reasons, including corruption, rent-seeking and weak governance institutions.[39] Many countries that depend on mining revenues are ranked at the bottom of the UN's Human Development Index, highlighting the need for responsible wealth management. Furthermore, many mining companies are managing new risks and negotiating unprecedented deals to realise the potential of substantial profits. From the government and regulator side, there is a lack of adequate technical capacity to address the implementation gap concerning the responsible sourcing of green energy technologies and the minerals needed to power them. Several major governance standards and

35 Natural Resource Governance Institute, *Preventing Corruption in Energy Transition Mineral Supply Chains* (New York: Natural Resource Governance Institute, 2022).

36 Benjamin Katz, Louis Maréchal and KC Michaels, "Why Is ESG so Important to Critical Mineral Supplies, and What Can We Do About It?", September 9, 2022.

37 Kathryn Sturman et al., *Mission Critical: Strengthening Governance of Mineral Value Chains for the Energy Transition*, Report (Oslo: Extractives Industries Transparency Initiative, 2022).

38 Natural Resource Governance Institute, *Preventing Corruption*.

39 De Jong, Sauerwein and Ludivine, "Mining and the Green Energy Transition".

frameworks have been developed in response to these governance challenges, such as the Extractives Industries Transparency Initiative (EITI), the RMI and the OECD Due Diligence Guidance on Responsible Mineral Supply Chains.

Regional and sub-regional mineral frameworks

African heads of state and government adopted the African Mining Vision (AMV) in 2009 to support 'transparent, equitable and optimal exploitation of mineral resources to underpin broad-based sustainable growth and socio-economic development'.[40] The AMV remains the overarching policy framework guiding African stakeholders to ensure that Africa's extensive mineral resource wealth translates into tangible developmental gains for the continent. Central to this vision is ensuring that Africa's minerals contribute to industrialisation through local processing and value addition, an ambition echoed in the continental development framework Agenda 2063. As articulated in the AMV, 'a resource-based African industrialisation and development strategy must be rooted in the utilisation of Africa's significant resource assets to catalyse diversified industrial development'.[41] At the sub-regional level, this same ambition to promote value addition for job creation and industrialisation has been articulated in policy frameworks such as the Regional Indicative Strategic Development Plan, the SADC Mining Protocol and the SADC Regional Mining Vision. A joint statement by the AU Commission and other essential continental institutions at the November 2022 Africa Industrialisation Week reiterated this call, arguing that the mining sector requires 'a strategic shift from the traditional extraction and export of commodities to massive investments in productive transformation and industrialisation'.[42]

While these frameworks all highlight the potential contribution of mining to development in terms of value addition, industrialisation, growth and jobs, there is also a recognition that mining should be conducted in more environmentally and socially responsible ways. African communities and economies are highly reliant on functioning ecosystems for services that support agriculture, fisheries, the provision of timber and non-timber products, tourism industries and a range of other sectors and activities. Ensuring communities benefit from the region's mineral wealth is equally a priority. The AMV, therefore, works towards a 'sustainable and well-governed mining sector that effectively garners and deploys resource rents and that is safe, healthy, gender & ethnically inclusive, environmentally friendly, socially responsible and appreciated by surrounding communities'.[43]

Resource-led industrialisation: Barriers and enablers

A just energy transition must consider supply chain actors to ensure that the opportunities resulting from increased mining activity contribute to inclusive economic participation,

40 AU, *Africa Mining Vision* (Addis Ababa: AU, February 2009), v. .
41 AU, *Africa Mining Vision*, 3.
42 AU, "Joint Statement on the Africa Industrialization Week", Press Release, November 23, 2022.
43 AU, *Africa Mining Vision*,

especially in mining communities. If governed responsibly, the energy transition can accelerate economic diversification by building linkages to other important sectors of the economy, such as manufacturing.[44] However, the history of natural resource development on the African continent shows that possessing large natural reserves does not necessarily translate into improved human development outcomes. Instead, poor linkages with the broader economy have often led to the creation of 'enclave' economies where the mining sector contributes to improved macroeconomic indicators without creating meaningful long-term prosperity.[45]

A crucial policy lever for economic development in mining host countries is the local procurement of goods and services. Local procurement plays an essential role in creating economic opportunities for local firms in host countries by building their capacity and promoting inclusive economic growth. Many mineral-rich countries have, at one time or another along their development trajectory, put in place policies aimed at diversifying the economy by increasing the mining sector's use of locally available resources.[46] The current efforts to leverage heightened demand for and prices of Africa's critical minerals for greater local benefit are not without precedent. The AMV was developed and adopted amid a commodities supercycle that dramatically increased the prices of many of Africa's mineral resources and other commodities. This partly fuelled the ambitions articulated in the AMV to ensure that the region more effectively benefits from its resource wealth. Governments have various regulatory tools to encourage or even compel local value addition. In its more extreme forms, this may include outright bans on the export of unprocessed minerals, as implemented by Indonesia to promote local value addition of its vast tin resources. A range of tax and other regulatory incentives may also be employed. In Africa, several countries have revised mining and tax regulations over the past few decades to attempt to promote local value addition of mineral resources. This includes Botswana's efforts to develop a local diamond cutting, polishing and jewellery sector and bans issued by the DRC and Tanzania on the export of unprocessed mineral ores. However, the resurgence of local content policies in the just energy transition has been pronounced, given previous failed attempts at creating linkages between the mining sector and the broader economy. In recent years, there has been a proliferation of local content policies to promote local supply chain developments, with several countries having created institutions to guide their local content policy programmes. Local content policies have had mixed results, partly due to a failure to implement regulatory frameworks and initiatives on a practical policy level. Research shows that resource extraction multinationals and their first-stage suppliers often continue to operate almost solely with foreign second-stage suppliers, leaving many local companies at the lower end of the natural resource supply chain.[47] In short, while countries have introduced and enforced local content requirements for employment and skills

44 Mining Shared Value, *Local Mining Supply Chain Preparedness for the Green Transition* (Toronto: Mining Shared Value, 2022).

45 Mark Beare, "Five Key Linkages to Enable Resource-Led Growth", July 10, 2017.

46 Jane Korinek and Isabelle Ramdoo, "Local Content Policies in Mineral-Exporting Countries" (Trade Policy Paper 209, OECD, Paris, 2017).

47 John Page and Finn Tarp, "Mining for Change: How Can Natural Resources Support Inclusive Growth in Africa," (Policy Brief 4/20, UN University World Institute for Development Economics Research, Helsinki, 2020).

transfer, these procurement regulations have mostly failed to increase the participation of local firms in natural resource supply chains.

While countries have introduced and enforced local content requirements for employment and skills transfer, these procurement regulations have mostly failed to increase the participation of local firms in natural resource supply chains

A review of downstream value addition policies by the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development (IGF) notes that policies aimed at processing commodities in-country are often driven by political factors rather than an economic rationale.[48] The assessment notes plenty of examples where governments have implemented policies to move downstream processing activities that have resulted in costly and unproductive 'white elephant' projects, both in developed (eg, Australia) and developing countries (eg, Nigeria). Given the context and commodity specificities, resource-rich governments must take a selective approach regarding downstream policies rather than implementing blanket policies that affect all minerals. Factors highlighted by the analysis as central to the success of downstream value addition initiatives include the importance of having a guaranteed market demand, both domestically and internationally; the relevance of geographical location and good infrastructure; access to reliable and cost-effective energy; the need to have a competitive labour force; the importance of policy coherence and a sound business environment; the need to have monetary and macroeconomic stability; and proximity to raw materials.

Several country case studies (see p 26) conducted by the IGF on local content policies provide guidance on which policies have succeeded or failed.[49] It is essential to realise that local content policies are no panacea for resource-led development, and there is no simple template for successful policy formulation. Each country has different resource endowments, capacities in its labour force, infrastructure challenges and investment environments. For a country to benefit from its resources, a wide range of legislative and regulatory frameworks should be in place to mobilise both human and natural resources to promote inclusive development. Furthermore, the success of these policies is heavily dependent on the effectiveness of other policy areas, such as education, infrastructure, finance and innovation. Good governance is often regarded as a prerequisite, as

48 Nicolas Maennling and Perrine Toledano, *Local Content Policies in the Mining Sector: Fostering Downstream Linkages*, Report (Winnipeg: International Institute for Sustainable Development, 2018).

49 Intergovernmental Forum on Mining, Metals and Sustainable Development, "Local Content Expert Papers and Case Studies" (Intergovernmental Forum on Mining, Metals and Sustainable Development, 2018).

responsibility for these crucial issues is scattered across different government ministries and regulatory departments. This means there will have to be effective coordination and communication if policymakers are to succeed in linking natural resources to more comprehensive socio-economic development. While it is important to note that each country's challenges and objectives are unique, several central lessons are fundamental for policymakers.

- **Australia** has achieved high levels of development as a minerals-driven economy, thereby successfully avoiding the resource curse.
  - » While the Australian government did not target specific linkages, it set the framework for their development by encouraging the market process, supporting skills and innovation and continually adjusting local content policies to meet the challenges of a changing marketplace.
  - » The Australian case study demonstrates that developing capabilities and linkages requires a long-term approach and an overall business environment conducive to developing sustainable connections.

- **Chile** is the world's largest copper producer and its mining sector is a significant driver of its economy.
  - » Despite lacking formalised local content legislation, good governance and strategic foresight have enabled the country to develop durable linkages between the mining sector and the broader economy. Instead of requiring mining firms to meet specific local content targets, the Chilean government uses income from taxes and royalties to finance its more general socio-economic goals.
  - » An essential part of the country's mining policies is the continuous commitment to improving skills and fostering innovation to encourage diversification. The Chilean experience shows that a wide range of factors must be aligned successfully for sustainable growth.

- **Indonesia** is the world's largest exporter of nickel ore and tin and one of the largest copper and gold producers.
  - » To foster local value addition, the Indonesian government imposed an export ban, recently watered down due to private sector demands and falling revenues. The losses incurred during the export ban were exacerbated by falling commodity prices and economic downturns for regions dependent on copper and nickel extraction.
  - » The Indonesian case study illustrates the shortcomings of blanket regulations and emphasises the need to consider changing market dynamics before deciding on beneficiation policies.

- **South Africa** is the world's leading producer of gold and platinum. Its mining sector has been one of the primary drivers of the country's economy, attracting significant foreign investment and generating substantial employment opportunities for the local population.
  - » The South African government has used local content policies in the mining sector to create opportunities for equity and employment for historically disadvantaged groups. However, the new Mining Charter has raised significant concerns, given the lack of consultation related to its provisions and the fact that overly stringent rules on local ownership and employment will likely deter investment.
  - » South Africa's linkages are the product of the unique scale of the country's resources, which has allowed the private sector to develop a thriving upstream supplier sector that has expanded into other industries and overseas markets. The South African case study demonstrates that while regulation can help to enforce local content aims, local content policies that are overly complex can negatively impact market confidence and foreign investment.

- Due to an influx of diamond revenues, sound macroeconomic management and a fiscally responsible expenditure strategy, **Botswana** developed from one of the poorest countries at independence to middle-income status by the mid-1990s.
  - » Since the early 2000s, the government of Botswana has launched several diversification initiatives centred around diamond beneficiation to move beyond diamond extraction.
  - » To this end, the government negotiated a complex beneficiation agreement with De Beers to provide the necessary infrastructure for moving downstream. The case study of Botswana shows the importance of moving beyond extraction to developing successful beneficiation policies to help diversify the economy and promote inclusive private sector-led growth.

Country case studies

SADC critical mineral rationale

In developing a critical mineral rationale for the SADC region, it is important to ask what critical minerals are and what makes them critical. The raw materials (minerals and metals) that comprise the parts of clean energy technologies needed to transition to a low-carbon future are often called critical. While the term 'critical minerals' is the most commonly used phraseology, there is no universally agreed upon definition, and the term is often used synonymously with terms such as 'green minerals', 'strategic minerals', and 'transition minerals' (see Box 1 for a list of organisational uses of these terms). That being said, what makes a mineral 'critical' is context specific, ie, it depends on the extent to which different countries are endowed with unique mineral resources, the relative importance of certain minerals to economic security and geopolitical analyses of supply risks and market

volatility.[50] Taking this diverse set of relevant considerations into account is what informs the different mineral strategies of each country or region.

For example, certain countries and regions tend to define criticality in terms of the economic importance of minerals and their vulnerability to supply chain disruptions due to these mineral reserves' high geographic and processing concentration in a few countries. This view of criticality is assumed mainly by countries such as the US and the UK and regional bodies such as the EU. However, this is not the only way criticality is thought about. Another distinct, albeit related, definition of criticality is determined by the fact that these mineral reserves are abundant in specific countries eager to exploit their comparative advantage to secure a place in global supply chains. This qualified view of criticality is primarily adopted by countries such as China and Australia and is the definition most relevant to countries in the SADC region. It is important to note that these definitions of criticality tend to overlap, as the reasons for a particular mineral being placed on a country's critical minerals list change over time in line with more fundamental socio-economic and technological changes. The many aspects that inform criticality have been summarised into five dimensions, as shown in Table 3.[51]

TABLE 3 FACTORS AFFECTING CRITICALITY IN DIFFERENT COUNTRIES/REGIONS

Dimension	Factors to consider
Economic	• Economic security • Strategic or competitive advantage • Industrial development objectives • Social development goals • Infrastructure development needs
Supply chain	• Supplu risks and vulerability • Import dependency • Geographic concentration of production and processing (refinery) • Viability of substitutes and availability of secondary sources • Value chain opportunities
Technology	• Essential input to clean technologies • Required for low-carbon transition • Technological innovations and emerging mineral substitutes
Geopolitical	• National seciruty considerations • Risks of resource nationalism stockpiling • External shocks and geopolitical realignments
Geological	• Natural resouences endowment • Availability of reserves and producion capacit • Location and quality of ores, metal or mineral content and depletion rates

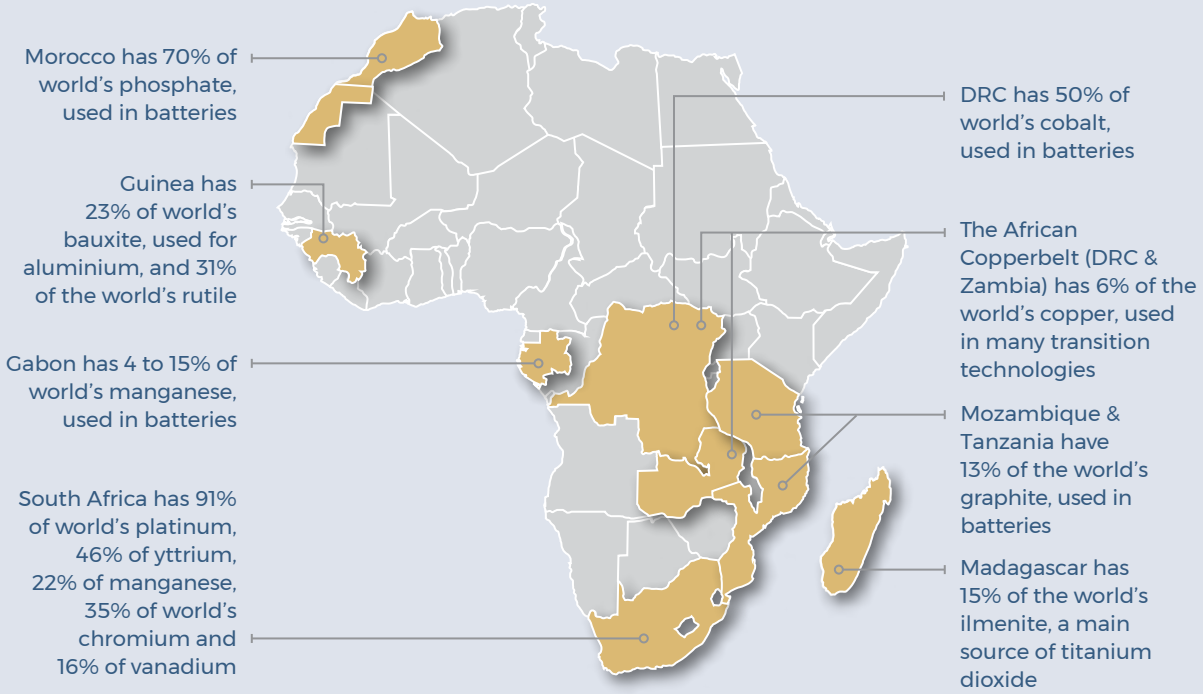
Source: Murtiani Hendriwardani and Isabelle Ramdoo, *Critical Minerals: A Primer*, Report (Intergovernmental Forum on Mining, Metals and Sustainable Development, 2022)

50 Murtiani Hendriwardani and Isabelle Ramdoo, *Critical Minerals: A Primer*, Report (Intergovernmental Forum on Mining, Metals and Sustainable Development, 2022).

51 Hendriwardani and Ramdoo, *Critical Minerals Primer*.

While there are clear parallels between the core lists of minerals across different countries and the African Green Mineral Strategy's critical mineral list, this analysis will focus on those deemed critical for the SADC region. While the continent has abundant critical mineral reserves, industrialisation has been limited, mainly due to a lack of investment in crucial enablers such as technology innovations and infrastructure. At present, minerals are exported in unprocessed form or, in certain instances, in concentrates for value addition somewhere beyond the region. Apart from South Africa, this failure to capture shares in global supply chains is due to the fact that the region lacks the capacity for processing operations, manufacturing and resource-based industrialisation. Therefore, the continent is likely to remain one of the major exporters of raw critical minerals unless investment can be scaled up in conjunction with a restructuring of governance policies on critical mineral development. There has also been a resurgence of resource nationalism in several countries in sub-Saharan Africa, mainly driven by high mining sector profits, a boom in battery mineral investments and precedents in other countries such as Indonesia. Considering these factors, the following case studies have been selected as potential leverage points for the SADC region.

Figure 1 African countries with large shares of critical minerals



Source: Papa Daouda Diene et al., *Triple Win: How Mining Can Benefit Africa's Citizens, Their Environment and the Energy Transition*, Research Report (New York: Natural Resource Governance Institute, 2022)

Apart from South Africa, this failure to capture shares in global supply chains is due to the fact that the region lacks the capacity for processing operations, manufacturing and resource-based industrialisation. Therefore, the continent is likely to remain one of the major exporters of raw critical minerals unless investment can be scaled up in conjunction with a restructuring of governance policies on critical mineral development

Copper in the DRC, South Africa and Zambia

Unlike the market for many other critical minerals, the copper market is comparatively less concentrated, given that the copper industry is well established. It also has several key actors that have been involved in the sector over an extended period.[52] Mines in South America, particularly in Chile and Peru, produce the most copper globally, while China dominates the market for the refinement of copper. Africa is also a strategic region for copper production and exploration, with key countries involved in the copper industry being the DRC, Zambia, South Africa and Namibia. For example, in 2021, the DRC and Zambia were the fourth- and seventh-largest copper producers, respectively. Together, the DRC and Zambia account for 52 000 000 tons of global copper reserves, which represent 6% of total global copper reserves.[53] Over the past two decades, Chinese control over copper-producing mines in Africa has grown substantially due to the ability of Chinese companies to assume greater risk than their competitors and subsequently revive production in high-quality copper deposits that had previously been abandoned. For example, Chinese companies control around 28% of copper in the DRC and Zambia.[54]

The IEA projects that, in a 'Sustainable Development Scenario', the demand for copper will more than double by 2040, presenting a significant opportunity for African countries to develop their copper supply chains to their benefit.[55] However, analysts are highlighting the copper supply deficit as a reminder that there is market inertia in responding to price signals, given the investment and time needed to bring new copper mines online.[56] For this reason, there can be periods of supply deficit and excess if new mining projects are not carefully coordinated with market demand. The potential danger of demand outstripping supply is compounded by more fundamental challenges facing the major South American producers, such as decreasing ore quality and high levels of water stress. In short, the potential supply-demand gap for copper is expected to be critical as the

52 Luc Leruth et al., "Green Energy Depends on Critical Minerals. Who Controls the Supply Chains?" (Working Paper 22-12, Peterson Institute for International Economics, Washington DC, 2022).
53 US Geological Survey, *Mineral Commodity Summaries 2022* (Virginia: US Geological Survey, 2022).
54 Adreoni and Roberts, "Geopolitics of Critical Minerals".
55 IEA, *The Role of Critical Minerals in Clean Energy Transitions* (Paris: IEA, 2022).
56 S&P Global, *The Future of Copper: Will the Looming Supply Gap Short-Circuit the Energy Transition?* (New York: S&P Global, 2022).

transition proceeds, unless substantial new supplies come online promptly. While adopting new emergent technologies – such as coarse particle recovery, sulphide leaching and process optimisation with machine learning – can address the supply gap, technological innovations will be insufficient to meet coming demand unless deployed in conjunction with new mine development.[57] Considering these challenges, copper is arguably the critical mineral of an industry in transition, where demand is accelerating, supplies are becoming scarcer and a successful energy transition depends on reducing the environmental impacts of mining and production.

In this context, the African Copperbelt region spanning the DRC and Zambia could become an even more significant source of global copper supply. Furthermore, the fact that the DRC and Zambia can process their ores to almost refined metal production is promising. A considerable amount of value-addition potential for copper-cobalt ore makes this an area for coordination in developing regional value chains.[58] Coordinated across an entire region, such as Southern Africa, regional bodies such as SADC and initiatives such as the African Continental Free Trade Area are essential in potentially developing regional hubs for critical mineral development. However, one key risk is tariff and non-tariff barriers, as well as the resurgence of resource nationalism.

Coordinated across an entire region, such as Southern Africa, regional bodies such as SADC and initiatives such as the African Continental Free Trade Area are essential in potentially developing regional hubs for critical mineral development

Lithium in the DRC, South Africa and Zimbabwe

Lithium production has been concentrated in Australia, Argentina, Chile and China, with other countries contributing a relatively minor share of global output. The DRC, Mali, Zimbabwe, Ghana and Namibia are the main countries representing Africa's lithium reserves and have a combined 4 380 000 tonnes in lithium reserves, which represents 5% of the global total.[59] Abundant lithium reserves occur primarily in four countries (DRC, Mali, Namibia and Zimbabwe), with Zimbabwe and Namibia already exploiting the metal deposits but exporting raw ore for processing in other countries. Although Zimbabwe has Africa's most extensive lithium resources, it remains a relatively insignificant lithium producer in global markets. Namibia is the only other African country, after Zimbabwe, that

57 McKinsey & Company, *Bridging the Copper Supply Gap* (New York: McKinsey & Company, 2023).
58 David Manley, Patrick Heller and William Davis, *No Time to Waste: Governing Cobalt Amidst the Energy Transition*, Report (New York: Natural Resource Governance Institute, 2022).
59 US Geological Survey, *Commodity Summaries 2022*.

has exported lithium mineral concentrate in recent years. While Namibia produced 500 metric tonnes of lithium in 2018 and 2019, this production stems largely from exploration companies, and the country does not have any further engagement in the battery supply chain beyond this stage.[60] While the DRC is currently only engaged in the exploration stage of the lithium supply chain, it does have some of Africa's largest lithium pegmatites, with the Manono deposit being the largest known deposit discovered to date.[61] However, the numbers around lithium production are likely to change in the future as there is an active effort by many countries to process lithium reserves themselves.

While Zimbabwe's extensive lithium deposits have yet to be fully exploited, several new mining projects at various supply chain stages could start production in the next few years in response to rising demand for lithium-ion batteries. At the time of writing, the Bikita mine in Zimbabwe is the only sizeable active lithium producer in Africa that is a fully established mining operation.[62] Despite its boasting significant lithium reserves and being the largest lithium producer in Africa, there is limited engagement in the battery supply chain beyond the mining stage, as most lithium ore is exported to other countries for processing.[63] In response, the Zimbabwean government has signalled its intentions to exploit these resources to advance its industrialisation programme by integrating the country into the global value chain of the lithium battery industry.[64] Historically, however, the management of the Zimbabwean mining sector has been characterised by corruption and lack of transparency.[65] Ensuring that lithium extraction benefits Zimbabwe's population will largely hinge on how the government tackles these long-standing governance problems. A recent report has highlighted the fact that there is inadequate information and disclosure on contractual conditions for lithium projects, an absence of a comprehensive critical mineral strategy and limited community public consultation on the potential environmental impacts of lithium mining projects in the country.[66] Also worth noting is the significant role played by Chinese companies in Zimbabwe's lithium mining sector. For example, the government has seen numerous mining deals in the lithium sector, primarily funded by Chinese companies eager to profit from the current lithium price boom.[67]

Given that Africa does not produce much lithium, African industries might start at the other end of the value chain by assembling battery packs from imported cells. South Africa already has some emerging involvement along the value chain in activities such as

60 African Natural Resources Management and Investment Centre and AfDB, *Lithium-Cobalt Analysis for Mineral Based Industrialisation in Africa* (Abidjan: AfDB, 2021).
61 African Natural Resources Management and Investment Centre and AfDB, *Lithium-Cobalt Analysis*.
62 African Natural Resources Management and Investment Centre and AfDB, *Lithium-Cobalt Analysis*.
63 Kathryn Goodenough, Eimear Deady and Richard Shaw, *Lithium Resources, and Their Potential to Support Battery Supply Chains, in Africa*, Report (London: British Geological Survey, 2021).
64 Charlie Mitchell, "Will Zimbabwe's Ban on Unprocessed Lithium Exports Advantage China?", *African Business*, January 17, 2023.
65 Church and Crawford, "Green Conflict Minerals".
66 Zimbabwe Environmental Law Association, *Implications of the Lithium Mining Rush in Zimbabwe: Analysis of Legal Developments* (Harare: Zimbabwe Environmental Law Association, 2023).
67 Wei Shen and Zhengyun Zhou, "Chinese Investments Amid the Energy Crises and Mineral Treasures in Zimbabwe" (Policy Brief 01, International Institute of Green Finance, Beijing, 2023).

assembling battery packs for mining equipment and refrigeration.[68] Furthermore, a recent report has identified the refining and processing stage as a significant supply chain where South Africa could deepen its engagement.[69] Most activities related to cell component manufacturing are currently taking place in South Africa, where local businesses have started to invest in the assembly and manufacturing of lithium-ion battery packs. Given the country's central role in the SADC region, there is potential for regional industrial integration of these industries related to lithium and other critical minerals.[70] While lithium processing presents several potential opportunities for countries in the region, there are also many risks. For example, the increased demand for lithium driven by soaring demands for battery technologies poses the risk that buyers further down the supply chain will acquire lithium reserves irrespective of the governance record of countries such as Zimbabwe.[71] Furthermore, mining lithium deposits requires exceptionally high water consumption levels and carries high contamination risks. Lithium mining in countries such as Namibia could exacerbate increasingly frequent droughts.[72]

While lithium processing presents several potential opportunities for countries in the region, there are also many risks. For example, the increased demand for lithium driven by soaring demands for battery technologies poses the risk that buyers further down the supply chain will acquire lithium reserves irrespective of the governance record of countries such as Zimbabwe

Cobalt in the DRC and Zambia

Cobalt production in both Zambia and the DRC is mainly realised as a by-product of the major copper mines, with several smelters processing concentrates, which are then sold on global markets.[73] The global cobalt market involves relatively few countries and is dominated by the DRC, which has cobalt reserves amounting to 3 500 000 tons and that constitute 46% of the world share.[74] Altogether, Africa is responsible for 3 660 000 tons of global cobalt reserves, representing 48% of the world's total. The IEA predicts that, based on existing policies, global demand for cobalt will increase six-fold by 2040, but in the

68 Edem Foli, "SADC e-Mobility Outlook: Accelerating the Battery Manufacturing Value Chain" (Occasional Paper No. 316, South African Institute of International Affairs, Johannesburg, 2020).
69 Gaylor Montmasson-Clair, Lesego Moshikaro and Lerato Monaisa, "Opportunities to Develop the Lithium-Ion Battery Value Chain in South Africa" (Policy Brief, Trade and Industrial Policy Strategies, Pretoria, 2021).
70 Adreoni and Roberts, "Geopolitics of Critical Minerals".
71 Church and Crawford, "Green Conflict Minerals".
72 Diene et al., "Triple Win".
73 Manley, Heller and Davis, "Cobalt Amidst the Transition".
74 US Geological Survey, "Commodity Summaries 2022".

'Sustainable Development Scenario' a more than 20-fold increase will be required.[75] In this context, it is evident that Congolese cobalt will be crucial in the energy transition. However, given the various risks associated with cobalt supply chains, innovations are currently being undertaken to reduce the battery sector's dependence on cobalt by replacing it with a suitable substitute, such as nickel. Depending on how battery chemistries evolve in response to technological innovations and supply chain risks, cobalt markets will likely be subject to continued volatility for the foreseeable future.[76]

The UN Economic Commission for Africa has identified several opportunities to develop regional value chains that cut across Central Africa into East and Southern Africa for battery minerals and EVs. In November 2021, the results of a Bloomberg study to determine the cost of producing lithium-ion battery precursors in the DRC demonstrated that the country could play a viable role in the lithium-ion battery supply chain.[77] Since then, Zambia and the DRC have signed a cooperation agreement to facilitate the development of an integrated value chain in the electric battery and clean energy sector.[78] The cooperation agreement is expected to provide a framework for bilateral cooperation on the initiative to develop the battery value chain and strengthen collaboration between Zambia and the DRC. At a regional level, mining countries could coordinate to create even more scale for suppliers. A robust regional supply chain could be as follows: the DRC and Zimbabwe provide the essential battery minerals, while South Africa uses those materials to manufacture batteries. However, regionalisation will benefit some countries more than others, creating new regional tensions over who benefits from these programmes. As a failed attempt to establish a regional coltan refinery in South Africa demonstrated, regional bodies such as SADC must find a way to share the profits of increased industrial activity and the more comprehensive economic benefits with supplier countries.[79] The proposed SADC Regional Mining Vision suggests mechanisms to coordinate and redistribute benefits across countries to encourage cooperation.

Despite the potential the DRC's resource wealth holds for its economy, the country's history of weak governance and widespread corruption poses an ongoing risk to the responsible extraction of resources. In addition, the DRC's already poor resource governance scores have been on a downward trend in recent years, demonstrating limited established practices in place for its resources.[80] For example, the cobalt industry in the DRC has been mired in corruption, money laundering, tax evasion and bribery allegations for many years. Cobalt mining in the DRC has also been shown to have a serious impact on the surrounding environment and local communities.[81] While the full extent of environmental damage is

75 IEA, "The Role of Critical Minerals".
76 Deloitte, *Africa's Role in a Clean Energy Future* (Johannesburg: Deloitte, 2022).
77 UN Economic Commission for Africa, *The Cost of Producing Battery Precursors in the DRC* (Addis Ababa: UNECA, 2021).
78 UNECA, "Trade Ties: Zambia and DRC Sign Cooperation Agreement to Manufacture Electric Batteries, Create Jobs", *Africa Renewal*, May 9, 2022.
79 Diene et al., "Triple Win".
80 Church and Crawford, "Green Conflict Minerals".
81 Rights and Accountability in Development, *The Road to Ruin? Electric Vehicles and Workers' Rights Abuses at DR Congo's Industrial Cobalt Mines* (Oxford: Rights and Accountability in Development, 2021).

unknown, the border between Zambia and the DRC, known as the African Copperbelt, is one of the most polluted areas in the world due to the discharge of pollutants from mines.[82] The human rights impact of cobalt mining is found in the terrible working conditions in the formal and artisanal mining sectors.[83] Due to a lack of formal oversight and appropriate governance measures, artisanal miners are forced to work in unsafe conditions without proper equipment. They are subject to the constant risk of caves collapsing in on them. Moreover, the impact of mining these critical minerals could worsen substantially as the surge in demand for metals could encourage more mining activity in environmentally sensitive areas.[84]

Graphite in Mozambique

Graphite is essential in lithium-ion batteries in EVs and energy storage technologies. While China still overwhelmingly dominates the global production of graphite, Mozambique and Madagascar are among the top five graphite producers globally. Madagascar (8.1%), Mozambique (7.8%) and Tanzania (5.6%) combined are responsible for over one-fifth of global reserves, slightly short of China's share of global reserves (22.8%). Mozambique, Madagascar and Tanzania have a combined 69 000 000 tonnes in graphite reserves and represent the major African countries in the global graphite supply chain.[85] Significant deposits are also found in Namibia and Madagascar. According to the IEA's 'Sustainable Development Scenario', the demand for graphite is expected to increase significantly, meaning that African graphite will most likely play an essential role in meeting the mineral demand for the energy transition.[86] Nearly half of the graphite projects in Mozambique or Madagascar are either in an advanced development phase or already in production with the potential to supply global markets in the medium to long term. For example, the Balama Graphite Project in northern Mozambique is reportedly the world's largest graphite deposit, with an expected production life of nearly 50 years.[87] While representing a comparatively smaller share of global graphite production markets than China, the deposits in Mozambique have the advantage of a grade quality suitable for producing lithium-ion batteries.[88]

In recent years, high graphite prices and the need to diversify away from China have led to several new projects being developed in Mozambique, Madagascar and Tanzania. In this regard, producer countries in Africa, the EU and the US are uniquely positioned to combine their capital, knowledge and mineral reserves to set up a supply chain that meets environmental standards while securing the required graphite supplies for the

82 Nicholas Niarchos, "The Dark Side of Congo's Cobalt Rush", *The New Yorker*, May 31, 2021.
83 Dorothée Baumann-Pauly, "Why Cobalt Mining in the DRC Needs Urgent Attention", Council on Foreign Relations, October 29, 2020.
84 Diene et al., "Triple Win".
85 US Geological Survey, "Commodity Summaries 2022".
86 IEA, "The Role of Critical Minerals".
87 Adreoni and Roberts, "Geopolitics of Critical Minerals".
88 Deloitte, "Africa's Role".

energy transition.[89] The past few years have also witnessed new transnational corporations' direct or indirect entrance. For example, the Australian mining company Syrah Resources recently signed an agreement with US EV manufacturer Tesla to supply graphite from its Balama mine in Mozambique.[90] Graphite from the Balama mine will be exported to a new facility in the US (partially funded by a loan from the US Department of Energy), where the concentrate will be processed into refined material for EV batteries. It represents not only an attempt by Tesla to expand its manufacturing capacity but also a geopolitical attempt by the US to build its domestic capacity and reduce its dependence on China. In short, this sophisticated supply chain is an example of the growing importance of the critical minerals industry and its role in the energy transition.

The graphite supply chain's value-addition phases primarily occur outside the African continent.[91] At present, graphite concentrate is shipped overseas, typically to China, leaving Africa at the end of the mining phase of the graphite supply chain. While pockets of technological capability and productive opportunities exist in South Africa, the supply chain is still emerging and remains disarticulated with different capacity levels along the supply chain.[92] Outside of South Africa, domestic processing capacity in the supply chain is limited to some extraction and concentrate processing, with high-value downstream activities such as battery manufacturing almost non-existent. If Africa engages in the processing stage of the graphite supply chain, regional cooperation will be needed to ensure that the supply chain is viable. To this end, Africa needs to invest significantly in its graphite processing capacity to capitalise on the opportunities created by potential supply disruptions and bottlenecks formed by the geographic concentration of graphite processing.[93] One area of concern is Mozambique's descent into civil war, which has seen the government and SADC forces attempting to neutralise a violent insurgency conducted by terrorist groups associated with al-Qaeda in Mozambique's mineral-rich Cabo Delgado province.[94] Cabo Delgado is home to some of Mozambique's most valuable mineral deposits, including graphite, and while production has largely continued, there have been security interruptions. In short, the future of Mozambique's graphite mining industry depends on how the security situation develops in the region.

Manganese in South Africa

Manganese is crucial for many green technologies, such as solar power, EVs and energy storage. Over 60% of global mine production for Manganese occurs in Africa, with several countries hosting manganese reserves. South Africa is the world's largest producer of

89 Irina Patrahau, Michel Rademaker and Amrish Ritoe, *Graphite: Supply Chain Challenges and Recommendations for a Critical Mineral*, Report (The Hague: The Hague Centre for Strategic Studies, 2022).
90 David Thomas, "Mission Critical: How African can Profit From its Minerals Boom", *African Business*, January 25, 2023.
91 Eimear Deady and Clive Mitchell, *Graphite Resources, and Their Potential to Support Battery Supply Chains, in Africa*, Report (London: British Geological Survey, 2021).
92 Adreoni and Roberts, "Geopolitics of Critical Minerals".
93 Tariye Gbadegesin, "Li-ion in Zion: Africa Must Assume its Place in the Global Battery Race", *The Africa Report*, January 7, 2020.
94 Cullen Hendrix, "Building Downstream Capacity for Critical Minerals in Africa" (Policy Brief 22-16, Peterson Institute for International Economics, Washington DC, 2022).

manganese, and Gabon, Ghana and Côte d'Ivoire have a combined total of 714 000 000 tonnes in manganese reserves, which constitute 47.6% of global reserves.[95] The IEA projects that the demand for manganese will increase three-fold by 2040 based on existing policies, but will need to increase more than eight-fold in a 'Sustainable Development Scenario'. In this context, African manganese will be essential to meet the coming demand.[96] While Africa has an abundance of critical minerals such as manganese, the continent does not have the capacity for processing operations due to a lack of investment in the infrastructure needed to drive industrialisation. As a result, minerals are exported in their raw form or, at best, in the form of concentrates for value addition somewhere beyond the continent. This is especially true in the case of manganese, where the mineral is primarily sourced in Africa, only to be exported to China for further processing.[97]

Limited mineral beneficiation initiatives are taking place in the SADC region, as most of the minerals mined in the region are exported to Europe, Asia and North America for beneficiation into battery-grade material.[98] South Africa's manganese producers generally process a part of manganese ore into ferromanganese before exporting to steel manufacturers.[99] Battery-grade material is a high-purity product that is a precursor in making the battery materials needed to produce cell components. Nevertheless, the global energy transition will present resource-rich African countries with an opportunity to boost economic growth and employment by playing a more significant role in mining and processing critical minerals such as manganese. Within this context, the AfDB and its partners are seeking to develop an African Green Minerals Strategy that will address several challenges, including improving the investment environment, strengthening institutions and encouraging policy and regulatory reforms.[100] While manganese mining has been subject to fewer controversies than other critical minerals, challenges remain concerning governance, environmental protections and community relations.

Nickel in Madagascar, South Africa and Tanzania

Indonesia is the world's leading nickel producer, with the Philippines and Russia at second and third, respectively. Like copper, nickel is a well-established mining industry with a few major players that have a long history. However, the global nickel landscape could change, as several nickel exploration projects are underway, especially in Africa. Currently, South Africa (1.8%) and Madagascar (1.4%) are the only African countries that account for more than 1% of global nickel production.[101] As of 2020, Africa accounts for 4.1% of global production and produces 2 136 000 tons of nickel, with South Africa, Madagascar,

95 US Geological Survey, "Commodity Summaries 2022".
96 IEA, "The Role of Critical Minerals".
97 Hendriwardani and Ramdoo, "Critical Minerals Primer".
98 Foli, "SADC e-Mobility Outlook".
99 Government of the US, USAID, *Mining and the Green Energy Transition: Review of International Development Challenges and Opportunities* (Washington DC: USAID, 2021).
100 AfDB, "Introducing the Green Minerals Partners: Mining Indaba Session Reveals Africa's Plan to Cash In on Battery and Electric Mineral Market", June 2, 2022.
101 US Geological Survey, "Commodity Summaries 2022".

Zimbabwe, Botswana and Zambia being its most prominent producers.[102] Most of Africa's nickel mining occurs in Zimbabwe and South Africa, where nickel is mined as a by-product of platinum-group metals. Madagascar's nickel exports are still relatively modest despite its being home to the Ambatovy Project, one of the world's largest nickel mines and refineries.[103] The boom in nickel battery demand and the corresponding price increase have renewed interest in the sector. With battery-grade nickel remaining in deficit, Africa's wealth of nickel deposits will position the continent to take advantage of an upswing in prices in the coming years, with South Africa and Tanzania set to benefit the most.

South Africa benefits from being the most industrialised economy in the SADC region and having the largest installed non-hydroelectric renewables capacity base. In addition, South Africa's substantial potential for green hydrogen production could result in a more sustainable nickel sulphide smelting process. In short, the country's lower mining risk in comparison to that of other countries in the region means it is well positioned to provide downstream processing for battery-grade nickel. Production at the Thakadu nickel sulphate refinery in South Africa introduces Africa to value-addition processing activities.[104] The Thakadu Nickel Sulphate Project forms part of South Africa's Black Industrialists Programme and is a pure nickel sulphate plant aimed at producing battery-grade material for the export market.[105] Another project worth highlighting in the SADC region is the Kabanga Nickel Project.[106] The mining company is accelerating its work on the deposits in Tanzania and plans to begin production in 2025 to coincide with a predicted inflexion point in EV manufacturing.

Rare earth elements in South Africa and Tanzania

REEs are widely used in clean technologies and are indispensable to the clean energy transition. REEs do not have many readily available substitutes in most of their applications, with their core application being permanent magnets used in EV motors and wind turbines. Neodymium, dysprosium and terbium are the essential elements applied in magnets. The two African countries with the largest REE reserves are Tanzania and South Africa, with the two countries accounting for 890 000 tons and 790 000 tons, respectively.[107] While significant reserves have been discovered in South Africa and Tanzania, there are also existing mining projects that have found REEs in countries such as Burundi, Madagascar, Mozambique, Namibia and Zambia. Unfortunately, Africa's full REEs potential is mainly unknown, given the comparatively low levels of exploration.[108] This reality highlights the need to scale up exploration efforts to enable Africa to quantify these minerals accurately.

102 Fitch Solutions, "Africa Nickel Developments: Opportunities and Risks for Participation in the Battery Revolution", April 12, 2021.
103 Hendrix, "Building Downstream Capacity".
104 Fitch Solutions, "Africa Nickel Developments".
105 Foli, "SADC e-Mobility Outlook".
106 Fitch Solutions, "Africa Nickel Developments".
107 US Geological Survey, "Commodity Summaries 2022".
108 Gracelin Baskaran, "Could Africa Replace China as the World's Source of Rare Earth Elements?", Brookings Institute, December 29, 2022.

One noteworthy example is South Africa's Steenkampskraal Mine, which has one of the highest grades of REEs in the world with large deposits of neodymium and praseodymium.[109] Given the continent's relatively low level of exploration, these deposits are not insignificant. They could allow South Africa to become an essential supplier to world markets. Similar to some other minerals discussed above, China has considerable control over both the reserves and production of crucial REEs. It also controls most of the supply chain, which means that any country interested in processing goods that require REEs will most likely have to import REEs from China or depend on China during some stage of the supply chain.[110] While there are few significant REE operations outside of China, many countries that plan to expand EV use seek to diversify their REE supply chains away from China.

A complex and potentially environmentally harmful process of concentration, separation and refining of individual elements is the most sensitive part of the value chain. Hence, without activating a regional economic strategy within regional blocs such as SADC, African countries are likely to continue exporting these ores without benefiting from local processing

Given this context, there is a real opportunity for certain African countries to help build secure supply chains for REEs, such as neodymium, which has no readily available substitute and a long list of industry applications.[111] However, the extraction and value addition process is typically challenging to accomplish within a single country, given the prohibitive costs of REE separation facilities. Extraction from primary ore deposits accounts for most REE production. A complex and potentially environmentally harmful process of concentration, separation and refining of individual elements is the most sensitive part of the value chain. Hence, without activating a regional economic strategy within regional blocs such as SADC, African countries are likely to continue exporting these ores without benefiting from local processing. Making this vision a reality requires considerable focus on the part of African governments and mining companies and improved coordination between the public and private sectors. Development finance institutions such as the AfDB need to explore these capacity inadequacies and work with countries and mining companies to support the development of REE value chains where appropriate.[112]

109 Keerthana Nambiar, "China's Scramble for Africa's Rare Earth Elements", Observer Research Foundation, September 1, 2022.
110 Leruth et al., "Green Energy Depends on Supply Chains".
111 John Pham, "Africa's Real Strategic Import for the Green Economy", Atlantic Council, March 29, 2021.
112 African Natural Resources Management and Investment Centre and AfDB, *Rare Earth Elements (REE) Value Chain Analysis for Mineral Based Industrialisation in Africa* (Abidjan: AfDB, 2021).

CHAPTER 3

Conclusion

In concluding this comprehensive exploration of the SADC critical minerals ecosystems and their intricate intersections with the global energy transition, it becomes strikingly clear that the choices made today will shape the destiny of the region for generations to come. Our research underscores the urgency and complexity of the challenges faced by SADC countries as they seek to harness their critical mineral wealth for sustainable development, economic wellbeing and environmental responsibility. The findings resonate with both promise and peril, highlighting the need for a strategic and balanced approach that safeguards the interests of the region's present and future.

The research spotlights implications that are both transformativeand cautionary. On the one hand, the demand for critical minerals is set to surge exponentially with the global energy transition, offering SADC countries an unprecedented window of opportunity to capitalise on their resource wealth. The successful leveraging of these resources can catalyse economic diversification, technology transfer and the emergence of a vibrant green industry. However, the pitfalls of history loom large: a lack of robust governance frameworks could amplify social inequalities, damage fragile ecosystems and perpetuate the resource curse, further marginalising the vulnerable and impeding long-term progress.

In light of these implications, the policy landscape unfolds as a mosaic of possibilities. Countries could opt for blanket local content policies to stimulate downstream value addition, but the track record of such approaches is mixed. There is also the potential for pursuing specialised local content regulations that consider each mineral's unique context, market dynamics and value chain. An alternative could involve embracing strategic partnerships that promote responsible mining practices, value addition and equitable wealth distribution. However, the examples of policy failures, where political motivations overshadow economic rationale, warn against simplistic solutions.

Building upon these implications, this report culminates in a series of transformative recommendations that form a roadmap for SADC's critical minerals ecosystem in the context of the global energy transition. These recommendations are underpinned by empirical evidence, grounded in international best practices and tailored to the unique needs of the region.

- **Strategic regional value chain development**: SADC countries should adopt a systemic approach to critical mineral value chains that considers not only extraction but also processing, manufacturing and an advanced version of the circular economy. By fostering strategic partnerships with both local and international actors, SADC nations can create a synergy between mineral wealth and industrial development.
- **Robust governance frameworks**: Policymakers must prioritise comprehensive governance frameworks that ensure transparency, accountability and environmental stewardship in critical mineral extraction. The establishment of independent regulatory bodies and adherence to international standards, such as the EITI and the OECD Due Diligence Guidance, will be pivotal in upholding these principles.
- **Tailored local content policies**: Local content policies should be crafted with precision, accounting for specific mineral contexts, market dynamics and socio-economic conditions. Flexibility in policy design will prevent the missteps of one-size-fits-all regulations and foster inclusive economic participation.
- **Skills development and innovation**: Investing in human capital and technological innovation is crucial for sustainable value addition. Governments should collaborate with educational institutions and the private sector to equip local populations with the skills needed for the renewable energy industry.
- **Responsible partnerships**: Forming strategic partnerships with global stakeholders, such as the US, Europe and China, can facilitate technology transfer, knowledge sharing and responsible mining practices. These collaborations can bolster the credibility of SADC's critical regional mineral supply chains.
- **Ecosystem preservation and stewardship**: SADC countries should prioritise ecosystem preservation and environmental stewardship alongside mineral extraction. Implementing stringent environmental regulations, promoting reforestation and investing in sustainable mining technologies will mitigate negative ecological impacts.
- **Stakeholder engagement**: Engaging local communities, civil society and Indigenous groups in decision-making processes is paramount. A consultative approach will ensure that the benefits of mineral extraction are equitably distributed and that social grievances are addressed proactively.

In conclusion, the path ahead for SADC's critical minerals ecosystem is both challenging and promising. The policy choices made today will reverberate across time, shaping the region's role in the global energy transition and its journey towards sustainable development. Our recommendations, firmly rooted in robust research and global best practices, offer a compass to navigate this complex landscape. By embracing a multi-dimensional approach that balances economic wellbeing, environmental preservation and social equity, SADC countries can forge a new paradigm that transforms their critical mineral wealth into a catalyst for inclusive prosperity. The journey is arduous, but the destination is one of immense potential. The time for action is now.

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