Special Report 3

FUTURES: CRITICAL MINERALS

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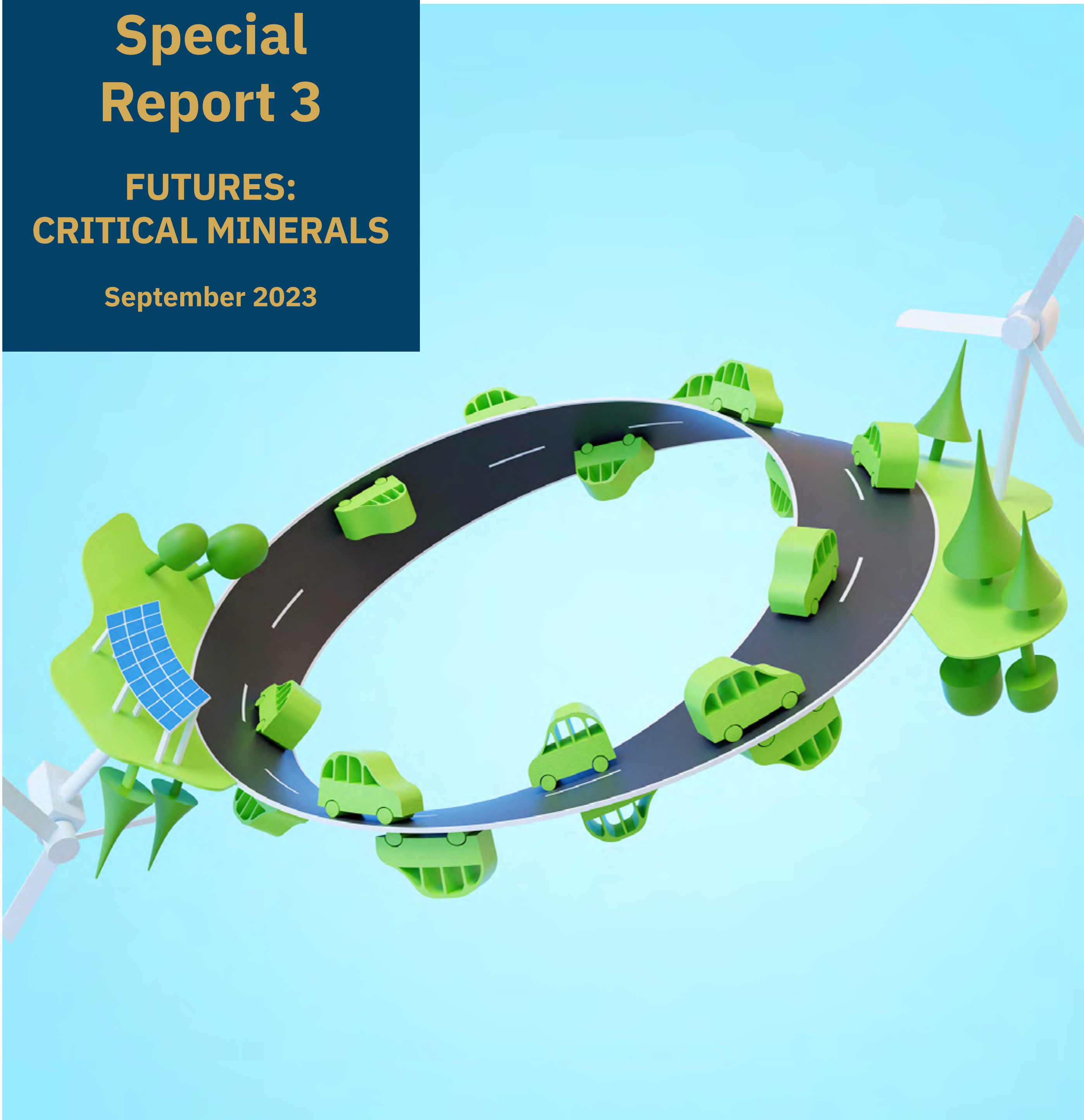

Re-imagining the Critical Minerals Ecosystem in SADC
Building Anticipatory Governance

DEON CLOETE, LETITIA JENTEL, NDEAPO WOLF, LITHA MZINYATHI, ALEX BENKENSTEIN & ADRIAN JOSEPH

African perspectives
Global insights

SOUTH AFRICAN INSTITUTE OF INTERNATIONAL AFFAIRS

Executive summary

In an era defined by transformative shifts in global markets, energy systems and industrial production, the need for a fundamental re-evaluation of our approach to critical minerals has become pressing. With the transition away from fossil fuels in the linear economy, there is a growing urgency to understand the complex landscape of critical minerals, particularly in Southern Africa.

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

The report delves into the imperative of re-imagining the critical minerals ecosystem, exploring its futures from a critical futures studies perspective and the implications for regional development, sustainability and economic progress.

Southern Africa plays a pivotal role in the post-oil global landscape due to its vast mineral deposits. This report scrutinises the intricate challenges posed by the unprecedented demand for critical minerals for the green energy transition and proposes strategies that can address both local and global dynamics. Key questions are addressed, including the practical limitations of the green transition, restructuring of resource trade agreements, attracting foreign direct investment, leveraging critical minerals for sustainable economic models and the role of anticipatory governance.

The report highlights the multi-faceted relationship between economic wellbeing, energy flows and complexity, underscoring the link between a stable global industrial system and resource availability. It advocates transitioning to non-fossil fuel systems while recognising the challenges related to infrastructure and technology readiness. The report critiques prevailing paradigms, shedding light on the shortcomings of an approach that relies solely on technology and the circular economy.

Amid environmental degradation and economic model limitations, the report introduces the new paradigm of the resource-balanced economy (RBE) for the SADC region. The

RBE envisions a symbiotic connection between industrial activity, resource consumption and ecological realities, aiming for a balance that integrates sustainable energy systems, responsible raw material sourcing and a societal contract embracing sustainability and human rights.

With current economic systems reinforcing inequities, the report emphasises the urgency of revisiting resource trade agreements and investment risks, opening a path for more inclusive and equitable development. The conclusions advocate for alternative economic models emphasising inclusivity and environmental sustainability, requiring collaborative efforts across sectors. The report introduces an array of strategies, including adopting an RBE, exploring new financial innovations, fostering bioregionalism and re-localisation, pioneering a new social contract and implementing anticipatory governance.

The report challenges conventional thinking, urging Southern African nations to choose between perpetuating outdated economic models or embracing innovative pathways for sustainable and resilient development. By examining limitations in current paradigms and proposing alternative strategies, it paves the way for policy, industry and societal decisions, guiding the region toward an RBE and anticipatory governance for the green energy transition.

Abbreviations & acronyms

AMDC	African Minerals Development Centre
AMV	African Mining Vision
AU	African Union
EU	European Union
GDP	gross domestic product
RBE	resource-balanced economy
SADC	Southern African Development Community
SAIIA	South African Institute of International Affairs
STEEP-V	social, technological, economic, environmental, political, and values
UK	United Kingdom
UN	United Nations
US	United States
VUCA	volatile, uncertain, complex and ambiguous
4IR	Fourth Industrial Revolution

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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.

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CHAPTER 1

Overview and background

In an era marked by seismic shifts in global economic markets, industrial production and energy systems, the need for a comprehensive and urgent rethinking of our approach to critical minerals has become paramount. The pervasive reliance on fossil fuels in the linear economy[1] has encountered formidable challenges, as evidenced by declining oil fields and uncertainties surrounding future energy sources.[2] The repercussions of this transition are manifold, not least of which being an unprecedented demand for critical minerals and the complexities associated with primary resource extraction.

Amid these circumstances, this special report explores the imperative of re-imagining the critical minerals ecosystem from a critical futures studies perspective, particularly in the context of Southern Africa. In addition, it examines the futures of critical minerals and the implications for regional development, sustainability and economic progress.

As the region hosts significant deposits of vital minerals, it assumes a pivotal role in shaping the trajectory of the global post-oil era. The report delves into the complexities surrounding this issue and proposes strategies that address both local and global dynamics, laying the groundwork for a more inclusive and equitable future.

The analysis undertaken in this report seeks to address these key questions:

- What are the practical limitations of the proposed green transition, and what alternative pathways are necessary to surmount the challenges that lie ahead?
- How does the complex adaptive systems framework shed light on the behaviour of the global industrial system, particularly in relation to energy, interconnectedness and the mining of critical raw materials?
- How can Southern African countries restructure natural resource trade agreements to ensure sustainable development and broader economic benefits?
- What strategies can be adopted to attract foreign direct investment while minimising investment risks?

1 A conventional linear economy adheres to the sequential approach of "extract-produce-dispose". In this process, raw materials are gathered and converted into goods that have a lifespan until they are eventually jettisoned as refuse. The generation of value within this economic framework is achieved by maximising the production and sale of numerous products. Neeta Baporikar, ed., *Handbook of Research on Entrepreneurship Development and Opportunities in Circular Economy* (Hershey: IGI Global, 2020), 23.

2 Michael Bradshaw, Thijs van de Graaf and Richard Connolly, "Preparing for the New Oil Order? Saudi Arabia and Russia", *Energy Strategy Reviews* 26 (November 1, 2019).Poland, made clear the divisions between the winners and losers of a low-carbon energy transition.

- How can the region leverage its critical mineral resources to transition toward a more inclusive and ecologically sustainable economic model?
- What role does anticipatory governance play in reshaping the critical minerals ecosystem and ensuring a just and prosperous future for Southern Africa?

The analysis in this report underscores the intricate interplay between economic wellbeing, complexity and energy flows, elucidating the undeniable connection between a stable global industrial system and the availability of resources, especially energy and minerals. It highlights the urgency of transitioning to non-fossil fuel systems while acknowledging the significant hurdles presented by the unprecedented demand for minerals, coupled with the lag in infrastructure and technology readiness.

Furthermore, the report examines the fault lines within prevailing paradigms, particularly the assumptions that technology alone will sustain the green transition and that the circular economy, in its conventional form, is a comprehensive solution. It critiques the inadequacies of these approaches in addressing the energy and raw material requirements of a post-fossil fuel industrial system.

With the degradation of the environment, the depletion of renewable resources, and the limitations of existing economic models, the report's analysis positions the concept of a resource-balanced economy (RBE) as a potential paradigm shift for the SADC region. The RBE envisions a systemic and symbiotic relationship between industrial activity, resource consumption and ecological realities. It strives for an equilibrium that incorporates new energy systems, responsible raw material sourcing and an evolved societal contract that encompasses sustainability and human rights.

The global economic and financial systems, underpinned by an exponential growth paradigm, continue to shape the trajectory of development. However, this paradigm often perpetuates inequities, especially in regions rich in natural resources. African nations, including those in Southern Africa, have encountered challenges in harnessing the benefits of their abundant resources due to historical trade agreements that prioritise short-term gains over long-term public well-being. This report underscores the pressing need for re-negotiating these agreements to ensure sustainability goals are met and economic advantages are shared more broadly.

Furthermore, the report highlights the disparities in valuation models between more developed economies and African nations. Southern African countries often face elevated investment risks due to the application of Western financial models that neglect the local context. This imbalance can hinder foreign direct investment, exacerbating economic vulnerabilities. As the global economy grapples with interest rate hikes and currency fluctuations, African countries find themselves caught in a cycle of high-risk evaluations and limited access to global markets, thus perpetuating poverty and underdevelopment.

At the core of this issue lies the increased global demand for critical minerals essential for decarbonisation and technological advancements. This demand presents both an opportunity and a risk for Southern Africa. The region could either face financial capture within the prevailing economic systems or leverage its resources for innovative, sustainable and economically balanced development pathways. The report raises pertinent questions about how African leaders can navigate this dilemma and proposes alternative pathways such as building anticipatory governance systems to redefine their economic trajectories.

The conclusions drawn from this analysis underscore the need for a paradigm shift in economic thinking. The report identifies alternative models and economic systems that emphasise inclusivity, environmental sustainability and broader ownership of wealth. Such a shift requires collaborative efforts between the public and private sectors, as well as a reimagining of governance structures. The report suggests adopting an RBE, rethinking SADC financial innovations for critical minerals, fostering bioregionalism and re-localisation, pioneering a new social contract on mining in the region and adopting anticipatory governance. These strategies can reshape the critical minerals landscape, empower local communities and position Southern Africa for a sustainable and equitable future.

As the global landscape continues to evolve, Southern African countries stand at a crossroads, faced with a choice between adhering to outdated economic models or embracing innovative pathways toward resource-balanced and financially resilient economies. This report serves as a challenge to conventional thinking by proposing more complete alternative futures of critical minerals and mining for policymakers, stakeholders and the broader public to envision a more just and sustainable future for Southern Africa through the prism of critical minerals and anticipatory governance. Through thoughtful analysis and proactive recommendations, the report aims to inspire a new era of policy and institutional reforms that prioritise long-term thinking, intergenerational fairness, human well-being, environmental sustainability and economic progress.

In sum, the challenges of re-imagining the critical minerals ecosystem in Southern Africa are urgent and multifaceted. This special report engages with the complexities of this issue, aiming to provoke dialogue and innovative thinking about how the region can transition towards a resource-balanced economy and adopt anticipatory governance that is forward looking, sustainable, equitable and resilient. By exploring the limitations of existing paradigms and proposing alternative pathways, it offers a comprehensive framework to guide policy, industry and societal decisions as we navigate the uncharted waters of a post-oil era.

CHAPTER 2

Critical futures and critical minerals: Interrogating assumptions

The world is undergoing profound changes that affect economic markets, industrial production and energy systems. The fossil fuel-based linear economy has struggled to sustain growth in recent decades. Energy is a crucial resource that enables physical work, technological advancements and the functioning of modern cities. Our society heavily relies on petroleum and fossil fuels for essential industrial needs. The future outlook for oil as an energy source is uncertain, with most oil fields declining at a rate of 5–7% annually.[3] Transitioning to non-fossil fuel systems poses significant challenges, including the unprecedented demand for minerals and the risks associated with primary resource mining.

Given these circumstances, a comprehensive plan for the post-oil era is urgently needed globally and especially in Southern Africa, considering the large amounts of critical minerals deposits. We argue that the proposed green transition faces practical limitations, and alternative approaches are necessary to address the challenges ahead.

A complexity-informed understanding of the global industrial systems in transition

The functioning of our global system, operating as a complex adaptive system (CAS), depends on crucial hubs within their stable domains and the continuous flow of energy and resources to maintain its operations.[4] Korowicz suggests that this system exhibits self-organising behaviour, with regions that have localised dependencies merging into an integrated global system. These keystone hubs adapt to their co-evolving conditions, shaped by economic circumstances and energy productivity over the past century. However, when these conditions change, especially if economic growth declines, the hubs undergo critical transitions and simplify significantly. The CAS framing can enable greater understanding of the global and regional industrial system's behaviour, linking global economic growth, complexity, interconnectedness, interdependence and the speed of industrial processes to available energy and capital, including the mining of critical raw materials.[5]

3 Simon P Michaux, "The Resource Balanced Economy to Meet the Twin Challenges of Phasing out Fossil Fuel Energy and Self-Sufficient Supply of Raw Materials" (BSR Policy Briefing 2/2023, Centrum Balticum Foundation, Turku, February 2023).

4 David Korowicz, "Trade-Off Financial System Supply-Chain Cross-Contagion: A Study in Global Systemic Collapse" (Metis Risk Consulting & Feasta, Cloughjordan, 2012).

5 David Korowicz, "Catastrophic Shocks Through Complex Socio-Economic Systems: A Pandemic Perspective", David Korowicz Human Systems Consulting, 2013.

> These keystone hubs adapt to their co-evolving conditions, shaped by economic circumstances and energy productivity. However, when these conditions change, the hubs undergo critical transitions and simplify significantly

Complexity has become a defining characteristic of the global industrial system. The technology that dominates global markets is a result of the intricate just-in-time supply system spanning six continents, operating at high complexity levels. The structure of the global economy has been undergoing significant but often overlooked changes, with increasing complexity relying on fossil fuel energy.[6] This holds true even if it lacks explicit indicators or representation in economic models. As our dependencies have grown more complex, we have become more susceptible to severe economic shocks and stresses. Despite all the best forecasting using state-of-the-art computational and mathematical modelling, the predictions cannot navigate surprises and the inherent uncertainty of the CAS. However, we tend to take these dependencies and the nature of embedded uncertainty for granted in thinking about the future and navigating complexity.[7]

The key parameter that drives this transformation is energy flow within the globalised economy. From a biological perspective, the amount of energy input into an organism determines its size and complexity.[8] If the organism receives less energy, it will shrink and become less complex. This fundamental concept can be applied to other descriptive models, such as industrial activity and the economic value derived from physical work. All economic activity adheres to the laws of thermodynamics, where low entropy energy (exergy) is transformed into higher entropy heat to perform work.[9] Complex adaptive systems can be viewed as open thermodynamic systems, sustained by energy and raw material flows between their structural components. Therefore, the energy flow, in its adaptive forms (such as food, fertilizer, light, heat, electricity or fossil fuels), is generally a determining factor for the system's stability.[10]

The magnitude of transitioning from fossil fuel-based systems to non-fossil fuel systems on an industrial scale, both globally and specifically in Southern Africa, is considerably greater than what is currently recognised or acknowledged. Achieving this goal would require an unprecedented demand for minerals, many of which have not been extensively

6 Korowicz, "Trade-Off Financial System Supply-Chain".
7 Korowicz, "Trade-Off Financial System Supply-Chain".
8 Rika Preiser, "Key Features of Complex Adaptive Systems and Practical Implications for Guiding Action" (CST Policy Briefing, Centre for Sustainability Transitions, Stellenbosch, 2018).
9 Simon P Michaux, *The Mining of Minerals and the Limits to Growth*, Report (Espoo: GTK Geological Survey of Finland, 2021).
10 Ludwig Von Bertalanffy, "The History General and Status of General Systems Theory", *The Academy of Management Journal* 15, no. 4 (1972): 407–26.

mined before, especially those essential for renewable energy transition. Additionally, most of the infrastructure and technology required to replace fossil fuels is yet to be manufactured.[11] The concept of recycling is not applicable to products that have not yet been manufactured. Within the existing system, demand for various types of metals is on the rise while the quality of ores being processed is decreasing.[12]

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Fault lines in the current and future green transition

One could contend that both the linear economy reliant on fossil fuels (in terms of energy resources) and the green transition (in establishing new energy sources) are encountering comparable challenges simultaneously. This can be attributed to the fact that the prevailing industrial business model paradigm has misconstrued the fundamental nature of the commodities industry at a time when the production of these commodities has become exceptionally expensive. From a systems and futures thinking standpoint, this observation highlights the underlying issue within the current industrial business model and the paradigm informing it. The paradigm at the core of the green transition incorporates the concept of decoupling, which assumes that technology can sever the connection between human lifestyles and their ecological impact.[13] However, there is currently not enough strong evidence to support this assumption, making it an unsustainable long-term proposition.

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11 Simon P Michaux, *Assessment of the Extra Capacity Required of Alternative Energy Electrical Power Systems to Completely Replace Fossil Fuels*, Report 42 (Espoo: Geological Survey of Finland, 2021).GTK Open File Work, Circular Economy Solutions KTR (Espoo, Finland: Geological Survey of Finland, 2021

12 Michaux, *The Mining of Minerals and the Limits to Growth*.

13 Rika Preiser, Laura M Pereira and Reinette Biggs, "Navigating Alternative Framings of Human-Environment Interactions: Variations on the Theme of 'Finding Nemo'", *Anthropocene* 20 (2017).

Michaux argues that, previously, the entire commodity sector was viewed as a market phenomenon rather than finite non-renewable natural resources with extraction engineering bottlenecks.[14] He asserts that technological development follows a two- to four-year cycle and seemed to assume that the supply of energy and raw materials would be determined solely by market prices. According to his assertion, the ability to create a market emerged once the necessary capital was obtained. Consequently, he argues that most technological advancements have overlooked the limitations imposed by energy and mineral resources. Technological advancements have primarily focused on improving technology itself, assuming that energy and raw materials supply will always be governed by market forces, which now are waking up to the uncertainty of supply as highlighted by the COVID-19 pandemic. Commodity industrial operations, such as mining, can take decades to develop. Innovation related to sourcing metals from mining has been relatively slow, requiring significant capital investment and resulting in incremental improvements. All of these fault lines are what Michaux calls energy and minerals blindness.[15]

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Consequently, he holds that all three sectors (fossil-based, green transition and commodities) are now facing challenges. There is a possibility that the peak of crude oil production has already been surpassed, and the existing form of the planned green transition may not be viable. The decline in the quality of mineral resources has been ongoing for several decades and acquiring greater access to these resources without relying on fossil fuel energy poses additional challenges across various sectors. Whatever unfolds in the future will be influenced by a novel set of constraints unlike any encountered by humanity before.

Another assumption following the ecomodernist and transhumanist paradigms is the hope that technology alone will provide a new energy system, and thereby disregards the fact that energy must come from somewhere. The success of the green transition heavily relies on the supply of metals from mining, at least for the next few decades. However, as explained, thermodynamics suggests that this approach will not be viable. Michaux asserts that energy efficiency applied to technology has inherent limitations and yields diminishing returns over time. He states that each change or improvement saves progressively less with

14 Michaux, "The Resource Balanced Economy".

15 Michaux, *The Mining of Minerals and the Limits to Growth*.

each iteration.[16] This indicates an immediate requirement for a completely new energy system and industrial paradigm to inform the mining-industrial complex.

In addition to these difficulties, human society is depleting renewable resources, such as ecosystem products, at a rate that surpasses our ability to replenish them. If we were to compare this situation to a mining operation, it would resemble an instance of extracting resources for immediate benefit without considering the long-term sustainability or practising responsible resource management. Consequently, any future planning should acknowledge the transformation occurring in the commodities sector and the need for a revolution in how it supports both society and industrial systems.

A fatal assumption under the current economic paradigm is that planning has focused on economics and technology development. However, the commodities sector encompasses minerals, economics, technology and energy. As Michaux convincingly argues, any genuine investigation considering physical actions in resource extraction must encompass all four aspects and acknowledge that natural resources are harvested from the planet.[17] Unfortunately, this recognition has been absent from the calculations of strategic planners for some time. Any future plan for industrial reform must incorporate this fundamental concept. To reinforce the argument, the current industrial system was originally built on the consumption of presumed infinite natural resources. The notion that there might be system-based limits to global resource extraction like planetary boundaries is considered foolish by the current economic market. Michaux argues that the issue lies not in the depletion of resources but in our industrial capacity to extract useful quantities of metals from these resources in an economically viable manner.[18]

The alternative proposed to the current economic paradigm is the circular economy. While the circular economy, in its current form, may not be practical, it could serve as a stepping stone to an alternative, more complete solution.

Shortcomings of the classical circular economy

The concept of the circular economy has emerged as a means of transforming society's approach to managing raw materials in a more sustainable manner.[19] It presents a systems framework that offers a set of principles aimed at shifting from the prevailing linear economy, characterised by resource extraction, manufacturing and waste disposal in landfills, towards a high-value industrial economy. This new approach emphasises waste prevention and employs waste management strategies such as the 3Rs (reduce, reuse and recycle) to keep products and materials in use for longer periods. The goal is to establish a more sustainable relationship with the environment. In theory, a successful circular

16 Michaux, *The Mining of Minerals and the Limits to Growth*.

17 Michaux, *The Mining of Minerals and the Limits to Growth*.

18 Michaux, *The Mining of Minerals and the Limits to Growth*.

19 World Economic Forum, "What Is the Circular Economy, and Why Does It Matter That It's Shrinking?", June 14, 2022.

economy would reduce the demand for new materials and significantly improve resource productivity across the value chain.

In an ideal circular economy scenario, all industrial waste would be collected and 100% of the various metals, minerals and materials in each waste stream would be recycled, leaving no final waste. However, as Michaux explains, this assumes that the mass and content of metals and materials sourced from recycled waste would match the mass of metals and materials required for manufacturing, aligning with consumption demand.[20] However, achieving this ideal scenario is currently hindered by existing practices. Recycling plants are typically optimised to recover one primary metal, and sometimes a polymetallic plant is constructed to target a few secondary metals at the expense of reduced recovery efficiency. The remaining material, which can constitute a significant portion (up to 95%) of the waste stream mass, is considered uneconomical to process and often ends up in landfills. Consequently, most of the recyclable material within the internal material flows still ends up as waste, resulting in the loss of a significant amount of metals and materials.

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Moreover, there are substantial logistical challenges in collecting all recyclable waste streams, partly due to the nature of each waste stream and insufficient community participation in recycling at the collection point. For an effective recovery process in a recycling plant, the feedstock should primarily consist of the same end-of-life waste product from which the plant is designed to extract a specific metal. Therefore, proper sorting of end-of-life waste products into appropriate streams is crucial, ensuring that each waste stream reaches the corresponding process plant. However, achieving this level of sorting has been logistically challenging, with only basic sorting achieved for some waste streams. Additionally, each process plant typically deals with highly variable feedstock based on its specific optimisation, resulting in lower recoveries compared to what could be achieved with more optimised feedstock.

Michaux's main critique, in addition to the shortcomings already outlined, is that the conventional form of the circular economy is not thermodynamically balanced.[21] However, it is important to note that the circular economy can be viewed as a stepping stone to further advancements. It is the most promising area of study for developing a true replacement for the current fossil fuel-based energy system.

20 Michaux, "The Resource Balanced Economy".
21 Michaux, "The Resource Balanced Economy".

Opening to alternative industrial ecosystems

Society's annual consumption of mineral resources continues to increase, but there is a lack of awareness regarding our dependence on minerals for the functioning of various sectors. Although the recycling industry is gaining momentum, mainly in the Global North, it is still in its infant stages in Southern Africa and cannot single-handedly facilitate the transformation of the industrial ecosystem or the mining industrial complex. Therefore, alongside a fully developed recycling network, mining will necessarily take place at an unprecedented scale to meet the demands of constructing a post-fossil fuel industrial system.

The availability of critical minerals may become an issue due to the increasing cost of extracting metals resulting from declining grade, further increasing production costs and environmental externalities. Moreover, fewer new deposits are being discovered. The mining industry heavily relies on fossil fuel-based energy, and the viability of this energy supply ecosystem has been progressively closing for the past five to 10 years. Consequently, the mining operations required to meet future metal demands are unlikely to proceed as planned.

Market forces and economics have thus far managed to maintain production to meet demand, but shareholder value for multinationals is prioritised to the detriment of local communities, which remain in poverty. However, the decreasing quality and size of energy raw materials (such as oil, gas and coal) are posing challenges. This decreasing grade, which was previously not seen as problematic, becomes more pressing as energy resources become more expensive. The significance of energy supply in the African mining context has not been fully appreciated.

Another concerning trend is the degradation of the environment. Industrial pollution has impacted various subsystems, including the hydrosphere, biosphere, atmosphere and geosphere. Natural living systems worldwide have significantly reduced in size and complexity due to industrial agriculture, urbanisation and other industrial activities. Overloaded biogeochemical cycles, particularly nitrogen and phosphorus from industrial agriculture, further strain the global environment. These impacts have been absorbed by the environment without there being a full understanding of the implications in the development of the global industrial ecosystem. This has a knock-on impact on global food production, which will likely be a flashpoint for this trend.

> Persisting with the economic growth paradigm will gradually become inefficient and result in the wastage of valuable resources

If we consider the 'Limits to Growth' study[22] as a reliable model for forecasting the industrial ecosystem, it suggests that the prevailing industrial practices are unsuitable. Persisting with the economic growth paradigm will gradually become inefficient and result in the wastage of valuable resources. Any endeavours in this direction will be counterproductive, especially if future short-term profits gained from critical minerals were obtained without addressing the socio-economic and environmental challenges of the past.

22 Donella H Meadows et al., *The Limits to Growth: A Report to the Club of Rome's Project on the Predicament of Mankind* (New York: Potomac Associates, 1972).

CHAPTER 3

The resource-balanced economy in SADC: Towards a new paradigm and system

Developing a new paradigm and system, such as the RBE, for addressing the challenges in the critical minerals and mining sector in the SADC region is a complex undertaking. It requires a fundamental shift in energy and raw material consumption patterns and a re-evaluation of our approach to materials sourcing. The aim is to shrink the industrial footprint and transition from a growth-based economic model to one that does not rely on continuous growth. As the existing system deteriorates, a new, smaller system will gradually emerge and evolve.

According to Michaux,[23] four primary aspects need to be considered to address these challenges effectively. Firstly, it entails developing fundamentally different energy systems that necessitate a new form of industrial activity. This implies transitioning from fossil fuel dependence to renewable and sustainable energy sources. Secondly, it involves establishing a new relationship with the environment that aligns with ecological realities. This requires a shift in perspective from viewing the environment as a resource to be exploited to recognising our interdependence and the need to protect and preserve natural ecosystems.

Thirdly, reimagining raw material sourcing is essential, considering resource availability and technological capabilities. This includes exploring alternatives to scarce or environmentally detrimental materials and embracing sustainable extraction and recycling practices. Lastly, restructuring society is crucial to reflect a new social contract that encompasses our understanding of the environment, energy, resources and our relationships with one another. This transformation necessitates a systemic approach that integrates scientific and engineering advancements, improved education and communication, and adherence to the principles of the rule of law and human rights.

The proposed system – the RBE – addresses a range of challenges faced by SADC, including peak crude oil production, the interdependence of human society and the environment, environmental degradation, the limitations of growth-based economics, the phasing out of fossil fuel-dependent transportation networks, metal shortages, regional industrial capacity limitations and the shift away from petrochemical-based products.[24] To tackle these challenges effectively, a comprehensive examination of all aspects within a dynamic systems context is required.

23 Michaux, "The Resource Balanced Economy".

24 Michaux, "The Resource Balanced Economy"

> The proposed system – the RBE – addresses a range of challenges faced by SADC, including peak crude oil production, environmental degradation, the limitations of growth-based economics, and the shift away from petrochemical-based products

The RBE incorporates the integration of statistical entropy and material flow analysis for each resource. By deriving industrial output and gross domestic product (GDP) from natural resources, the RBE aims to achieve long-term sustainability for all stakeholders. However, it is important to acknowledge the limitations imposed by exergy thermodynamics, which set boundaries on resource utilisation. To develop and implement the RBE, systems network theory is proposed as the mathematical foundation for its design and operation.[25]

The concept of the RBE builds upon the ideas popularised by the Venus Project[26] and the Zeitgeist Movement.[27] It envisions a system where resources, technology and services are accessible to everyone without the need for monetary exchange or servitude. In the evolution of the RBE, the inclusion of exergy as a limiting metric makes it a practical and feasible system for long-term sustainability. Successfully implementing this paradigm shift in SADC requires a shift in how society perceives the natural environment. Rather than viewing ourselves as mere consumers, it is essential to recognise our role as part of the planetary environment. This necessitates a restructuring of the entire industrial ecosystem, starting with the evolution of the social contract. Science, guided by philosophy, should play a central role in problem-solving, independent of monetary and political influences.

The ultimate goal of the proposed RBE system is to develop a symbiotic relationship with the natural environment on a planetary scale. Unlike the current linear economy, which prioritises economic efficiency alone, the RBE seeks to maximise both economic efficiency and true sustainability. To achieve this, Michaux[28] outlines seven dominant considerations: resource accounting, embodied energy analysis, dynamic equilibrium management, strategic design, statistical entropy combined with material flow analysis, biophysical signatures and the evolution/devolution of technology applications over time. These considerations form the foundation for the development and implementation of the RBE in the SADC region.

25 Simon P Michaux, *Restructuring the Circular Economy into the Resource Balanced Economy*, GTK Report 3/2021 (Espoo: GTK, 2021).
26 The Venus Project, https://www.thevenusproject.com/.
27 The Zeitgeist Movement, https://www.thezeitgeistmovement.com.
28 Michaux, "The Resource Balanced Economy".

Resource accounting

The current administration of the global industrial ecosystem operates under the assumption of unlimited natural resources. However, the reality is that the planet is a finite and dynamically self-regulating system that has maintained relative stability over geological eras. Since the advent of the first industrial revolution, the industrial ecosystem has rapidly expanded in size and complexity. Yet, this growth is limited by a finite biosphere, relying on both non-renewable resources such as metals and renewable resources derived from flora and fauna.

To ensure the sustainability of the environment for future generations, it is crucial to maximise the efficient use of every resource, leaving sufficient reserves for our descendants and ensuring intergenerational fairness. This entails effective management of the planet's carrying capacity. In order to secure the sustainability of the natural environment for future generations, it is vital to implement efficient management strategies to regulate this carrying capacity.[29] This requires quantifying and understanding global natural resources in all their forms and mapping their distribution and usage. Michaux argues a new methodology of resource classification is needed to establish a dynamic system that links resource availability, industrial requirements and application needs.[30] To achieve this, comprehensive quantification of global natural resources and their various forms is necessary. Michaux explains that this new methodology of resource-mapping parameters should be developed and utilised in an exergy[31] industrial entropy analysis. With exergy is meant its application to thermodynamics to account for natural resources and material fluxes, evaluating the real energy costs or replacement costs relative to a standard reference environment. By expressing data in terms of exergy using established methodologies and standard states, it becomes possible to compare the energy costs of different industrial operations in a consistent unit (joules [J]). In thermodynamics, exergy represents the maximum useful work achievable as a system reaches equilibrium with a heat reservoir, reaching maximum entropy. The portion of energy that can be transformed into work through a reversible process is referred to as exergy, while the remaining energy is termed anergy, corresponding to waste heat. The term 'exergy' – derived from the Greek words 'ex' and 'ergon', meaning 'from work – was coined in 1956 by Zoran Rant.

He explains we must understand the precise requirements of our industrial ecosystem and the specific applications of these resources. This methodology of exergy industrial entropy analysis to resource classification establishes dynamic links between available resources, their intended uses and their geographical distribution.

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29 Will Steffen et al., "Planetary Boundaries: Guiding Human Development on a Changing Planet", *Science* 347, no. 6223 (2015).

30 Michaux, "The Resource Balanced Economy".

31 Exergy is defined as the amount of work (= entropy-free energy) a system can perform when it is brought into thermodynamic equilibrium with its environment. In simple terms, it refers to the "usable" or "available" energy within a system that can be used to perform useful work. Unlike total energy, which includes all forms of energy (including waste or low-quality energy), exergy focuses on the energy that can actually be harnessed and put to practical use. SE Jørgensen and BD Fath, *Encyclopedia of Ecology*, https://www.sciencedirect.com/topics/earth-and-planetary-sciences/exergy.

Mapping global resources at different levels of precision, such as reserves and resources, requires a more sophisticated standard of resource classification. According to Michaux,[32] the following aspects should be included in the mapping process for all valuable raw materials:

- quantity (with practical precision levels);
- quality (grade, penalty elements);
- form (mineralised ore, industrial waste product, etc.);
- renewable or non-renewable nature;
- association with other minerals/metals/materials within the same stream;
- grain size of minerals/metals/materials (implications for energy consumption); and
- extraction profile and process path.

These resource mapping parameters should be structured in a way that enables their utilisation in exergy industrial entropy analysis, as proposed by Reuter *et al.*[33]

Embodied energy consumed vs. strategically useful outcome accounting

Michaux believes we are entering a phase of lower energy intensity, where non-fossil fuel energy systems have lower energy return on energy investment ratios[34] and are less flexible than fossil fuel sources such as oil, gas and coal.[35] As a result, energy becomes more valuable, and it is crucial for society to manage it with careful consideration, similar to how money is managed.

At present, a significant portion of the physical activities performed by society are superfluous and influenced by a consumerist mindset that prioritises entertainment and fleeting desires over essential necessities. In this context, each industrial and consumption action should be evaluated based on the energy consumed and whether it represents an intelligent use of resources. The question that needs to be asked is: should we engage in this activity?

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32 Michaux, "Restructuring the Circular Economy".

33 MA Reuter et al., "Fundamental Limits for the Recycling of End-of-Life Vehicles", *Minerals Engineering* 19, no. 5 (April 1, 2006): 433–49. it is suggested that a market driven approach is required to ensure optimal performance of the recycling system in which each actor in the system optimises its activity within the boundaries of its relevant environmental legislation, physics, chemistry, which all dictate the limits of recycling. In order to illustrate this industry/market driven approach, a system model was developed, conjecturing that the intrinsic property determining the recyclability and recoverability of a product respectively, is not just determined by the different materials and alloys used, but primarily by the mineral or joint classes (combination of materials due to design

34 Charles AS Hall, Jessica G Lambert and Stephen B Balogh, "EROI of Different Fuels and the Implications for Society", *Energy Policy* 64 (January 1, 2014): 141–52.cheap and seemingly limitless fossil energy has allowed most of society to ignore the importance of contributions to the economic process from the biophysical world as well as the potential limits to growth. This paper centers on assessing the energy costs of modern day society and its relation to GDP. Our most important focus is the characteristics of our major energy sources including each fuel's energy return on investment (EROI

35 Lars Schernikau and William Hayden Smith, *The Unpopular Truth about Electricity and the Future of Energy* (Berlin: Books on Demand, 2023).

To foster a sustainable industrial ecosystem a new business model should be developed, shifting the focus from solely pursuing monetary gains to a resource-based approach guided by sustainable metrics. It is important to carefully consider what fundamental metrics should underlie this new model. The prevailing linear economy, driven by the maximisation of economic value in a globalised market and free trade, has resulted in the escalating consumption of resources, leading to strains on the system. The circular economy, although a step forward, still operates within the same paradigm of economic growth. Therefore, a completely new approach is necessary.

Michaux[36] says that the metric of efficiency that guides decision-making in this new system should be carefully determined. It can be a single metric from the concepts listed below or a combination thereof. However, practical implementation needs to be considered, as each additional metric adds complexity to the overall system:

- economic efficiency;
- machine efficiency;
- energy efficiency;
- effective resource use;
- thermodynamics-based exergy, enthalpy and entropy;
- biophysical footprint; and
- environmental footprint.

The decision-making system implied by these metrics would need to incorporate an energy term (such as exergy) and, if feasible, incorporate a biophysical footprint term and an ecological footprint term.

Dynamic equilibrium

The linear economy model emphasises the importance of maximising consumption to ensure employment for a growing population and the functioning of the economy. However, this approach is not sustainable in the long run. To achieve sustainable management of natural resources, it is crucial to implement a methodology that enables monitoring of resource consumption, remaining quantities and regrowth potential. Maintaining a dynamic equilibrium requires tracking the rates of change and regeneration of resources, as well as monitoring environmental indicators. For instance, the harvesting of trees should be carefully managed in balance with tree growth to ensure a sustainable

36 Michaux, "Restructuring the Circular Economy".

equilibrium. Michaux argues that a systems management protocol based on the concept of dynamic equilibrium, as Smith and Lewis[37] and Chung and Choi[38] proposed, is needed.

Strategic design

Due to the mass consumption mindset of the linear economy, resource allocation is not effectively optimised in a strategic and conservative manner. The prevailing approach revolves around arbitrary monetary considerations, focusing on what the supplier can afford based on production costs and what the consumer is willing to pay as commodity prices. Michaux[39] contends that this approach lacks consideration for the most scientifically efficient and sustainable long-term resource usage. The emphasis is placed on maximising profit rather than maximising the lifespan of products. Additionally, recycling is often neglected during the design phase, with waste disposal being seen as someone else's responsibility and resolved through landfill sites. Cost efficiency frequently leads to technological inefficiencies.

Michaux exemplifies the matter by drawing a comparison between European industrial production, which is influenced by environmental regulations and minimum wage laws, and the industrial systems in China. China's dominance in global industrial markets stems from considerably lower costs and distinct environmental regulations that pertain to industrial pollution.

All of these factors hinder the achievement of truly sustainable design. Michaux explains that when developing long-term strategic industrial ecosystem designs, the following considerations should be considered, whenever possible:[40]

- accepting lower material purity as feedstock, reducing the pressure on refining targets;
- designing for effective recycling; and
- designing multiple parallel systems that are resourced by different minerals.

The statistical entropy coupled with material flow analysis of each resource

The importance of energy as a crucial resource has been established. It serves as the foundation of any industrial ecosystem, enabling its functioning and operation. The current linear economy heavily relies on cheap and abundant fossil fuel energy sources such as oil,

37 Wendy K Smith and Marianne W Lewis, "Toward a Theory of Paradox: A Dynamic Equilibrium Model of Organizing", *Academy of Management Review* 36, no. 2 (April 2011): 381–403.

38 Goo Hyeok Chung and Jin Nam Choi, "Innovation Implementation as a Dynamic Equilibrium: Emergent Processes and Divergent Outcomes", *Group & Organization Management* 43, no. 6 (December 1, 2018): 999–1036.

39 Michaux, "The Resource Balanced Economy".

40 Michaux, "The Resource Balanced Economy".

gas, coal and uranium. However, in order to transition towards a circular economy, which promotes recycling and renewable energy systems such as wind and solar power, there needs to be a shift in focus from energy resources to the mineral resources necessary for the production of batteries, solar panels and wind turbines.

While metals can theoretically be recycled infinitely, practical limitations exist due to the complexity of product designs.[41] Michaux explains that most products are optimised for performance rather than recyclability, resulting in a degradation in quality with each recycling cycle. In order to tackle this challenge, he emphasises the importance of establishing approaches that can measure the effectiveness of recycling systems, offer optimisation recommendations for current technologies and facilitate the development of new products guided by robust scientific and engineering principles. Michaux has introduced a methodology that merges statistical entropy and material flow analysis, aiming to optimise separation and purification processes, specifically focusing on lithium-ion battery recycling. His approach offers a systemic viewpoint that considers the concentration or dilution of components across the entire process, encompassing products, by-products and waste streams. By establishing a relationship between the quality of final recoveries and earlier stages of separation through entropy, this methodology facilitates a comprehensive evaluation of the process's efficiency. This approach incorporates the concept of exergy, which is a suitable global and strategic indicator for assessing the sustainability of mineral resources.

Regarding the RBE, Michaux proposes that the following forms of analysis be used in resource management:

- evaluation of mass losses for target and associated elements;
- exergy analysis;
- thermo-economics of industrial entropy;
- biophysical signatures; and
- life cycle analysis.

The concept of exergy offers a valuable framework for measuring the energy consumption or previously embedded energy associated with resource materials such as metals. It enables an evaluation of the maximum potential for useful work during a process that brings the system into equilibrium with a heat reservoir, where the exergy diminishes to zero upon reaching equilibrium.

41 Michaux, "The Resource Balanced Economy".

Biophysical signatures: A change in our perception of the natural environment and its lessons

Within the realms of biology and ecology, it is currently acknowledged that an organism's interaction with its environment primarily relies on its energy acquisition from the surroundings and its ability to maintain a certain distance from thermodynamic equilibrium.[42] Living systems derive their power from the sun and can reproduce, collect information and control the energy and matter they receive from their surroundings.

Similarly, the industrial ecosystem relies on energy but predominantly uses non-renewable and finite resources such as oil, gas, coal and uranium within the framework of the linear economy.

The stress points within the linear economy indicate the need for a shift in our perception of the natural environment. Many current perspectives hold an idealistic view of how the planetary system operates. To better understand the functioning of the environment and establish sustainable interactions with the industrial ecosystem, it is beneficial to model it as a complex system on a grand scale. At a macro level, this system demonstrates stability, while individual organisms compete for survival. As conditions on the planet change, various components within the flora and fauna subsystems adapt and excel in terms of survival, leading to the decline of previously prevalent species.

This understanding aligns with the principles of the free market and the development of the linear economy. According to the Gaia hypothesis,[43] when an animal population surpasses the carrying capacity of its environment, a sharp reduction in population occurs due to a lack of available resources. This routine method of natural system regulation operates on a small, localised scale.

It is also crucial to comprehend large-scale macroscopic changes. In geological history there have been five mass extinctions.[44] The study of global-scale mass extinctions has proposed a theory explaining the periodic high-stress changes and long periods of stability in biodiversity over geological time frames.[45] These brief periods of high-stress change are characterised by mass species die-offs and the emergence of new species, to the extent that the fossil records exhibit distinct systems and are classified as different geological eras.[46]

There is a proposed correlation between massive volcanic events and the occurrence of mass extinctions, highlighting how dramatic shifts in the environment trigger a

42 Roberto Poli, *Introduction to Anticipation Studies*, Vol. 1 (Berlin: Springer, 2017).

43 James Lovelock, *The Ages of Gaia: A Biography of Our Living Earth* (New York: Oxford University Press, 2000).

44 Elizabeth Kolbert, *The Sixth Extinction: An Unnatural History* (New York: Picador, Henry Holt and Company, 2015).

45 V Courtillot, *Evolutionary Catastrophes: The Science of Mass Extinction* (New York: Cambridge University Press, 1999).

46 Courtillot, *Evolutionary Catastrophes*.

transformation in the biodiversity of flora and fauna. The modified environment can no longer sustain the previous ecosystem, eventually resulting in its demise.[47]

As Michaux explains, this concept can be applied to model the current state of the linear economy and its industrial ecosystem.[48] For Michaux, the diminishing effectiveness of the energy source (declining energy return on energy invested) has exceeded the carrying capacity of the global environment, resulting in signs of strain and deformation. He indicates that the fundamental driver of this phenomenon lies in how the linear economy consumes resources and maintains its habitat. If his assessment is correct, he posits that the linear economy is on the brink of a substantial reduction in size and significance.

The main claim from Michaux is that industrial ecology offers a valuable framework to explore this idea. Industrial ecology investigates the intricate interactions within industrial material production, use and recycling systems, drawing inspiration from nature.[49] For Michaux, the concept of the circular economy has merit and is necessary for long-term sustainability. However, the current implementation of the circular economy has structural flaws.[50]

The evolution/devolution of technology applications over time

Developing the RBE involves the application of technology in unconventional ways, aligning with the development of the Fourth Industrial Revolution (4IR).[51] The 4IR, also known as Industry 4.0, entails the widespread automation and integration of digital, biological and physical systems using advanced technologies such as artificial intelligence, cloud computing, robotics, 3D printing, the Internet of Things and advanced wireless technologies.[52]

For Michaux there is a need to shift the current paradigm of industrial development and acknowledge existing blind spots, particularly the dependency on fossil fuels and mineral resources.[53] A potential concern with the proposed 4IR approach is that individuals and society as a whole may become overly reliant on these technology systems, potentially leading to a decline in individual self-sufficiency without the assistance of technological tools.

The high-tech automation systems advocated by 4IR proponents would require a highly complex industrial ecosystem,[54] surpassing the complexity of the current linear economy system. Following Michaux, from a biophysical exergy perspective, this level of complexity

47 Courtillot, *Evolutionary Catastrophes*.

48 Michaux, "Restructuring the Circular Economy".

49 TE Graedel, Thomas E Graedel and Braden R Allenby, *Industrial Ecology* (Englewood Cliffs: Prentice Hall, 1995).

50 Michaux, "Restructuring the Circular Economy".

51 Mike Moore, "What Is Industry 4.0? Everything You Need to Know", TechRadar, November 5, 2019.

52 Klaus Schwab, *The Fourth Industrial Revolution* (Geneva: World Economic Forum, 2016).

53 Michaux, "Restructuring the Circular Economy".

54 N Nasman et al., "Fourth Industrial Revolution for the Earth Harnessing the 4th Industrial Revolution for Sustainable Emerging Cities", pwc, 2017.

may not be practical. Hence, there is a legitimate question as to whether this approach should be pursued at all.

There is an ongoing debate surrounding society's dependence on technology and its long-term implications.[55] From one perspective, technology is regarded as a tool for progressing society, aiming to benefit the collective as a whole. However, society has become deeply dependent on technology, to the extent that individuals feel powerless without their mobile devices and access to the internet. However, this debate may become irrelevant if widespread automation, which hinges on a complex industrial ecosystem supplied with abundant energy and substantial quantities of natural resources, continues to strain the current linear economy. Thus, Michaux argues that the linear economy will struggle to accommodate the increased complexity due to the escalating demand for mineral resources.

Nonetheless, Orlov[56] raises a valid point. It is crucial for us to grasp, on both personal and national levels, whether we are being served by the technosphere or if we are serving it. The role of automation should be optimised to thrive in a low-energy world, empowering human beings as significant contributors to the ecosystem rather than being viewed as the weakest link. Our interaction with technology should undergo a transformation towards a more suitable state. Michaux highlights that the limitations imposed by exergy and the thermo-economics of industrial entropy should guide the strategic application of 4IR technologies, determining when and where they should be employed.[57]

Examples of seeds[58] of preferable futures of critical minerals in developing an RBE are:

- GTK Mintec's pioneering solutions for mining operations and the circular economy, its pilot plant and research laboratories in Outokumpu and Espoo, Finland, and cooperation projects in Africa;
- mining projects that lead the way toward circular mining and zero mining waste;[59] and
- The initial steps taken by the African Minerals Development Centre (AMDC) toward anticipatory governance with the creation of a regional futures expert group in strategic foresight for critical minerals. This group can provide insights and guidance for policymakers, industry stakeholders and researchers in developing a resource-balanced economy in SADC.

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55 Dmitry Orlov, *Shrinking the Technosphere: Getting a Grip on Technologies That Limit Our Autonomy, Self-Sufficiency and Freedom* (Gabriola Island: New Society Publishers, 2016).

56 Orlov, *Shrinking the Technosphere*.

57 Michaux, "Restructuring the Circular Economy".

58 Seeds or 'pockets of the future in the present' in futures thinking refer to 'early manifestations that grow from fringe activity in the present that introduces completely new ways of doing things but which turn out to be much better fitted to the world that is emerging than the dominant H1 systems'. Bill Sharpe, 'Three Horizons', *University for the Third Horizon* (blog), November 2019, https://www.h3uni.org/tutorial/three-horizons/.

59 Alan Young and Maria Laura Barreto, "Circular Economy for Mining Operations: Key Concepts, Drivers and Opportunities" (Enviro Integration Strategies Inc., MERG, Saskatoon, December 2021).

CHAPTER 4

Rethink financial innovations towards fair trade

The current global financial and economic systems perpetuate the exponential growth paradigm. Many African leaders prioritise short-term earnings over longer-term public good through natural resource trade agreements that are one-sided. These agreements are also in urgent need of renegotiation to ensure that sustainability goals are achieved and economic benefits broadened.

More developed economies apply purely Western financial valuation models, which are reductionist in nature, to African countries without consideration for local context. This unfavourable positioning places African countries at varying levels of investment risk, with the most rated as high-risk investments. Table 1 highlights the extent to which sub-Saharan Africa has the most countries that are close to breakpoint. A country's ability to attract foreign direct investment, which plays a pivotal role in an open and efficient global economic system and stimulates development, is inversely related to its risk score. In other words, the higher the risk score, the less likely the country is to attract foreign direct investment.[60] According to analysis conducted by the UN Conference on Trade and Development, foreign direct investment increased by 64% in 2021, reaching $1.6 trillion. However, detailed analysis point out that, from 1990–2021, Southern African countries consistently received the smallest portion, with the highest amount recorded in 2021 being $42 million.[61]

TABLE 1 NUMBER OF COUNTRIES BY WORLD REGION IN EACH RISK BRACKET (2021)

Risk rating	Asia-Pacific	CEE & CIS	Central America & the Caribbean	Middle East & North Africa	North America	South America	Sub-Saharan Africa	Western Europe
Very low risk (0–30)	8	2	0	2	2	0	0	14
Low risk (>30–40)	2	9	1	3	0	1	1	5
Manageable risk (>40–50)	4	13	6	4	0	3	5	1
High risk (>50–60)	8	4	4	5	0	5	13	0
Very high risk (>60)	1	0	1	3	0	1	5	0

Source: Hope Moses-Ashike, "Sub-Saharan Africa Currency Depreciates by 8% - IMF", *Business Day*, May 16, 2023

60 Folasade Bosede Adegboye and Uchechukwu Emena Okorie, "Fragility of FDI Flows in Sub-Saharan Africa Region: Does the Paradox Exist?", *Future Business Journal* 9 (February 2, 2023).

61 UNCTAD, "Investment Flows to Africa Reached a Record $83 Billion in 2021", June 9, 2022.

Although Southern African countries require foreign direct investment, the level of risk assessment assigned to these countries highlights the negative feedback loop at play. It is expected that lower risk appetite in global markets will prevail, which is mostly driven by external factors such as interest rate hikes in the US. This pushes investors away from sub-Saharan Africa towards safer options, such as higher-paying US treasury bonds.[62] Since January 2022, sub-Saharan African currencies have recorded an average 8% depreciation, contributing to higher inflation, increased public debt and a deteriorating balance of trade.[63] The devaluation of African currencies hinders their ability to access and contribute to global markets through fair trade. By implication, imports become more expensive and exported goods such as mining proceeds cost international buyers less, further increasing demand and giving rise to more mining activities.

The devaluation of African currencies hinders their ability to access and contribute to global markets through fair trade

These market dynamics afford high-risk and very high-risk evaluations to countries rich in natural resources with little room to escape the poverty trap. If these trends continue, such as increased interest rates and an appreciating US dollar, debt servicing costs will rise rapidly. The external debt stocks for sub-Saharan Africa increased from $240 billion to $640 billion over 11 years, ie, by 266%.[64] African countries are further burdened with insurmountable debt and forced to make difficult choices between debt servicing and much-needed socio-economic development. Temporary spikes in debt service costs (commonly known as debt walls) are expected in 2024,[65] when countries are meant to make good on their debts. A vicious circle is created when distressed countries take on new foreign debt to adjust their fiscal balances.

The risk of financial capture

With the increased global demand for critical minerals to decarbonise economies, coupled with prevailing economic conditions, Southern Africa is at risk of financially capture and becoming stuck in low- to middle-income traps. Increased globalisation in the prevailing economic system has left many people behind and more inclusive economic models are needed, where humanity and the environmental impacts of economic activities inform economic progress. African leaders face a dilemma: stay within the current outdated

62 Hope Moses-Ashike, "Sub-Saharan Africa Currency Depreciates by 8% - IMF", *Business Day*, May 16, 2023.

63 Moses-Ashike, "Sub-Saharan Africa Currency".

64 "Your Guide to Africa's Debt Distress", *African Business*, February 7, 2023.

65 "Your Guide to Africa's Debt Distress".

economic systems and face these risks, or embark on new pathways to transition towards resource-balanced and financially innovative economies. The pathways are summarised below.

> African leaders face a dilemma: stay within the current outdated economic systems and face these risks, or embark on new pathways to transition towards resource-balanced and financially innovative economies

- Use decarbonisation and environmental sustainability ambitions as precursors for investment and consumption patterns. This will require collaborative public–private sectoral planning.
- Transition towards more active industrial policies where environmental and social challenges such as housing, health, education and digital inclusion of communities are included in economic growth metrics. This will lead to more just macroeconomic policies where job creation through increased industrialisation is balanced with public debt levels.
- Ensure public investments to support economic growth are broad based to demonstrate job creation and contribute to improved wellbeing and social cohesion.
- Revisit financial regulation to limit adverse impacts on asset inequality and currency depreciation to improve economic resilience.
- Innovate regional competition policies, as multinational monopolies become increasingly powerful as they strengthen their energy supply chains. Environmental and mining standards can be raised through international trade agreements. In addition, more stringent regional processes can be incorporated to ensure that tax evasion practices are avoided. Effective competition policies will ensure healthy competition between artisanal miners and multinationals, which will be reflected in advantageous consumer price points.
- Implement redistributive policies to address ownership of wealth by broadening ownership models to communities and employees. Many industrial sectors are replacing manual labour with technology applications to improve productivity, where traditionally those benefits would accrue to the owners of capital. Redistributive policies should ensure that profit maximisation is not achieved to the detriment of employees and the environment, by instituting universal basic income grants to communities where employment is replaced with automation.

Radical thinking and experimentation is required to implement new goals and measures of economic and social progress, while including the environmental impacts there. A deeper understanding and application of economic progress is needed where economic growth, human wellbeing and environmental sustainability have equal importance. This will give rise to new tools and techniques to support equality within societies and among countries. It paves the way for more just policy and institutional reforms.

The identified economic pathways set out in Special Report 4 on "Towards systemic innovations for SADC critical material ecosystems" of this series of special reports highlight that alternative models and economic systems are entering the mainstream, but more experimentation is needed to understand the implications fully. Lessons from history are that wars are the precursors for economic change or paradigm shifts, highlighting the interconnection between geopolitics and economic policies.[66] Russia's invasion of Ukraine creates a platform for global leaders, especially on the African continent, to take on the daunting task of ensuring a fundamental shift in economic policymaking.

66 Gabriela Ramos and William Hynes, "Beyond Growth: Towards a New Economic Approach" (OECD, Paris, September 18, 2019).

CHAPTER 5

Pioneer new mining frontiers by prioritising bioregionalism in regional value chains

To ensure a sustainable supply of minerals, new African mining frontiers should be explored and used differently. Given the potential challenges in continental and global free trade, opening an African mining frontier for exploration and operations could strategically negotiate the sale of raw materials from the perspective of bioregionalism[67] and re-localisation.[68]

Understanding bioregionalism and re-localisation

Bioregionalism is a concept that emphasises the interdependence of humans and the natural environment in a defined geographic region. It recognises the unique ecological characteristics, resources and cultural identities of a specific area. Bioregionalism promotes sustainable development and management practices by aligning human activities with the natural systems and ecological boundaries of a region.

Re-localisation refers to the process of prioritising local production and consumption within a specific region. It aims to reduce dependence on global supply chains and foster self-reliance by promoting local industries, resource utilisation and community engagement. Re-localisation strengthens regional economies, reduces environmental impacts associated with long-distance transportation and fosters social cohesion and resilience.

The African Mining Vision (AMV) and the SADC Regional Mining Vision can be enhanced by prioritising bioregionalism and re-localisation. This will ensure that regional mining activities are carried out in harmony with the environment, contribute to local and regional development, and generate lasting benefits for communities and economies. The implementation of bioregionalism and re-localisation aligns with the objectives of the AMV and the SADC Regional Mining Vision and Action Plan. These concepts support the AMV's goal of harnessing mineral resources for broad-based development, industrialisation and socio-economic transformation. Similarly, they complement the SADC Regional Mining Vision's aim of promoting sustainable mining practices, regional integration and regional value chain development.

67 Bioregionalism recognises that the natural elements of our environment, including geography, climate, water systems and ecosystems, are crucial for sustaining life, and it emphasises the importance of honouring their interconnectedness. See Shrishtee Bajpai, Juan Manuel Crespo and Ashish Kothari, "Nation-States Are Destroying the World. Could 'Bioregions' Be the Answer?", *Resilience*, March 9, 2022.

68 Promoting local and regional economic systems, alongside international cooperation and equitable trade, fosters employment opportunities and strengthens community resilience. Emphasising re-localisation can contribute to an economic framework centred around care, for both individuals and their surroundings, leading to mutually beneficial social and ecological outcomes.

The African Mining Vision and the SADC Regional Mining Vision can be enhanced by prioritising bioregionalism and re-localisation. This will ensure that regional mining activities are carried out in harmony with the environment, contribute to local and regional development, and generate lasting benefits for communities and economies

The need for a bioregional mining approach

The increasing global competition over critical minerals poses significant challenges for Africa as it seeks to harness the potential economic benefits of its mineral resources while safeguarding the well-being of its communities and the environment. In this context, the adoption of a bioregional mining approach offers a promising pathway for Africa to navigate its way through this competition. By prioritising the principles of radical democracy, shared benefits and knowledge transfer, a bioregional approach can empower communities, enhance livelihoods and foster sustainable development. This will ultimately enable the continent to capture greater value from its critical minerals.

The current global level of mineral production falls short of the growing demand for metals, creating a supply deficit. 69 As major economic blocs such as the US, the EU and China intensify their competition for critical minerals, Africa and SADC must find innovative ways to maximise the value of these mineral resources. A bioregional mining approach can help Africa leverage its unique ecological and socio-economic strengths, enabling it to carve a niche in the global market and enhancing its resilience and sustainable resource management. By prioritising sustainable resource management practices such as responsible extraction, land rehabilitation and biodiversity conservation, the region can ensure the long-term availability of critical minerals. At the same time it can minimise environmental impacts because bioregionalism emphasises a systemic understanding of the local ecosystem and its interconnectedness with mining activities.

Bioregional mining differs from traditional national borders-based approaches by recognising the interdependencies between mining activities, local ecosystems and communities. It prioritises the sustainable use of resources within a specific bioregion, taking into account the ecological context, biodiversity conservation and ecosystem services. By aligning mining practices with local ecological conditions, SADC can ensure the long-term viability of its critical mineral resources, reducing environmental degradation and enhancing sustainability.

69 Michaux, "Restructuring the Circular Economy".

The bioregional approach emphasises radical democracy, where decision-making power is decentralised and communities have an active role in shaping the development and management of mining activities. By empowering local communities, ensuring their participation and respecting their rights and interests, a bioregional mining approach enables communities to have a greater say in shaping their own futures. This approach reduces the likelihood of conflict and violent extractive industries, fostering social cohesion and stability.

Bioregional mining promotes the equitable distribution of benefits throughout the entire value chain. By encouraging local beneficiation and the development of downstream industries, SADC can capture a greater share of the value from its critical minerals, creating employment opportunities, fostering economic diversification and enhancing regional value chains. Moreover, the bioregional approach promotes knowledge transfer and capacity building, enabling specialised expertise to develop within the region. This strengthens local capabilities and supports technological advancements, positioning SADC as a long-term influential player in the global critical minerals market.

Bioregionalism and re-localisation promote the development of regional value chains and downstream industries. By adding value to raw materials through processing and manufacturing, the region can capture a larger share of the economic benefits associated with mining. This reduces dependency on primary commodity exports and contributes to economic diversification and resilience.

Pioneering new mining frontiers based on bioregionalism and re-localisation requires collaboration and cooperation among countries in Southern Africa. This can lead to stronger regional integration, shared infrastructure development and harmonisation of policies and regulations. Enhanced regional cooperation fosters stability, attracts investment and facilitates knowledge sharing and technology transfer.

Bioregionalism emphasises responsible environmental stewardship. By adopting best practices in environmental management, such as reducing carbon emissions, promoting renewable energy use and implementing sustainable water management strategies, the region can contribute to global efforts to mitigate climate change and protect natural resources.

Bioregional mining and re-localisation practices in the mining sector call for transparent and accountable governance mechanisms. By strengthening institutions, enhancing regulatory frameworks and promoting public participation, the region can ensure good governance and reduce the risks of corruption, resource mismanagement and conflicts associated with mining activities.

Bioregional mining would require a massive expansion in geological surveys of Africa and regional bodies to step up efforts in exploring mineral deposits. To determine the optimal use of critical mineral deposits in different sectors over many countries in Southern Africa is a pressing challenge. It requires careful assessment of market demands, technological advancements, sustainability considerations and the needs of local communities. A critical aspect is the potential imbalance in benefit distribution among participating countries. To prevent certain countries from being left behind or obstructing agreements, mechanisms must be developed to ensure that all countries have tangible gains from critical minerals collaborations. Southern African countries also lack comprehensive strategies, plans, regulations, laws and policies tailored to critical minerals.

CHAPTER 6

Building Anticipatory Governance in SADC

Creating a new social contract for critical minerals in SADC

While the mining sector in SADC is undoubtedly an economic cornerstone, accounting for over 60% of foreign exchange earned and contributing at least 10% of GDP,[70] it has been lacklustre in its ability to ensure broad-based development and the delivery of socio-economic benefits to communities. Given this shortcoming, as well as the growing climate and cost-of-living crisis globally, a new social contract should reflect how we interact with energy, mineral resources, technology, economics, the environment and one another.

Corruption remains astronomical despite policies to govern and manage critical minerals. According to the AU, it is estimated at $140 billion a year – an amount that could finance an uninterrupted energy supply for every person on the African continent for three years.[71] Persistently high levels of corruption erode trust between governments and societies. Notably, the new social contract would outline a more equitable/balanced social agreement (ie, encouraging ecologies of mutual care and strengthening cultural immune systems),[72] which would also promote environmentally and socially responsible management/stewardship of mineral resources to achieve better and more inclusive outcomes for the coming decades. With the expected rise of new mining projects in the SADC region, the need to amplify social cohesion becomes imperative.

The AMDC plays a vital role in guiding sustainable mineral resource management in the region. Through initiatives such as the establishment of the Green Minerals Observatory, the AMDC can provide valuable support in mapping mineral deposits, tracking investments, identifying opportunities for African investment and monitoring value-addition efforts. These initiatives facilitate data-driven decision-making, promote transparency and enhance stakeholder cooperation.

> The SADC region can effectively address the diverse challenges associated with critical minerals by building anticipatory governance

70 SADC Business Council, "Status of Mining In SADC", July 24, 2020.
71 Femi Adekoyai, "'$140bn Yearly Loss to Corruption Can Address Africa's Power Challenge'", *The Guardian*, December 8, 2020.
72 Michaux, "Restructuring the Circular Economy".

To ensure the preferred futures of critical minerals in Southern Africa are achieved, it is crucial to establish a comprehensive and collaborative approach guided by anticipatory governance principles. The SADC region can effectively address the diverse challenges associated with critical minerals by building anticipatory governance. This approach encompasses building consensus, optimising resource utilisation, ensuring equitable distribution of benefits, establishing robust policy frameworks and investing in renewable energy and skills development. Southern Africa can position itself for a sustainable and just future in the critical minerals sector through these efforts.

Why is anticipatory governance needed for the SADC critical materials ecosystem?

Complexity has emerged as a fundamental characteristic of the worldwide industrial system amid the global polycrisis.[73] Traditional linear thinking often falls short when dealing with complex problems because it assumes that cause-and-effect relationships are straightforward and predictable. Single root causes can be identified and solved with simple fixes. However, in complex adaptive systems, cause-and-effect relationships are often nonlinear, and small changes in one part of the system can have significant and unexpected effects elsewhere. There are no easy fixes in complex systems, and the global industrial system in the context of the polycrisis should be more completely understood as a complex adaptive system in the VUCA (volatile, uncertain, complex and ambiguous) world.

The COVID-19 pandemic upended economic, social and political systems in dramatic ways, yet it is only the latest disruptor in a global system increasingly characterised by volatility, uncertainty, complexity and ambiguity. Climate change, biodiversity loss, rapid technological development, artificial intelligence and many other drivers will continue to reshape the world, often in unforeseen ways. In this 'post-normal' environment, basing decisions on linear extrapolation of past trends has limited value. New approaches and tools are required. Strategic foresight and the related concept of futures literacy provide a means to engage with uncertainty in meaningful and productive ways. A central insight of this field is that 'the future' as a single, defined reality does not exist. Instead, we are faced with multiple possible futures. In this sense, then, we should seek to 'use the future' by employing human faculties of imagination and anticipation.[74] Futures literacy speaks to this ability to imaginatively use the future and navigate towards preferred futures.

To deal with great acceleration and uncertainty, African countries should embark on a process of public sector renewal by adopting new approaches to organising and

73 A global polycrisis occurs when crises in multiple global systems become causally entangled in ways that significantly degrade humanity's prospects. These interacting crises produce harms greater than the sum of those the crises would produce in isolation, were their host systems not so deeply interconnected. Michael Lawrence, Scott Janzwood and Thomas Homer-Dixon, "What Is a Global Polycrisis? And How Is It Different from a Systemic Risk?" (Discussion Paper, Cascade Institute, Victoria, April 2022).

74 Riel Miller, ed., *Transforming the Future: Anticipation in the 21st Century* (London: Routledge Taylor & Francis Group, 2018).

organisation that feature futures literacy[75] and greater sensitivity to weak signals[76] about alternative futures.[77] For decades, governments relied on conventional reactive approaches to policymaking by responding to crises and problems with policy, service designs or legislation. However, the limitations and ineffectiveness of the reactive approach have been exposed in Africa by the COVID-19 pandemic, ever increasing natural disasters like floods and droughts due to climate change, civil unrest and riots, socio-economic turmoil and even terrorism. The need for governance methods that embrace a proactive, experimental and intentional approach to uncertainty, complexity and the future has become evident, given the limitations of reactive policymaking. Embracing proactive approaches to policymaking will facilitate regional responses that use resources more effectively, allowing for better anticipation and preparation in the face of crises and challenges.

> Anticipatory governance will enable SADC member states to respond to these crises with increased flexibility and speed and thereby build anticipatory governance in Africa

Anticipatory governance is a systems-based approach for enabling governance to cope with accelerating, complex forms of change.[78] It is relatively rare for inter-governmental organisations and African governments to engage with anticipatory governance processes – systems of foresight, networked governance, feedback for applied learning – despite the acceleration of complexity and lack of coherence in governance.[79] SADC countries require measures that consider longer time horizons and foster awareness of long-term futures that will impact future generations.[80] Governance institutions need to improve their capacity to cultivate both long-term planning and capability for action in ways that operationalise systems of government and help speed up the process of detecting error and propagating success.[81]

Anticipatory governance will enable SADC member states to respond to these crises with increased flexibility and speed and thereby build anticipatory governance in Africa. Examples of the implementation of anticipatory governance at national-government level

75 Riel Miller, "Getting the Questions Right: Challenges for 21st Century Policy Makers", *The Journal of Public Sector Management* 33, no. 3 (2003).

76 Laura Pereira et al., "Using Futures Methods to Create Transformative Spaces: Visions of a Good Anthropocene in Southern Africa", *Ecology and Society* 23, no. 1 (2018).

77 Elena Bennett et al., "Bright Spots: Seeds of a Good Anthropocene", *Frontiers in Ecology and the Environment* 14, no. 8 (2016): 441–448.

78 Leon Fuerth, "Operationalizing Anticipatory Governance", *PRISM* 2, no. 4 (2011): 31–46.

79 Fuerth, "Operationalizing Anticipatory Governance".

80 Fritz Nganje, "Building Anticipatory Governance in SADC: Post-COVID-19 Governance Outlook", (Occasional Paper 324, SAIIA, Johannesburg, 2021).

81 Fuerth, "Operationalizing Anticipatory Governance".

are gaining traction in Finland, Sweden, Spain, Portugal, Latvia and Ireland, but African examples require investigation.[82] Various regional and national/cabinet-level agencies have internal planning systems that approximate anticipatory governance, for example the South African government's National Planning Commission, the Centre for Public Sector Innovation and the Wester Cape's Department of the Premier.

Building anticipatory systems in governance structures will require a reimagining of the role of government and governance in the region and society. Decision makers need to grow personal capabilities to navigate uncertain African futures over extended timeframes. This will allow government structures to co-create future-orientated innovative governance responses to better anticipate emerging complex challenges that are fit for purpose in post-normal times, such as the post-COVID-19 pandemic era.[83]

The concept of anticipatory governance is currently explored within 'four influential strands of social science and sustainability science scholarship',[84] namely

- perspectives that connect science and technology studies, responsible research and innovation, and environmental governance;
- national security policy analyses, anticipatory democracy, new forms of representative governance;
- sustainability science, in the area of climate adaptation and resilience; and
- global environmental governance and environmental policy literatures.

There are, of course, also more critical perspectives on the idea of anticipatory governance, such as the monocropping of futures by central institutions85 and concerns that anticipation may largely rely on Western funding, science and technologies.86 These considerations and risks must also be taken into account in how SADC nations approach anticipatory governance.

The aim of building anticipatory governance in the SADC critical minerals ecosystem is to invite the conceptual and practical resources that might contribute to re-imagining African governance systems. The intention is to build enabling anticipatory capabilities and systemic innovations to foster institutional systems, rules and norms that provide a way to use foresight, networks and feedback that reduce risk and increase capacity to respond to events at earlier rather than later stages of development.

82 "Piret Tõnurist and Angela Hanson, "Anticipatory Innovation Governance: Shaping the Future through Proactive Policy Making" (Working Paper, OECD, Paris, December 24, 2020).

83 Ted Fuller and Ziauddin Sardar, 'Moving Forward with Complexity and Diversity', *Futures* 44, no. 10 (2012): 845–46.

84 Karlijn Muiderman et al., "Four approaches to Anticipatory Climate Governance: Different Conceptions of the Future and Implications for the Present", *WIREs Climate Change* 11, no. 6 (2020): 4.

85 Geci Karuri-Sebina, "Urban Africa's Futures: Perspectives and Implications for Agenda 2063", *Foresight* (2020).

86 Karlijn Muiderman, "Approaches to Anticipatory Governance in West Africa: How Conceptions of the Future Have Implications for Climate Action in the Present", *Futures*, 141 (2022).

Anticipatory governance is relatively new in the African context and therefore the conceptualisation, operationalisation and practice will be explored and grounded within broader current literature. The explicit engagement with the concept of building anticipatory governance in the SADC critical minerals ecosystem should be informed by African perspectives, while also critically engaging with the ideas of Fuerth,[87] Poli,[88] Guston,[89] Ramos,[90] Tõnurist and Hanson[91] and Muiderman *et al*.[92] Drawing upon existing bodies of literature centred around practical application, decision makers can learn how to effectively integrate foresight into the policymaking process. This involves utilising networked systems to foster comprehensive government responsiveness and implementing feedback mechanisms to monitor performance and accelerate learning from outcomes. The notion of African perspectives of anticipatory governance should be interrogated by exploring it through the four major current approaches[93] to its application and implementation.

The concept of anticipatory governance speaks to the ability to integrate futures literacy into governance processes; that is, decision-making rules and processes. Integrating diverse perspectives is an important element of this process. In this sense, anticipatory governance has been described as a 'sustainable decision-making process based on consensus on a desirable future or vision through the participation of various stakeholders, including government, market, the public and academics'.[94] This approach allows stakeholders in the public and private sector to deal with accelerating and complex forms of change while increasing their capacity to respond to a wide range of possible futures with flexibility and adaptability.[95]

Anticipatory governance in the mining sector

The mining sector is not exempt from the accelerating pace of change and growing uncertainty across a range of social, economic, technological and political dimensions. The AMV, adopted by African heads of state and government in 2009, is a forward-looking document that seeks to set a path for 'transparent, equitable and optimal exploitation of mineral resources to underpin broad-based sustainable growth and socio-economic development'.96 With the 10-year commemoration of the launch of the AMV at the 2019 African Mining Forum in Accra, Ghana, stakeholders could reflect on progress towards

87 Fuerth, "Operationalizing Anticipatory Governance".

88 Roberto Poli, "Working with the Future: Ideas and Tools to Govern Uncertainty", *EGEA spa* (2022).

89 David H Guston, "Understanding 'Anticipatory Governance'", *Social Studies of Science* 44, no. 2 (2014): 218–242.

90 Jose M Ramos, "Anticipatory Governance: Traditions and Trajectories for Strategic Design", *Journal of Futures Studies* 19, no. 1 (2014): 35–52.

91 Tõnurist and Hanson, "Anticipatory Innovation Governance".

92 Karlijn Muiderman et al., "Four Approaches to Anticipatory Climate Governance: Different Conceptions of the Future and Implications for the Present", *WIREs Climate Change* 11, no. 6 (2020): e673.

93 Muiderman et al., "Four Approaches".

94 Kyungmoo Heo and Yongseok Seo, "Anticipatory Governance for Newcomers: Lessons Learned from the UK, the Netherlands, Finland, and Korea", *European Journal of Futures Research* 9, no. 1 (July 11, 2021): 9.

95 Heo and Seo, "Anticipatory Governance for Newcomers".

96 AU, *African Mining Vision* (Addis Ababa: AU, February 2009), v.

the 'preferred future' articulated in this strategic framework. While progress was noted, stakeholders convened for the forum highlighted that much remained to be done to realise the ambitions of the AMV. The Mining Forum emphasised the importance of employing futures-informed approaches that are adaptable and responsive to the action plan for implementing the AMV.[97] Catalysing the green energy transition will only be possible in the context of a well-governed and anticipatory minerals and metals ecosystem to support emerging green economies.

Anticipatory governance can play a crucial role in addressing high-impact key uncertainties, challenges, and opportunities for the future of critical minerals in Southern Africa by adopting a proactive approach. Anticipatory governance is an approach to governance that emphasises forward-looking strategies to address emerging challenges and uncertainties. It involves systematically scanning the horizon for potential future developments, analysing their implications and taking pre-emptive actions to shape desirable outcomes.

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In anticipatory governance, decision makers and policymakers engage in long-term thinking and strategic foresight to anticipate and prepare for future trends, risks and opportunities. It aims to avoid reactive, crisis-driven responses and instead focuses on proactive measures to steer the trajectory of society, technology and the economy towards preferred outcomes.

Anticipatory governance can further be understood as a systems-based approach designed to enable governance to cope effectively with accelerating and complex forms of change. It involves the integration of various interconnected systems that work together to navigate uncertainty and address emerging challenges. Anticipatory governance can be conceptualised as a 'systems of systems' approach, encompassing multiple components that enhance its effectiveness.

The first key component of anticipatory governance is the disciplined foresight–policy linkage. It emphasises the importance of integrating strategic foresight into the policymaking process. By systematically scanning the horizon for potential future

97 Deon Cloete, "Futures Literacy in Mining: Empowering the African Mining Vision" (Policy Briefing 196 , SAIIA, Johannesburg, June 2020).

developments and analysing their implications, decision makers can anticipate emerging trends, risks and opportunities. This foresight informs the development of proactive policies that are aligned with preferred outcomes. The disciplined foresight–policy linkage ensures that decision-making is future-oriented, enabling governance to adapt and respond effectively to changing circumstances.

Another critical element of anticipatory governance is networked management and budgeting to mission. It recognises the need for coordinated efforts across different sectors and stakeholders to address complex challenges. Networked management involves establishing collaborative networks and partnerships among government agencies, civil society organisations, businesses and international institutions. These networks facilitate information sharing, joint problem-solving and the pooling of resources and expertise. Budgeting to mission ensures that financial resources are allocated strategically, focusing on the mission and desired outcomes rather than being driven solely by historical precedents or short-term considerations.

Feedback systems play a crucial role in anticipatory governance. They allow for the monitoring and adjustment of policies and strategies in response to changing circumstances. Anticipatory governance should be able to identify and monitor events that are on the brink of visibility, allowing decision makers to detect initial indicators of change or disruption at an early stage. Feedback systems provide continuous feedback loops, enabling rapid adjustments based on the interactions between policies and problems. This adaptive approach allows governance to effectively address unexpected and discontinuous events.

Features and characteristics of anticipatory governance

Anticipatory governance, as defined by Fuerth, encompasses a systems-based approach to governance that copes with accelerating and complex forms of change. It encompasses establishing strong connections between foresight and policy, implementing networked management and budgeting practices aligned with a mission, and incorporating feedback systems for continuous monitoring and adjustment.[98] By incorporating these components, anticipatory governance enables governance systems to anticipate, self-organise and adjust rapidly in the face of uncertainty. It promotes proactive decision-making, fosters collaboration and enhances the capacity of governance to navigate evolving challenges and achieve desirable outcomes.

Key elements of anticipatory governance include:

- **Future-oriented thinking**: Anticipatory governance involves considering multiple possible futures, exploring alternative scenarios and understanding the potential consequences of different pathways.

98 Leon S Fuerth and Evan M Faber, "Anticipatory Governance Practical Upgrades: Equipping the Executive Branch to Cope with Increasing Speed and Complexity of Major Challenges" (National Defense University, Center for Technology & National Security Policy, Washington DC, 2012).Center for Technology & National Security Policy, 2012

- **Early detection and monitoring**: It emphasises continuous monitoring of emerging trends, signals and indicators to detect early signs of change or disruption. This allows decision makers to respond promptly and adapt their strategies accordingly.
- **Stakeholder engagement**: Anticipatory governance recognises the importance of engaging diverse stakeholders, including experts, communities and affected groups, to gather insights, perspectives and expertise. This participatory approach helps to ensure that policies and decisions are inclusive and address a broad range of concerns.
- **Policy experimentation and adaptive management**: Anticipatory governance involves adopting flexible and adaptive policy approaches that can be adjusted based on new information and feedback. It encourages experimentation and learning from the outcomes of policy interventions.
- **Collaboration and coordination**: It emphasises the need for collaboration and coordination among various actors, including government agencies, civil society organisations, businesses and international institutions. This collaborative approach facilitates information sharing, joint problem-solving and the pooling of resources and expertise.

Overall, anticipatory governance seeks to enhance the capacity of governments and societies to navigate complex and uncertain futures by being proactive, adaptive and inclusive in decision-making processes. It aims to create resilient and sustainable systems that can effectively address future challenges and capitalise on emerging opportunities.

By adopting complex adaptive systems thinking about critical minerals, actors can embrace uncertainty, acknowledge the interconnectedness of various factors and recognise the importance of feedback loops and emergent behaviours. This type of thinking allows us to approach problems with a systemic perspective, identify potential unintended consequences and develop anticipatory strategies that are more adaptive to changing circumstances.

Anticipatory governance is an intricate and adaptable approach, grounded in complex systems and futures thinking and designed to equip governance with the capability to effectively navigate and address rapid and intricate forms of change.[99] This proactive approach to decision-making and policy development aims to address future challenges and uncertainties by identifying and analysing potential risks, opportunities and alternative scenarios in advance. It involves engaging diverse stakeholders, considering long-term consequences and implementing adaptive strategies to shape desirable futures. This is done by exploring methods for collective intelligence gathering networks; designing reflexive feedback approaches to navigate diverse uncertain futures; and illuminating the various political implications to respond to events in the present at earlier rather than later

99 Leon S Fuerth and Evan M Faber, "Anticipatory Governance Practical Upgrades".

stages of development by experimenting with ready-made, multiple safe-to-fail options of speculative future imaginaries.[100]

By adopting anticipatory governance, the critical minerals ecosystem in Southern Africa can reap several benefits.

- **Enhanced decision-making**: Anticipatory governance facilitates future scenario planning, enabling policymakers and stakeholders to identify potential challenges, opportunities and uncertainties in the critical minerals sector. By considering various scenarios, decision makers can develop robust strategies that are adaptable to different outcomes, ensuring more effective and informed decision-making.
- **Sustainable resource management**: Anticipatory governance emphasises sustainable resource management practices. It involves assessing critical mineral reserves, promoting responsible extraction techniques and maximising resource efficiency. By taking a long-term perspective and considering environmental, social and economic impacts, anticipatory governance helps mitigate negative consequences and promotes sustainable development in the sector.
- **Technological innovation and skills development**: Anticipatory governance encourages investment in research and experimentation to drive anticipatory innovations in the critical minerals industry. This includes exploring alternative extraction methods, improving processing techniques and promoting mineral recycling and reuse. By focusing on advancements in experimentation, anticipatory governance addresses challenges related to resource scarcity, energy efficiency and environmental impacts, thereby fostering a more sustainable and resilient sector.

By embracing these principles, the region can navigate uncertainties, mitigate risks and seize opportunities in the critical minerals sector, ensuring long-term sustainability and socio-economic development.

100 Karlijn Muiderman et al., “Four Approaches to Anticipatory Climate Governance: Different Conceptions of the Future and Implications for the Present”, *WIREs Climate Change* 11, no. 6 (2020).

CHAPTER 7

Conclusion and recommendations

There is a complex interplay between global economic systems, critical minerals and the imperative for anticipatory governance in Southern Africa. As we stand at the cusp of transformative change, it is clear that existing paradigms are inadequate to guide us through the challenges and opportunities that lie ahead. Our conclusions are unequivocal: the need to re-imagine the critical minerals ecosystem and institute anticipatory governance is paramount for the region's sustainable and equitable future.

The implications of our research reverberate far beyond the confines of this report. The global shift towards cleaner energy sources and decarbonisation is irreversible, leading to an unprecedented demand for critical minerals. This demand presents an opportunity for Southern Africa, yet the complexities of extraction, coupled with vulnerabilities in current economic structures, could result in financial capture and limited local benefits. The status quo is untenable, and alternative paths must be forged.

While various policy alternatives have been proposed, their efficacy in reshaping the critical minerals landscape is limited. Relying solely on technology-driven solutions and conventional circular economy models falls short in addressing the systemic changes required. Similarly, continuing to operate within the current economic framework risks perpetuating historical inequalities and leaving countries with abundant resources trapped in a cycle of poverty and underdevelopment.

In light of the research findings and implications, we present a comprehensive set of recommendations that not only tackle the challenges but also create pathways towards a brighter future for Southern Africa:

- **Adopt an RBE**
  Embrace the RBE model, which harmonises industrial activity, resource utilisation and ecological realities. This paradigm shift envisions a sustainable equilibrium by integrating renewable energy systems, responsible resource extraction and a societal contract that prioritises sustainability and human rights.
- **Institute anticipatory governance**
  Establish anticipatory governance mechanisms that proactively respond to accelerating complexities. Cultivate a proactive, experimental and intentional approach to policymaking that anticipates and prepares for uncertainties, thus enhancing regional resilience and responsiveness.

- **Renegotiate resource trade agreements**
  Collaboratively revisit trade agreements to ensure that sustainability goals are met, economic advantages are broadly shared and the well-being of communities is prioritised over short-term gains.

- **Enhance investment climate**
  Develop and implement measures that mitigate investment risks while attracting foreign direct investment. This involves reassessing risk assessment methodologies, promoting regulatory transparency and fostering a conducive business environment.

- **Promote bioregionalism and re-localisation**
  Prioritise local production and consumption by promoting bioregionalism and re-localisation. Reduce dependence on global supply chains, enhance regional value chains and strengthen local economies while minimising environmental impacts.

- **Forge a new social contract**
  Establish a new social contract that promotes environmentally and socially responsible management of mineral resources. Foster equitable benefit distribution, strengthen cultural immune systems and address corruption to enhance trust between governments and societies.

- **Invest in research and capacity building**
  Commit to comprehensive geological surveys, technological advancements and capacity building to ensure the sustainable exploration and extraction of critical minerals. Develop strategies that ensure benefits are shared among participating countries and prevent imbalances.

Our research has illuminated a stark choice facing Southern African nations: embrace innovative pathways toward sustainable, equitable and resilient development or perpetuate historical inequities within an outdated economic framework. The recommendations provided are not mere conjectures but robust conclusions derived from thorough research and analysis.

Inaction is not an option; the global landscape is evolving rapidly, demanding proactive and bold action. The recommendations we put forth are not only feasible but necessary for steering Southern Africa towards a future that prioritises environmental sustainability, economic progress and social equity.

The critical minerals ecosystem is at the crossroads of opportunity and challenge. By embracing these recommendations, leaders, policymakers, industries and communities have the chance to redefine the trajectory of Southern Africa. Together, we can forge a future that is not only resource-balanced but also economically robust, socially just and environmentally resilient for generations to come. The time to act is now; the course of Southern Africa's future rests in our hands.

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