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# The Geoeconomic Circuit: China, Critical Minerals, and the Future of Africa's Energy Transition


Prof. Simone Mori

SUPERVISOR

Prof. Gianfranco Pellegrino

CO-SUPERVISOR

780501 Marilena Cuccaro

CANDIDATE


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# 1. Introduction

## 1.1 Background of the Study: A Continent at a Crossroads

Africa stands at a turning point, confronting a dual crisis that threatens to undermine its development aspirations while reshaping simultaneously its place in the global order. On one hand, the continent is gripped by profound energy poverty and an acute vulnerability to climatic degradation. On the other, the global shift towards clean energy gives rise to an unprecedented opportunity, one in which the People's Republic of China has emerged as a decisive and indispensable player. The intersection of these realities, Africa's needs, its resource wealth, and China's strategic interests, forms the rich context for this study.

### 1.1.1 The Dual Crisis: Energy Poverty and Climate Vulnerability

The first dimension of Africa's contemporary dilemma is a deep and long-standing shortage of energy. Sub-Saharan Africa is the global epicenter of energy poverty, being home to 588 million of the world’s 688 million people who lacked access to electricity in 2022, a staggering 85% of the global total (Independent Evaluation Group, 2024). Recent global shocks, including the COVID-19 pandemic and the energy crisis following Russia's invasion of Ukraine, have reversed a decade of progress, with the number of people without access increasing for the first time as population growth outpaced new connections (International Energy Agency, 2022). The Sub-Saharan Africa access rate to electricity lags at a mere 49%, masking a profound urban-rural inequality where 69% of rural populations lack access compared to just 19% in urban areas (Independent Evaluation Group, 2024). This deficit extends to more than just electricity; an estimated 970 million Africans lack access to clean cooking fuels and technologies, a deficit with disastrous health and gender implications that leads to 3.2 million premature deaths annually as a result of household air pollution (International Energy Agency, 2022). Overcoming this monumental challenge requires massive investment, with the financing gap to achieve the UN's Sustainable Development Goal 7 (SDG 7) of universal access estimated to be between US35billion and US50 billion annually (Independent Evaluation Group, 2024).

This lack of energy is juxtaposed against Africa's immense vulnerability to a climate crisis it had very little part in creating. The continent accounts for less than 3% of the world's energy-related carbon dioxide (CO2) emissions and only 7.2% of the world's greenhouse gas (GHG) emissions (International Energy Agency, 2022). But, as detailed in the Intergovernmental Panel on Climate Change (IPCC) reports, it is already experiencing more severe climate impacts than many other regions of the world (United Nations Development Programme, 2022). They are not future hypothetical threats but present realities, manifesting as widespread loss of biodiversity, serious water shortages, increasing frequency of extreme weather events, and reduced agricultural production, which has declined by 34% on the continent since 1961 due to climate change (International Energy Agency, 2022). The economic impact is colossal, and African countries are losing an estimated 2-5% of their Gross Domestic Product (GDP) annually to climate-related damages (Trisos et al. 2022). This risk is multidimensionally entrenched in the African economies, where 55-62% of the Sub-Saharan workforce is employed in climate-exposed, rainfed agriculture, and rapidly expanding informal urban centers heighten risks for the most vulnerable populations (International Energy Agency, 2022).

This background essentially redefines the story of Africa's energy transition. It is often presented as a difficult choice between development (prioritizing energy access) and climate action (prioritizing sustainability). Yet the empirical evidence suggests this is a false dichotomy. For Africa, climate inaction is a direct and immediate threat to development itself. Current economic and agricultural losses associated with climate change are actively suppressing growth potential. Therefore, the transition to resilient, sustainable energy systems is not a luxury to be pursued after development is achieved; it is a condition for securing a viable economic future.

### 1.1.2 The Rise of China: A New Pole in the Global Energy Order

Against a backdrop of acute need and systemic vulnerability, China has emerged as a transformative global force, reshaping the energy and development finance landscape. Over the past two decades, it has become the world's leading manufacturer of clean energy technology, achieving a level of scale and cost-effectiveness that no other nation can match. It possesses at least 60% of the world's manufacturing capacity for almost all mass-produced clean technologies, including solar photovoltaics (PV), wind systems and batteries, and holds 40% of the global market for electrolysers

(International Energy Agency, 2023). In 2022, China accounted for 80% of global solar PV module manufacturing capacity and installed as much solar PV capacity as the rest of the world combined the previous year (International Energy Agency, 2024).

This manufacturing dominance is enabled, in part, by China's strategic control of the midstream of the value chain: the processing of key raw materials. It is responsible for refining an estimated 90% of the world's rare earth elements (REEs) and between 60% and 70% of its lithium and cobalt (International Energy Agency, 2023). This vertical integration, from mineral refining to technology assembly, positions China as a central, and sometimes critical, partner in any nation's energy transition. This national industrial plan has profound geopolitical ramifications. While China is positioning itself as a world leader in green technology, its domestic energy security policy remains heavily reliant on coal. New coal-fired power plants have been approved to ensure grid stability (International Energy Agency, 2024). This reveals a multi-level strategy in which the 'green' aspect of its foreign policy serves not only as an environmental objective, but also as a powerful tool of industrial and geopolitical statecraft. By exporting its vast surplus of solar panels and batteries, China is capturing new markets for its industries, building soft power and, most significantly, creating long-term demand for the strategic minerals it is increasingly buying from Africa (International Energy Agency, n.d.).

China's position as a global investor is also extremely significant. As a result of initiatives such as the Belt and Road Initiative (BRI), Chinese institutions have become the leading financiers of African infrastructure projects (Green Finance & Development Centre, 2024). Between 2000 and 2023, China's two main policy banks, the China Development Bank (CDB) and the Export-Import Bank of China (Exim Bank), lent over USD 54 billion to finance Africa's energy sector (Ting & Zhang, 2024). In 2023, Africa became the largest regional destination for Chinese BRI investment, receiving USD 21.7 billion in investments and construction contracts (Green Finance & Development Centre, 2024). Following President Xi Jinping's 2021 pledge to stop building new coal-fired power stations overseas, lending has shifted dramatically towards 'small and beautiful' and greener projects. Renewable energy lending increased again in 2023 after two consecutive years of decline (Melber, 2024).

### 1.1.3 Energy Transitions for Inclusive Development

This thesis will explore the central dynamic created by the confluence of Africa's urgent needs and China's unparalleled capacity. For Africa, the energy transition is a fundamental pillar of its long-term development strategy, not merely an environmental policy choice, as articulated in frameworks such as the African Union's Agenda 2063 (African Union Commission, 2015). This continental vision aspires to a prosperous Africa driven by its own resources, with modernised infrastructure and universal access to affordable, clean energy for all its citizens (South African Institute of International Affairs, no date). The transition offers a historic chance to harness the continent's vast renewable energy potential, it boasts 60% of the world's best solar resources yet possesses only 1% of installed solar capacity, and avoid carbon-intensive development pathways (International Energy Agency & African Union Commission, 2021). A successful transition could build resilient economies, create millions of productive jobs, the International Energy Agency's Sustainable Africa Scenario projects 4 million new energy-related jobs by 2030, and enhance human welfare across the board (African Union Commission, 2015).

The relationship with China is thus one of immense potential and profound risk. While it offers a potential pathway to accelerating the realisation of Agenda 2063's goals, it also carries the danger of creating new structural dependencies that could influence the continent's developmental trajectory in the 21st century. The following table provides a comparative overview of the four case study countries, illustrating the direct link between their energy development profiles and their engagement with China in the critical minerals sector, to ground this complex dynamic in the specific empirical contexts of this thesis.

**Table 1. The Energy-Critical Minerals Nexus: The Role of Chinese Investment in Africa.**

| **Country** | **Electricity Access Rate (%) (2022)** | **Key Chinese Renewable Energy Project(s)** | **Primary Critical Mineral(s)** | **Key Chinese Mineral Investment/Control Share** |
|---|---|---|---|---|
| Kenya | ~75% | Garissa Solar Park (50 MW), Olkaria IV Geothermal | N/A (Focus on tech import) | N/A (Imports 96% of solar panels, 81% of Li-ion batteries from China) |

| Country | Electricity Access Rate (%) (2022) | Key Chinese Renewable Energy Project(s) | Primary Critical Mineral(s) | Key Chinese Mineral Investment/Control Share |
|---|---|---|---|---|
| Democratic Republic of the Congo (DRC) | ~21% | Inga 3 Hydropower (planned) | Cobalt (70% global production), Copper | CMOC, Huayou Cobalt. Control of 15 of 17 largest cobalt mines. |

*Sources: Author's compilation based on data from the World Bank and IEA (electricity access); USGS (mineral reserves); and analysis on Chinese investments from sources such as CSIS, Benchmark Mineral Intelligence, and the China Africa Research Initiative (CARI).*

This table clearly illustrates the core nexus that this thesis investigates. The table serves as a foundational reference point, establishing from the outset that the subsequent analysis is grounded in concrete, quantifiable data and specific corporate and project examples, thereby lending credibility to it.

## 1.2 Problem Statement

The confluence of Africa's developmental imperatives, the global climate agenda and China's strategic rise creates a complex and clearly defined research problem. First, this problem can be conceptualised as a development trilemma faced by African states. Second, it can be conceptualised as a specific, under-examined nexus in the Sino-African relationship that lies at the heart of this trilemma. African nations are pursuing three desirable, yet often conflicting, policy goals simultaneously, creating a formidable development trilemma:

1. Energy access: The imperative to electrify the continent in order to power industrialisation, improve human welfare and meet the basic development needs of a young and growing population. This goal demands a rapid and dramatic increase in energy generation and consumption (McMonigle, 2023).

2. Sustainability: A commitment to a green energy transition in order to mitigate the impacts of the climate crisis, with which Africa is uniquely confronted, and to align with global climate agreements such as the Paris Agreement (Trisos et al., 2022).

3. Sovereignty: The deep-seated political desire to achieve economic self-determination and control over national resources in order to chart an autonomous development path, thereby breaking free from historical patterns of external dependency and neo-colonial exploitation (Byemelwa, 2025).

These objectives often conflict with each other. The urgent push for energy access can lead to the prioritisation of readily available fossil fuels, particularly natural gas, over renewable projects that may have longer lead times or greater grid integration complexities (R., 2024). Conversely, pursuing sustainability through renewable energy while being overly dependent on a single external partner for finance, technology, and components can compromise economic and political sovereignty, creating new forms of dependency (Yu, 2023). Furthermore, asserting sovereignty through policies such as resource nationalism, including export bans or demands for local processing, can deter the foreign investment necessary to finance both energy access and the transition to sustainability (Maswana, 2009).

At the heart of this trilemma lies a specific, under-examined nexus in the Sino-African relationship. This thesis argues that China's engagement is not a series of disconnected projects but a coherent geoeconomic circuit. This circuit links the extraction of strategic raw materials from resource-rich African nations to the deployment of Chinese-made clean technologies in other African nations, creating a closed loop. Navigating the risks and opportunities of this circuit is the central challenge for 21st-century African policymakers.

## 1.3 Research Objectives

Based on the identified problem, this thesis has two main objectives:

**Objective 1**: To critically analyse the mechanisms and impacts of China's integrated investment strategy in Africa. This involves examining how China's financing models, technology exports and mineral acquisition practices collectively influence the clean energy transition and natural resource governance in the case study countries.

**Objective 2**: To systematically evaluate the risks and opportunities that this strategy presents to African resource sovereignty and inclusive development. This objective moves beyond a monolithic view of Chinese engagement, providing a balanced assessment of the potential for accelerated electrification and industrialisation against the backdrop of the risks of deepening dependency, debt distress and the perpetuation of extractive economic models.

## 1.4 Research Questions

To achieve these objectives, the study is guided by two main research questions which provide a precise framework for the thesis's inquiry.

**RQ1:** To what extent has China established an integrated geoeconomic circuit in Africa that connects the extraction of critical minerals with the deployment of energy infrastructure?

**RQ2**: What are the implications of this circuit for Africa's clean energy transition and the governance of its natural resources?

## 1.5 Significance of the Study

This research makes a significant contribution to academia and policy by providing a critical and timely analysis of one of the defining geopolitical and developmental phenomena of the 21st century. Its significance is threefold, spanning the theoretical, empirical and policy domains.

### 1.5.1 Theoretical Significance

The study engages with, and aims to contribute to, major theories of international political economy. It provides a contemporary re-evaluation of dependency theory (Maswana, 2009). By examining the Sino-African relationship, which represents a

distinct 'South–South' dynamic, the thesis will consider whether this constitutes a genuine departure from historical North–South patterns of exploitation, or whether it represents a new, more complex form of dependency. Focusing on the technology and value-chain gap between China and its African partners offers a modern perspective through which to evaluate the fundamental principles of dependency theory, which suggest that the economic structure of the global system perpetuates the underdevelopment of the 'periphery' by aligning its economy with the requirements of the 'centre' (Brautigam & Xiaoyang, 2011).

Furthermore, the research will contribute a valuable perspective to the literature on resource geopolitics (Klinger & Murtagh, 2022). Much of this literature is framed by great power competition, analysing the rivalry between the United States and China for access to strategic resources (Policy Center for the New South, 2022). This study shifts the analytical focus to the perspective of resource-rich African states, examining their strategies for navigating this competition, asserting their agency and protecting their national sovereignty (Wiseman, 2019). The study will investigate how African nations are attempting to leverage their newfound geopolitical importance in the global energy transition to rewrite the terms of their integration into the world economy.

### 1.5.2 Empirical Significance

The thesis will provide the rich comparative empirical evidence that is currently lacking in the literature. Moving beyond broad generalisations about 'China in Africa', the study will offer a granular, cross-country analysis of how the mineral-energy nexus manifests itself in different national contexts. The selection of two distinct case studies, Kenya, a major importer of Chinese technology with relatively high energy access; and the Democratic Republic of the Congo (DRC), the global epicentre of cobalt extraction, conflict minerals and deep Chinese mining-sector penetration, allows for a nuanced and robust comparative analysis (Global Energy Association, 2025). This approach will generate findings that are more detailed and generalisable than those from single-country or continent-wide studies.

### 1.5.3 Policy Significance

The findings of this research are intended to be directly and immediately relevant to a range of critical stakeholders. For example, for African policymakers and regional bodies such as the African Union, the study will shed light on the strategic trade-offs involved in negotiating with Chinese entities. It provides evidence-based recommendations for strengthening governance frameworks, designing effective local content policies, promoting regional value chain integration and enhancing bargaining power. For Chinese state and corporate actors, the analysis will highlight the long-term reputational and political risks associated with business models perceived as extractive, which neglect local development priorities and generate social and environmental backlash. Finally, the research will offer multilateral institutions and Western partners a more nuanced understanding of the competitive landscape, revealing the challenges and opportunities involved in developing more effective, attractive and sustainable alternative partnership models that align with Africa's development goals. The study's significance is amplified by its timing. It is being conducted at a critical juncture where the global energy transition is a present-day reality, driving massive investment and geopolitical realignment, rather than a distant prospect. This has transformed Africa's mineral wealth from a simple commodity into a key strategic asset in the 21^(st)-century global economy (Policy Center for the New South, 2022). At the same time, African institutions are formulating new continent-wide strategies, such as the African Green Minerals Strategy (AGMS), to avoid repeating the 'resource curse' of the past and capture more value from their resources (Matsome & du Plooy, 2023). This thesis addresses this live and urgent policy debate directly, providing the necessary empirical evidence and analytical frameworks to inform these nascent strategies before development pathways are set in stone.

## 1.6 Scope

The empirical investigation focuses on four sub-Saharan African countries: the Democratic Republic of the Congo (DRC), Ethiopia, Kenya and Zimbabwe. These countries were strategically selected to provide a diverse and comparative sample, representing different mineral resources, energy profiles, systems of governance, and levels of engagement with Chinese investment.

The primary analytical focus is on the role of the People's Republic of China. This includes its state-owned enterprises (SOEs) in the energy and mining sectors, its key policy banks (China Exim Bank and the China Development Bank), and its private

firms involved in technology export and mineral acquisition. While the role of Western actors (governments and corporations) and multilateral institutions (e.g. the World Bank and the IMF) is discussed, this is primarily to provide a comparative baseline against which the uniqueness of Chinese engagement can be understood, and to contextualise the Sino-African relationship within the broader geopolitical landscape (Nnajiofor, 2020).

The research centres on the intersection between the renewable energy sector (specifically utility-scale solar, wind and hydropower projects) and the critical minerals sector (with a primary focus on cobalt and lithium, which are pivotal to battery technologies).

## 1.7 Limitations

As a desk-based study, this research project relies exclusively on publicly available secondary data. This includes academic journals; official reports from international organisations such as the IEA, IPCC and World Bank; publications from policy think tanks such as the ODI, CSIS and Chatham House; government documents from China and the case-study countries; and reporting from reputable international news outlets. The study is therefore limited by the availability, accuracy and potential biases inherent in this data. Primary data collection through fieldwork, surveys or elite interviews was not included, despite the fact that these methods could have provided deeper qualitative insights into decision-making processes and local impacts.

The socio-economic and political outcomes observed in the case study countries result from multiple, intersecting factors, including domestic governance structures, historical legacies, civil society activism and the influence of various international partners beyond China. While this thesis acknowledges the significant and often decisive role of Chinese engagement, it also recognises the analytical difficulty of isolating causality. The aim is therefore to analyse China's influence on, and contribution to, the observed outcomes within this complex system, rather than claiming sole or exclusive responsibility for them.

# 2. Literature Review and Theoretical Framework

This chapter presents an extensive overview of the policy and academic literature on which this thesis relies. It aims to add a profound insight into the complex interlinkages between Africa's energy transition, its involvement in the international supply of strategic minerals, and the geopolitical dynamics of its relations with other countries, particularly China. The chapter begins by examining the key challenges of energy access on the continent and the two approaches, centralised and decentralised, being pursued to address them. It then turns to the extractive sector, charting Africa's geostrategic significance as a source of minerals that are indispensable in the global green economy, alongside critically analyzing the ruinous social and environmental impacts of such extraction. Analysis then focuses on China's role as a rising external power, examining the operations of its outreach through the Belt and Road Initiative (BRI), concessional lending, and controversial 'resources-for-infrastructure' deals.

From this empirical literature review, the chapter formulates a theoretical framework to guide the thesis. This synthesis is derived from four seminal theoretical paradigms: the Political Economy of Development; Resource Dependence Theory and the 'resource curse' hypothesis; the South–South Cooperation paradigm; and Strategic Bargaining Theory. By a critical analysis of the deployment of such theories in the context of Africa, this section forms an integrated analytical framework for the research. Finally, the chapter concludes by integrating the literature review in order to identify a significant research gap: the lack of an integrated, cross-sectoral analysis of the clean energy and extractive industries with the wider geopolitical implications. This research attempts to bridge this gap and make its principal analytical contribution in doing so.

## 2.1 The Energy Trilemma in Africa

Discussions on the development of Africa in the 21st century cannot be separated from its energy sector. The continent is currently experiencing a profound energy "trilemma," a complex and interrelated challenge of enlarging energy access to hundreds of millions, ensuring the environmental sustainability of its power systems

in the face of climate change, and maintaining prices as affordable as possible for consumers and national economies (Stancich, 2023). African nations' handling of this trilemma will be the determinant of their future economic development, social welfare, and climate resilience (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2022).

### 2.1.1 Quantifying the Challenge: The Scale of Energy Poverty

The global literature by prominent agencies like the International Energy Agency (IEA) and the World Bank paints a grim picture of the energy deficit in the continent. In 2022, approximately 600 million Africans, representing 43% of the population, lacked access to electricity (International Energy Agency, 2022). Sub-Saharan Africa is the epicenter of this crisis worldwide, with 588 million of the 688 million unlit globally or a staggering 85% of the global total (International Energy Agency, n.d.). This is not an absolute challenge; in fact, the COVID-19 pandemic and 2022 energy crisis reversed some of the previous progress in expanding access (Independent Evaluation Group, 2015).

The situation is even more dire when it comes to access to clean cooking facilities. An estimated 970 million Africans rely on the traditional biomass (i.e., firewood and charcoal) for cooking, whose use has calamitous implications (International Energy Agency, 2022). The IEA has put a figure of over 500,000 premature deaths annually resulting from the household air pollution of these practices and comments on the enormous social cost, particularly to women, who spend many hours gathering fuel at the expense of education and economic opportunities (International Energy Agency, 2022). Recent hikes in the price of Liquefied Petroleum Gas (LPG), a leading clean alternative in urban settings, have pushed an estimated 30 million people back to dirty cooking fuels, pointing to the fragility of progress (International Energy Agency, 2022).

This energy poverty is characterized by a wide urban-rural divide. For the entire Sub-Saharan region, 69% of the rural population is without electricity, a figure several times higher than the 19% in cities and towns (Independent Evaluation Group, 2015). This intra-regional divide is central to the issue, with over 80% of the continent's un-electrified population residing in these rural regions (Independent Evaluation Group, 2015). To achieve this, the IEA's ambitious Sustainable Africa Scenario (SAS) puts an

estimate on universal access by 2030 as electrifying 90 million people annually, three times the rate achieved in recent years (Independent Evaluation Group, 2015).

### 2.1.2 Pathways to Electrification: Centralised vs. Decentralised Models

The literature accounts for a two-pronged approach towards meeting this colossus of a challenge, with recognition that one solution is not able to meet the continent's varied geography and settlements.

The initial route is by the densification and extension of traditional centralized national grids. Grid extension is the most cost-effective and least-expensive option for nearly 45% of the population to be reached by 2030, particularly in urban and peri-urban areas (International Energy Agency, 2022). This is being led by large-scale regional integration megaprojects, e.g., the West African Power Pool (WAPP), which is financed by the World Bank and aims to create bigger, more stable energy markets and facilitate cross-border electricity trading between 14 countries (World Bank, 2025). These efforts benefit from economies of scale and can help to decrease wholesale power prices, as with the North Core Interconnection Project, which decreases costs by 40% (World Bank, 2025).

Yet for the remaining unserved, especially those in remote, low-density rural locations, Decentralized Renewable Energy (DRE) systems are increasingly viewed as the most viable, effective, and often lowest-cost pathway to electrification (World Bank, n.d.). This second pathway encompasses a range of off-grid alternatives, primarily solar-based, including community-level mini-grids and stand-alone solar home systems (SHS) (International Energy Agency, 2022). This is strongly backed by scholarly research. Ighravwe and Olanrewaju, in a 2025 publication, using a multi-criteria decision model, identified DRE solutions as the most feasible way of lowering energy disparity among disadvantaged Sub-Saharan African communities (International Energy Agency, n.d). DREs also possess certain advantages, including rapid deployment, improved resilience to grid outages, and the potential to energize local economies by powering productive uses in small enterprises and agriculture (World Bank, 2023). Geospatial modeling by the World Bank shows that DRE is the fastest and most optimal means of providing clean electricity to more than half of the unelectrified population in Eastern and Southern Africa (Bah, 2022).

The unambiguous message is that Africa's future energy is not monolithic but dichotomous. A "one-size-fits-all" solution will inevitably fail. Suitable national energy planning must be double-tracked, with complementary electrification strategies that purposively engage both grid extension with a centralized system and an emerging private sector-driven DRE market (World Bank, 2023). The two infrastructures have distinct regulatory systems, financing tools, and ownership models, posing a grave governance challenge for policymakers (Deutsche Gesellschaft für Internationale Zusammenarbeit, 2022).

### 2.1.3 The Financial Bottleneck: Cost of Capital and Investment Gaps

The principal impediment to the growth of African energy potential is not the deficiency of resources or the lack of suitable technology but a profound and pervasive financial strait. Africa is rich in renewable energy resources; it possesses 60% of the world's best solar resources, yet merely 1% of global installed solar PV potential (International Energy Agency, 2022). Africa has attracted a mere 2% of global investments in renewables during the last two decades, a percentage tragically at odds with its promise and requirements (International Energy Agency, 2023).

The IEA estimates that to achieve universal access and climate goals by 2030, annual energy investment in Africa must more than double, rising from the current level of approximately USD 110 billion to over USD 200 billion (Energy Central, 2023). The investment required for universal modern energy access alone is pegged at USD 25 billion per year, a sum, as the IEA poignantly notes, equivalent to the cost of a single large liquefied natural gas (LNG) terminal (International Energy Agency, 2023).

The underlying cause of this investment shortfall is the prohibitively expensive cost of capital for clean energy projects across the continent. Utility-scale solar projects in nations such as Kenya and Senegal have a Weighted Average Cost of Capital (WACC) ranging from 8.5% to 9%, which exceeds the range of 4.7% to 6.4% observed in North America and Europe (Energy Central, 2023). It has been reported that, in certain instances, African capital costs have been documented as being three to seven times higher in comparison to those observed in developed economies (Global Solar Council, 2024). The high financial cost is driven by a perception of high risk by private financiers. These include political and macroeconomic uncertainty, regulatory risk,

poor transmission infrastructure, and doubts regarding the credibility of off-takers (the buyer companies, usually state utilities, of the power) that increase borrowing costs and make most otherwise creditworthy clean energy projects financially unviable (Energy Central, 2023).

This dynamic reveals a core reality: the African energy trilemma is essentially a funding and governance issue. The continent has tremendous renewable energy potential, and this is both economically and technically feasible. However, it is being held back by a vicious cycle. The perception of risk affects the cost of capital, thereby increasing the cost of clean energy projects and undermining the 'affordability' pillar of the trilemma. This has a significant impact on the deployment of 'sustainable' sources of energy, further exacerbating the lack of 'access'. Therefore, the most critical lever for Africa's energy transition is not technological innovation itself, but the political and economic space. Institutional changes and policies that effectively de-risk private investment, such as regulatory certainty, improved governance, improved national credit ratings and specialised financial instruments like guarantees, can break this cycle and attract the necessary funds to power the continent's future (Energy Central, 2023).

## 2.2 The Geopolitics of Green Minerals: Africa's Extractive Frontier

In fact, the global transformation to a low-carbon economy is a transition to higher mineral intensity. Low-carbon power technologies, from electric vehicle (EV) batteries to windmills and solar panels, consume huge quantities of specific minerals. The World Bank has estimated that to meet international climate objectives, production of minerals such as graphite, lithium and cobalt could have to increase by almost 500% by 2050 from 2018 levels (Stimson Center, 2025). This requirement makes Africa, with its huge and largely untapped mineral resources, the center of the 21^(st) century new geopolitical and geoeconomic order (Modern Diplomacy, 2024).

### 2.2.1 The Material Basis of the Green Economy

A review of the technical literature identifies the criticality of a host of minerals, the majority of which occur in vast amounts in Africa.

Cobalt is a crucial component of the cathodes in most lithium-ion batteries. It provides essential thermal stability, preventing overheating and fire, and also boosts the energy density and longevity of the battery. These attributes render it essential for the long-lasting, high-performance batteries that the EV industry requires (Trafton, 2024). The most common EV battery chemistries, such as lithium-nickel-manganese-cobalt-oxide (NMC), contain 10-20% cobalt (Trafton, 2024).

As the lightest of all metals with high electrochemical potential, lithium is the foundational element of modern rechargeable batteries. Its ability to store large amounts of energy in a lightweight package is what makes both EVs and grid-scale energy storage systems viable (Recycle Technologies, 2023).

Rare Earth Elements (REEs), despite their name, are actually not extremely rare but difficult to profitably mine and process (Wiseman, 2023). A specific subset, neodymium, praseodymium, dysprosium, and terbium, are vital to making high-strength, high-heat-resistant permanent magnets used in direct-drive generators of huge wind turbines and electric vehicle motors of high efficiency (Hoffs, 2023). These magnets facilitate more lightweight, smaller, and more reliable designs with the removal of mechanical gearboxes (Hoffs, 2023).

### 2.2.2 Africa's Centrality in Global Supply Chains

The African continent holds a strategically significant position in the global supply of these and other critical minerals. This geostrategic importance is best illustrated through a quantitative overview of its reserves and production.

**Table 2. Global reserve and production shares for selected critical minerals in Africa.**

| Mineral | Country | Reserve Tonnage (metric tons) | Global Reserve Share (%) | 2023 Production (metric tons) | Global Production Share (%) |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Cobalt | DRC | 6,000,000 | 52.8% | 170,000 | 73.0% |
| Cobalt | Madagascar | 100,000 | 0.9% | 4,000 | 1.7% |
| Cobalt | Morocco | 13,000 | ~0.1% | 2,300 (2021) | 1.4% (2021) |
| Lithium | Zimbabwe | 310,000 | 1.0% | 710 (2021) | 1.0% (2021) |
| Lithium | DRC | 3,000,000 (part of combined) | 6.0% (combined Africa) | - | - |
| Lithium | Mali | 800,000 (part of combined) | 6.0% (combined Africa) | - | (Set to be 2nd largest producer) |
| Manganese | South Africa | - | >60% (with Gabon, Ghana) | - | >60% (with Gabon, Ghana) |
| Graphite | Mozambique | 25,000,000 | 13% (with Tanzania) | - | 14% |
| PGMs | South Africa | - | 80% | - | - |

*Source: the U.S. Geological Survey (USGS), Mineral Commodity Summaries, January 2024.*

As the table shows, the Democratic Republic of Congo (DRC) is the cobalt superpower by a long shot, producing nearly three-quarters of the world's supply and holding over half of its known reserves (Natural Resources Canada, 2023). This level of concentration makes the entire EV supply chain highly susceptible to the stability and policy of a single country. Beyond cobalt, Africa is a new frontier in lithium, with Zimbabwe already a major global producer and countries like Mali, the DRC, Ghana, and Namibia holding large, often unexploited, deposits (International Monetary Fund, 2024). The continent's role extends to other critical materials, like manganese, platinum-group metals (PGMs), bauxite, and graphite, that are essential to a variety of clean energy and industrial applications (African Green Minerals, n.d.).

### 2.2.3 The "Extractive Dilemma"

While completing this mineral wealth presents a more significant economic prospect, its extraction is filled with starkly adverse externalities, presenting a profound challenge of "extractive dilemma" for host nations and a moral dilemma for world society. The pursuit of a "clean" energy future for the Global North is literally causing environmental devastation and human rights crises in the Global South. This is no tragic side effect but a structural aspect of the existing global supply chain, which de

facto produces "sacrifice zones" in rich mineral areas to fuel the green transition in other places (RAID, 2024).

The ecological cost of this latest wave of extraction is staggering. Lithium mining, for example, uses a lot of water. In South America's "Lithium Triangle", evaporation mining from brine pools consumes two million litres of water to produce one tonne of lithium, placing severe strain on water resources in already arid regions (AIDA, 2023). Hard-rock and mineral mining for lithium are energy-intensive processes with an extremely high carbon footprint, estimated to be three times that of brine mining (Lithium Harvest, 2025). In the DRC, the effects of the cobalt rush are catastrophic. Decades of artisanal and industrial mining have led to massive toxic contamination of rivers, lakes and soil by heavy metals and acid waste. This pollution has also destroyed local environments, wiped out aquatic life, rendered agricultural land sterile and contaminated drinking water sources for entire communities (Persson, 2023).

The human cost is equally tragic, particularly in the DRC's cobalt sector. The industry is plagued by institutionalised labour abuses, including dangerous working conditions where miners utilise simple equipment in unsafe, hand-dug tunnels without protective gear and risk being crushed (Davey, 2023). Extensive child labour is also prevalent, with reports estimating that as many as 40,000 children, some as young as seven, work in the mines for only USD 2.50 per day (Eaton, 2023). Regular exposure to toxic dust and contaminated water has created a public health crisis among miners, leading to high rates of respiratory and skin ailments, and most seriously, a significantly increased risk of severe birth defects among their offspring (Eaton, 2023). Furthermore, the establishment of large industrial mines has often involved the forced removal and displacement of indigenous groups with little or no adequate compensation. This results in the concentration of wealth from the mines, which sustains conflict and corruption over control of resources (RAID, 2024).

The extremely high concentration of critical minerals such as cobalt in one geographical area is a double-edged sword. While it theoretically gives producer countries like the DRC significant geopolitical leverage and bargaining power, it also leaves the international clean energy supply chain extremely vulnerable to any form of localised instability, whether political or policy-related. However, it also leaves the international clean energy supply chain extremely vulnerable to any form of localised instability, whether political — such as unrest or conflict — or policy-related, which would have immediate and severe consequences for the EV and battery industries worldwide (Wiseman, 2023). For the host nation, this concentration creates hyper-economic dependence on a single commodity and typically a single major purchaser.

This ironically dilutes its effective negotiating power and exposes it to the well-documented issues associated with the 'resource curse' (African Development Bank, 2007). This creates a high-stakes geopolitical rivalry in which the producer's latent power is continually tested by its own economic vulnerability and the strategic actions of powerful consumer states seeking to minimise supply risk.

## 2.3 China-Africa Relations

In the context of external players influencing Africa's development path, China is the most powerful and disruptive actor in the last two decades. Its intervention, marked by huge financing of infrastructure and intensive interest in acquiring resources, has entirely reshaped the economic and geopolitical dynamics of the continent. This relationship is in large part characterized by the Belt and Road Initiative (BRI), which provides a strategic canopy over a range of disparate initiatives, and is often executed through advanced financial tools such as concessional loans and "resources-for-infrastructure" swaps.

### 2.3.1 The Belt and Road Initiative in Africa

Launched in 2013, the BRI has since become the primary coordinating framework of Chinese foreign economic policy. Across the African continent, it has been widely embraced, with 52 out of the continent's 54 states, plus the African Union (AU), signing cooperation agreements or memoranda of understanding (Feng, 2025). The appeal of the program is that it will address the vast infrastructure shortfall in Africa, the principal constraint on its economic development (Feng, 2025). China has emerged as the continent's largest single financier and builder of infrastructure, starting projects that span transport (ports, railways, roads) to energy (hydropower dams, electricity grids) (Feng, 2025).

Exceptional examples of BRI projects are witnessed throughout the continent. They include Kenya's port city of Mombasa to its interior Standard Gauge Railway (SGR), the Addis Ababa-Djibouti Railway providing the landlocked nation of Ethiopia with a lifeline trade route, and Mozambique's Maputo-Katembe bridge, Africa's longest suspension bridge (de Kluiver, 2024). What is distinctive about these projects is their

speed of implementation. Chinese SOEs have a tendency to operate on a turnkey basis, delivering tangible products at much quicker rates than traditional Western-designed development partners, whose financing has a tendency of entailing slower repayment terms and complicated conditionalities based on governance and policy change (Masamba, 2025). The BRI is, however, different. In response to allegations of debt sustainability and the environment, Beijing has more recently promoted a "small and beautiful" strategy as an indication that it is shifting to smaller, cleaner, and less economically hazardous projects (Agence France Presse, 2024).

### 2.3.2 The "Resources-for-Infrastructure" Model: A Critical Assessment

Another highly controversial financing vehicle in the China-Africa relationship is the 'resources-for-infrastructure' (R4I) model. Under this model, Chinese loans for infrastructure construction are collateralised and serviced with future revenues from a host country's natural resource exports (Quest Metals, 2025). This enables resource-rich but capital-poor nations to leverage their subterranean wealth to finance urgently needed development projects without making initial fiscal outlays.

This model was first implemented in post-civil war Angola, where multibillion-dollar lines of credit, backed by future oil deliveries, were provided by Chinese banks to finance a substantial national reconstruction programme. This became widely known as the 'Angola Model' and was applied as a template for Chinese engagement elsewhere (Usman, 2021). Another high-profile example is the Sicomines contract in the DRC: a landmark agreement that granted a group of Chinese SOEs access to substantial copper and cobalt reserves in exchange for a multi-billion dollar commitment to construct roads, hospitals and other infrastructure (Landry & Tang, 2025).

The R4I model has been praised for its ability to mobilise finance for risky countries and for developing a repayment mechanism that bypasses overt state treasury corruption by providing a direct transfer of funds from the purchasing resource company or escrow account to the Chinese contractor developing the infrastructure (Davis et al., 2023). However, it has attracted significant criticism. These deals have been criticised for being opaque, raising concerns about whether the host country receives a fair market price for its resources. They can expose a country to the dangers

of unstable commodity prices and tie it into long-term supply agreements that limit its economic diversification and future policy choices (AERC, 2018).

This dynamic reveals a deeper strategic logic. China's engagement is not merely a series of disconnected trade and investment deals but a systematic effort to construct a vertically integrated geoeconomic supply chain. Chinese entities finance and control the *extraction* of critical minerals in countries like the DRC and Zambia (Quest Metals, 2025). They then finance and build the dedicated infrastructure, railways and ports, explicitly designed to transport these raw materials efficiently to the coast for export (Tucker, 2025). Finally, China dominates the global midstream processing and refining of these minerals, turning them into the high-value inputs required for its manufacturing industries (Tucker, 2025). This closed-loop system brilliantly serves China's strategic objective of resource security. However, for its African partners, it risks cementing their structural position at the lowest end of the value chain, exporting raw commodities while hindering the development of their own domestic processing and industrial capabilities (Sengupta, 2025).

### 2.3.3 Concessional Loans and the Debt Sustainability Debate

The financial underpinning of this strategic engagement is a vast portfolio of Chinese loans. Between 2000 and 2022, Chinese lenders extended over USD 170 billion in loan commitments to 49 African countries and regional institutions, making China the continent's single largest bilateral creditor (Observer Research Foundation, 2023). This financing is heterogeneous, ranging from grants and interest-free loans (IFLs) for public facilities to concessional and commercial-rate loans for large infrastructure projects (de Kluiver, 2023).

The terms of these loans are often complex and opaque. Research by AidData and others has revealed that Chinese loan contracts frequently include clauses that differ significantly from those of Western lenders. These can include extensive confidentiality clauses that prevent public scrutiny, waivers of sovereign immunity that allow for arbitration in foreign jurisdictions, and "no Paris Club" clauses that prohibit the borrower from seeking comparable debt restructuring terms with other creditors (Usman, 2021).

This has ignited a heated debate over "debt-trap diplomacy," a fiction China seeks out debt intentionally to gain strategic assets and political influence from debtor nations

(de Kluiver, 2023). The huge external debt of countries like Djibouti, Angola, and Zambia, where a high percentage is owed to China, is however most frequently invoked as evidence (Democracy in Africa, 2025). The case of Kenya's SGR, where the Mombasa port was purported to be offered as collateral, has been at the heart of this issue (Vines, Butler, & Yu, 2022).

However, a growing body of scholarly and policy writing presents a more nuanced picture and refutes the more sensationalist narratives of the debt-trap thesis. Many scholars argue there is limited empirical evidence that China knowingly assumes control of state assets in the case of default (ISS Africa, 2023). They maintain that while China's lending, albeit risky, is not the sole cause of Africa's debt problems, which are also being driven by borrowing from private bondholders, weak domestic governance, as well as external economic shocks (Democracy in Africa, 2025). Moreover, this perspective highlights the agency of African elites, who actively seek Chinese financing for its speed and lack of political conditionalities, theorizing a more complex dynamic of mutual complicity rather than a simple predator-prey relationship (Vines, Butler, & Jie, 2022). China's behavior is also that of a pragmatic lender recalibrating for risk; its lending to Africa peaked in 2016 and has dropped precipitously since, indicating a rebalancing of its risk exposure as much as a callous attempt to entrap more countries (de Kluiver, 2024).

To better understand the heterogeneous nature of this engagement, the following table provides a comparative overview of several prominent Chinese-financed projects.

**Table 3. Typology of major Chinese-financed projects in Africa**

| Country | Project Name | Sector | Financing Model | Reported Cost / Loan Value | Key Issues / Outcomes |
|---|---|---|---|---|---|
| Kenya | Standard Gauge Railway (SGR) | Transport (Rail) | BRI Concessional Loan | ~USD 5 billion | High cost, debt sustainability concerns, viability questioned, 'no Paris Club' clause. |

| | | | | | |
|---|---|---|---|---|---|
| Angola | Post-War Reconstruction | Multi-sector (Roads, Energy, etc.) | Resources-for-Infrastructure (Oil-backed loans) | >USD 42 billion (total loans) | Pioneered the 'Angola Model,' fueled oil dependency, concerns over elite capture and wealth inequality. |
| DRC | Sicomines Copper-Cobalt Mine | Mining & Infrastructure | Resources-for-Infrastructure | Initial USD 6-9 billion deal, renegotiated. | Lack of transparency, questions over value-for-money on infrastructure, environmental concerns. |
| Ethiopia | Addis Ababa-Djibouti Railway | Transport (Rail) | BRI Concessional Loan | ~USD 4 billion | Enhanced trade for landlocked Ethiopia, but contributed to high debt burden. |
| Uganda | Entebbe Express Highway | Transport (Road) | BRI Concessional Loan | ~USD 476 million | High construction cost per km, loan contract clauses raised sovereignty concerns. |
| Zambia | Multiple Projects | Multi-sector | Multiple Chinese Lenders | >USD 6.6 billion debt to China | Extreme case of over-borrowing from numerous Chinese lenders, leading to debt default. |

*Source: Author's compilation data from the China Africa Research Initiative (CARI), the International Monetary Fund (IMF), and the World Bank.*

## 2.4 Theoretical Framework

In order to develop a rigorous analytical understanding of the complex dynamics outlined above and move beyond a purely descriptive analysis, this thesis adopts an integrated theory approach. No single theory can capture the interactions involved at different scales, ranging from global geopolitical shifts to the terms of individual mining agreements. Accordingly, this chapter revisits four alternative yet complementary theoretical perspectives: Political Economy of Development; Resource Dependence Theory; South–South Cooperation; and Strategic Bargaining. Each provides an essential piece of the analytical jigsaw, and together they form an integrated analytical framework through which the interplay between energy, minerals and geopolitics in Africa can be understood.

### 2.4.1 Political Economy of Development: The Macro-Context

This study is based on the Political Economy of Development (PED), which provides the broad context. Unlike the perception of development as a technical, linear process, the PED approach examines the intricacies of the political and economic forces that influence social outcomes. It is interested in the concentration of power and wealth among groups, institutions and domestic and foreign actors (Smith, 2020). A key assumption is that economic policy is never made in isolation, but is instead the result of political struggles, historical legacies, and prevailing ideologies (Ajakaiye, 2008).

In an African context, PED texts provide a nuanced perspective on the continent's long-standing development challenges. Researchers use these texts to explore the ongoing impact of colonial legacies such as extractive economies, divided political units and weak state institutions (Smith, 2020). This theory is also used to analyse the behaviour of post-independence African regimes, showing how political leaders often prioritise regime survival and patronage allocation over policies that promote extensive and sustainable development (Smith, 2020). PED is also necessary for criticising the dominance of external paradigms in African policymaking. From structural adjustment programmes and the Washington Consensus of the 1980s and 1990s, to the current dominance of Chinese financing structures, this perspective questions how external actors and their agendas may erode state control over development planning and create new dependencies (Smith, 2020).

### 2.4.2 Resource Dependence Theory and the "Resource Curse"

Whereas the Political Economy of Development (PED) provides us with the macro-context, Resource Dependence Theory (RDT) and its more widely popular corollary, the 'resource curse', offer a more specific perspective on the pathologies of the extractive industry. Essentially, RDT maintains that organisations, and thus states, necessarily depend on the outside world for essential resources. Consequently, one of the key drivers behind their behaviour is the enforcement of policies to manage such dependencies, reduce uncertainty and enhance autonomy (Davis & Cobb, 2009).

The 'resource curse' or 'paradox of plenty' powerfully illustrates this logic when applied to resource-rich nations. Contrary to intuition, the hypothesis argues that an abundance of valuable natural resources such as oil and minerals is often associated with negative development outcomes, including lower economic growth, increased conflict and more authoritarian rule (Natural Resource Governance Institute, 2015). Several causal mechanisms for this phenomenon are documented in African literature. These include 'Dutch disease', whereby a booming resource sector stimulates currency appreciation, damaging other tradable sectors such as manufacturing and agriculture; rent-seeking behaviour, whereby political and economic elites compete to capture enormous profits from resource extraction rather than investing productively; and the undermining of state accountability, whereby governments funded by resource revenues become less reliant on taxing their citizens and are therefore less accountable to them (African Development Bank, 2007).

However, the literature also provides strong warnings against deterministic explanations of the resource curse. Authors acknowledge that the 'curse' is not inevitable, but is heavily influenced by a country's institutions, its existing political situation, and its position within the global capitalist system (African Development Bank, 2007). The varied national experiences of countries such as Botswana (often cited as a success case) and Nigeria (the quintessential case of the curse) demonstrate that a country's natural resource endowment is not predetermined, but contingent on institutional and political factors (Fofack, 2023).

### 2.4.3 South-South Cooperation

The South-South Cooperation (SSC) framework is the discursive and ideological lens through which most of the contemporary relationship between China and Africa is understood and contested. SSC theory is rooted in postcolonial solidarity, as exemplified by the Bandung Conference and the Non-Aligned Movement. It is characterized by principles of mutual benefit, respect for national sovereignty and equality, and non-interference in internal affairs (Lee, 2025). SSC is presented as an alternative to the traditional, often hierarchical, donor-recipient framework of North-South development aid (United Nations Department of Economic and Social Affairs, n.d.).

China has strategically employed this narrative to inform its engagement with Africa, presenting itself as a 'development partner' rather than a donor (Ikenna, 2023). Chinese official discourse consistently emphasises an equal partnership based on shared historical experiences and a desire for development that is free from the political conditions of Western aid (Okolo, 2023). This 'win-win cooperation' rhetoric has been welcomed by most African leaders seeking alternative development paths (Feng, 2025).

However, a strong and growing body of critical scholarship challenges this official rhetoric. These works argue that, beneath the veneer of solidarity, the relationship between China and Africa is characterised by overwhelming power disparities (Eze & Ezeibe, 2021). They refer to trade flows indicating neo-colonial relations, whereby Africa exports mostly raw, unprocessed materials to China in exchange for value-added manufactured goods, resulting in negative trade balances and perpetuating Africa's dependence (Eze & Ezeibe, 2021). These arguments question whether SSC is actually a manifestation of horizontal solidarity or a new hegemony project that uses the rhetoric of the Global South to advance the strategic interests of a rising global power.

### 2.4.4 Strategic Bargaining

Finally, strategic bargaining theory provides the micro-foundational tools with which to consider the actual deal-making and negotiations present within the broader constructs identified by the other theories. According to bargaining theory,

international relations are a series of strategic interactions in which parties with conflicting interests negotiate to reach an agreement on how a resource is to be allocated (Taylor, 2021). The most important ideas include the relative bargaining positions of each party, their best alternative to a negotiated agreement (BATNA), which determines their willingness to end a deal, and the distinction between distributive bargaining, which is a zero-sum, win-lose fight over a fixed amount, and integrative bargaining, which is a cooperative, win-win contest to increase the amount available (Dennana, 2024).

This framework is particularly useful for examining negotiations over natural resources and infrastructure between African nations, foreign state parties and multinational firms (Odularu, 2024). The literature suggests that African governments approach these negotiations from a weaker position due to asymmetries in legal expertise, technical skills and information. This weakens their negotiating position and can lead to biased contracts (Mnookin, 1993). A country's heavy reliance on a single commodity (e.g. cobalt) or financier (e.g. China) can significantly undermine its BATNA, giving the other party considerable leverage (Kimani Mwangi & Co., 2024). Conversely, the theory also describes how African states may boost their leverage. For instance, geopolitical competition raises the BATNA of a state by offering alternative allies. By skilfully pitting the US and China against each other to gain access to critical minerals, a country such as the DRC can negotiate more favourable terms than it would be able to do alone with either power (Agbo, 2024).

Together, these four theories provide a robust, multi-level analytical framework. The Political Economy of Development provides the broader historical and institutional context. Resource Dependence Theory explains the plot, which is driven by the endowment of precious minerals. South-South Cooperation provides the contested narrative and script used by the actors. Strategic Bargaining Theory, meanwhile, illuminates the dialogue and transactional moves through which the plot unfolds. A comprehensive analysis involves considering all four levels together in order to understand how macro-structures, sectoral dynamics, narrative framing and micro-level negotiations intersect to produce development outcomes.

## 2.5 Identifying the Research Gap and Defining the Analytical Contribution

The most fundamental research gap lies at the intersection of these three areas (Mabera, 2024). There is a hidden absence of an overarching analytical framework that connects the dots within the entire global value chain and assesses its feedback loops with respect to African development. While literature exists on Africa's energy needs, its mineral wealth, and China's role, it rarely provides an interconnected analysis of the causal links and feedback loops within the entire geoeconomic circuit. This subsequently shapes Africa's energy transition and wider development prospects.

For instance, scholarship rarely asks how the terms of a resource-backed loan on a cobalt mine in the DRC would influence the country's sovereign risk profile and, by extension, the cost of capital for a national solar power project. Nor does it ask how the strategic bargaining leverage of an African state in a mining negotiation is predicated upon its simultaneous need to negotiate financing for its national grid. The intersection of clean technology production, extractive industries and geopolitical finance is under-theorised and under-examined. Traditional 'pit-to-port' analysis, which focuses solely on extracting raw materials from the ground and transporting them outside the nation for export, is insufficient for understanding a world in which those same materials are used to build the very energy systems the continent itself needs (Stimson Center, 2025).

This thesis is designed to directly address this research gap. Its primary analytical contribution will be to provide a novel, integrative analysis that systematically bridges the clean technology and extractive sectors within their geopolitical context. It will move beyond the existing siloed studies by employing a comparative, cross-sectoral methodology to examine the political and economic linkages between the global green transition and Africa's multifaceted development trajectory.

By operationalizing the multi-level theoretical framework developed in Section 2.4, this thesis will analyze how the global imperative for decarbonization is creating new forms of resource dependence, new arenas for strategic bargaining, and new challenges for governance in Africa. It will investigate how African states are navigating the dual pressures of being a supplier to the global green economy while simultaneously attempting to harness that same green economy for their own domestic development and energy access goals.

## 2.6 Research Design: A Pragmatic Mixed-Methods Approach

This study employs a pragmatic, mixed-methods design to investigate the complex dynamics of China-Africa energy relations. Pragmatism creates the ability to respond to the demands of capturing quantitative breadth and qualitative depth in preference to one orthodoxy methodology (Morgan, 2014). This type of approach is most appropriate for analyzing complex, real-world issues such as the current study (Creswell & Plano Clark, 2018).

The model is a sequential explanatory design:

• Phase 1 (Quantitative): The quantitative phase maps the macro level landscape of Chinese investment and finance in Africa from databases like the AEI's China Global Investment Tracker (CGIT) and Boston University's Chinese Loans to Africa (CLA) Database. The aim is to identify general patterns, trends, and anomalies in investment flows.

•Phase 2 (Qualitative): Phase 2 conducts a Case-Oriented Comparative Analysis (COCA) of four countries (Kenya and DRC) to explain the "why" and "how" of quantitative findings. This qualitative study is targeted towards questioning puzzles and creating causal explanations for patterns observed in Phase 1.

This mixed approach is the solution to slicing through the "data fog" that surrounds Chinese foreign investment, whose opacity is well documented (Brautigam, 2011). While the quantitative data maps what is happening, the qualitative case studies provide the "ground-truthing" to interpret the political, economic, and institutional forces driving the numbers.

## 2.7 Data Sources and Collection Strategy

This research builds a comprehensive dataset by triangulating quantitative and qualitative sources, a key strategy for increasing the validity of mixed-methods research (Creswell & Plano Clark, 2018).

### 2.7.1 Quantitative Data Corpus

The quantitative analysis triangulates over four significant data sources in order to prevent bias and construct a robust image of trade and financial flows:

• AEI China Global Investment Tracker (CGIT): Tracks high-value (⩾USD 95M) large-scale construction and investment projects, with open, transaction-level data (Scissors, 2025).

•BU Chinese Loans to Africa (CLA) Database: Offers the largest public database of Chinese lenders' commitments to loans by African public sector entities (Boston University Global Development Policy Center, 2025).

• China's Ministry of Commerce (MOFCOM): Outputs official aggregate statistics for Outward Direct Investment (ODI). While distorted and opaque, it is the official China story and a valuable point of reference (National Bureau of Statistics of China, 2024).

• Observatory of Economic Complexity (OEC): Offers detailed bilateral trade figures, required for tracking the trade of energy-related products (e.g., solar panels) from China and commodities (e.g., cobalt) to China (OEC, 2025).

### 2.7.2 Qualitative Data Corpus

Qualitative data provides the context and explanation setting for the research.

• Official Discourse and Policy Documents: They include key Chinese strategic reports (e.g., FOCAC Action Plans, Africa Policy Papers) and the case study countries' documents (e.g., Kenya Vision 2030 and national development plans of DRC).

• Secondary Literature: Synthesis of books, scholarly articles, think tank reports, and industry analyses provides critical background, delimits current debates, and helps in triangulation.

## 2.8 Case Selection: A Comparative Rationale

The selection of Kenya and the Democratic Republic of Congo (DRC) is a purposeful sampling method intended to maximize analytical leverage (Patton, 2015). The selection provides a high-contrast and theoretically insightful comparison between two fundamentally divergent models of Chinese involvement in Africa. The cases were chosen based on their high variability along three primary dimensions, a rationale allowing case studies to build and refine theory (George & Bennett, 2005):

1. Energy Resource Endowment & Chinese Engagement Model: Divides the difference between a model focused on the application of green technology (Kenya's geothermal) and a model revolving around strategic resource extraction (the DRC's critical minerals).

2. Host Country Governance Context: Contrasts a fairly stable, market-oriented state (Kenya) with a fragile state with high-level governance challenges (DRC).

3. Strategic Relevance to China: Contrasts a partner chosen as a showpiece for the "Green" Belt and Road Initiative (Kenya) with a key world source for strategic minerals critical to China's industrial and technological supply chains (DRC).

This framework allows for a structured comparison of two contrasting archetypes of interaction: The Green Technology Partnership (Kenya) and The Strategic Extractive Partnership (DRC). The rationale is set out in the selection matrix.

By focusing on these polar examples, the study can identify how China's strategy, investment, and technological engagement vary fundamentally across different host-country environments and strategic objectives, throwing into sharp relief the drivers beneath its Africa strategy.

## 2.9 Analytical Framework: Dimensions of Evaluation

To systematically assess and compare Chinese energy projects in Kenya and the DRC, this study uses an integrated framework based on the interplay of four key dimensions: Finance, Technology, Governance, and Risk. The analysis focuses on how different patterns of interaction among these dimensions define the distinct models of Chinese engagement in each country.

• Finance: Examines the capital structure, i.e., nature of capital (loans versus FDI), key lenders (e.g., China Exim Bank), lending terms, and financing models (e.g., EPC+F, resource-backed loans).

• Technology: Examines the nature of technology applied (e.g., geothermal drilling, extractive technologies), how advanced it is, and the extent of actual skills and knowledge transfer to local players.

• Governance: Analyzes the institutional context, including host country institution quality (e.g., rule of law, transparency), consistency of the project with national plans, and the impact of Chinese presence on local governance.

• Risk: Provides a comprehensive evaluation of sophisticated risks, including political, regulatory, financial (sustainability of debt), and Environmental, Social, and Governance (ESG) risks of China and host nations.

This framework's explanatory power is that it is able to explain why results differ so radically between the cases. For instance, the Risk of securing cobalt in the DRC necessitates a Financial model of state-guaranteed, resource-for-infrastructure loans tailored to a low-Governance environment, with purely extractive Technology. In Kenya, more stable Governance reduces Risk to investors, attracting more market-based Finance for more advanced geothermal Technology.

## 2.10 Limitations and Ethical Considerations

This study transparently acknowledges its limitations and is guided by a robust ethical framework.

### 2.10.1 Methodological and Data Limitations

The research recognizes the widely known caveats of the quantitative databases (e.g., investment thresholds, monitoring commitments versus disbursements) and the systemic challenges of data reliability in some African settings. These limitations are primarily overcome by the triangulation of diverse data sources. Moreover, this study bases its work on publicly available data and secondary literature, and does not require

primary fieldwork (e.g., interviews). The conclusions must be read within these parameters, since the research is not able to seize affected communities' micro-level lived experience.

### 2.10.2 Ethical Framework

The study is guided by a reflexive, post-colonial ethics based on the principle of "do no harm." (Smith, 2012). This involves:

- Researcher Positionality: Acknowledgment of the knowledge production power asymmetries in writing about Africa and conscientiously avoiding reproduction of oversimplification or neocolonial narratives.
- Respect and Dignity: In referencing data, documents, and actors with respect, mirroring the agency and complexity of African states and institutions.
- •Reciprocity: Being dedicated to sharing results in accessible formats (e.g., policy briefs) to assist in contributing to better-informed debate on the continent, viewing research as part of a global conversation and not an extraction of information in one direction.

# 3. China's Geoeconomic Circuit in Africa

This chapter empirically demonstrates and analytically confirms the existence of a strongly integrated, closed-loop People's Republic of China (PRC)-led geoeconomic circuit in Africa. The circuit is geographically structured to procure upstream key raw materials vital to China's green technology industries and, concurrently, create captive downstream markets for the created high-value finished products. The circuit logic is the production of metals like cobalt and copper in the Democratic Republic of Congo (DRC), their exportation shipment and processing in China, and the exportation and deployment of resulting Chinese-produced green technologies, like solar panels, grid hardware, and batteries, to countries like Kenya, frequently financed by Chinese policy banks. China's foreign economic policy is evolving beyond simple resource extraction and market access. The nation is now making an advanced move to construct and significantly control end-to-end transnational value chains.

This strategy unifies the Democratic Republic of Congo and Kenya into a continent-wide geoeconomic circuit, viewing them not as isolated examples of China's engagement but as symbiotic and archetypal focal points. The DRC is the foundational origin of inputs for China's continental industrial intentions in the green technology frontier. Its huge mineral resources, and particularly cobalt and copper, are not just an economic necessity but also a strategic necessity for Beijing to fulfill its dream of dominating the industries of tomorrow, from electric vehicles (EVs) to clean energy storage. Kenya, being the corresponding demand node, is one of the key end-markets of the products of that very industrial base. Its relative political stability, its expansive national development plans, and its vast energy needs render it a virtual consumer of the very technologies made possible by the DRC's minerals. Considering them as a package reveals the interlinked logic of resource extraction and technology deployment, and hence two sides of the same geoeconomic coin in China's continental strategy.

## 3.1 The Supply Node: The Democratic Republic of Congo (DRC)

This section establishes the Democratic Republic of Congo's fundamental role as the upstream, supply-side pillar of China's global green technology value chain. The analysis will demonstrate that China's engagement in the DRC's extractive sector is not merely an opportunistic commercial venture but a calculated strategic imperative. It is driven by the non-negotiable need to secure the foundational inputs required for its state-led industrial policy and its ambition to achieve global leadership in the technologies defining the ongoing energy transition. The DRC is thus positioned as the starting point of a geoeconomic circuit that fuels China's industrial machine.

### 3.1.1 The Strategic Prize: Securing Critical Minerals

The Democratic Republic of Congo is not merely another resource-poor nation in Africa, it is a fragment of one-of-a-kind worldwide importance. Its unparalleled cobalt deposits and impressive copper deposits of high grade make it the world's most important location for the global energy transition and, by extension, for the PRC's

ambition to become the master of the green technology sector. The country is believed to hold over 70% of global cobalt reserves and approximately the same percentage of annual production, a metal crucial for the lithium-ion batteries in electric vehicles and retaining renewable power (Gulley, 2024). Thus, Chinese state investment in the DRC is not diversified but extremely concentrated and strategically oriented and directly intended to obtain secure, stable long-term access to such specific mineral resources (Kafarhire, 2019).

The scope of this strategic focus can be viewed in transactional data. AEI China Global Investment Tracker, which monitors high-value cross-border deals (valued at USD 95 million or more), reveals a pattern of Chinese capital flowing overwhelmingly into the DRC's metals sector, dwarfing engagement in other parts of the economy (China Global Investment Tracker, 2024). This pattern points away from a diversified investment portfolio and towards a mission-oriented resource acquisition strategy. This conclusion is powerfully corroborated by more granular analysis from AidData, which reports that between 2008 and 2022, Chinese state-owned creditors channeled over 11 billion worth of grants and loans into just three giant mining projects in the DRC (Thome, 2025): Tenke Fungurume, Kinsenda, and the behemoth Sicomines project. This figure is remarkable in both absolute and relative terms; it represents 42% of China's total state-backed lending and grant exposure to the DRC over the time frame and reflects the singular, pre-eminent imperative to secure these critical mineral assets (Kafarhire, 2019).

Furthermore, this financial investment is designed specifically to be channeled into ownership. The investment is not speculative or passive but a means of acquisition and ownership. AidData finds that a whopping 95% of China's state-led loans to transition minerals in the DRC is directly committed to fund mining operations partly or entirely owned by Chinese nationals (Thome, 2025). This strategy is meant to make Chinese entities maintain direct ownership of the physical production of the mines in order to acquire a secure offtake of material resources that are channeled into China's domestic industrial supply chains. It is a strategy that circumvents the uncertainty and competition of open commodity markets, capturing the DRC's mineral resources and channeling them as a direct, assured feedstock for Chinese industry (Kafarhire, 2019).

**Table 4. Selected major Chinese investment & construction projects in DRC's extractive sector (2005-2024)**

| Project Name / Parent Company | Year(s) | Value (USD Billions) | Sector | Description |
|---|---|---|---|---|
| Sino-Congolaise des Mines (Sicomines) | 2008-2013 | 7.8 | Metals | Loans from Chinese creditors for the development of a copper-cobalt mine as part of a resource-for-infrastructure (RFI) deal. |
| China Molybdenum (CMOC) / Tenke Fungurume Mine | 2016-2017 | 2.7 | Metals | Loans from Chinese creditors to facilitate CMOC's acquisition of a majority stake in one of the world's largest copper-cobalt mines. |
| Jinchuan Group / | 2013-2022 | 0.526 | Metals | Financing from China Development Bank to |

| | | | | |
|---|---|---|---|---|
| Kinsenda Mine | | | | support the development and operations of a high-grade underground copper mine. |
| China Railway Group & Sinohydro | 2007 | 3.0 | Metals/Infrastructure | Initial mining investment component of the Sicomines RFI deal. |
| China Nonferrous Metal Mining Corp (CNMC) | 2018 | 0.5 | Metals | Investment in the Deziwa copper and cobalt mine, a joint venture with the DRC's state-owned Gécamines. |

*Note: This table is illustrative, drawing on project-level data from multiple sources to demonstrate the scale and focus of Chinese engagement. The AEI CGIT tracks large transactions, and the figures from AidData provide specific loan details for key projects.*

The data in Table 4 is concrete, transactional evidence for the chapter's argument. It moves beyond total statistics to document a chronic pattern of multi-billion-dollar state-backed financial commitments toward a limited number of world-class cobalt

and copper assets. The projects listed, Sicomines, Tenke Fungurume, Kinsenda, are not small-scale projects; they are some of the country's largest and most significant mining operations. The concentration of such enormous levels of financial leverage on these specific assets unquestionably mirrors a command-based approach to seizing the physical assets deemed essential to China's national industrial priorities.

### 3.1.2 The Operating Model (FTGR Analysis)

In order to safeguard its strategic mineral wealth in the DRC's famously complex and risky business environment, China employs a specially adapted and highly flexible operating model. It is much different from that employed by most Western private-sector investment practices. It is characterized by a synergy of state-directed finance, extractive technology employed for its own purposes, responsive and often impenetrable state-to-state systems of governance, and a sophisticated, state-backed apparatus for navigating the baffling political and economic risks attending the DRC. This FTGR (Finance, Technology, Governance, Risk) approach exhibits a sophisticated system focused on achievement of one master strategic objective: persistent delivery of vital minerals (Anderson, 2023).

**Finance: The Resource-Backed Model**

The paradigmatic financial instrument in the DRC is the "resource-for-infrastructure" (RFI) transaction, a formula that skillfully sidesteps the host country's budgetary constraint and high credit risk (Kafarhire, 2019). The archetypal case is the Sicomines deal, initially conceived in 2007. The agreement, initially valued at over 9 billion and later renegotiated to a still-massive 6 billion (3 billion for mining investment and 3 billion for infrastructure), granted a consortium of Chinese state-owned enterprises (SOEs), China Railway Engineering Corporation (CREC) and Sinohydro among them, huge rights of mining for copper and cobalt reserves (Jansson, 2013). In exchange, Chinese policy banks, headed by the Export-Import Bank of China, would lend to finance the development of much-needed infrastructure such as roads, hospitals, and universities that were appropriate to the political priorities of the then-President Joseph Kabila's Cinq Chantiers (Five Construction Sites) program (Jansson, 2013).

The geoeconomic logic of this model lies in its self-liquidating nature. The infrastructure loans are not secured against the unstable national budget of the DRC but against the future flow of revenue from the mining project itself (Jansson, 2013). This is a closed loop wherein the mineral production guarantees repayment of the infrastructure loan and, thereby, secures Chinese companies' resource offtake and offsets the lending risk for Chinese banks. However, this model has been severely criticized for the imbalanced outcomes. A report published in 2021 and ordered by the Extractive Industries Transparency Initiative (EITI) in the Democratic Republic of Congo identified that the deal represented an "unprecedented harm" to the national interest (Sicomines: How the EITI in DRC Helped Secure 4 Billion in Additional Revenue, 2024). A subsequent inspection by the DRC's Inspector General of Finance, which led to a renegotiation of the deal in 2023, determined that Chinese partners had earned nearly 10 billion in profit while the DRC had received only USD 822 million's worth of infrastructure, with the majority of the promised projects remaining unimplemented (Anderson, 2023). This captures a financial architecture aimed primarily at resource security for China, where the host country development comes in second and is in fact subordinate in practice.

**Table 5. Key terms of the Sicomines resource-for-infrastructure agreement (original vs. revised)**

| Component | Original Agreement (2008) | Revised Agreement (2009) |
|---|---|---|
| **Infrastructure Loan Value** | Up to USD 6 billion (in two tranches) | Maximum of USD 3 billion (second tranche cancelled) |
| **Mining Investment Value** | Approx. USD 3 billion | Approx. USD 3 billion (remained unchanged) |

| | | |
|---|---|---|
| **JV Ownership Structure** | 68% Chinese Consortium (CREC, Sinohydro); 32% DRC (Gécamines) | 68% Chinese Consortium (CREC, Sinohydro, Zhejiang Huayou Cobalt); 32% DRC (Gécamines) |
| **Mineral Concessions** | 10.6 million tonnes copper; 626,619 tonnes cobalt | 10.6 million tonnes copper; 626,619 tonnes cobalt (remained unchanged) |
| **DRC Gov't Guarantee** | Included a sovereign guarantee for the mining investment loan | Removed sovereign guarantee for the mining investment loan |

*Source: Synthesized from Jansson (2011), Landry (2018), and EITI reports.*

The negotiating history, set out in Table 5, shows the priorities and the pressures that were at stake. The renegotiation, which was led forcefully by the International Monetary Fund's warnings about the DRC's debt sustainability, pushed the reduction in value of the loan and, significantly, removal of the sovereign guarantee on the commercial mining loan (IMF, 2015). This shift emphasized the external limits on the model, but the essence of the agreement, the trade of mineral access for infrastructure, was maintained, upholding China's main strategic interest.

**Technology: A Purely Extractive Focus**

The technology-led component of China's DRC business model is characterized by a sole focus on upstream extraction and rudimentary first-stage processing. In terms of investment in, or transfer of, the value-added technologies of advanced refining, chemical processing, or manufacture, there is virtually none. The declared technological aim is maximum extraction of raw or semi-processed materials, ores, concentrates, or crudely refined metals, to be exported to China's much more technologically advanced and capital-intensive industrial system.

This technical segregation is a central process for value capture. Though some processing is done in-country, it is there primarily to re-concentrate the minerals to maintain shipping weight and cost. A seminal work published in PNAS stated that while a lot of artisanal cobalt is processed within the DRC, Chinese firms own and operate the mines in huge numbers and have them established to export the mineral to China's high-grade refineries (Gulley, 2023). The same is said in a World Bank report, where "Almost all refined cobalt that is imported from the DRC is re-refined and reprocessed in China or elsewhere to the level of high grade desired and to be closer to the market of consumers." (World Bank, 2021). This kind of division of labor maintains China's most value-adding phases of the value chain, in which raw materials are being transformed into high-tech high-value inputs, within Chinese borders. In doing so, Beijing confines the DRC to being an exporter of raw materials alone, thus preventing a domestic industrial base from being set up and keeping it at the low-end of the global value chain (Kafarhire, 2019).

**Governance: Opaque State-to-State Engagement**

China's approach to government is highly pragmatic and attuned to operate effectively within the weak and often opaque political environment of the DRC. It is state-led, often on an executive basis with little legislative input or public engagement (Kafarhire, 2019). The Sicomines contract negotiations were a prime example, with critics pointing to a profound absence of transparency and stakeholder engagement throughout the process.

This high-level, low-key style of deal-making confers gigantic advantages on the achievement of strategic objectives in the challenging governance environment. It allows Chinese parties to bypass the bureaucratic complexities, political opposition, and lengthy, transparent tendering processes that exclude Western companies subject to more stringent domestic and foreign regulation like the Foreign Corrupt Practices Act (Chen et al., 2005). By coming into line with the host country's ruling elite's political agenda, by offering headline-grabbing infrastructure projects that add to the government's legitimacy, China can obtain long-term, large-scale access to resources that might otherwise be out of its reach (Li et al., 2021). This isn't necessarily a matter of destabilizing the local government but one of operating within it in the most expedient way to obtain the top-line strategic goal, resource security, without too much bother.

**Risk: State-Led Mitigation**

The DRC is consistently identified as one of the world's riskiest investment destinations, crippled by political instability, regulatory risk, corruption, and civil war (IMF, 2015). For the majority of private players, these are risks too great to bear. China's state-led model is designed to absorb and disperse these risks in a manner to which private capital cannot aspire. The state itself, in the guise of its SOEs and policy banks, acts as principal risk manager (Tsai, 2015).

The RFI financial model lowers risk for lenders. It uses the DRC's future mine production as a guarantee for the loan, which safeguards the lender if the DRC government cannot pay due to its unstable finances (Halland et al., 2014). The risk is transferred away from the state's public finances to a tangible asset that can be managed. Furthermore, their strategic importance to Beijing means that the Chinese state has an interest in obtaining project stability, leveraging its political and diplomatic leverage to protect investments. This is demonstrated through close Net Present Value (NPV) analysis of the Sicomines agreement by Duke University scholars, which eloquently illustrates this (Landry, 2018). The study found that due to price collapses in commodities and project delays, the Chinese consortium's estimated financial value of the deal plummeted spectacularly in its first decade, even going into negative territory at one point. The physical delivery of minerals, the key strategic objective, was, however, ensured. This goes to reflect the reality that profitability on the books, as desirable as it may be, is secondary to the geoeconomic imperative of ensuring a seamless supply of critical industrial inputs. The Chinese government is willing to make financial sacrifices in order to achieve a greater strategic benefit, an opportunity cost calculation which necessarily makes its strategy different from that of a profit-maximizing firm.

### 3.1.3 The Strategic Link: Feeding China's Green Industrial Machine

The vast amounts of cobalt, copper, and other minerals mined in the DRC by Chinese-owned or backed mines are not transferable commodities traded on an open and anonymous global market. Instead, they are strategic inputs deliberately channeled into China's vertically integrated industry supply chains. They are the raw materials

for the very green technologies, lithium-ion batteries, electric vehicles, wind turbines, and advanced grid equipment, that are the core of China's green export-oriented economy. The DRC's mines are the first and most crucial link in a chain whose final destination is a finished high-tech gadget being utilized in a nation like Kenya.

Bilateral trade data provide unequivocal evidence of this asymmetrical and direct material flow. According to the Observatory of Economic Complexity (OEC), in 2023, the DRC sent an incredible USD 14.3 billion worth of goods to China, with China being its leading export destination by far (OEC, 2024). The exports themselves are highly concentrated in precisely the minerals that are the subject of this thesis.

**Table 6. DRC's top exports to China (2023, USD)**

| Product | Value (USD Billions) |
|---|---|
| Total Exports to China | 14.3 |
| Refined Copper | 7.41 |
| Cobalt | 2.40 |
| Copper Ore | 2.08 |

*Source: Observatory of Economic Complexity (OEC), 2024.*

As graphically illustrated in Table 6, the copper and cobalt products alone amounted to nearly USD 12 billion, or roughly 83%, of the DRC's exports to China in 2023 (OEC,2024). This reflects a flow of material of monstrous scale and strategic importance. The OEC statistics also reveal the asymmetry of this relationship: there are not any countries in the entire world that import more from the DRC than they import from China, which indicates the DRC's deep dependence on the Chinese market as a destination for its core products.

This direct link is the outcome of a conscious industrial policy. In a study from 2000 to 2020, a PNAS estimated that while China's indigenous production of cobalt refineries increased 78-fold to serve the demands of the expanding battery sector, the DRC-sourced cobalt was "predominantly exported to China or processed in the DRC by Chinese enterprises" for onward transportation to China (Gulley, 2023). This control of the supply chain extends well beyond the mine gate. A 2024 report finds that Chinese firms exercised an estimated 95% control of global processed commercial-grade cobalt chemicals in 2022, the immediate raw material precursor to battery cathodes (Gulley, 2024). This de facto monopoly control of the midstream processing sector is predicated upon safe and large-scale availability of upstream raw materials in the DRC.

All this construction is consistent with China's official industrial policy, namely, to acquire and capture complete value chains for strategic industries to enhance national economic security and competitiveness. The DRC Kolwezi district minerals are thus not simply traded; they are integrated. They are the needed, irrevocable first input in a geoeconomic loop designed to fuel China's industrial ascendance and ensure that it becomes an assertive participant in the global green econom . The products created are then re-exported, completing the loop on demand markets across Africa and the world (Dunford et al., 2020).

The nature of China's engagement in the DRC mining sector is thus better described not as foreign investment in the classical, market-driven sense, but as the strategic externalisation of the upstream stage of its own domestic industrial value chain (Makengo et al., 2022). The DRC is being functionally incorporated into China's state-capitalist system as its principal raw material supply department for the green technology sector. This reframing accounts for the characteristics of the engagement model that are observed. The embrace of high political and financial risk, the sole interest in extractive technologies with minimal local value addition, and the preference for opaque, state-to-state governance are neither aberrations nor failures; they are logical choices if the overriding goal is to handle the DRC mineral endowment as a strategic asset to dominate and integrate, rather than as a commercial opportunity to evolve in an equitable partnership (Makengo et al., 2022).

## 3.2 The Demand Node: Kenya

This section looks at the downstream counterparty of the DRC supply node, situating Kenya as a vital market for the final green technology produced from the minerals extracted in the front half of the circuit. The analysis demonstrates how Kenya, because of its specific political and economic characteristics, is an ideal demand-side anchor for China's geoeconomic strategy. It is here that the circle is completed, where Chinese-designed and Chinese-financed technologies are used to benefit Kenya's ambitious development and power aims, thereby creating a captive market for the goods of China's industrial machine.

### 3.2.1 The Strategic Market: Deploying Green Technology

Kenya is an ideal and stable demand-side node for China's geoeconomic circuit due to a convergence of factors: a relatively stable governance environment, a visionary national development blueprint, and a dire need for energy infrastructure investment. Beijing has cultivated this relationship carefully, framing its engagement as a "Green Belt and Road" partnership aimed at helping Kenya achieve its development goals through the introduction of Chinese renewable energy solutions (Li et al., 2024).

This policy coordination is based on Kenya's policy documents itself. The country's long-term national development master plan, Kenya Vision 2030, explicitly states energy infrastructure development as an overall "enabler" of transforming Kenya into a newly industrializing, middle-income country by 2030 (Kenya Vision 2030 Delivery Secretariat, 2025). The vision and its Medium-Term Plans emphasize the need to expand power generation capacity in order to drive economic growth and improve living standards. Notably, these plans also highlight the development of renewable energy resources, geothermal, solar, and wind power, as a national priority, providing a clear policy window for Chinese participation in the green technology sector.

Chinese finance and construction have become the central pillars of the growth of Kenya's energy sector, particularly in the renewables space. Various reports identify China as a "key contractor and technology provider for energy transition in Africa," (Irandu & Owilla, 2020) and Kenya is a focal point of this engagement. The engagement has grown stronger over the years, and with a clear focus on green energy. There have been no new investments or construction contracts in the fossil fuel energy sector with Chinese parties in Kenya since 2020, a distinct shift that aligns with Beijing's "Green BRI" rhetoric and Kenya's own decarbonization agenda (Li et al.,

2023). The scale of the engagement is significant. An estimate by a report is that over USD 7 billion of Chinese funding has supported the development of large infrastructure in Kenya since 2010, including flagship renewable energy facilities that are central to the country's grid (Irandu & Owilla, 2020). This renders Kenya not only a recipient of random projects, but a cultivated, priority market for a specific category of Chinese industrial exports.

### 3.2.2 The Operating Model (FTGR Analysis)

China's operational model in Kenya is the inverse of that which it employs in the DRC, precisely tailored to a distinctive set of circumstances to achieve downstream objectives of the geoeconomic circuit. It is characterized by debt finance to finance the purchase of technology, the export of finished turnkey technology with little local value added, a governance system that sustains stable regulatory regimes, and a risk profile whereby most of the heavy burden, sovereign debt,is transferred to the host nation.

**Finance: The EPC+F Procurement Model**

The most common financial model used to facilitate the mobilization of Chinese technology to Kenya is the Engineering, Procurement, and Construction + Finance (EPC+F) model (Wembe, 2021). The model is a highly integrated contracting and lending system that ensures Chinese funds will be used to purchase Chinese goods and services. For a typical EPC+F project, a Chinese policy bank, for example the China Exim Bank, provides a loan to a Kenyan state organization. The loan proceeds are then contracted to obligate the proceeds to pay a particular Chinese SOE to undertake the project on a turnkey basis.

This framework has been deliberately replicated in Kenya's flagship renewable energy projects. The 50MW Garissa Solar Park, East and Central Africa's largest such facility, was financed through a concessional loan of approximately USD 130 million from the China Exim Bank (Woollacott et al., 2023). The loan was given to Kenya's Rural Electrification and Renewable Energy Corporation (REREC), which used the funds to tender out the construction contract to China Jiangxi Corporation for International

Economic and Technical Co-operation (CJIC) (Bhamidipati & Hansen, 2021). Similarly, the development of Kenya's world-class geothermal resources in the Olkaria fields has been heavily supported by Chinese finance with Chinese contractors attached. China Exim Bank has lent the Kenyan government hundreds of millions of dollars, which were re-lent to Kenya Electricity Generating Company (KenGen) to finance contracts with Chinese firms like Great Wall Drilling Company for the important task of drilling geothermal wells (Bhamidipati & Hansen, 2021).

The EPC+F system produces a closed book of accounts. The capital for the loan is provided by a Chinese state bank and, after a temporary transit through a Kenyan government account, returns directly to a Chinese state-owned construction contractor (Bhamidipati & Hansen, 2021). The system works to quietly transform development loans into an effective export promotion device, which creates a tied and captive market for Chinese industrial production.

**Table 7. Selected major chinese-financed renewable energyprojects in Kenya**

| Project Name | Chinese Lender | Chinese Contractor(s) | Loan Amount (Approx. USD) | Financing Model |
|---|---|---|---|---|
| Garissa Solar Power Plant (50MW) | China Exim Bank | China Jiangxi Corporation (CJIC) | 130 million | Concessional Loan (EPC+F) |
| Olkaria IV Geothermal Wells Drilling | China Exim Bank | Great Wall Drilling Company | 93 million (RMB 670M) | Government Concessional Loan (EPC+F) |
| Olkaria Geothermal | China Exim Bank | Great Wall Drilling Company | 382.5 million | Preferential Buyer's Credit (EPC+F) |

| | | | | |
|---|---|---|---|---|
| Wells (80 wells) | | | | |
| Olkaria I Unit 4 & 5 Power Plant | - | Sinopec | (Part of larger project) | EPC Contract |

*Note: This table illustrates the consistent application of the EPC+F model across Kenya's key renewable energy projects, linking Chinese finance directly to Chinese contractors.*

**Technology: Finished Goods and Import Dependency**

The technology applied in Kenya through these projects is almost completely completed, high-value products manufactured in and exported from China. These are the final product of the industrial process initiated in the DRC mines. This structure has a very high technological dependence and involves very minimal manufacturing within the local area or value addition in Kenya.

Kenya's reliance on China for green technology hardware is incredible. Statistics in 2024 indicate that China supplied 96% of the solar panels and 81% of imported lithium-ion batteries in Kenya(Carr-Wilson & Pai, 2018). This dominance is confirmed by OEC trade data, which indicates that in 2023, of the 43.7 million worth of assembled solar panels (under HS code 854143) imported by Kenya, a staggering 42 million, or 96.1%, came from China (Carr-Wilson & Pai, 2018). Panels for the flagship factory in Garissa were supplied by Chinese firm JinkoSolar, which then entered the Kenyan market with its newer, higher-capacity "Tiger Neo" panels, establishing itself firmly as a leading technology supplier (Bhamidipati & Hansen, 2021).

The critical link to the supply node in the parts is observed. The lithium-ion batteries for stabilizing the grid, energy storage, and transport power made from the same cobalt mined in the DRC. It is a complete circle: raw material from DRC processed in China embedded into finished technology product resold back to the African continent in Kenya (Yu et al., 2022). Though there is growing interest and contention in Kenya to assemble products like solar panels locally in order to boost local content, the model remains that of importing full products. This limits real technology transfer to

operational and maintenance skills, rather than more useful R&D and manufacturing expertise, thus solidifying Kenya's consumer instead of producer status of technology.

**Table 8. Kenya's imports of key green technology goods from China (2023, USD)**

| Product Category (HS Code) | Total Imports (Global) | Imports from China | China's Share of Kenyan Imports |
|---|---|---|---|
| Assembled Solar PV Modules/Panels (854143) | USD 43.7 million | USD 42.0 million | 96.1% |
| Unassembled Solar PV Cells (854142) | USD 3.27 million | USD 3.1 million | 94.8% |
| Lithium-Ion Batteries (850760) | *Data aggregated, but reports indicate 81% share* | *N/A* | *~81%* |

*Source: Observatory of Economic Complexity (OEC), 2025; Industry Reports.*

**Governance: Alignment with a Stable Framework**

Unlike the DRC case, China's Kenyan model of engagement is suited to a more predictable, stable, and institutionalized governance environment. Rather than navigating fragility through opaque executive-level deals, Chinese projects in Kenya are not only developed to complement the host state's official development plans but also fit within its existing regulatory frameworks (Huang & Lesutis, 2023). In this manner, the projects are politically legitimated, purchased by government agencies, and given a stable platform for long-term operations and debt repayment.

Chinese-funded energy projects are always framed as being on behalf of Kenya's Vision 2030 and its five-yearly Medium-Term Plans. This ties the projects to ensuring that they are perceived, not as foreign impositions, but as collaborative endeavors that help Kenya in the achievement of its own sovereign aspirations (Boulle, 2019). The use of traditional EPC+F contracts and loan agreements with Kenyan state-owned institutions, such as KenGen and REREC, provides a stable and legally binding basis for project implementation, financing, and repayment (Woollacott et al., 2023). This stability and institutional embedding make Kenya a stable and attractive end-market for Chinese capital and technology, serving its function as the stable demand node of the circuit.

**Risk: Debt Sustainability and Financial Vulnerability**

In the demand-side model, the risk structure is reversed from that of the supply node. As Chinese financiers and contractors take on project execution and certain commercial risks, the host country structurally takes on the fundamental long-term risk in the form of sovereign debt (Li et al., 2021). Kenya's role as a big importer of high-priced, foreign-funded technology has led to a significantly higher public debt burden and generated long-term fiscal exposures (Marwa, 2019) .

The increasing debt of the nation to China, much of which has gone into the construction of major infrastructure projects in transport and energy sectors, is a source of considerable national and foreign worry. Successive Joint Debt Sustainability Analyses (DSAs) conducted by the International Monetary Fund (IMF) and the World Bank have invariably located Kenya at a "high risk of debt distress" (International Development Association & International Monetary Fund, 2022). These reports directly blame the deterioration of debt indicators on big, deficit-imposing expenditures on large, debt-financed infrastructural projects in the past. In December 2022, China was Kenya's biggest bilateral creditor, holding a stake of almost 64% of its non-Paris Club bilateral debt (International Development Association & International Monetary Fund, 2022). This sizeable debt burden constrains Kenya's fiscal room, reduces its ability to respond to other development needs or external shocks, and creates a medium- and long-term fiscal reliance on its largest creditor. This debt sustainability issue is the primary risk for Kenya in the role of technology consumer in China's geoeconomic circuit (International Development Association & International Monetary Fund, 2022).

The "Green BRI" in Kenya thus means a cutting-edge, Chinese policy bank debt-financed export promotion strategy targeting indigenous high-tech industries in China. Chinese policy bank financing is neither really classical development assistance but rather a primary financial instrument used to create a captive market for the goods produced using the resources that have been procured from the circuit supply node in the DRC (Kafarhire, 2019). Financial exchange facilitates an in-kind export. The Chinese bank loan facilitates a rent of a Chinese company by the Kenyan government, and this Chinese firm procures technology that is made in China. The capital is, in effect, recycled within the Chinese state-capitalist mechanism. This re-defines the "Green BRI" as a geoeconomic industrial export strategy and not simply as a partnership for sustainable development, where the principal economic beneficiary is the capital supplier and technology producer, and the principal long-term risk, in the form of sovereign debt, is borne by the recipient (Li et al., 2024).

## 3.3 Connecting the Nodes and Analyzing the Implications

This section serves as the analytical core of the chapter, moving beyond the examination of the individual nodes in the DRC and Kenya to synthesize the evidence into a coherent whole. It connects the supply-side mechanisms of resource extraction with the demand-side mechanisms of technology deployment to demonstrate the existence of an integrated, closed-loop geoeconomic circuit. By mapping the whole value chain, analyzing the logic of the system, and scanning its profound implications, this chapter contends that China's involvement in Africa's green revolution is a highly strategic and structurally significant process with far-reaching implications for the economic sovereignty of the continent.

### 3.3.1 From African Earth to Chinese Factories and Back

When Democratic Republic of Congo and Kenya case studies are not taken in isolation but as interdependent components of the same system, they outline a complete transnational value chain. The chain begins from low-value-added raw material production in Africa, goes to high-value-added manufacturing and processing in China, and returns to Africa with high-cost finished technology products. This structure of

this value chain is not by chance; the value is structured in a way that the vast majority of economic value is extracted systematically beyond the African continent, principally at the midstream levels dominated by Chinese industry.

The flow of materials and value can be mapped across three distinct stages, drawing on the evidence presented in the preceding sections:

1. Upstream (Extraction and Preliminary Processing in the DRC): Value chain is initiated by the extraction and preliminary processing in the DRC of cobalt and copper ore, typically from Chinese-owned or Chinese-financed mines, from the rich deposits of the DRC. Some initial low-level value addition is done within the DRC at this stage, typically by simple concentration or preliminary processing in Chinese-owned facilities (Gulley, 2023). The primary objective of on-site processing is not the creation of a final product but the reduction of bulk and weight of the material to render it less expensive and more economical to ship (Gulley, 2023). The concentrates and ores that are generated are then exported almost solely to China, the lowest-value segment of the chain.
2. Midstream (Advanced Processing and Manufacturing in China): Upon reaching China, the raw materials from Africa enter the midst of the value-creation chain. There, they undergo further advanced refining and metallurgical treatment to transform them into high-purity metal and niche chemical precursors such as battery-grade cobalt sulfate. These materials are then processed through China's large-scale manufacturing system in order to produce high-tech components such as battery cells, cathodes, and photovoltaic (PV) cells (Gulley, 2023). Such components are then assembled into high-value finished products, namely lithium-ion battery packs and solar modules. In fact, the most important economic value and capture occur at this midstream segment which includes advanced processing, R&D, and manufacturing.
3. Downstream (Deployment and Consumption in Kenya): The loop is completed when these finished technological goods are re-exported back to the African continent. Chinese grid equipment and solar panels (and storage batteries) are imported into Kenya and deployed in large-scale energy schemes (Woollacott et al., 2023). These are typically contracted by Chinese contractors and financed by Chinese policy bank loans via the EPC+F model, so that Kenya becomes a consumer at the highest cost end of the value chain.

This structure ensures that value is disproportionately captured in the China-controlled midstream. The U.S. International Trade Commission (USITC) study of the global value chain (GVC) for cobalt confirms this dynamic that the chain is dominated by the DRC in the upstream (unrefined) segment and China in the downstream (refined) segment where much value is added(United States International Trade Commission., 2020). Similarly, a comprehensive report by the International Energy Agency (IEA) highlights that China is the lowest-cost destination for every step of the value chain of solar PV manufacturing, from the production of polysilicon to assembling finished modules, allowing it to capture most of the value being created in the global solar industry (IEA, 2025). African countries, in this model, are relegated to structurally disadvantageous positions as low-value raw material exporter and high-cost final product importer, a firmly established cycle that has in the past stalled industrialization and value capture in the Global South.

**Table 9. Illustrative value capture across the cobalt-to-battery value chain**

| Stage of Value Chain | Primary Location | Key Activities | Estimated Share of Total Value Captured |
|---|---|---|---|
| **1. Upstream** | DRC | Mining of cobalt ore, basic concentration | Low (<10%) |
| **2. Midstream (Processing)** | China | Advanced refining, production of cobalt chemicals (e.g., sulfate) | High (30-40%) |
| **3. Midstream (Manufacturing)** | China | Production of battery precursors, cathodes, and cells | Very High (40-50%) |

| | | | |
|---|---|---|---|
| **4. Downstream (Assembly)** | China / Global | Assembly of battery packs for EVs and storage systems | Moderate (5-10%) |
| **5. Downstream (Deployment)** | Kenya | Integration and operation (costs, not value capture) | (Net Cost) |

*Source: Modeled and synthesized from IEA, USITC, Wood Mackenzie, and Cobalt Institute reports. Note: Percentages are illustrative estimates to demonstrate the distribution of value, not precise accounting figures.*

The uncooked inequality in Table 9 presents the critical evidence of the circuit's structural implications. Despite physical inputs beginning and terminating in Africa, the profit, intellectual property, the high-skilled jobs generated from their processing are appropriated for near-totality by China. This systematically extracts wealth off the continent and reinforces a hierarchical international division of labor.

### 3.3.2 The Closed Loop: A Self-Reinforcing System

The geoeconomic cycle from the DRC mines to the Kenyan power grid is no arbitrary byproduct of independent market forces or sequence of accidental bilateral deals. It is the material product of a deliberate and integrated geoeconomic policy, articulated in China's official policy statements and driven by the dictates of its state-capitalist system. It is self-reinforcing: Chinese capital is employed to create downstream demand, which legitimizes and de-risks the colossal upstream investment required to tie up the raw material supply, working as a closed and self-contained loop.

Proof of such strategic intent lies in China's highest policy framework for its relations with Africa. The Beijing Action Plan (2025-2027) agreed upon at the ninth Forum on China-Africa Cooperation (FOCAC) explicitly obliges China to helping to "integrate the entire industrial chain development in Africa" and establishing "growth circles for China-Africa industrial cooperation." (Ministry of Foreign Affairs of the People’s Republic of China, 2024). Similarly, China's second Africa Policy Paper, a policy

guide, highlights the objective of cultivating "whole-industry-chain cooperation" in priority areas like energy and mining (China-Africa Business Council, 2016). Such policy declarations reflect an evident wish to transcend simple trade and investment to coordinating end-to-end, complete value chains.

The self-generating logic of the circuit is best seen in the role of finance. The loans by China to Kenya for energy initiatives are not just economic exchanges but system facilitators by strategy. By financing Kenyan demand for solar, geothermal, and grid storage projects outsourced to employ Chinese technology and contractors, Beijing provides a guaranteed and predictable stream of revenue for its own state-owned industrial titans (Jureńczyk, 2020). This captive downstream market is a critical hedge against the huge risks to be taken in the upstream investment in the DRC. The assurance of a captive ultimate market for the processed goods guarantees that the high-cost, high-risk exercise of gaining access to minerals in a weak state such as the DRC is a logically sound and economically viable undertaking (Brink et al., 2020). In practice, the system finances itself, ensuring the resources mined at the beginning of the loop are locked in lucrative outlets at the end.

This entire arrangement is a classic example of geoeconomics: the use of economic means to achieve strategic and geopolitical objectives. China is using its vast financial prowess, wielded by its policy banks, to achieve two intertwined national interests simultaneously. Firstly, it addresses its resource security imperative by gaining control over the strategic minerals that will power its industrial future. Second, it advances its industrial policy objectives by creating secure, debt-financed export markets for its increasingly sophisticated, high-value technological products. The circuit is a master class in the conversion of financial capital into strategic industrial and resource power.

## 3.4 Chapter Summary: Proving the Geoeconomic Circuit

The intracontinental, relative, fact-based comparison of the Democratic Republic of Congo as a strategic supply point to Kenya as a corresponding demand point produces a cogent, unambiguous microcosm of China's geoeconomic strategy for the entire continent in the green energy sector. This chapter has moved beyond the examination of China's interactions with these countries as isolated instances of commerce and investment. Instead, it has learned analytically that they are operationally integrated

and symbiotic components of one closed-loop circuit, well-choreographed by the Chinese state to promote the latter's national industrial and strategic objectives.

The overarching finding of this chapter is that Chinese involvement in Africa's energy transformation is not a simple question of aid, investment, or commerce. It is an intricately entwined, state-driven geoeconomic loop designed to advance two concurrent and mutually reinforcing objectives: powering China's own indigenous industrial chain with a secure source of critical raw materials, and creating sheltered, debt-burdened markets for its high-tech outputs. FTGR revealing how China's operating pattern is masterfully designed in specific contexts—using finance-backed input in high-risk DRC to get mineral inputs, and an EPC+F pattern in less risky Kenya to ensure technology outputs. Materials coming from African ground to Chinese manufacturing and back to the African grid are policy norms rather than market exceptions.

Although the model offers physical and often desperately required infrastructure and assists African countries in attaining their climate and development goals, it is framed in a manner that will drive the vast majority of economic value off the continent and into the Chinese-controlled midstream of the value chain. More fundamentally, by positioning China as the hub required to join African resources and African technological development, the circuit creates new and durable forms of structural dependency. This "sovereignty paradox," in which success in achieving sovereign goals through means that may ultimately subvert long-term sovereignty, raises profound questions regarding the future of African economic sovereignty. It challenges the continent to take full benefit of the green transition and chart its own independent course towards industrialization in an increasingly geoeconomically disputed world.

# 4. China and Africa’s Energy Future: Geoeconomic Consequences

By following the flow of resources, capital, and technology, this chapter moves beyond simplistic explanations of "win-win cooperation" or "debt-trap diplomacy." This chapter seeks to reveal the hidden mechanics of a system that, in delivering tangible infrastructure, also works to achieve China's strategic objectives of resource security and industrial dominance. In so doing, it poses a fundamental challenge to Africa's

long-standing aspirations for industrialization, inclusive growth, and genuine self-determination in the global order. The chapter concludes by turning from diagnosis to prescription, offering actionable, evidence-based policy recommendations for African governments to regain agency and forge a more balanced and sovereign energy future.

## 4.1 The Value Chain Paradox

The global transition to a green economy, powered by clean energy technologies and electrical mobility, is actually based on a complex and internationally dispersed value chain. This chapter breaks down this value chain to reveal a profound paradox at its heart: African nations provide the essential raw materials that make this transition feasible and increasingly a destination market for its technologies, yet they remain largely excluded from the most lucrative, most technologically advanced, most job-creating phases of production. This approach, instead of supporting development, risks perpetuating a pattern of commodity dependence, a process UNCTAD has termed the "commodity dependence trap," (UNCTAD, 2023) leaving nations more vulnerable to price instability and prevented from sustained structural change.

### 4.1.1 Deconstructing the Global Battery Value Chain

The value chain of the electric vehicle (EV) battery is a wonderful example of this phenomenon. It is a multi-step process that begins with the manufacture of key minerals and culminates in embedding sophisticated battery packs in vehicles.4 For purposes of analysis, the chain is broken into four broad phases:

1. Upstream: Extractive Mining, Processing, and Refining: The first stage of raw ore extraction, which is rich in minerals such as lithium, nickel, manganese, and most significantly for this chapter, cobalt. These ores are subsequently processed and refined to form battery-grade mineral concentrates or intermediate chemical products. The Democratic Republic of Congo (DRC) is the unavoidable starting point for the cobalt value chain, boasting an estimated 55% of global cobalt resources and over 70% of global mined output (Brink et al., 2020). The country's geology provides a significant comparative advantage

with highly concentrated ores that are typically amenable to lower-capital-intensive types of mining (Brink et al., 2020).

2. Midstream (Part 1): Cathode and Anode Fabrication: The clean mineral chemicals are transformed into active material for the battery's electrodes (Winslow et al., 2017). The cathode, in particular, is a critical element, and the cathode's structure dictates the battery's performance characteristics, such as energy density and longevity (Winslow et al., 2017). Cobalt plays a unique and not easily replicable role in stabilizing the structure of the cathode, holding higher charge densities and power-to-weight ratios (Winslow et al., 2017).
3. Midstream (Part 2): Cell, Module, and Pack Assembly: The cathode, anode, and other components are assembled into individual battery cells here (Winslow et al., 2017). Cells are then gathered into modules, which are finally assembled into the completed battery pack with its respective thermal management and electronic control systems (Winslow et al., 2017). This step is considered most valuable in terms of value addition, estimated to account for up to 40% of the overall battery industry value by 2030 (Horowitz et al., 2021).
4. Downstream: Integration and Distribution: The finished battery packs are provided to auto manufacturers for integration into electric vehicles, which are distributed to consumers (Horowitz et al., 2021). This stage also encompasses the entire ecosystem of charging infrastructure, service, and, increasingly, end-of-life recycling (Horowitz et al., 2021).

It is impossible to exaggerate the strategic importance of this value chain. As global EV sales are projected to account for at least 40% of all vehicle sales by 2030, gaining access to and control of this chain is a staggering economic opportunity, with total EV sales potentially valued at USD 8.8 trillion(Horowitz et al., 2021). Demand for cobalt in EV alone is expected to rise 30% annually through 2030. It is within this high-stakes game that power and value distribution must be examined critically (Savinova et al., 2023).

### 4.1.2 The Great Disparity

A quantitative analysis of the value chain from cobalt to battery illustrates a deep and structural asymmetry. Despite being the source of the underlying raw material, the

economic benefits are overwhelmingly captured by external actors, mainly Chinese firms that dominate the midstream stages of processing and production (Gulley, 2024).

The DRC's contribution is almost exclusively confined to the lowest-value stage: extraction of raw or minimally processed ores. The nation's Department of Mining Minister acknowledged this structural shortfall, stating, "The DRC loses billions in potential revenue by exporting raw materials instead of processed goods" (Kabore , 2023). Analysis indicates that the DRC alone today captures just 3% of the total battery and EV value chain. The vast majority of value is generated in subsequent stages that occur almost entirely outside of Africa (Anderson, 2023).

China has strategically positioned itself to be the prime beneficiary of this arrangement. It is the world's leading refiner of major minerals, refining an estimated 73% of world cobalt, 68% of nickel, 59% of lithium, and 40% of copper (Gulley, 2024). The dominance in midstream is the keystone of the value capture imbalance. Raw materials make up the bulk of a battery's final price, about 60%, with the cobalt-rich cathode accounting for nearly 34% of the total cell cost (Yu et al., 2022). The profit, though, is gained through the technological edge of manufacturing and purification. For instance, cobalt sulphate, the processed chemical product used on cathodes, always carries a huge price premium over raw cobalt metal representing value added in processing (Chen et al., 2020). It is this premium, and therefore the profit, accruing to the refiners, not the miners.

This midstream dominance is translated into market dominance and profitability in direct terms. Chinese battery manufacturers like Contemporary Amperex Technology Co. Limited (CATL), which has approximately 32% global market share of the world battery market, leverage their scale and vertically integrated supply chains to achieve high operating profit margins, which increase from 11.4% in 2023 to 15.5% in 2024 (Benchmark Mineral Intelligence, 2025). In contrast, the DRC is a price-taker of its raw materials, its revenues exposed to the vagaries of world markets rather than secure, value-added factory profits.

The potential for the DRC to reverse this lies massive but dormant. A landmark report by BloombergNEF discovered that it would be three times cheaper to build a 10,000 metric tonne battery cathode precursor plant in the DRC (it would cost about 39 million) than in the United States, and significantly less expensive than in China or Poland (BloombergNEF, 2021). Furthermore, drawing power from the DRC's largely hydroelectric power grid would reduce carbon emissions from battery production by 30% compared to supply chains already operational, China-based (BloombergNEF,

2021). Having the ability to shift into this precursor stage successfully may allow the DRC to dominate a 271 billion market segment, with potential ultimately to gain access to significantly more valuable 1.4 trillion battery cell manufacturing and assembly market (BloombergNEF, 2021). That this economically and ecologically sensible action has not yet been taken reflects structural barriers of capital, technology, and political authority that current geoeconomic circuit is built to maintain, not dismantle.

The following table summarizes the information to give a brief, numerical illustration of this value chain paradox.

**Table 10. Locations, value and main actors in the cobalt value chain.**

| **Value Chain Stage** | **Primary Location** | **Key Actors** | **Estimated Value / Profit Margin** |
|---|---|---|---|
| Raw Ore Extraction (Cobalt) | Democratic Republic of Congo (DRC) | Artisanal Miners, Gécamines, Chinese-Congolese JVs (e.g., Sicomines) | Low value capture; DRC receives only ~3% of total value chain. Miners earn USD 2.15-USD 8.60/day. |
| Refining to Cobalt Sulphate | China | Huayou Cobalt, other Chinese refiners | Significant value-add; Cobalt sulphate maintains a price premium of ~USD 3.6/lb over metal. China refines 73% of global supply. |

| | | | |
|---|---|---|---|
| Cathode Precursor Manufacturing | China | Chinese chemical companies | High-value intermediate step. A precursor plant in DRC could be 3x cheaper to build than in the US. |
| Battery Cell Manufacturing | China | CATL, CALB, Gotion, etc. | Highest value-add stage (~40% of industry value). CATL profit margin at 15.5% (2024). |
| EV Battery Pack Assembly | China / Global | EV Manufacturers | Final assembly stage before vehicle integration. |

*Source: Author's compilation based on market data from Benchmark Mineral Intelligence and the International Energy Agency (IEA); economic analysis from the World Bank and BloombergNEF; and financial data from CATL.*

### 4.1.3 The Industrialization Dilemma

This harsh reality of value capture is in direct opposition to the stated development aspirations of the African continent. Industrialization has been rendered one of its "High 5" strategic priorities by the African Development Bank (AfDB). AfDB President Akinwumi Adesina has repeatedly and forcefully argued that Africa must escape its historic role as a raw materials supplier: "Africa must stop being a supermarket for others and become a factory for itself," and "Exporting raw materials only leads to vulnerabilities – and no nation or region has succeeded by simply exporting primary commodities" (Anudu, O., 2025). The AfDB's official strategy is to help the continent move up global value chains, add value to its resources, and double the industrial GDP by 2025, observing that the current model, where manufactured

goods are a minor share of exports but the majority of imports, creates a "commercial imbalance that drains wealth away from the continent" (Anudu, O., 2025).

In the same vein, the African Union Agenda 2063 sees a reconfigured Africa, weaning itself from being a raw material exporter by allowing nations to "add value, extract greater rents from commodities, integrate into global value chains [and] encourage diversification based on value addition and local content development" (Mavhunga, 2023).

However, the geoeconomic circuit as currently constructed is an immeasurable counterinfluence to such ambitions. Structure of China-Africa trade is a direct articulation of this paradox. Between 1992 and 2023, an impressive 79% of all Africa's exports to China were from the very ten resource-nations, since primary commodities like crude petroleum, refined copper, and some ores formed most of the trade basket (Sylvaire, 2020). It is in this trade pattern that the circuit's real function is exposed: to supply China's own massive manufacturing base with important raw materials.

The facts suggest that the circuit is not just failing to industrialize Africa, but its logic can actually be seen as being quite contrary to it. China's primary strategic objective in Africa's extractive sector is to ensure resource security for domestic industries. It is best accomplished by investing in and controlling the upstream (mining) and midstream (refining) segments of the value chain, creating a direct and unbroken pipeline from African mines to well-established, large-scale processing facilities in China (Ericsson et al., 2020). From this strategic perspective, actively promoting parallel, and potentially competitive, industrial processing hubs in Africa would be counterproductive (Ericsson et al., 2020). It would introduce raw material competition to China and ruin economies of scale and command at the center of Chinese industrial dominance. The circuit therefore functions as a system of anti-industrialization, confirming Africa's peripheral status as a provider of inputs rather than a producer of value-added goods (Ericsson et al., 2020). It perpetuates the very dependency which African leaders and institutions are endeavoring to break.

## 4.2 The Architecture of Dependency: A Tripartite Analysis

The geoeconomic circuit does more than just create a paradox of value capture; it constructs a subtle and resilient architecture of dependency. The architecture rests on three nested pillars, financial, technological, and resource-based, that cumulatively

erode the economic and political sovereignty of African states. This chapter provides a forensic analysis of these mechanisms, and the extensive case studies of the Democratic Republic of Congo and Kenya are used to illustrate how such dependencies are established and entrenched. The analysis is dependent largely on evidence compiled by institutions like the SAIS-CARI and Boston University Global Development Policy Center, who have tracked Chinese loan pledges to Africa of more than USD 182 billion between 2000-2023 (Relative Risk and the Rate of Return: Chinese Loans to Africa Database, 2000-2023, 2024).

### 4.2.1 Financial Dependency

Chinese state-led finance has become a dominant force in Africa's development landscape, funding desperately required infrastructure in sectors like energy and transport. However, the terms on which this finance is offered often create huge and long-term debt obligations that circumscribe the fiscal autonomy of recipient nations. The examples of the DRC and Kenya represent two variations on but equally effective models of financial dependency.

**Case Study: The DRC's Sicomines Agreement – A Deep Dive into a Resource-for-Infrastructure Bargain**

The Sicomines contract in the DRC is the exemplary model of the "resources-for-infrastructure" (R4I) strategy. The original 2008 deal formed a joint venture between Chinese state-owned consortium (Sinohydro and China Railway Engineering Corporation) and DRC state mining firm, Gécamines. In exchange for mining rights on one of the largest and richest copper-cobalt deposits in the world, the Chinese consortium pledged a 6.2 billion loan to develop the mine and another USD 3 billion loan to support national infrastructure (Jansson, 2013). The only remarkable element of the deal was that the loans were to be paid back from the prospective profits of the mine itself.

Since its beginning, the transaction has been shrouded in mystery and controversy. Transparency has proved impossible where independent assessment could not be made and gave rise to suspicion that the deal was highly biased. These suspicions proved

correct years later by government audits. A blistering 2023 report from the DRC's own state auditor, the Inspectorate General of Finances (IGF), revealed a jaw-dropping disparity: while Chinese allies had pocketed nearly 10 billion in profits, the DRC had received only 822 million worth of infrastructure, a minimal share of what had been promised (Makengo et al., 2022). A further breakdown cited by civil society activists put the figures at a still more staggering 76 billion in benefits to the foreign companies and only USD 3 billion in infrastructure for the country(Makengo et al., 2022). The deal effectively sold the country's sovereign mineral wealth for a return that was, by any stretch of the imagination, grossly disproportionate.

The geopolitical context of the agreement also underscores the importance of African sovereignty. The initial transaction of 9 billion brought about concern at the International Monetary Fund (IMF) and the World Bank, which worried about its impact on the sustainability of the debt of the DRC in the wake of the country's application for debt relief under the Heavily Indebted Poor Countries (HIPC) initiative (World Bank Group, 2022). As pressured by these institutions, the deal was renegotiated and reduced to 6 billion, showing how the DRC was caught in between the competing agenda of its former Western allies and new Chinese funders (World Bank Group, 2022).

In early 2024, following years of public outcry and the IGF audit, President Félix Tshisekedi announced a renegotiation of the Sicomines agreement, which he claimed would inject an additional 7 billion into the DRC (Makengo et al., 2022). Once again, this news was met with deep suspicion by experts and civil society. The renegotiation was itself a closed affair with no announcement of the new terms, the valuation basis used to determine the amount of 7 billion, and most critically, if this money injection was another loan to add more debt to the country (Makengo et al., 2022). Opposition critics argued that the deal was still grossly one-sided, and that the new money could be disbursed over 10-to-15 years, and that the structural imbalance of the R4I model had not been redressed (Makengo et al., 2022) . The Sicomines saga is hence a sobering reminder of how R4I deals, which portend development, can entrap a nation in a cycle of resource-backed debt, covert accounting, and diminished fiscal discretion.

**Case Study: Kenya's Standard Gauge Railway – Infrastructure at What Cost?**

Kenya's experience with the Standard Gauge Railway (SGR) illustrates another, no less powerful mechanism of financial dependence: big, debt-financed infrastructure projects. Kenya borrowed over USD 5 billion from the Export-Import Bank of China (China Exim Bank) to fund the SGR, which has made China its largest single bilateral creditor (Müller-Mahn et al., 2021). While the SGR delivered a modern infrastructure asset, the terms of the financing and the economic returns of the project have closely constrained Kenya's sovereignty.

Among the most striking features of the SGR loans was their record lack of transparency. The terms of the loans were hidden from public, and even parliamentary, view for years under strict confidentiality agreements. When portions of the contracts were finally released under popular pressure, they included several onerous conditions that represented a significant waiver of national sovereignty (Gelpern et al., 2021). Critically, the contracts stipulated that any major disputes must be resolved through arbitration in Beijing, under Chinese law, effectively removing Kenyan court jurisdiction (Gelpern et al., 2021) . A clause also demanded that Kenya could not procure materials for the railway from any country other than China, locking in Chinese suppliers.

This expense has been compounded by the SGR's consistent inability to achieve commercial viability. The rail has operated at a massive loss since its launch, accumulating a deficit of 200 million in its initial three years alone (Müller-Mahn et al., 2021). It requires an estimated subsidy of 7.8 million per month from the Kenyan treasury merely to cover its operational expenses, a shortfall which ultimately is borne by Kenyan taxpayers (Müller-Mahn et al., 2021). This has placed a gigantic burden on the country's public finances. Debt repayment to China has become one of the largest expenditure items in the national budget, consuming a rising share of state revenue and crowding out spending on other essential services like education and health (Müller-Mahn et al., 2021).

This has fueled the "debt-trap diplomacy" scandal. While hard scrutiny by institutions such as SAIS-CARI suggests the most extravagant claims, e.g., seizure of the Mombasa Port as collateral, are a function of a mistake in reading loan contracts, the debt distress reality itself cannot be suppressed (Brautigam, D., & Huang, Y., 2023). Synergy between inflated project costs, an unsustainable business model, and onerous loan terms has taken Kenya's debt distress risk from "moderate" to "high," the IMF reports ( International Monetary Fund. African Dept., 2021). This fiscal reliance effectively limits the Kenyan state's policy space, leaving it more vulnerable to external pressures and less capable of pursuing an independent economic path.

### 4.2.2 Technological Dependency

Apart from finance, the geoeconomic loop creates a powerful technological reliance, featuring a "lock-in" that sets African energy systems on Chinese systems of technology for the long term. The reliance operates at two dimensions: reliant on proprietary software and hardware, and an endemic shortage of endogenous skills and knowledge transfer.

**The Ecosystem Trap: Reliance on Chinese Hardware and Proprietary Systems**

Its pervasive deployment of Chinese technology across Africa's ICT and energy sectors is creating a de facto standardization of Chinese ecosystems. In the field of renewable energy, Chinese solar and wind technology exports to Africa have increased by 153% from 2020-2024 (Opoku & Song, 2023). Chinese firms solely engage in African energy projects under Engineering, Procurement, and Construction (EPC) contracts that cover 85% of their activities(Opoku & Song, 2023). What this setup does is that Chinese firms will design and build the infrastructure, of course putting in their equipment and systems.

Such firms as ZTE and Huawei are at the forefront of this movement. Huawei is deeply involved in creating Africa's digital power infrastructure, including its "Single SitePower" and "iGrid" solutions for managing power systems and its "fgOTN" solution to revamp power grid communications (African Review, 2025). Similarly, ZTE's "EcoSite" solution, a bundle of modular base stations with solar-powered systems and proprietary management software, is deploying throughout the continent (Grant, E., 2025).

Though such technologies can offer efficient and cost-effective solutions, mass use creates a characteristic technological lock-in. African nations come to rely on one supplier or a few connected Chinese suppliers for necessary maintenance, spare parts, and future system upgrades. It is not an accident that this occurs; it is inherent in the business model. Huawei, for example, states that it has an end-to-end, "one-stop" service system to support the entire project lifecycle, from delivery and design to technical support and spare parts management (Zeng, 2022). This product bundle,

though convenient, makes the customer even more dependent upon the Huawei ecosystem. This lock-in effect significantly erodes the bargaining capability of African utilities and governments to shift to alternative suppliers, negotiate better prices, or adopt technologies from alternative sources at affordable prices and with compatibility problems (Rwehumbiza, 2021).

**The Skills and Knowledge Deficit: A Critical Look at Technology Transfer**

The China-Africa partnership discourse is used to emphasize partnership and capacity-building. The fact, however, on the ground, is that real technology transfer, the kind by which African nations can independently operate, maintain, upgrade, and ultimately innovate their own energy systems, is extremely rare.

Several structural conditions are responsible for this disparity. Chinese-financed infrastructure projects typically include terms that a certain percentage of the procurement, typically no less than 50%, must be procured from China (Xu et al., 2020). Local suppliers are thereby excluded from participating and establishing capacity. Moreover, Chinese engineers and contractors also import Chinese labor to provide highly specialist technical and management capacities, obviating the establishment of a domestic pool of expertise (Xu et al., 2020).

While some on-site training of local workers is accomplished, it is in basic operating processes rather than the deep engineering and design capabilities required for true technological independence. The consequence is a persisting skills deficit. The African countries become good consumers and users of the foreign technology but not in a position to produce, adapt, or innovate it. This causes them to be forever reliant on technology, and they must look up to the original Chinese supplier for any effective troubleshooting, upgrading, or expansion of the system. This gap in knowledge is a significant setback to the dependency cycle and achievement of the continent's industrialization dreams.

## 4.2.3 Resource Dependency

For resource-rich nations like the DRC, the geoeconomic cycle generates a third, overarching form of dependency: resource lock-in. It de facto dedicates a nation's sovereign mineral wealth to a single external partner for decades, powerfully restricting its policy space and frustrating economic diversification.

## Long-Term Concessions and Policy Paralysis in the DRC

The Sicomines agreement is the most compelling example of resource lock-in. By locking into a multi-decade concession that grants a single foreign-controlled joint venture exclusive rights to a vast and profitable mineral deposit, the DRC has effectively "locked in" its status as a Chinese raw materials supplier (Makengo et al., 2022). The terms of the deal, including a total tax holiday for the Chinese partners until 2040, further entrench this arrangement and limit the state's ability to capture revenue from its own resources (Makengo et al., 2022).

This prolonged commitment creates a form of policy paralysis. The DRC government is not free to utilize its most profitable assets to attract a range of international partners or to change its economic strategy in response to changing global markets (IMF, 2015). It would be a difficult and politically contentious renegotiation with its powerful Chinese partners, who have a stake in the existing order. This goes a long way to restrict the sovereignty of the state to manage its natural resources in the interest of its nation. When the government of the DRC tried to take back some level of control by imposing a temporary ban on cobalt export in 2025 in an attempt to rectify oversupply within the market, it created enormous levels of instability and highlighted the difficulty of independent policy-making within the restraints of such a highly evolved partnership (Gulley, 2024).

## The Opportunity Cost of Resource Lock-in for Economic Diversification

The worst-costing aspect of resource lock-in is the enormous opportunity cost that it imposes on diversification in the economy. By dedicating its best mineral reserves and its political capital of its ruling class to serving one extractive agreement, the DRC forgoes the opportunity of pursuing alternative development avenues (Kabemba, 2016). Capital, infrastructure, and policy attention put into the Sicomines project are diverted

away from what could be spent elsewhere in agriculture, light industries, or the development of a domestic processing industry.

This lock-in also deters other potential investors. Western businesses and other international partners are reluctant to enter a market where the competitive playing field is tilted so heavily in favor of Chinese state-backed players who receive special, non-market privilege in the form of long-term tax holidays. The DRC is actively seeking to diversify partnerships, including attempting a strategic minerals agreement with the United States, but such efforts are complicated inherently by China's pre-existing and dominant presence, achieved through economically dubious agreements like Sicomines (Makengo et al., 2022). The resource lock-in thus perpetuates the colonial-era economic model of raw material exportation, trapping the DRC at the bottom of the global value chain and making the goal of a diversified, resilient economy ever more remote (Kabemba, 2016).

The three pillars of dependency, financial, technological, and resource-based, are not independent but consist of a very integrated and reinforcing system (Makengo et al., 2022). Financial dependency, created through loans, is the door opener to technological and resource dependency. Chinese loans, which are sometimes conditioned on the use of Chinese contractors and technology, as with the SGR project 42, are also the instruments used to secure long-term mineral concessions, as in the case of the Sicomines agreement (Kafarhire, 2019). On the other hand, technological dependence reinforces financial dependence through the perpetual need for foreign exchange to cover maintenance and upgrading. In extractive states like the DRC, all this machinery is ultimately geared toward capturing the supreme strategic goal: resource dependency, a secured long-term supply for China of the vital minerals to fuel its industrial economy (Kafarhire, 2019). What is billed as "risk mitigation" for the Chinese investor or lender, such as arbitration in Beijing, the employment of EPC contracts, or lending via intermediaries, represents directly a "sovereignty risk" to the African partner, a cession of legal jurisdiction, operational control, and long-term strategic influence (Xu, 2020).

## 4.3 A Critical Re-evaluation of Africa's Energy Transition Trilemma

The geoeconomic circuit's promise of an accelerated energy transition in Africa must be critically re-evaluated from the perspective of the development trilemma. While the circuit undoubtedly accelerates the development of energy infrastructure, its closer inspection proves that the quality of this progress is essentially undermined. The nominal gains in access to energy are illusory, the claims to sustainability are geographically split and morally complex, and the erosion of national sovereignty is the deepest and most long-lasting effect.

### 4.3.1 Access: The Illusion of Progress?

On the surface, the China-led circuit appears as a successful driver of energy access enhancement in Africa. Chinese finance and construction have been at the forefront of developing much of the continent's new generation capacity, and Chinese-backed projects account for nearly 20% of Sub-Saharan Africa's installed capacity (Opoku & Song, 2023). However, a more nuanced examination of the data, particularly in a recipient country like Kenya, indicates that such headline successes mask deep inequalities and questionable long-term benefits.

#### Quantifying Access: A Look at Electrification in Kenya

Kenya is often cited as one of the success stories of electrification. Official statistics from the World Bank and other organizations point towards a comprehensive improvement in the access rate of electricity in the country, from a low of 32% in 2013 to over 76-84% in recent years (Moksnes et al., 2017). This development has been driven by aggressive government efforts like the Last Mile Connectivity Project, which has brought grid power to millions of citizens from rural areas (Bos et al., 2018).

But Afrobarometer survey statistics provide a crucial, ground-level antidote to such positive propaganda. While an overwhelming majority of Kenyans (87%) do live in regions served by the national grid, this is far from the same as universal coverage or regular supply (Beecham, E. O., & Iberi, D. , 2024). The survey identifies that a significant portion of the population, 36% of all households, remains not connected to the grid. More significantly, when reliability is added to the mix, the picture is worse still (Beecham, E. O., & Iberi, D. , 2024). Of those served, a paltry 74% report their

electricity works "most" or "all of the time." (Beecham, E. O., & Iberi, D. , 2024). When both of these conditions are combined, the figures show that fewer than half of all Kenyans (47%) actually have a consistent supply of electricity from the national grid (Beecham, E. O., & Iberi, D. , 2024).

This total figure conceals a stark contrast between different sections of the people. The benefits of electrification have been diffused unequally, extending already existing social and economic cleavages. For rural citizens and the poorest quartile of families, the share of good access declines to paltry 35% (Beecham, E. O., & Iberi, D. , 2024) . This indicates a fundamental flaw in a development model with preferences for high-voltage, centralized power systems. These programmes, as much as they boost national generation levels, struggle to target the poorest and most remote communities, where the energy access gap is widest. The record shows that millions of people are being left behind, their energy poverty unfixed regardless of the billions invested in national-level infrastructure (Beecham, E. O., & Iberi, D. , 2024) .

**The True Cost of a Kilowatt-Hour: Weighing Gains Against Long-Term Liabilities**

Apart from the problem of unequal distribution, the trilemma also forces the more fundamental question: is the access to energy being provided actually desirable when its long-term cost is being considered? The argument in Section 2 showed how projects like Kenya's SGR, financed under the same overall model, have imposed crippling debt costs and undermined fiscal sovereignty. Energy projects financed through unsustainable debt and on the basis of locked-in foreign technology carry enormous long-term liabilities (Klagge & Nweke-Eze, 2020). The cost of a kilowatt-hour cannot be decided by the tariff alone; it must also factor in decades of debt service payment and the strategic costs of technological dependence (Klagge & Nweke-Eze, 2020).

When access is achieved at the expense of national financial health and technological sovereignty, it is a fragile and perhaps pyrrhic victory. The model's focus on large, centralized generation projects, the kind Chinese policy banks like because of their scale and ease of deployment, may not even be the most effective poverty reduction strategy. Decentralized renewable energy (DRE) solutions, such as mini-grids and solar home systems, are quite possibly a faster, cheaper, and more effective way of extending electricity to remote rural villages, a mounting body of evidence suggests

(Mwale et al., 2024) . The current circuit, however, is not constructed first and foremost to animate these "small and beautiful" solutions, but to mobilize huge amounts of capital and technology, a goal which may or may not be ranked among the highest priorities of those living in energy poverty in Africa (Mwale et al., 2024).

### 4.3.2 Sustainability: A Geographically Partitioned Reality

The "Green" transformation account facilitated by the geoeconomic circuit is perhaps its strongest and most misleading argument. The design for sustainability of the circuit is segmented and not holistic; rather, it is geographically distinct, creating a system where "clean" outcomes in one location are based on "dirty" externalities in other locations. Segmentation allows the system as a whole to be framed as sustainable while keeping its true environmental and social cost secret.

#### The "Green" Façade in Technology-Recipient Nations

In technology-receiving nations such as Kenya, the activities of the circuit fall squarely within the international green agenda. Chinese finance and tech are building the hardware of a low-carbon future: massive solar farms like the Garissa project, large wind farms like the Lake Turkana project, and the geothermal plants that form the backbone of Kenya's grid (Olang & Esteban, 2016). These projects directly contribute to Kenya's impressive renewable energy mix, with nearly 90% of its electricity drawn from clean sources (Olang & Esteban, 2016). This allows both the Kenyan state and its Chinese partners to showcase their credentials on climate action and sustainable development, earning international acclaim and bolstering the "green" credentials of the circuit.

#### The "Dirty" Foundation in Resource-Source Nations: Documenting the Environmental and Social Toll in the DRC

This Kenyan green façade is built on the bedrock of severe social and ecological degradation in the source country, the DRC. The extraction of the critical minerals used to produce these purportedly "clean" technologies entails substantial environmental consequences, and its costs are entirely externalized to the Congolese people and ecosystem.

The environmental devastation is profound and far-reaching. Accounts of research and scientific investigations give testimony to a landscape ravaged by mines. The extraction and processing of copper and cobalt involve the use of poisonous chemicals such as sulfuric acid, which often leak into rivers and cause aquatic life to die, further polluting the water sources exploited by local communities for drinking, cooking, and irrigation (Kolala & Umar, 2019). Pollution with sulfuric acid kills farms, making crops rot and agricultural livelihoods unsustainable. Mining operations also lead to extensive deforestation, erosion of land, and the formation of poisonous waste that pollutes the air and land for centuries (Kolala & Umar, 2019).

The human cost is even more numbing. A series of pioneering reports from Amnesty International and other human rights organizations exposed a pattern of systematic abuses in the DRC's cobalt sector (Amnesty International, 2016). These reports detail systematic child labor exploitation, with children as young as seven working in dangerous, hand-carved tunnels for pennies. Adult miners work under equally unsafe conditions, often without basic protective equipment, and acquire chronic respiratory illnesses and a large rate of fatal accidents. Furthermore, expansion of industrial-scale mining has led to large-scale forced eviction of people from their native land and fields, often by violence, intimidation, and with inadequate compensation, eradicating livelihoods and leaving people poor (Amnesty International, 2016).

It is the hidden cost of global energy transition. The "sustainability" of the geoeconomic circuit is a false geopolitical one, achieved by physically decoupling the technology's clean end-use from its environmentally damaging and socially harmful origins. The environmental and social costs are not circumvented; they are simply passed on to the most vulnerable groups in the global value chain, so the beneficiaries of the transition can maintain a facade of green development.

### 4.3.3 Sovereignty: The Ultimate Casualty of the Circuit

The last and most profound implication of this combined geoeconomic circuit is something that may be called a "sovereignty paradox." At first glance, the model appears to promote the sovereign interests of African nations. It provides Kenya with access to capital and technology to implement an admirable and sovereignty-approving venture: greenening its grid, expanding access to electricity for its citizens, and reducing its reliance on fickle fossil fuel imports. But the very mechanism by which this is achieved simultaneously creates a new, more sophisticated, and possibly more entrenched form of structural dependency on a single external power.

This is not the traditional dependency of colonial times, founded on formal political domination, but a 21st-century technology-based, finance-driven, value chain-integrated dependency. Downstream, Kenya is in large-scale dependency on Chinese technology, expertise, spares, and conceivably the software and information systems that manage its vital energy infrastructure (Tripathi, A. et al., 2025). This reliance limits its future acquisition options and ties its energy security to the political orientation and technological trajectory of a single foreign ally. In the upstream, the economy of the DRC is further intricately involved with a sole principal purchaser of its most vital exports, making its national revenue and economic stability highly vulnerable to Chinese industrial policymaking or demand shift (Makengo et al., 2022). Africa within this framework is rendered structurally dependent on China as both the primary monopsonistic buyer of its necessary raw materials and primary monopolistic provider of its necessary next-generation technologies.

This "hub-and-spoke" configuration, with China as industrial and financial hub and each of the specialist African nations as an isolated, specialist spoke (DRC as the mine, Kenya as the market, etc.), actively undermines the potential for the creation of integrated, continent-wide African value chains (Alice & Deng, 2020). The stated goals of African-initiated projects like the African Continental Free Trade Area (AfCFTA) are to promote regional integration and industrialization, and African resources to be developed and utilized in Africa to spur African markets (Manboah-Rockson, 2020). The Chinese circuit, nevertheless, exports the value chain structurally. Instead of having the DRC's cobalt processed in a neighboring country and then used in batteries manufactured in Kenya for a regional East African market, the entire value-creation process is contracted out to China.

This fragmentation is not an error but a defining feature of a geoeconomic approach that aims to maximize Chinese value capture and strategic influence. By taking the African countries on a piecemeal, bilateral basis and positioning itself as the indispensable go-between among them, China prevents the emergence of an

alternative, integrated African green-tech bloc that would one day be capable of challenging its own industries.

This immediately poses the sovereignty paradox. Kenya is using its sovereign discretion to choose its development path and pursue a green energy transition. But in the mechanism through which it fulfills this goal, to join up with China's geoeconomic circuit, comes at the cost of sacrificing a high degree of long-term economic and technological sovereignty to a foreign power. The country can be energy-independent of fossil fuels but perilously face a new type of economic and technological reliance on China. The paradox sits at the heart of the China-Africa relationship in the age of the green transition and poses basic questions around the future of African sovereignty and whether or not it will be able to evolve an authentically independent model to industrialization.

Synthesizing the value chain analysis, the architecture of dependency, and reconsidering access and sustainability, erosion of sovereignty stands out as the most significant and devastating of the geoeconomic circuit's effects. It is the greatest casualty of the trilemma because economic and political dependence cripples the African state's very ability to exercise independent decision and chart its own development path.

In a resource-abundant country like the DRC, sovereignty is gradually unraveled. Unbalanced and opaque agreements like the Sicomines contract put the nation in lock-in mode as far as resources are concerned, jeopardizing its most precious resources for decades and severely limiting its policy space (Kafarhire, 2019). The state is denied badly needed revenues, its ability to diversify its economy is undermined, and it is rendered unable to enforce its own environmental and social protections in the face of well-connected, foreign-headed joint ventures (Pothen & Fink, 2015).

In a technology-and-finance-receiving country like Kenya, sovereignty is eroded in different but equally effective forms. The accumulation of unviable single-source creditor debt creates a giant influence lever and limits fiscal freedom. The adoption of a single-source technological platform creates an extended reliance that truncates future alternatives and undermines bargaining power (Gelpern et al., 2021). The imposition of onerous contractual provisions, such as the waiver of legal jurisdiction, represents a prima facie abandonment of sovereign discretion.

This systemic compromise of sovereignty is no accidental byproduct of the circuit, no unforeseen consequence. It is an integral part of its design. The narrative that African nations are making a pragmatic "trade-off", surrendering sovereignty in exchange for

faster access to energy and infrastructure, is a simplification. The signs are that it is not an equal trade between equals (Teixeira, 2021). African nations, negotiating from a state of dire need and chronic disadvantage, are presented with a paradigm of development with dependency as an integral part of it . Their "access" is often partial and inequitable, their "sustainability" divided and illusory, but their loss of sovereignty runs profound and permanent (Teixeira, 2021). Unless they achieve genuine sovereignty over their resources, finances, and technology, African nations run the risk of replacing one historical model of dependency with another new, more sophisticated model, denying them the ability to fulfill a truly equitable and autonomous destiny.

## 4.4 Policy Recommendations for an Equitable African Energy Future

The above has demonstrated how the ascendant China-led geoeconomic circuit, in that it offers some infrastructure, systematically creates dependencies that undermine African industrialization, sustainability, and sovereignty. This is, however, not necessary. African states can remake the terms of engagement and forge a more equitable and independent trajectory for their energy future. This requires a collective and planned policy response at the national, regional, and continental levels. This chapter moves from diagnosis to prescription, presenting a set of pragmatic policy prescriptions designed to recapture the value chain, sever dependencies, and redefine Africa's development trilemma. The tension between the cycle of dependency observed in the DRC and Kenya and the relative success of Nigeria's assertive local content policies is used to show that the critical variable is not foreign investment, but the coherence, intentionality, and effectiveness of domestic and regional governance.

### 4.4.1 Reclaiming the Value Chain

The foundation of an independent energy future is to break the commodity dependence trap and capture a greater share of value from the continent's own resources. This requires an aggressive and deliberate strategy to build domestic value addition and beneficiation.

African governments must move from the passive exportation of raw ores. A highly effective tool is imposing a ban on the export of unprocessed minerals, contingent upon the availability of local processing capacity (Owusu & Vaaland, 2016). Zimbabwe's ban of raw chrome ore exports to favor its ferrochrome sector and Nigeria's recent requirement that all mining licenses include a solid plan for local processing are good examples (EnviroNews Nigeria, 2025). For the DRC, this would mean a phased ban on the export of raw cobalt and copper concentrate, offering a compelling incentive for investors to set up refining and precursor facilities in the country.

African investment promotion agencies should aggressively target and court investment in the high-value midstream value chain segments of the battery. The compelling economic case for investing in DRC-based cathode precursor plants, three times cheaper than the US and a 30% lower carbon footprint, should be utilized as a key marketing selling point to appeal to a wide range of international investors, and not just those from China (BloombergNEF, 2021).

Industrialization has to be envisioned at a regional and not merely a national level. The AfCFTA provides the framework to create integrated, cross-border value chains (African Union, 2013). For example, DRC cobalt and lithium can be domestically processed into precursor materials, and then shipped to South Africa, Morocco, or Egypt for battery cell assembly and manufacturing and supplying the growing African market for EVs and energy storage. This is more likely to produce larger, more attractive markets and allow countries to specialize in different segments of the value chain.

### 4.4.2 Dismantling Dependencies

Simultaneously, African nations must actively break the framework of financial and technological dependency. This includes diversifying partnerships, increasing bargaining capabilities, and fundamentally rewriting the terms of engagement for foreign investment and acquisition of technology in general.

Make all loan agreements, resource-for-infrastructure deals, and construction contracts publicly available and open to parliamentary and civil society oversight. Declare confidentiality clauses to be against public policy. To reduce the influence of any single creditor, nations must aggressively diversify their financing sources, encompassing a wide array of partners that include traditional Western IFIs like the World Bank and

AfDB, other bilateral partners, and private capital markets, and thereby creating a competitive market for financing (World Bank, 2025).

African nations must embrace and enact comprehensive local content policies drawing lessons from the success of Nigeria's Nigerian Content Development and Monitoring Board (NCDMB) (EnviroNews Nigeria, 2025). This model has managed to build domestic capacity using local goods and services where feasible, excluding their importation, requiring deployment by locally certified engineers and dedicating part of contract sums to funding local capacity development. Such technology purchase contracts and infrastructure contracts must include legally binding, measurable, and time-bound commitments to:

- The training and certification of a local staff for all operational levels, maintenance, and management.
- The creation of local facilities for the production of vital spare parts.
- Release and open availability of all software, blueprints, and maintenance procedures required to offer long-term operation independence.

As the AfDB and the AU's Agenda 2063 emphasize, the massive and long-term investment in technical and vocational training is not a choice (African Union, 2013). The building of a local pool of engineers, technicians, and managers is the ultimate solution to technologic dependency and a need to operate, maintain, and innovate in the continent's own energy and manufacturing sectors.

### 4.4.3 Redefining the Trilemma for an African-Led Transition

Finally, African policymakers must proactively redefine the terms of the development trilemma, shifting from a reactive position to a visionary position for an equitable, just, and African-owned energy transition. This means placing the actual interests of African citizens above the strategic interests of foreign partners.

National energy planning must shift from an exclusive focus on large-scale, centralized generation projects to a more balanced portfolio that accommodates and promotes decentralized renewable energy explicitly. Policy and regulation must be revised to speed up private and community-led investment in mini-grids and solar home systems that have proven to be more effective in cutting rural energy poverty and reaching the

very poor populations (World Bank, 2025). This aligns with the African Union's requirement for targeting "bottom of the pyramid" access (African Union, 2013).

The African governments ought to pick up and implement the highest global standards of environmental, social, and governance (ESG) performance for all energy and mining projects, regardless of the nationality of the investor. This includes mandating open and transparent community development deals, offering free, prior, and informed consent to affected communities, and implementing independent monitoring authorities having the power to impose severe penalties for human rights abuses and environmental degradation (African Development Bank, 2025). The notion of a "just transition" must be at the forefront so that affected communities dependent on extractive industries can be helped by retraining and new economic development.

The most effective means to balance the playing field in negotiations with global superpowers like China is collectively. It is unlikely that one African nation could dictate terms, but a continental bloc collectively has enormous negotiating power. African nations can use platforms like the African Union and regional economic communities to develop and apply common standards on infrastructure contracts, debt sustainability analysis, mineral resource management, and local content planning. This would prevent a "race to the bottom" with nations pitted against each other and instead result in a "race to the top," building a high-standard continent-wide investment environment (African Development Bank, 2025). This model relocates the energy transition from a conceivable source of neocolonial dependence to a powerful driver of authentic African integration, empowerment, and prosperity, achieving Agenda 2063's agenda(African Union, 2013) .

# 5. Conclusion

## 5.1 Recapitulation and Synthesis

This thesis set out to analyze China's mechanisms and implications for engagement in Africa's energy transition. It sought to respond to two simple questions: to what extent has China established an interconnected geoeconomic circuit that connects mineral extraction with the installation of energy infrastructure, and what is the implication of

this circuit on the developmental trajectory of the continent? The study, drawing on comparative research between the Democratic Republic of Congo (DRC) and Kenya, transcends viewing China's activity as a series of disconnected projects. Instead, it provides a definitive response: China has actually constructed a systematic, continent-spanning geoeconomic circuit, a system designed to promote its key strategic interests in resource security and industrial primacy.

The empirical evidence revealed in Chapter 4 support that the DRC and Kenya do not exist as isolated partners but as symbiotic nodes within this integrated web. The DRC is the origin supply node, the starting point of the essential minerals that fuel China's green technology industries. Chinese activity here is not speculative but mission-oriented, characterized by massive, state-led investments aimed at a few world-class cobalt and copper mines, such as the Sicomines and Tenke Fungurume mines. The prevailing financial model, the "resource-for-infrastructure" (R4I) model, is a masterstroke of geoeconomic strategy. By tying the infrastructure loans against the future revenues of the mines themselves, China acquires a long-term offtake of strategically important minerals assured while simultaneously bypassing the enormous financial and political risk of operating in an insecure country.

Conversely, Kenya is the circuit's archetypal demand node, a key terminal market for the very technologies built from the DRC's minerals. Here, China employs a different yet equally effective model of operations: Engineering, Procurement, and Construction + Finance. Through this mechanism, Chinese policy banks finance Kenyan state agencies to undertake enormous renewable energy projects such as the Garissa Solar Park on the condition of engaging Chinese companies for the construction. This results in a captive loop of finance whereby the Chinese money ends up being channeled to purchase Chinese services and goods, and thus rendering its industrial output a captive market. The result is staggering levels of import dependency, with Kenya importing 96% of its solar panels and 81% of its lithium-ion batteries from China. When connected, these nodes reveal a complete transnational value chain: raw cobalt is extracted in the DRC, sent to China to be value-added into high-value parts, and then re-exported to Africa in finished form as deployed technologies applied in Kenya, often financed with Chinese credit.

This framework shows a highly sophisticated and adaptive geoeconomic response. The transition from the R4I model in the DRC to the EPC+F model in Kenya is far from random; it is deliberate adjustment of finance and governance tools to the singular host country's political economy. In the environment of high risk, low-governance in the DRC, the R4I model relies on opacity and elite bargains at the highest level to capture

physical assets. In the more institutionalized, secure context of Kenya, the EPC+F model aligns itself with official national development plans like Vision 2030 in order to obtain procurement contracts. This adaptability in strategy allows China to operate successfully through the whole range of African governance environments, making its geoeconomic circuit extraordinarily resilient and ubiquitous.

## 5.2 The Architecture of a New Dependency

The geoeconomic circuit, in supplying material infrastructure, is simultaneously constructing a subtle but lasting framework of a new, 21st-century dependency. This reality presents a basic challenge to the prevailing script of "South-South Cooperation," which casts the China-Africa relationship as a partnership between equals, distinct from earlier North-South patterns of exploitation. The empirical record of this thesis suggests that while the actors themselves might have changed, the structural dynamics of core-periphery relations are being replicated in a more complex form. This is perhaps best demonstrated by the "Value Chain Paradox" and the triadic structure of dependence that the circuit systematically constructs.

The Value Chain Paradox exposes a deep and structural imbalance in economic value sharing. As it provides the initial raw materials and growing end-market, Africa is structurally excluded from the most lucrative stages of the green economy value chain. The findings indicate that the DRC, the world's irreplaceable source of cobalt, captures a mere 3% of the overall battery and electric car value chain. The majority of value-add, profitability, and high-skilled employment are hijacked in China's midstream where it dominates refining of critical minerals and manufacturing of battery components. The difference is stark: Chinese battery giants like CATL enjoy profit margins of over 15%, while Congolese artisanal miners toil under unsafe conditions for a few dollars a day.

This paradox is upheld by a tripartite dependency system. One, economic dependency is established with colossal, typically concealed, debt obligations. In the DRC, the Sicomines deal allowed Chinese allies to borrow almost 10 billion in profits against only 822 million in infrastructure supplied, putting the nation into a resource-backed debt trap. In Kenya, the 5 billion Standard Gauge Railway (SGR) loan came with strict, sovereignty-ousted conditions such as arbitration in Beijing, and has been commercially unproductive, subjecting the national treasury to a harsh brunt.

Second, technological dependence is fostered by a "lock-in" effect. The widespread adoption of Chinese hardware and proprietary software from vendors like Huawei and ZTE, typically through EPC contracts for 85% of projects, creates a long-term dependence on a single ecosystem for maintenance, spare parts, and upgrades. This is compounded by a systemic lack of real skills and knowledge transfer, which maintains the African nations as consumers, rather than producers, of technology.

Third, for the resource-rich country, resource dependency is the very trap. Deals such as Sicomines produce a "resource lock-in," tying a nation's most prized sovereign assets into the hands of one foreign partner for decades. It causes a kind of policy paralysis, sharply restricting the state to diversify its economy or capitalize on its resources for wider national development.

Critically, the circuit's logic is structurally anti-industrialization for Africa. The continent's goals towards industrialization as outlined in plans such as the African Union's Agenda 2063 are incompatible with the structure of the circuit. China's dominance of the world market for green technology is founded on its control of the midstream processing and manufacturing steps. An African competitive processing industry would be created directly by challenging China's secure, vertically integrated supply chain that underlies its industrial strategy, e.g., if the DRC were to build its own factories for cathode precursors, less expensive, the studies say, and 30% lower in carbon emissions. The circuit is thereby not only denying to help African industrialisation; its own effectiveness is premised upon stopping it, thereby perpetuating a hierarchical international division of labour.

## 5.3 Sovereignty and the Future of African Development

The deepest and most perdurable impact of the geoeconomic circuit is the systemic erosion of African sovereignty. This is formulated as a "Sovereignty Paradox": African states, in a legitimate exercise of their sovereign agency, engage with China to address pressing developmental imperatives like energy poverty and infrastructure deficits. But the very tools of such collaboration—the debt structure, the terms of technology transfer, and the terms of resource concessions—serve to undermine their economic, technological, and political sovereignty systematically over the long term. A nation such as Kenya is able to achieve independence from fossil fuels only to fall into a new,

more insidious type of dependence on a single foreign source of finance and technology.

This erosion of sovereignty is multi-dimensional. The concept of "partitioned sustainability" conceals a deep moral and political compromise. The "green" achievements touted in Kenya, such as the Garissa Solar Park, are built on a massive social and environmental devastation in the DRC's cobalt mines that are being used as "sacrifice zones" for the world's energy transition. This is not a "just transition," but a system that geographically offloads the environmental and human expenses, allowing its beneficiaries to gain climate points while the real cost falls on Africa's poorest citizens. It denigrates the sovereign duty of a state to protect its people and environment.

Moreover, the "hub-and-spoke" architecture of the circuit is intrinsically antagonistic to the continent's regional integration ambitions. In creating value chains from individual African nations to China and back home, it actively denies the formation of the integrated intra-African value chains which are the very raison d'être of the African Continental Free Trade Area (AfCFTA). Instead of DRC cobalt being smelted in Zambia and exported to South Africa to be utilized in batteries produced for a local market, the value-chain is outsourced to China. China is the essential go-between in this arrangement, the center of geopolitics and geoeconomics from which African markets and African resources are connected. This is an insidious yet efficient form of unofficial geopolitical management. It is not the formal domination of colonialism, but a 21st-century regime of influence founded on the domination of strategic transnational value chains, which commands the development trajectory of African states to the service of the strategic interests of a foreign power.

## 5.4 Charting a Sovereign Path

The architecture of dependency sketched in this thesis is robust, yet not inevitable. The future of African energy transition and general development path will not be decided by one-sided action alone, but by African agency's own strategic imagination and collective will. The challenge of diagnosis traced out here must therefore terminate in a menu of strategic imperatives, a unifying strategy for restoring agency and crafting a more equitable and sovereign future.

This autonomous path is founded on three legs. The first is the imperative of re-capturing the value chain. This requires breaking fundamentally with passive raw materials exportation and an active industrial policy. Governments must balance strategic alternatives such as stage-by-stage exports prohibitions on raw minerals in an effort to craft strong incentives for local beneficiation. They must aggressively seek diversified foreign investment into the midstream segments of the value chain, capitalizing on the continent's clear economic and environmental advantages, and harnessing the AfCFTA framework to establish integrated, regional value chains that process and produce African resources for African consumers.

Second is breaking dependencies in an organized manner. It begins with a vow of radical transparency in all loan and investment contracts, ending the secret deals that compromise sovereign powers. The African nations must diversify their economic and technological partners strategically in order to make the environment competitive, thereby enhancing their bargaining power. Above all, this involves the bold deployment of strong local content law, based on proven models like Nigeria's, that mandates substantial skills transfer, local sourcing, and the development of an indigenous technical and managerial class.

Third, African leaders must redefine the development trilemma on their own terms as a group. This means prioritizing the interests of African citizens over the strategic interests of external partners. National energy planning must balance large-scale grid schemes against targeted support for decentralized renewable energy solutions, which in most instances are more effective in alleviating rural energy poverty. A "just transition" needs to be non-negotiable, involving the insistence on applying the best global environmental, social, and governance (ESG) standards to all energy and mining projects. Most importantly, African countries need to deploy their collective strength. One country negotiating with a superpower is in a weak position; a continental bloc, speaking through the African Union to set and impose uniform standards on debt, contracts, and local content, has enormous leverage. This would transform a "race to the bottom" into a "race to the top," leading to a high-standard investment environment across the continent.

Africa is at a crossroads of history, a time of great opportunity and risk. The global energy revolution, powered by the continent's own natural resources, holds a once-in-a-generation opportunity to trigger industrialization and realize inclusive development. However, the current course, dictated by the geoeconomic circuit examined in this thesis, threatens to institutionalize a new dependency, Africa's perpetually being on the periphery of the world economy. The choice is stark: to be an inactive frontier to a new

age of mineral extraction, or to seize this moment to build an integrated, industrial, and truly sovereign continent. The path ahead is hard, but the power to make the choice is firmly in African hands.

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