



POLICY FRAMING PAPER

Positioning Zambia for a copper-plus future

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As the global demand for minerals critical for clean energy increases, Zambia can use its natural resource wealth to unlock sustained opportunities for development. To do so, Zambia must look beyond extracting value from copper and create openness in the supply chain and a more adaptive development strategy. The focus for Zambia should be on two goals: value addition in the sector (copper and other critical minerals) and supply chain linkages throughout the country, encouraging investment in related industries (manufacturing) and improving livelihoods.

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CONTENTS

Introduction	2
1. Copper mining in Zambia	6
Resource deposits	7
Mining firms	9
Energy use	10
2. Renewable energy	13
3. Regulatory and policy environment	19
Legal and business environment	19
Tax and fiscal policy	20
Environmental policy	22
4. The value and value chain in copper	26
Building Zambia's role in the global value chain (GVC)	27
Public investment to support productivity growth	31
Industrial policy	33
How can this change?	36
5. The global energy transition	37
Copper demand in a decarbonised future	37
Politics of the energy transition	38
Zambia in the energy transition	40
A copper-plus future for Zambia	42
6. Conclusion	44

Introduction

Zambia has a wealth of natural resources, primarily copper, which is essential to achieve a global transition to low-emission energy infrastructure. Early recognition of the demand for copper can give Zambia the opportunity to pivot into the supply chain for low-emissions technologies. The global energy transition is an economic transformation which can provide enough near and medium-term demand to sustain the link between mineral resources, economic growth, and poverty reduction.

Zambia has an opportunity to create a well-developed vertical supply chain and diverse interlinkages in the mining sector for sustained growth. Other countries' growth stories have stalled with an over-reliance on natural resource wealth, crowding out other economic opportunities.¹ **Investing in the mineral supply chain requires avoiding potential pitfalls which could leave Zambia vulnerable to future fluctuations in commodity prices.** The development and strength of the copper industry should be leveraged to support industrial development within and beyond the sector. Long-run development for a copper-plus future will require harnessing and re-investing the revenues of the mining sector to develop the linkages within other high, potential growth sectors for the future.

There is a unique opportunity to capitalise on both the availability of natural resources - minerals - and renewable energy potential to create low-cost infrastructure to support business investment. Improving the productivity and size of the copper value chain requires, firstly, a broad base of reliable electricity. Increasing demand for electricity in the sector will require new generation capacity, which can be provided by solar energy. Solar power projects have a short time frame for development given it is less capital intensive than traditional energy generation sources, and with rapidly declining prices. New solar capacity can serve a source of reliable electricity, with the potential to catalyse wider economic growth.²

1 Sachs, Jeffrey D. & Warner, Andrew M. (2001). "The curse of natural resources," *European Economic Review*, Elsevier, vol. 45(4-6), pages 827-838, May.

2 Fried, Stephanie, and David Lagakos. (2023). "Electricity and Firm Productivity: A General-Equilibrium Approach." *American Economic Journal: Macroeconomics*, 15 (4): 67-103

This paper is divided in the following sections:

Section 1 evaluates the state of mineral extraction in Zambia and how the country can achieve sustainable development through its resource wealth today and in the future.

Section 2 evaluates the renewable energy and potential generation capacity for industrial development.

Section 3 reviews the regulatory framework for the mining, electricity, and industrial sectors, and identifies areas for further support.

Section 4 brings together the previous sections and identifies the theory and relevant opportunities for expansion of the mining value chain in Zambia.

Section 5 draws together the theory and practical information to situate Zambia on a potential pathway towards export-led growth through integration into the global market for goods and services which support the transition to a low-emissions future.

The paper concludes with a discussion of a policy framework in **Section 6**.



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1. Copper mining in Zambia

Zambia is the second largest producer of copper in Africa, behind the DRC.³ In 2021, Zambia had the highest share of raw copper in its export bundle.⁴ Copper constitutes 47% of annual exports and brings in over \$6 billion USD per year. Mining dividends to ZCCM-IH, Zambia's state-owned copper company, has grown significantly in 2022, reaching 4,868 million kwacha (180 million USD). Despite fluctuating output in the last twenty years, Zambia is poised to increase extraction via a strong push for production targets and growing demand for the resource. Copper grades have been declining in the country, yet new exploration is being planned and undertaken to identify potential deposits.

In February 2024, KoBold Metals discovered a large-scale and high-grade copper deposit.⁵ This copper deposit is the largest discovered in a century and is believed to be one of the largest high-grade copper mines in the world once production opens. This additional discovery supports the urgent need for Zambia to complete a timely mineral mapping⁶ and build a comprehensive picture of the available resources from copper to other critical minerals for the transition. Construction on this mine will likely break ground this decade, with new production beginning by 2030.

Economic activity within the country is primarily focused on extraction and early-stage refinement, with potential for growth in downstream and side stream activities. The primary product exported is copper ore, while there is some processing and smelting which occur at large, integrated mines. **In contrast to copper ore, copper cathodes and other refined copper products have been decreasing in total export value.**⁷ We discuss the potential areas for investment further along the value chain in **Section 4** of this report.

To better understand how Zambia can expand its production of copper ore and further processed copper products along the mining value chain, we take a deeper look at the current output in both stages. We will first look at resource deposits and the productivity of key mines throughout Zambia, and then evaluate the current state of energy consumption and inputs which are essential to running an efficient mine.

Zambia's natural resource wealth is well suited to future demand under decarbonisation policies and for relevant technologies. Overall, Zambia's largest and most developed natural resource is copper, with a growing interest in identifying and mining cobalt in partnership with the DRC.⁸ Both resources are essential for the energy transition, and we review the potential role Zambia can play in the electrification value chain. We focus firstly on the

3 PriceWaterhouse Cooper (2023). Zambia 2023 Mining Report. <https://www.pwc.com/zm/en/assets/pdf/zambia-mining-report-2023.pdf>

4 OEC (2023). Zambia World Country Profile. <https://oec.world/en/profile/country/zmb>

5 Financial Times (2024) Bill Gates-backed mining company discovers vast Zambia Copper deposit. <https://www.ft.com/content/28c36ea0-fd3a-48be-b49c-76fe63b9a0f2>

6 Werker (2023) A strategy for resource-led development in Zambia. Policy Brief, IGC. <https://www.theigc.org/sites/default/files/2023-10/Werker%20Policy%20brief%20September%202023.pdf>

7 OEC (2023) Copper trade flows. <https://oec.world/en/profile/bilateral-product/rawcopper/reporter/zmb?yearGrowth2=exportYear5&>

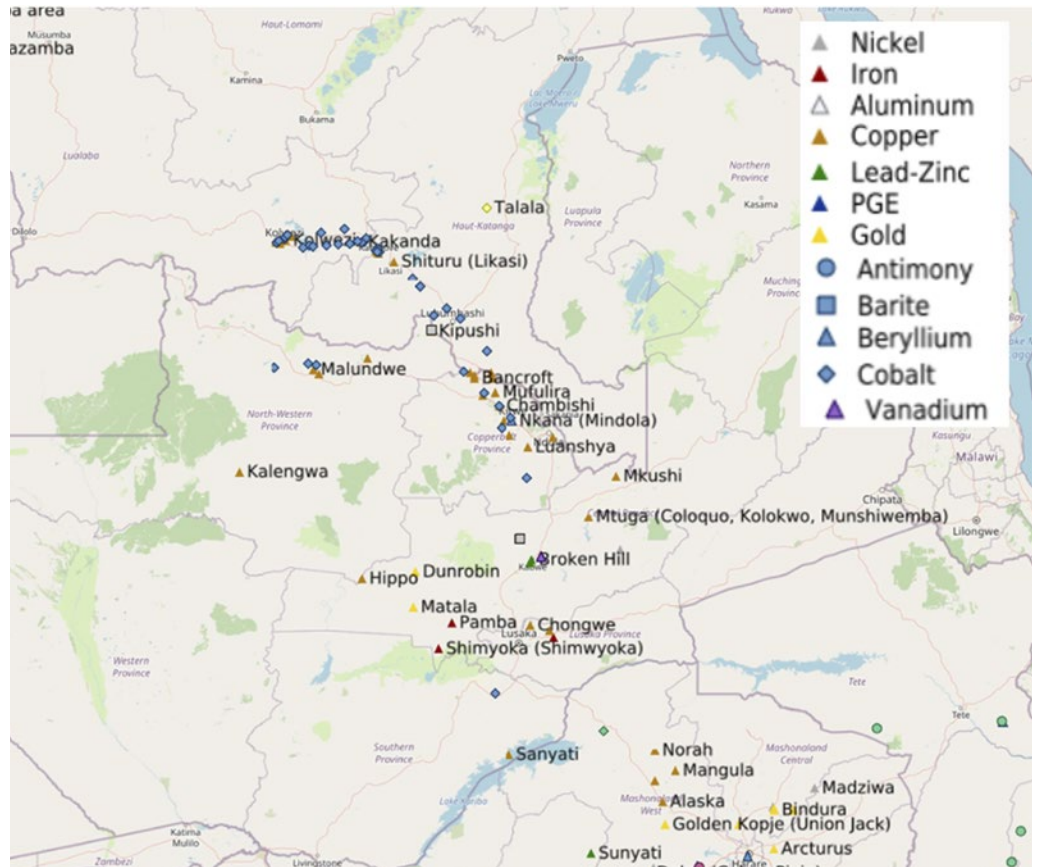
8 African Business (2023) <https://african.business/2023/04/long-reads/drc-and-zambia-to-establish-sezs-for-electric-vehicle-production>

state of resource deposits, the landscape of firms, and the energy use by mining companies to understand the current context of mining activity in Zambia.

Resource deposits

Zambia's copper assets are concentrated in the Copperbelt region, with ten mines focused either primarily or jointly on copper extraction. But, as the quality of copper in existing mines degrades, new capacity for extraction is occurring outside of the Copperbelt, in the neighbouring North Western province. Today, the top three producing mines are located in this province, and higher output has subsequently been concentrated in this area. Additional shifts in the concentration of the mining sector may occur after a geographic analysis of resource deposits is conducted.

Figure 1. Map of Zambia's major mineral deposits (USGS MRData)



Mining in Zambia experienced flooding and extraction of lower copper ore grades in 2022, slowing down GDP growth.⁹ In Zambia, government revenues are explicitly linked to the price of its key export commodity, copper, which leads to immediate effects on aggregate economic activity. Real GDP changes occur frequently in response to commodity price shocks. At the same time, existing mines continue to extend to extract more ore, but the overall

⁹ PriceWaterhouse Cooper (2023). Zambia 2023 Mining Report. <https://www.pwc.com/zm/en/assets/pdf/zambia-mining-report-2023.pdf>

quality of the copper ore has been declining in existing mines. Concerns were placed on the Kansanshi Mine and Chibuluma mine where ore depletion rates are declining.¹⁰ The Mopani mine underwent a refurbishment in 2019 but requires further expansion to remain viable and expand production.¹¹ However heterogeneity across the mining productivity and resource size exists. At Kansanshi mine in the North Western province, an upgrade to the smelter and expansion of the processing plant is being undertaken to extend production capability through 2044.¹²

Figure 2. Historical copper price (Trading Economics 2024)



New mapping of Zambia's mineral deposits could significantly improve the government and investors' understanding of total available minerals. The government plans to undertake a mapping exercise beginning in 2025. Current mapping of Zambia's mineral deposits has been carried out using an above-ground survey, where minerals that outcrop - seen from the above-ground geology - are assessed.¹³ The United States Geological Survey provides data on the deposits, prospects and permissive tracts for copper resources, including estimates of undiscovered copper resources.¹⁴ But, enhanced surveys are needed to help the government identify new deposits of critical minerals and improve the accuracy of existing estimates for copper ore.

10 Barry, J. (2019) The Mineral Industry of Zambia. 2019 Minerals Yearbook, United States Geological Services. <https://pubs.usgs.gov/myb/vol3/2019/myb3-2019-zambia.pdf>

11 Mining Technology (2023) Zambia's Mopani copper project posts \$298m loss amid takeover talks. <https://www.mining-technology.com/news/mopani-zambia-copper-loss/?cf-view>

12 Crux Investor (2023) First Quantum Mining Pursues renewable Energy in Zambia to Support Ambitious Copper Production Growth. <https://www.cruxinvestor.com/posts/first-quantum-mining-pursues-renewable-energy-in-zambia-to-support-ambitious-copper-production-growth>

13 MFZ (2022) Mapping the minerals of the future. <https://miningforzambia.com/mapping-minerals-future/>

14 USGS (2024) Mineral Commodity Summaries: Copper. <https://www.usgs.gov/centers/national-minerals-information-center/copper-statistics-and-information>

Mining firms

The largest mining firm in Zambia was Mopani Copper Mines, a Zambian mining company that was originally part of the state-owned Zambia Consolidated Copper Mines Limited (ZCCM) until 2000. In June 2023, it was announced the mine would be sold, with four companies shortlisted for the takeover, including Sibanye-Stillwater of South Africa, China's Zijin Mining, and Norinco Group, a Saudi Arabian and Chinese-funded investment firm.¹⁵

First Quantum Minerals (FQM) produces the highest share of copper in Zambia. After FQM, production is followed by Barrick Gold, Glencore, and several smaller producers.¹⁶ Currently, ZCCM holds a minority stake in most of the country's copper mines.

Firms are concentrated in the Copper Belt and North Western province.

Future exploration may yield additional deposits along different regions in Zambia. Along the border with the Democratic Republic of Congo (DRC), some mining firms operate in both countries to capitalise on copper and other critical minerals for the energy transition. Barrick Gold is conducting joint exploration in Zambia and DRC for copper to expand its existing presence and identify new opportunities in the region.¹⁷ The location of other critical minerals, such as cobalt, may shift the location choice of mining firms in Zambia.

The minerals exports go primarily to Switzerland or firms based in or trade from Switzerland¹⁸. Next, China is the second largest importer of Zambia copper. In recent years, there has been a growth in the import of copper to both Canada and the US, indicating strong growth in these markets as support for electrification and low-emissions technologies are introduced at the national level in these countries. A recent loan of \$250 million was made to Zambia from the US to refurbish the Angolan rail line, connecting major mines in the region with an Atlantic port, while China has proposed \$1 billion USD for a rail refurbishment to the Dar-es-Salaam port in Tanzania.¹⁹ This growing investment infrastructure demonstrates a sustained interest by both large North American and Chinese firms within the region.

Beyond key producers, firms downstream and upstream in the value chain are responsible for the further processing of copper or providing the inputs to key firms. Upstream from the mining sector includes any inputs needed to operate a functioning mine, importantly, electricity. Two regional utilities and ZESCO undertake electricity provision, the state-owned utility (discussed further in the following subsection). Other upstream and side-stream industries include construction, catering, transportation, and logistics

15 Mining Technology (2023) Zambia's Mopani copper project posts \$298m loss amid takeover talks. <https://www.mining-technology.com/news/mopani-zambia-copper-loss/?cf-view>

16 Mining Technology (2023) Copper Production in Zambia and Major Projects. <https://www.mining-technology.com/data-insights/copper-in-zambia/?cf-view&cf-closed>

17 Mining.com (2023) Barrick CEO wants to search for more copper in Zambia and Congo. <https://www.mining.com/web/barrick-ceo-says-to-search-for-more-copper-in-zambia-and-congo/>

18 OEC (2023) Copper. [https://oec.world/en/profile/bilateral-product/rawcopper/reporter/zmb?yearGrowth2=exportYear5&yearGrowth=exportYear2&tradeGrowth=flow0&shareMarket=shareMarket&flowCompeTtor=bu\[onExports](https://oec.world/en/profile/bilateral-product/rawcopper/reporter/zmb?yearGrowth2=exportYear5&yearGrowth=exportYear2&tradeGrowth=flow0&shareMarket=shareMarket&flowCompeTtor=bu[onExports)

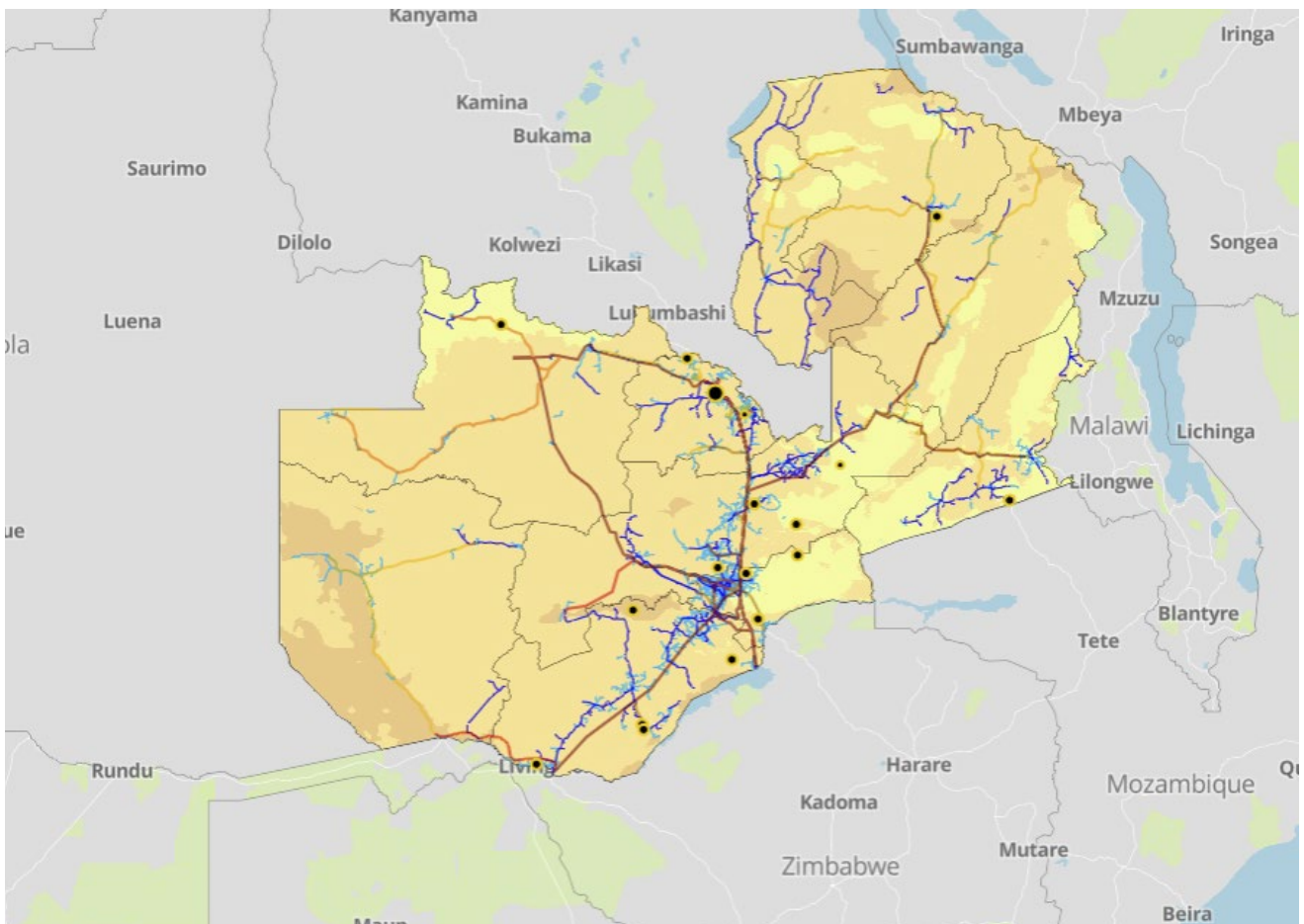
19 Bloomberg (2024) China Proposes a \$1 Billion Tanzania-Zambia Railway Revamp. <https://www.bloomberg.com/news/articles/2024-02-07/china-proposes-a-1-billion-tanzania-zambia-railway-revamp?leadSource=verify%20wall>

services. Firms downstream may process and smelt copper.²⁰ Firms operating smelters have high overlap with the set of firms currently undertaking extraction.

Energy use

The grid infrastructure in Zambia is essential for understanding access to electricity for mining. High voltage transmission lines run from the Copperbelt to Lusaka. There are two major utilities which provide energy to mining firms: ZESCO, the country's national utility company and Copperbelt Energy Corporation Plc (CEC); a regional utility.²¹ CEC delivers electricity to eight mines in the Copperbelt and operates six gas turbines independently. Both suppliers collectively provide 51% of the country's generated electricity to the mining sector.²²

Figure 3: Energy (transmission and distribution lines) and mining infrastructure in Zambia
(World Resource Institute, Energy Access Explorer)



Note: Dark red and brown lines indicate large scale transmission lines, while light and dark blue represent distribution lines (lower capacity). Yellow/black circles represent current mines.

²⁰ For a long list of enterprises who may contribute to these upstream services, please see the IGC's 2014 Zambian Enterprise map. Access here: <https://www.theigc.org/publications/enterprise-map-zambia>.

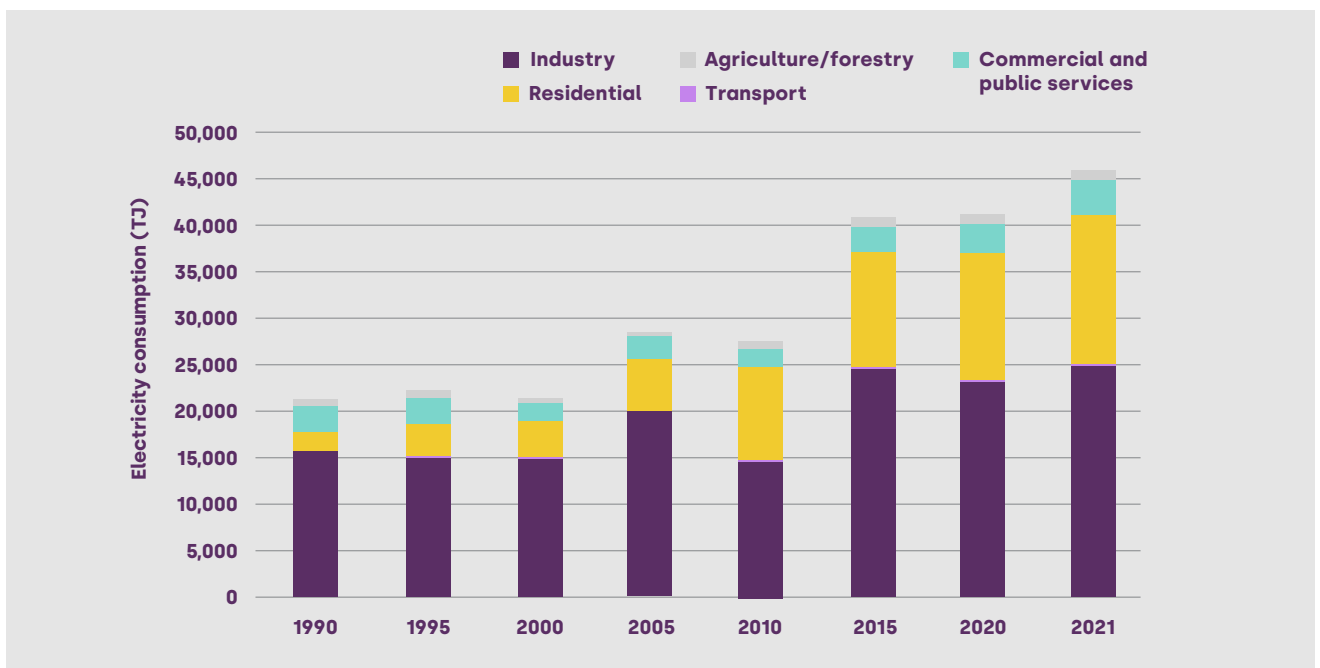
²¹ GE Solutions (2016) Subsector Analysis: Zambia https://www.german-energy-solutions.de/GES/Redaktion/DE/Publikationen/Marktanalysen/2016/studie_2016_subsector-solar-in-mining-zambia.pdf?__blob=publicationFile&v=6

²² Ministry of Energy, Zambia (2024) Zambia's energy sector overview. https://www.moe.gov.zm/?page_id=2198#:~:text=The%20installed%20generation%20capacity%20in,the%20domestic%20sector%20at%2033%25.

Recent investments in solar projects by the regional utility seek to reduce the cost of energy and create an independent generation source for the CEC. In the Copperbelt, two flagship solar projects have been developed by the CEC to serve mining customers. These projects include the recently completed 34 MW solar plant in Riverside and the 60 MW Itimpi solar plant - which is still under construction. This proposed solar will serve the demand from mining companies in the region.

While renewable energy sources supply a majority of electricity in Zambia (80%), it is mainly from hydroelectric plants. Solar energy accounted for just 3% of total electricity generation capacity.²³ Energy from hydroelectric generation sources requires transmission and distribution through the grid and is subject to potential variability from changes in precipitation. Electricity access for mining firms has been limited, given competing demand during these low supply events and the production capacity of ZESCO.²⁴

Figure 4. Electricity consumption by sector in Zambia (IEA 2023)



Electricity consumption is needed for extraction, processing and transportation. **As Zambia works to expand the production of downstream industries, energy requirements along the value chain will grow.** For example, as copper ore quality decreases, mines must be dug deeper, increasing energy intensity of production.²⁵ The process of grinding and crushing the ore is also energy intensive, an increasingly so as ore grade declines. Final processing of the ore makes up the largest relative share of energy

23 Ministry of Energy, Zambia (2024) Zambia's energy sector overview. https://www.moe.gov.zm/?page_id=2198#:~:text=The%20installed%20generation%20capacity%20in,the%20domestic%20sector%20at%203%25.

24 Policy Monitoring and Research Centre (2023) Zambia's Mining Key Reforms for the Actualisation of 3 Million Metric Tonnes of Copper in a Decade. <https://pmrczambia.com/wp-content/uploads/2023/09/Zambias-Key-Reforms-for-the-Actualization-of-the-3-Million-Metric-Tonnes-of-Copper-in-a-Decade.pdf>

25 Aramendia et al (2022). Global energy consumption of the mineral mining industry: Exploring historical perspective and future pathways to 2060. *Global Environmental Change*. Accessed at: <https://eprints.whiterose.ac.uk/206880/7/1-s2.0-S0959378023001115-main.pdf>

consumption along the value chain.²⁶ But Zambia is well placed, relative to other countries in the region, to attract new investment in generation capacity, particularly for the sector. Zambia is currently the only country in Africa where there are private firms operating in the generation, transmission, and distribution of energy.²⁷ Additional capacity requirements for energy are needed as copper ore quality declines, and Zambia extends production into downstream processing activities.

Other energy consumption in mining is driven primarily by transport fuels. Rail transportation is essential for transportation of large quantities of copper,²⁸ and current rail operations are not electrified in Zambia. Heavy duty vehicles (HDVs) are also used on site and for final transportation in the mining sector. Both freight and commercial vehicles rely primarily on petroleum fuels, such as diesel or gasoline.



26 Jeswiet & Szekers (2016) Energy Consumption in Mining. 23rd CIPR Conference on Life Cycle engineering. 14-145. / <https://core.ac.uk/download/pdf/82250924.pdf>

27 IEA (2022) Africa's Energy Outlook: 2022. <https://iea.blob.core.windows.net/assets/220b2862-33a6-47bd-81e9-00e586f4d384/AfricaEnergyOutlook2022.pdf>

28 Policy Monitoring and Research Centre (2023) Zambia's Mining Key Reforms for the Actualisation of 3 Million Metric Tonnes of Copper in a Decade. <https://pmrczambia.com/wp-content/uploads/2023/09/Zambias-Key-Reforms-for-the-Actualization-of-the-3-Million-Metric-Tonnes-of-Copper-in-a-Decade.pdf>

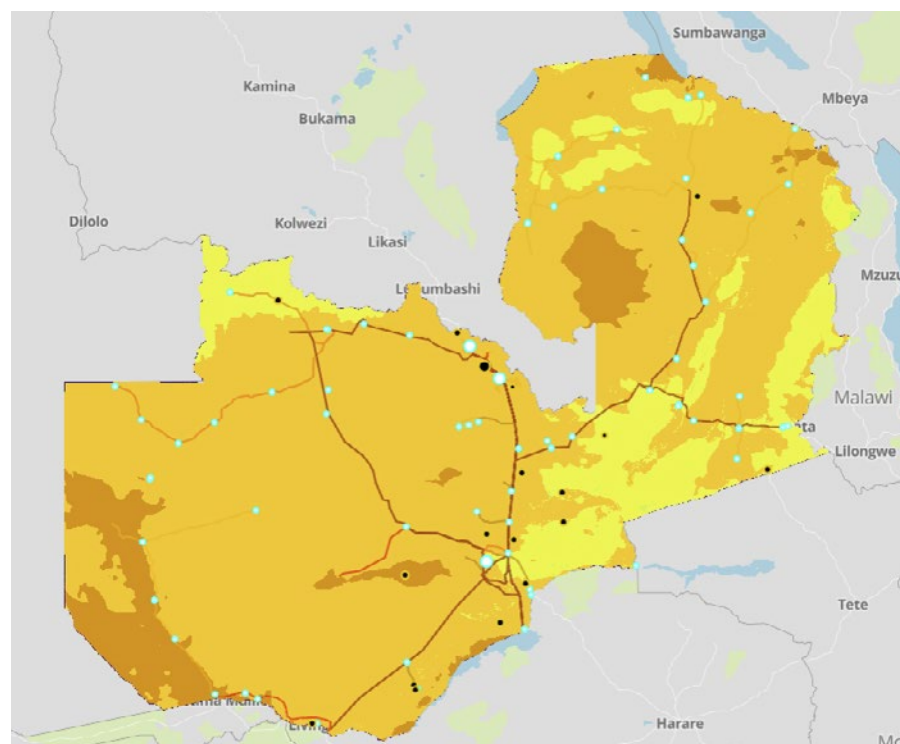
2. Renewable energy

In addition to natural resources, Zambia's geographic location is highly favourable to the generation of renewable energy, particularly solar. Located in the world's solar belt with high levels of solar irradiation, there is an ample opportunity to co-develop solar generation capacity in proximity to mining activities. Mineral extraction uses over 50% of the country's generated electricity, and only recently has the regional utility serving mining customers begun to develop small-scale solar PV projects.

Solar potential is favourable throughout the year. During late summer months, in September and October, Zambia has the highest long term monthly average total of irradiation (over 6 kWh/m²).²⁹ Despite this, electricity generated from solar varies from <1% to 9%, the highest share of solar-generated electricity being consumed in Lusaka. Current installed capacity of electricity in the country is about 3,000 MW, with demand growing 150-200 MW per year.

There is significant potential to generate low cost solar as technology costs decline. The cost of solar technology has dropped dramatically in the last two decades, lowering the capital cost of building out solar projects. But, even with cheaper technology, scaling up projects requires balancing the capital cost with future returns. Additional costs, including transaction costs, risk and the cost of borrowing can inflate large project costs, including in the renewable energy sector.

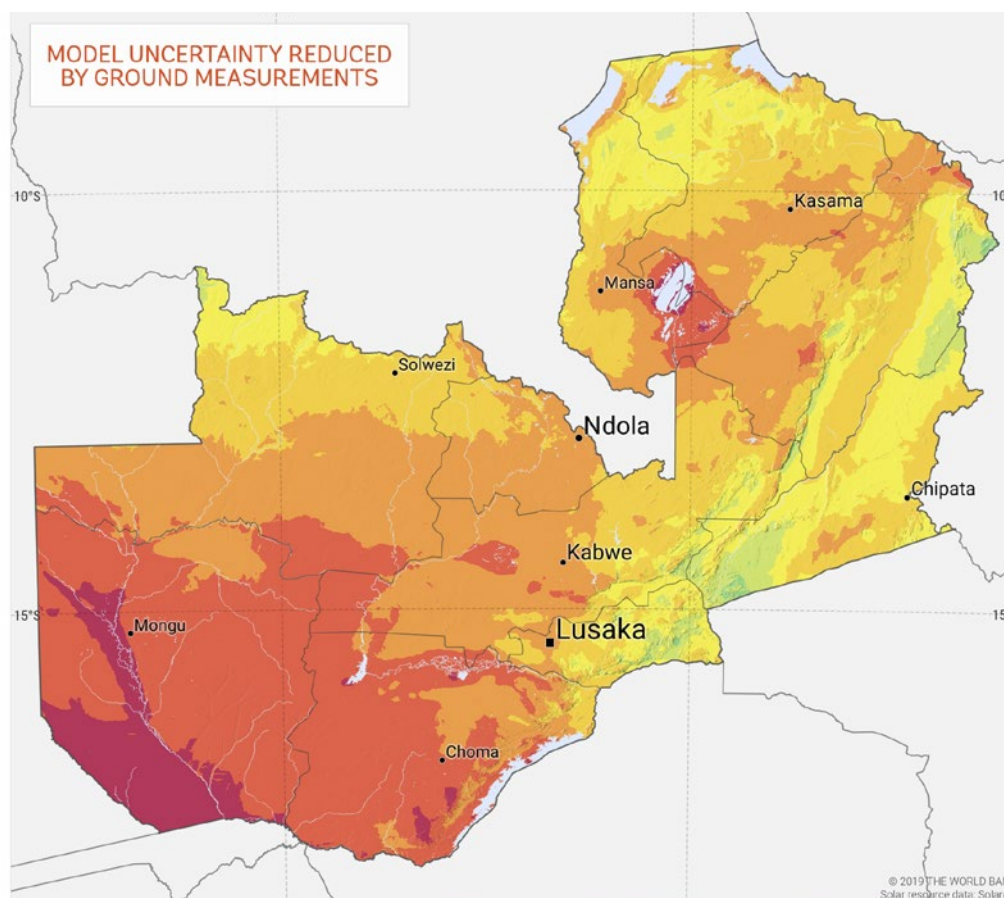
Figure 5a. Solar irradiation potential and energy, mining infrastructure in Zambia (World Resource Institute, Energy Access Explorer)



Note: blue dots indicate hydroelectric power potential, brown lines represent transmission infrastructure, and black dots indicate mines. Solar irradiation is higher in darker areas.

²⁹ Ministry of Energy, Zambia (2024) Zambia's energy sector overview. https://www.moe.gov.zm/?page_id=2198#:~:text=The%20installed%20generation%20capacity%20in,the%20domestic%20sector%20at%2033%25.

Figure 5b. Long term PV output in Zambia (Global Solar Atlas)



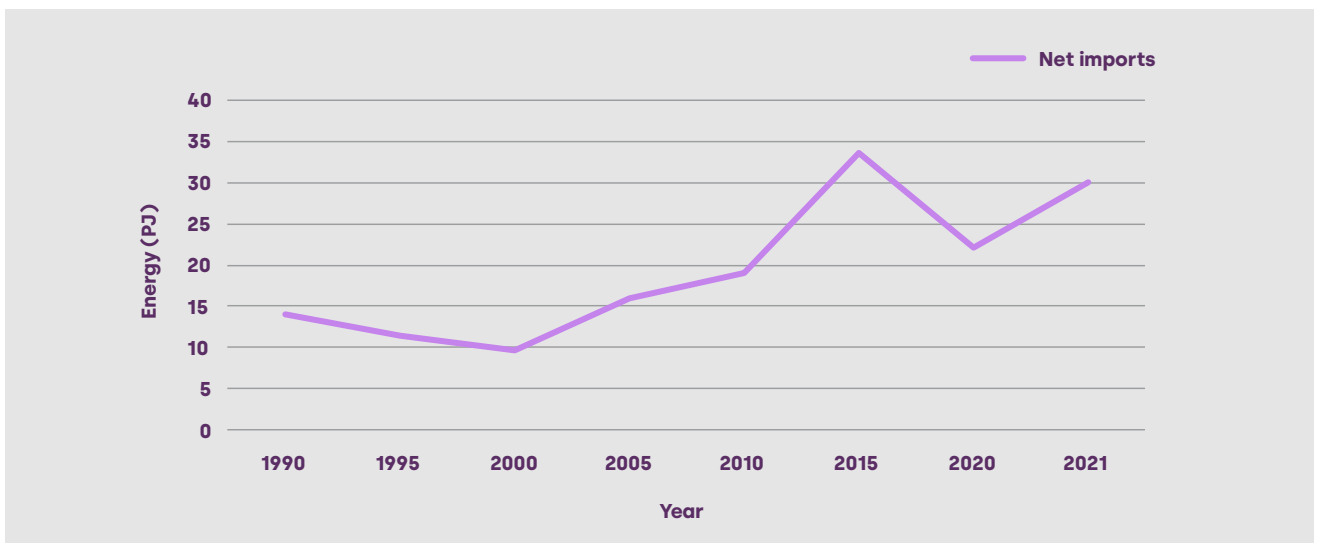
Targeted renewable energy production by 2030 in Zambia would see a significant uptick in the share of solar capacity in the energy mix. Zambia aims to increase total capacity to 500 MW by 2030,³⁰ to make it 25% of the total renewable energy mix (86% of today's mix). To reach this target and provide the energy capacity needed to meet growing demand, investments across the electricity sector are needed: in generation, in transmission, distribution and in digital and telecommunications infrastructure to support expanding and increasing competition in the electricity market. At this point in time, ZESCO owns about 75% of the country's electricity generation capacity, and the majority of transmission and distribution.³¹

Zambia's main source of electricity generation today remains sourced from hydropower, making its energy low emissions but at risk of changing rainfall due to climate change. Small hydroelectricity is located throughout the country, and larger projects serve grid customers. Hydroelectricity constitutes 89% of energy generation in the country and is sourced from the largest dam, the Karima Dam, under joint ownership with Zimbabwe. In 2023, energy supply reductions to firms and households were undertaken due to drought lowering levels in the dam.

³⁰ Ministry of Energy, Zambia (2024) Zambia's energy sector overview. https://www.moe.gov.zm/?page_id=2198#:~:text=The%20installed%20generation%20capacity%20in,the%20domestic%20sector%20at%2033%25.

³¹ Wincewics-Bozy (2021) The Supply Chain of the Mining Industry: The Case of Copper Mining <https://ersj.eu/journal/1958/download/The+Supply+Chain+of+the+Mining+Industry++The+Case+of+Copper+Mining.pdf>

Figure 6. Net energy imports in Zambia (IEA)



Zambia's current installed capacity of solar energy is low, although the government has made strides to encourage investment and expansion of solar mini grids and grid-connected solar PV plants. Zambia has a target for 500 MW of solar power to be installed by 2025, nearly fourfold its current installed capacity. In 2015, the government undertook a partnership with the World Bank to tender for private solar investment, with risk born by the bank. In 2016, two solar plants of 50 MW were tendered, and in 2018, a second round of procurement for 100 MW of solar PV was announced.³²

Despite the concentration of mines in one area, solar generation is still slow to be developed in the region. While it seems an easy fit to scale solar where mines are operating, there is little evidence on explicit cost reductions from co-location of renewable energy and commercial productivity. The IFC Scaling Solar project has been the only pilot programme evaluating the link between reduced demand-side risk and lower cost of large-scale solar projects. In emerging news, First Quantum Mining (FQM), has agreed to develop a 430 MW wind and solar project to supply up to 60% of Kansanshi's power demand.³³ By using co-location, FQM anticipates reducing transmission and distribution costs while shielding the firm from risk of water-stress related energy shortages.

There are two ways to continue to pursue this strategy:

- The regional or state-level utilities serving mining firms can make generation investments and negotiate long-term contracts to that have less volatility risk for the buyer and less demand risk for the supplier.
- Mining firms themselves can make backward-linkage investments in their own, utility-scale solar projects, capturing higher quality sites for development.

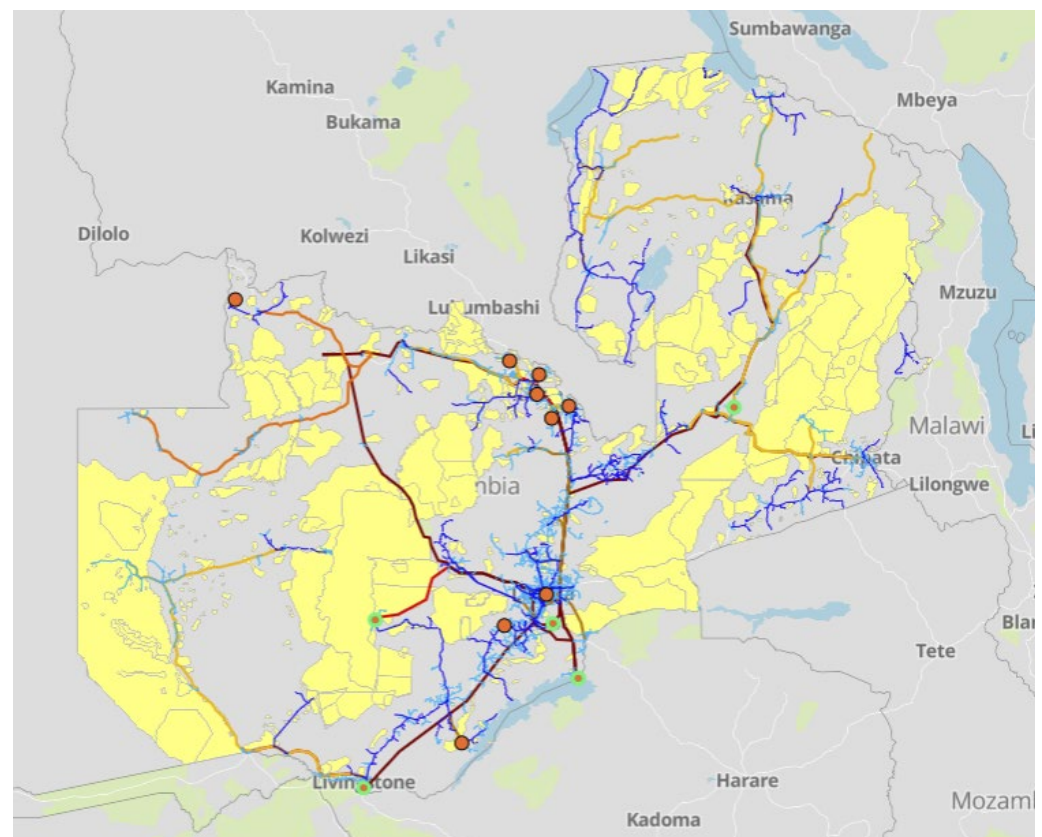
³² IFC (2017) Zambia Signs Second Scaling Solar Mandate to Develop Another 500 MW of Renewable Energy. <https://pressroom.ifc.org/all/pages/PressDetail.aspx?ID=18182>

³³ Crux Investor (2023) First Quantum Mining Pursues Renewable Energy in Zambia to Support Ambitious Copper Production Growth. <https://www.cruxinvestor.com/posts/first-quantum-mining-pursues-renewable-energy-in-zambia-to-support-ambitious-copper-production-growth>

Improvements in aggregate generation capacity must come with infrastructure investments. While some households can potentially be served by off-grid solar or small systems, regional coordination of grid infrastructure to match demand with supply sources is necessary. Increased regional planning of electricity grids and interim connections need to be considered at the local level, to meet the needs of both firms and households in different regions. Grid infrastructure will need to be enhanced in the long term, to provide a marketplace for generators to encourage lower-cost development of projects. Currently, ZESCO operates a vertically integrated utility, with a single-buyer model, and consideration of developing a privatised market for electricity should be considered in the medium and long term. Expanding the ability for generators to generate and sell electricity on the market is a potential avenue for attracting private investment to the sector.

On the supply side, securing a long-term, consistent customers for new solar projects can reduce the volatility of the risk. The Zambian government can attract new renewable energy suppliers through increased coordination in early projects. For example, the government may facilitate a matching between suppliers and industrial consumers. Co-locating renewable energy assets with mines allows for a simpler purchase agreement to be developed, with lower costs as it may avoid additional transmission and distribution costs. Policymakers should focus on removing barriers to renewable energy development to catalyse low cost, reliable energy supplies for firms.

Figure 7a. Energy infrastructure and existing power generation in Zambia
(World Resource Institute, Energy Access Explorer)

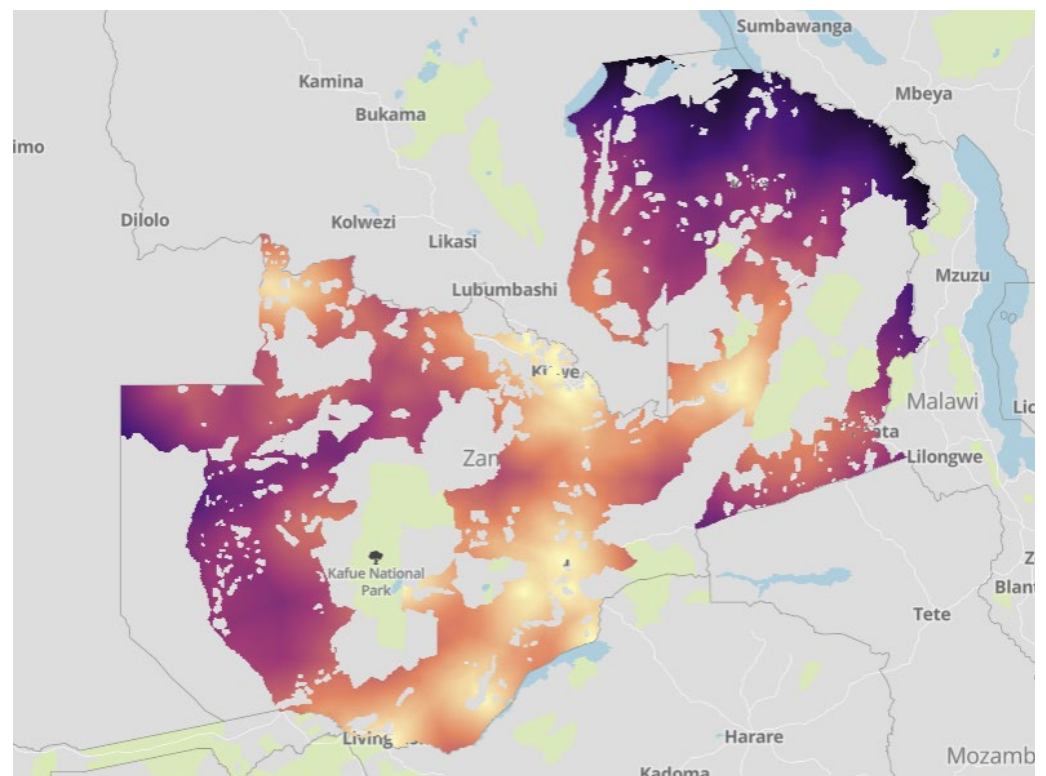


Note: the blue lines are local distribution, the red and brown lines are transmission, orange circles are powerplants and orange/green circles are existing hydroelectric assets. Conservation areas are highlighted yellow in this map.

There has been a significant push for decentralisation of grid infrastructure, to devolve the sector and encourage local level planning for electrification. Decentralisation in Zambia's electricity system remains low, although the country has a strong foundation and policy environment for decentralisation in the sector.³⁴ Currently, ZESCO is responsible for all technical and resource planning concerning the supply of electricity to townships. Energy needs assessments have not been conducted by either ZESCO or local governments, meaning development of energy infrastructure is at risk of not keeping pace with growing urban areas or industrial demand for electricity. Despite a fairly centralised model, both North Western Energy Company and the Copper Belt Energy company operate network assets exclusively in regions with mining activity.³⁵

Energy is an essential input for businesses, and the link between the two is acute in Zambia. Zambia experienced production cuts in its mining operations in 2021 due to a lack of reliable energy supply for mining operations to continue at their normal pace. As discussed in **Section 2**, energy as an input for mining firms is essential, and with household and residential demand for electricity growing at 6-8% per year, there is an urgent need to scale up generation capacity to ensure both firms and households have a reliable supply of electricity.

Figure 7b. Energy access potential, based on existing electricity assets
(World Resource Institute, Energy Access Explorer)



Note: energy access potential is scaled from high (yellow) to low (black). Energy access potential is high along existing infrastructure lines, driven by existing hydroelectric and coal assets. Solar assets could remarkably shift access potential upward in regions on the periphery of the mining regions and urban centres (including Lusaka).

34 Climate Compatible Growth (2023) The Status of Power Sector Decentralisation in Zambia. www.climatecompatiblegrowth.com/wp-content/uploads/The-Status-of-Power-Sector-Decentralisation-in-Zambia.pdf

35 Wincwics-Bozy (2021) The Supply Chain of the Mining Industry: The Case of Copper Mining <https://ersj.eu/journal/1958/download/The+Supply+Chain+of+the+Mining+Industry++The+Case+of+Copper+Mining.pdf>

In the case where the electricity sector is unproductive, the ability for a country to see sustained growth can be hindered. Electricity prices are currently subject to volatility, and this could have knock on effects for investor choice. Additionally, unreliable energy access can have adverse effects on a firm's productivity, and greatly deter future investments in necessary research, development, and skills training. Economic evidence has shown a mix: short-run effects of increased energy access has had minimal impact in some cases on firm productivity.³⁶ But, in the long run, reliable energy has significant impacts on aggregate growth in economies.³⁷ Given the mining industry's future demand increases, securing long term generation capacity will be essential for full development of the sector and subsequent industries along the supply chain.

Without further investment in low-cost energy, FDI activity along the mining supply chain may contract. Firms perceive a lack of secure energy supply as less than adequate, and a potential hindrance to the firm's productivity. A lack of reliable energy ranks highest among the barriers to doing business in Zambia (alongside contract enforcement and property registration),³⁸ constraining new investment. Electricity access in Zambia will likely have spillover benefits to firm productivity and foreign investment flows, if grid infrastructure and new generation capacity is supported.

SINCE SOLAR ENERGY POTENTIAL IS SO HIGH IN ZAMBIA, WHAT IS HOLDING INVESTMENT BACK?

There are several reasons that there is not stronger development of solar generation in Zambia, due both to geographic and institutional constraints. Evidence from the country's partnership with the World Bank on the Scaling Solar project show that lowering the cost of debt financing through favourable lending to producers and facilitation of the transaction between ZEC and the generator made the programme more successful.³⁹ With the current policy environment for electricity only setting ambitions and no legally binding targets for energy generation, policymakers in government need to work to increase the policy support to attract private investment into more diversified sources of generation, and for the purpose of ensuring reliable energy for business development.

36 Jack (2022) How much do we know about the development impacts of energy infrastructure? *World Bank blogs*. <https://blogs.worldbank.org/energy/how-much-do-we-know-about-development-impacts-energy-infrastructure>

37 Fried, Stephanie, and David Lagakos. (2023). "Electricity and Firm Productivity: A General-Equilibrium Approach." *American Economic Journal: Macroeconomics*, 15 (4): 67-103

38 World Bank (2020) Ease of Doing Business Index: Zambia <https://archive.doingbusiness.org/content/dam/doingBusiness/country/z/zambia/ZMB.pdf>

39 Energy for Growth (2023) Solar Can't Scale in the Dark. https://energyforgrowth.org/wp-content/uploads/2023/06/2023-05-08_Teal-Emery_Scaling-Solar.pdf

3. Regulatory and policy environment

Legal and business environment

Zambia faces similar barriers to other countries in the region in attracting foreign investment and encouraging domestic firm growth. We focus here on the existing obstacles face in the legal and business environment to attracting foreign investment into Zambia, particularly along the mining supply chain. While mineral extraction is being conducted by firms in the EU, China and Zambia, the government can intervene to reduce the frictions in the environment which may be holding up investment.

A key problem to attracting new investment is the hold-up concern, where investments are sunk by private actors only for the government to change the terms of a contract, particularly the taxation, ex-ante.⁴⁰ Additionally, the Zambian government revised its fiscal terms of mining contracts mid-way through existing private contracts, creating uncertainty in Zambia's ability to enforce and adhere to both contracts and fiscal regimes.⁴¹ For a country to be an attractive investment location, the country must support the fair provision and enforcement of business contracts.

Improvements to business registration processes in Zambia has fostered a stronger sense of trust in institutions and support investment growth. The digitalisation of business processes and ability to apply for permits and business licences electronically, as enacted in 2023, supports the openness of the country's business environment.⁴² Currently business licences for other sectors are not obtainable online, but further digitalisation can reduce transaction costs. Today, it takes an average of three days to get a permit in person.⁴³ The next component of this process improvement is increased speed in approval. Legal costs and the time associated with contracting should also be accelerated, in other process steps, including obtaining property titles for land or office space and building permits for the construction sector. Excessive wait times for separate permits or to file business documents can cause foreign firms to locate elsewhere. These quick policies can smooth the business process for MNCs looking to invest along the copper supply chain.

Within the sector, recent reforms to the mineral regulatory framework have increased clarity and reduced uncertainty within the sector. The Mines and Minerals Development Act is the primary law in the sector and has replaced the 2008 version by the same name. Other key mining legislation includes the Mines Acquisition (Special Provisions) Act, both No.1 and No.2.⁴⁴ The Special Provisions act appears to facilitate the transfer of a stakeholdership of the mine to the federal government of Zambia. How this is enforced is still unclear.

40 Venables (2016) Using Natural Resources for Development: Why Has It Proven So Difficult? *Journal of Economic Perspectives*. 30:1, pgs. 161-184 <https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.30.1.161>

41 Venables (2016) Using Natural Resources for Development: Why Has It Proven So Difficult? *Journal of Economic Perspectives*. 30:1, pgs. 161-184 <https://pubs.aeaweb.org/doi/pdfplus/10.1257/jep.30.1.161>

42 Ministry of Mines and Minerals Development (2023) Transition from manual to online application of mining licenses under the mining cadastre system. <https://www.mmmd.gov.zm/?p=2654>

43 World Bank (2020) Ease of Doing Business Report - Zambia. <https://archive.doingbusiness.org/content/dam/doingBusiness/country/z/zambia/ZMB.pdf>

44 Global Legal Group (2024) Mining Laws and Regulations Zambia. <https://iclg.com/practice-areas/mining-laws-and-regulations/zambia>

General improvements, not specific to the mining sector, must target reducing transaction costs. Particular barriers, such as high time cost to secure legal property rights over new sites for mines, conduct environmental review and enforce legal contracts must be overcome. Reducing the time necessary to break ground on new projects can demonstrate to investors the ease of establishing new firms in Zambia.

Tax and fiscal policy

Taxation policy in the mining sector is critical for attracting investment and retaining revenue. With respect to revenue retention, the mining sector is a critical component of the economy. In Zambia, the contribution of the mining sector to overall GDP was at a ten-year peak in 2017, at 17% of nominal GDP (PWC). 80% of export revenues come from mining, including copper.⁴⁵ From 2019-2021, capital flows from foreign firms dropped from 3.6 billion USD to 1.9 billion USD.

In 2019, the government introduced an increase in royalties on copper, and eliminated any corporate tax exemption for mining producers.⁴⁶ This policy move, coupled with low investment in infrastructure and unreliable power reduced new investment in the country's mining sector. But the removal of the exemption on copper royalties is not a critical barrier to future investment.

The broader issue is uncertainty in the regulatory environment. There have been several significant changes to the tax regime in mining in Zambia in the last decade. While this uncertainty creates concerns for future changes to the tax rate, the current tax region, outlined in **Table 1b**, has been positively received by firms in the mining sector.⁴⁷

Under the Mines and Minerals Act, No.29, passed in 2018, new incremental royalties were passed (see **Table 1a**). In 2022, the mining policy was changed to remove double taxation and lower the levy. This was done to incentivize mining firms to make new investments, and to expand mineral production.⁴⁸ At the same time, a mineral royalty rate was increased from the one in 2018, changing expectations on operating costs for mining firms. In 2023, the regime was again changed, to reflect an incremental tax rate as opposed to a tax rate on aggregate production. Despite the royalty rate change on extraction, income tax on mining operations and manufacturing of copper cathodes has remained steady since 2018. The rate on mineral processing income tax has decreased from 2021 to 2022, dropping from 35% to 30%.⁴⁹ Other minerals, excluding copper, have a separate tax rate, which varies from 5% to 8% depending on the mineral.

45 Zambia Development Agency - ZDA (2023) Mining sector overview <https://www.zda.org.zm/mining/>

46 S&P Global (2019). Zambia Copper Outlook <https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/metals/122719-zambia-2019-copper-output-drop-due-to-new-mining-taxes-com>

47 PriceWaterhouse Cooper (2023). Zambia 2023 Mining Report. <https://www.pwc.com/zm/en/assets/pdf/zambia-mining-report-2023.pdf>

48 Brookings Institute (2023). Tripling Zambia's copper production: A way out of the debt crisis. <https://www.brookings.edu/articles/tripling-zambias-copper-production-a-way-out-of-the-debt-crisis/>

49 Zambia Tax Revenue (2022) 2022 Statistics for the tax authority. <https://www.zra.org.zm/wp-content/uploads/2023/09/2022-Tax-Statistics.pdf>

Table 1a. Historical Mineral Royalty Tax

Norm Price Range Mineral Royalty Rate	2018	2019	2020	2021	2022
Less than US\$4,500 per tonne	4	5.5	5.5	5.5	5.5
US\$4,500 but less than US\$6,000 per tonne	5	6.5	6.5	6.5	6.5
US\$6,000 but less than US\$7,500 per tonne	6	7.5	7.5	7.5	7.5
US\$7,500 but less than US\$9,000 per tonne	6	8.5	8.5	8.5	8.5
US\$9,000 per tonne and above	6	10	10	10	10

Table 1b. 2023 Mineral Royalty Tax

Price range	2023 (rate (%) on incremental price)
Less than US\$4,000 per tonne	4
US\$4,001-5,000	6.5
US\$5001-7,000	8.5
More than US\$7,000	10

The mining sector is primarily dominated by large firms. 85% of the gross domestic tax revenue collected from the sector in 2022 was paid by large firms. The remaining tax is paid at 14% by small firms, and less than 1% by medium firms.⁵⁰ Given the sector is comprised mainly of large producers, oversight and enforcement of tax collection can be focused on these key firms, to ensure the government collects tax revenues in a timely and accurate manner.

Due to lower prices of copper, mineral royalties in 2022 dropped from 15% to 12% of total taxes collected. This only emphasises the need for strong oversight and revenue management within the tax system to ensure that fluctuations in the price of copper do not create a fiscal burden for Zambia. As copper prices recovered through 2023, there is a need to ensure the taxation system remains certain and future revenues are captured from mining. At the same time, Zambia experienced a number of mines closing for routine maintenance as well as lower grade ore outputs and some operational challenges.⁵¹ Discussion of support for infrastructure in the mining sector is taken up in **Section 4**.

Implicitly, related to taxation are the fiscal rules which guide the allocation of tax revenues. In mining, there is inherent pro-cyclical volatility as the price of copper is determined by the global market. During periods of high resources prices, overspend or investment in less productive goods can lead to an overburden of debt and unkept promises in counter-cyclical periods.⁵² First, Zambia must deploy fiscal rules to reinvest resource rents into productive economic activities, and then to manage remaining debt loads.⁵³

50 Zambia Tax Revenue (2022) 2022 Statistics for the tax authority. <https://www.zra.org.zm/wp-content/uploads/2023/09/2022-Tax-Statistics.pdf>

51 PriceWaterhouse Cooper (2023). Zambia 2023 Mining Report. <https://www.pwc.com/zm/en/assets/pdf/zambia-mining-report-2023.pdf>

52 Werker (2023) A strategy for resource-led development in Zambia. Policy Brief, IGC. <https://www.theigc.org/sites/default/files/2023-10/Werker%20Policy%20brief%20September%202023.pdf>

53 See Werker (2023) for recommendations on the design of fiscal rule making for resource rent management.

CASE STUDY: CHILE'S NATURAL RESOURCE REVENUE MANAGEMENT

Chile implemented successful fiscal policy reform in response to fluctuating copper prices to counteract the volatility from the commodity-linked government revenue. These reforms were designed to ensure savings was sufficiently resilient to swings in the global price of copper, ensuring fiscal stability domestically in the long run. Evidence suggests that developing economies often borrow more during boom periods, and in bust periods, experience higher terms-of-trade volatility.⁵⁴ In 2001, Chile introduced a self-imposed rule to keep fiscal expenditures to a ceiling close or equal to long-term revenue, irrespective of changes in government revenue from economic activity, driven largely by the swings of copper prices.

This fiscal rule reduced spending in high commodity price periods and allowed for moderate spending in downturns. Chile was successful in deploying this rule, and eventually created a sovereign wealth fund (SWF) to manage the surplus. This fund then receives a minimum transfer amount and is used to pay into the pension system or debt obligations in periods of low government revenue. The creation and obligation by policymakers to stick to this fiscal rule allowed Chile to recover from a short recession after the 2008-09 crisis. The deployment of a mildly countercyclical fiscal policy allowed Chile to build up more government savings and is a feature of fiscal policy which can help secure revenues even when commodity prices dip. Zambia has the opportunity to exercise fiscal control on the spend side in budgeting decisions, to ensure rents are reinvested across activities and over time. Strong investments include human capital and infrastructure development, which can drive productivity improvements in firms.

Environmental policy

Another key area of regulation in mining is around the environmental impacts of primary production of ores. When contemplating environmental policy in Zambia, it is important to contextualise what environmental impacts are first-order for the country to target. Zambia emits less than .02% of the world's CO₂ and produces less than 9 Mt of CO₂ per year, compared to the UK's 318 Mt.⁵⁵ Given such a small quantity of emissions produced in relation to other countries, the key issue in Zambia is the generation of local emissions and pollutants as opposed to carbon dioxide. Local pollutants can have direct and indirect impacts on biodiversity, human health and ecosystem services.

Environmental policy for mining is enacted and enforced through three separate agencies. Currently, environmental health and safety laws are

⁵⁴ Luis Felipe Céspedes, Eric Parrado, Andrés Velasco (2014) Fiscal Rules and the Management of Natural Resource Revenues: The Case of Chile. *Annual Review of Resource Economics* 6:1, 105-132

⁵⁵ Our World in Data (2024). Zambia, Energy Profile. <https://ourworldindata.org/co2/country/zambia?country=ZMB-GBR>

overseen by the Zambian Environmental Agency, the Ministry of Mines and Mineral Development, as well as the Occupational Health and Safety Institute.⁵⁶ The Environmental Act passed in 2011 is the primary governance tool for concerns related to mining's impact on the environment. Passed in 1997, the Ministry of Mines and Minerals also has an Environmental Regulation.

Environmental policy currently governs the environmental review in the pre-drilling stage, and the closure and remediation of mines at the exhaustion of the mine. Pre-permitting can take upwards of six months, due to multiple hearings or court appearances with respect to the environmental review. The closures of mines were historically unregulated before the passing of the Environmental Regulation for mining, leading to several health and safety concerns at closed mines, such as the lead mine in Kabwe, Zambia.⁵⁷ Current policy meets the standards for providing environmental review in the before and after period for a mine but does not currently work to ensure high environmental integrity during the mining process.

As copper extraction increases and high-quality copper requires more intensive drilling, the environmental impacts of mining increase. Environmental policy can also include efficiency upgrading policies, either through technology requirements or other instruments. **Implementing a policy, either through command-and-control standards, technology requirements, or taxation will require an assessment of the current scale and scope of environmental damage.** But, hazardous elements, such as arsenic, require more robust monitoring and regulation as the process to extract minerals of the same quality intensifies.

Other improvements to environmental impacts of mining include consideration of increasing the energy efficiency of operational processes. The energy (or emissions) intensity of processes at the mine can also be improved through policy support. Improvements in the energy efficiency of certain processes reduces the per unit spend of electricity on that process, reduces pressure on electricity demand, and decreases overall environmental impact. There are few interventions in this sector, but both business and transportation energy intensity can be improved. For example, the introduction of electric vehicles can reduce the cost of oil consumption by transport vehicles, and the introduction of small-scale, on-site solar energy can reduce the cost of energy for computing, data storage, and other small equipment use. While this tackles only a small portion of the net emissions of a mining operation, it can downwardly adjust costs and reduce indirect emissions for firms, who may be subject to reporting or internal sustainability measures and targets.

Other environmental policies in the sector include transparency regulations and environmental disclosures. These policies are increasingly urgent as firms who either extract or purchase copper have an increasing interest in disclosure of environmental impact through either third-party verification, voluntary agreements or consumer pressure. From a survey conducted of

56 Zambia Extractive Industries transparency Initiative (2022) Annual Report <https://zambiaeiti.org/zambia-eiti-reconciliation-reports/>

57 Human Rights Watch (2023) Zambia: 'Green City' Plan Should Focus on Lead Mine Remediation. <https://www.hrw.org/news/2023/03/09/zambia-green-city-plan-should-focus-lead-mine-remediation>

mining firms in the Zambia, 50% said they comply with global sustainability reporting.⁵⁸

Zambia has a long-standing partnership with the Extractive Industries Transparency Initiative (EITI). Joining in 2009, the government releases an annual report to evaluate the governance for the industry. While this report is not explicitly focused on environmental concerns, the transparency initiative tracks voluntary social payments made by extractive industries into corporate social responsibility funds which support social and environmental protection. But firms are not required to disclose complete information, and the value of information currently disclosed may be insufficient to understand whether they are meeting certain government and regulatory objectives on the environment.

Voluntary sustainability initiatives may provide a strong incentive for developing data and monitoring of supply chains but are still insufficient to propel high quality environmental policy in the sector. For example, the EITI only provides proof of financial contribution for remediation and does not provide an actual assessment of local environmental impacts.⁵⁹ In order for the country to demonstrate its mining practices are deliberately designed to support environmental protection, additional steps need to be taken to bolster environmental regulation.

To deliver on improvements in environmental performance, the government must invest in increased monitoring and enforcement of environmental regulations at existing and future mines. For example, regular groundwater testing, monitoring of land use and land use change around mining sites, and more frequent waste audits can ensure compliance. This information can then be recorded and disclosed to increase information transparency.

A key risk in the environmental performance of firms in Zambia is the impact on biodiversity. Biodiversity risk in Zambia is high, even with the substantial number of game parks and preserved areas within the country. **18% of total land area in Zambia is dedicated to national parks or reserves,⁶⁰ yet deforestation, particularly in the Northwestern province continues with the expansion of mining.**

58 PriceWaterhouse Cooper (2023). Zambia 2023 Mining Report. <https://www.pwc.com/zm/en/assets/pdf/zambia-mining-report-2023.pdf>

59 Sequeira, A. R., McHenry, M. P., Morrison-Saunders, A., Mtegha, H., & Doepel, D. (2016). Is the Extractive Industry Transparency Initiative (EITI) sufficient to generate transparency in environmental impact and legacy risks? The Zambian minerals sector. *Journal of Cleaner Production*, 129, 427–436. <https://doi.org/10.1016/j.jclepro.2016.04.036>

60 Convention on Biological Diversity (2023) Country Profile: Zambia. <https://www.cbd.int/countries/profile?country=zm>



F. epalik

While agriculture and human settlement are other, more substantial drivers of deforestation, mining can have additional adverse consequences on ecosystems, through waste site contamination, groundwater contamination, or flooding that releases toxic waste outside of the mining site itself. Biodiversity remains highly valued in Zambia, both for its critical role in ecosystem service provision and for wildlife tourism. Deforestation in Zambia is an on-going issue that requires policy intervention to best determine what level of risk exists with new and existing mines.

The tension between biodiversity and mineral extraction requires re-framing, as both natural endowments have value. To create ample economic opportunities across sectors, consideration must be made to how biodiversity can be protected to ensure the country can continue to realise its benefits. The Ministry of Green Economy and the Environment, in tandem with the Ministry of Mines can enact rules on protection for sensitive habitats, areas where critically endangered species exist, or require a 'no net biodiversity loss' policy on investing firms, in which they must protect or restore the equivalent land lost to extraction.

4. The value and value chain in copper

Investing in a copper-plus future will require leveraging the benefits of Zambia's natural resource endowment to expand production into both a wider set of industries and more advanced industries. Historically, natural resource endowments have not been clearly link to poverty reduction.⁶¹ The strength of having natural resources has been marred by a failure to capture tax revenues and to meet production targets. But these barriers can be overcome through institutional reforms to increase the overall economic productivity of Zambian firms, expand access to good quality jobs, and develop a competitive advantage in several ways. We focus first on Zambia's placement within the regional and international value chain of minerals, and then on **Zambia's ability to build out the national industrial strategy to reflect their competitive advantage in the mining sector and its link to green value chains.**

Zambia can pursue two tangential routes to forge a path to resource-led growth.

- The country can expand production along the copper and critical mineral value chain and create a targeted framework to support nascent sectors that are poised for growth in a decarbonized future. This means creating an attractive and stable business environment to grow investment in the upstream extraction and processing sector of the copper value chain.
- Next, the government should push to diversify its economic activities through leveraging spillovers from the infrastructure to support the mining value chain and ensuring resource rents from extractive activities are re-invested in productivity generating activities. New economic activities can spur either within-sector or within-geography of existing mining activities.

We begin this section with the discussion on value chains, expansion of productive economic activity through public support and then the deployment of industrial policy to meet two complementary goals: reducing environmental externalities and development. Given the projected growth of copper demand in the coming decades:

- Zambia needs to leverage its role in the global value chain (GVC) to attract more foreign investment and improve domestic productivity.
- The creation of public goods, such as electricity and road infrastructure can support the operations of new businesses, and crowd in investments.
- Finally, the industrial strategy in Zambia should be oriented towards low-emissions activities, as Zambia is already positioned as a key producer within this green GVC and can secure economic growth that both enhances livelihoods and reduces damage to its other key natural asset - biodiversity.

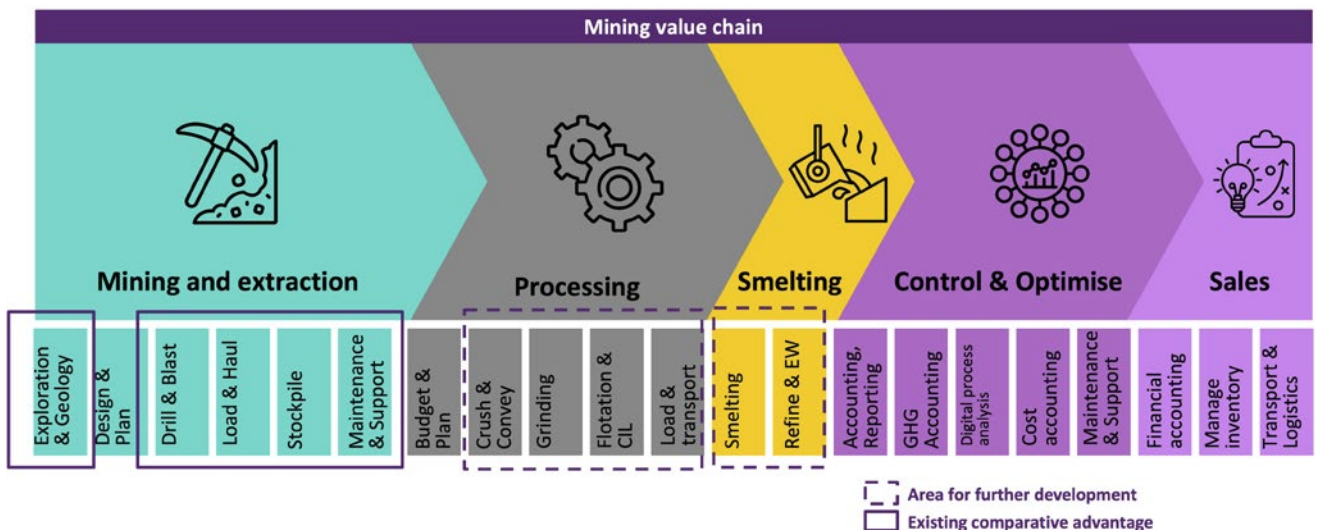
⁶¹ van der Ploeg, F. (2011). Natural Resources: Curse or Blessing? *Journal of Economic Literature*, 49(2), 366–420. <http://www.jstor.org/stable/23071620>

Building Zambia's role in the global value chain (GVC)

The mining sector presents ample opportunity for developing secondary and tertiary sectors domestically. The purpose of establishing linkages across the value chain instead of further exploiting natural resources is that the advantages or the economic gains from mining must be reinvested in the economy to create an opportunity for growth even beyond the extraction point. Identifying the entry points for government support can be difficult, and depends on the following factors including:

- Relative size and productivity of sectors,
- Existing market failures,
- Skill development and the local labour market,
- Cost of capital,
- Marginal return on investments; and
- Competition

Figure 8. The Mining value chain (Adapted from Metallurgical Systems)



Zambia should identify its current competitive advantage to increase specialisation in this area. For example, smelters located at the mines in the Copperbelt provide not only the raw materials, but the capabilities to make refined copper products. Additionally, the shared mines across the DRC and Zambia mine both cobalt and copper, making the area a strategic hub for buyers demanding both goods. Zambia is well placed to work with its regional partner, DRC, to position itself to sell both copper and cobalt to buyers along the electric vehicle supply chain. The establishment of a special economic zone (SEZ) between the two countries for the purpose of attracting EV manufacturers leverages both country's competitive advantage. Additionally, business enterprises zones, such as Multi-facility Economic Zones (MFEZ) in the Lusaka area, have been established. But, these zones, as a comparison to the SEZ, have faced several barriers including long and fragmented business

permit processing time and a lack of provisional infrastructure for firms.⁶² This underscores the importance of both energy infrastructure (**Section 2, 5**) and effective governance to ensure firms can easily invest in the area. To derive all projected benefits of the SEZ agreement with the DRC, strong institutions will be necessary to coordinate on building physical infrastructure and reduce frictions for access to credit and licences and reduce any uncertainties about the business environment. This approach has the potential to give Zambia the power to shape the global value chain in electric vehicles but will require taking learnings from other place-based industrial policies.

To create a thriving SEZ in the region, caution should be exercised in the initial design and solicitation of investments. A previous review of SEZ policies by the IGC indicates SEZs may fail where they lack a clear framework on industries of value, fail to match with the local labour supply, have low quality infrastructure, and unreliable energy services.⁶³ **A successful SEZ requires first demonstrating a secure supply of energy for businesses, the infrastructure for trade and telecommunications.** SEZ policies, when structured well, primarily benefit low-wage workers who experience long-run gains in their wages. Evidence on other SEZs in Africa is mixed, with findings that suggest:

- Spillover effects are generated from larger, foreign firms to local firms. Therefore, the SEZ should accommodate both types of firms in order to facilitate knowledge transfer.
- Low-wage workers are less likely to see a rise in wages in the near term, but in the long run, will likely see an increase.
- Improvements in trade and logistics infrastructure lowers frictions in doing business and can stimulate secondary jobs outside of the direct activities of the SEZ.

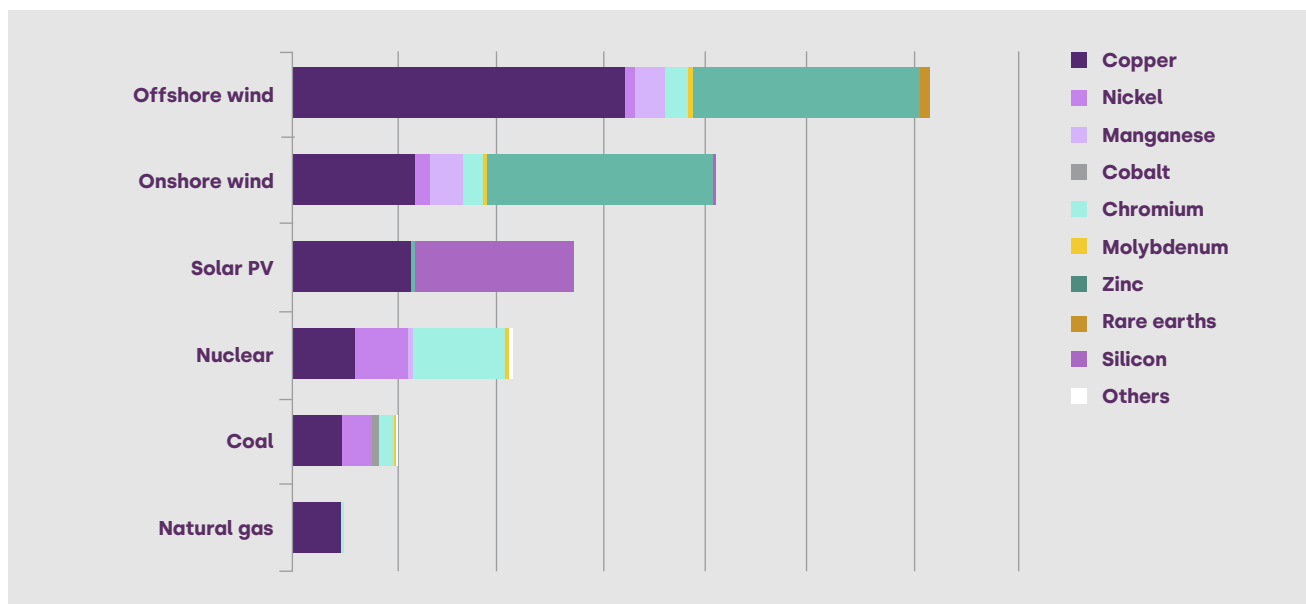
SEZs should offer a narrow competitive advantage to attract investment, then harness spillovers from investing firms in the long run. Given SEZs are designed with attracting foreign investors, we should consider the benefits to MNCs making greenfield investments in Zambia, in addition to the ways local firms may upgrade as a result of their co-location.⁶⁴ Identifying a particular competitive edge, reducing the cost of transportation from components along the supply chain, and offering reduction in tax incidence, can crowd in private investment. While this can lead to a growth in government revenues in the near term, the most effective result would be for Zambia to remain embedded in the supply chain for electrification technologies, and not become a temporary, low-cost provider of primary inputs. Zambia must use the SEZ to build up linkages for other firms which make related products or expand the functions of existing firms. These firms must already be able to perform their specific function, as there is a high risk of encouraging new firms in nascent industries to leverage place-based spillovers, as opposed to government support.

62 World Bank (2016) Multi-facility Economic Zones in Zambia: Progress, Challenges and Possible Interventions <https://documents1.worldbank.org/curated/en/720981495115586647/pdf/115143-WP-PUBLIC-Feb-2016-GTCCS-ZambiaMFEZ.pdf>

63 Gebrowelde (2019) Special Economic Zones: Evidence and prerequisites for success. <https://www.theigc.org/publications/special-economic-zones-evidence-and-prerequisites-success>

64 Crescenzi and Harman (2022) Harnessing global value chains for regional development: How to upgrade through regional policy, FDI, and trade, *Regional Studies*, DOI: 10.1080/00343404.2023.2291248

Figure 9. Minerals used in clean energy technologies compared to other power generation sources in kg/MW of energy produced (IEA 2023)



Foreign direct investment (FDI) is heavily focused in the mining sector, particularly in the extraction of resources. It is expected with Zambia's growing stability and more levelised copper prices in the near term, copper investments will increase. FDI will not always guarantee a place for firms in a certain region full embeddedness in the supply chain. For example, investors in mines can leave after extracting some minerals if they feel they could produce at a lower cost elsewhere. Firms often migrate, and Zambia must prove it has the local governance structure and economic institutions to support firm growth.

Embedding directly in the GVC and encouraging the development of domestic firms alongside foreign investment can secure future growth external to the copper industry. Extraction of copper mining has seen limited innovation in terms of technology, and it is likely that actual endowment size of natural resources drives value more than advances in mining.⁶⁵ While technology may not drive increased resource rents, creation of new firms which benefit from co-location allow for diversification in the source of economic activity and increased aggregate output. Leveraging potential side and downstream linkages in the mining sector is a more progressive approach to balancing investments across economic activities.

Evidence from other developing countries illustrate that exporting to wealthier countries generates productivity improvement in developing countries firms.⁶⁶ By exporting the wealthier countries, the demand for increased quality of product increases, as well as improvements in the efficiency of operating costs. Because of these potential gains, **securing trade partners in developed countries can generate positive spillover effects for Zambia,**

65 Judith Fessehaie & Mike Morris (2013). "Value Chain Dynamics of Chinese Copper Mining in Zambia: Enclave or Linkage Development?," *The European Journal of Development Research*, Palgrave Macmillan; European Association of Development Research and Training Institutes (EADI), vol. 25(4), pages 537-556, September.

66 Verhoogen, Eric. (2023). "Firm-Level Upgrading in Developing Countries." *Journal of Economic Literature*, 61 (4): 1410-64.

in both the mining sector and other manufacturing sectors. Embeddedness can then improve the productivity of firms focused on other activities beyond extraction.

At a national-level, expansion along the value chain should be concentrated in integrating workers in MNCs at extraction sites and expanding existing downstream activities. Additional processing or downstream activities such as advanced manufacturing face high barriers to development, including high capital costs, low profit margins, and a lack of qualified domestic labourers for expansion.⁶⁷ Focusing on diversification in areas with existing capacity and which upskills workers should be the primary focus when leveraging the mining value chain. This avoids overextension by the government while fostering human capital development and ensuring the well-functioning of the primary activity – extraction.

Investments from MNCs can generate positive externalities. MNCs can facilitate a higher level of knowledge transfer to local workers, encourage technology uptake and increase local competition. 93% of miners in Zambia are nationals, meaning only 7% are expatriated workers.⁶⁸ Because of the large share of domestic workers, exposure to the managerial and technological practices at an MNC can encourage an increase in productivity. When FDI takes places in developing countries, there is evidence that both capital and technology can be transferred more easily to the domestic partner. Additional to improvements in technology, when a MNC locates a new firm or subsidiary within a developing country, local wages can rise.⁶⁹ **Yet, foreign firm ownership is no silver bullet, and unless firms hire local workers, those welfare gains will not be realised by local workers.**

In addition to supporting domestic industry, attracting FDI can create spillover effects for human capital development and essential technology transfer. FDI supports furthering Zambia's embeddedness in the global value chain, and with it, the ability to capture the benefits from its participation. But steering FDI sources toward Zambia requires ensuring high institutional quality, existing technological capability of firms operating in the country, infrastructure, and labour capacity.

Finally, we end on the shifting perspectives of how to ensure MNCs will locate and bring investment into Zambia. Firstly, export bans can cause severe domestic shocks, causing price volatility domestically and disruptions to producers abroad as they scramble to switch suppliers. No empirical evidence on export bans indicates they are effective in inducing foreign investment. On the contrary, MNCs and other foreign investors often locate in new regions dependent business environment factors, but in the case of mining, they have additional geographic restrictions. Other parameters MNCs consider is political stability, cost of doing business, electricity access and technological progress. These factors are far more important for creating sustained and efficient investments, as opposed to blanket bans on exportation.

67 Werker (2023) A strategy for resource-led development in Zambia. Policy Brief, IGC. <https://www.theigc.org/sites/default/files/2023-10/Werker%20Policy%20brief%20September%202023.pdf>

68 ZAMSTAT (2021) Labour Force Survey. <https://www.zamstats.gov.zm/wp-content/uploads/2023/05/2021-Labour-Force-Survey-NHPP.pdf>

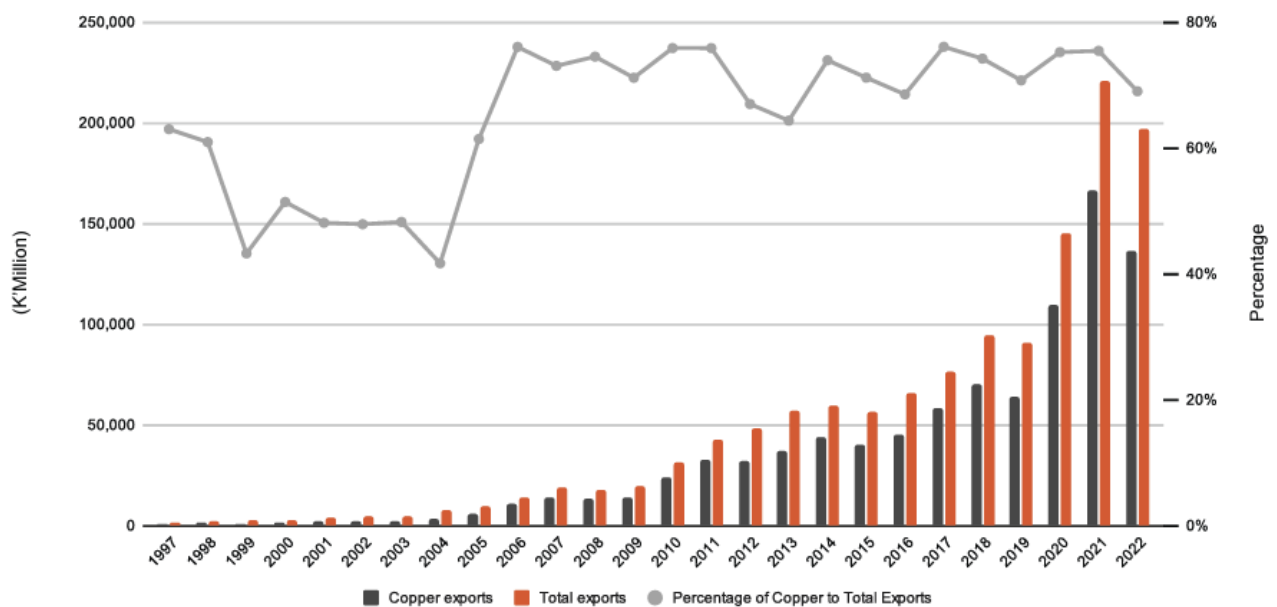
69 Crescenzi and Harman (2022) Harnessing global value chains for regional development: How to upgrade through regional policy, FDI, and trade, *Regional Studies*, DOI: 10.1080/00343404.2023.2291248

Instead of pushing forward on restrictions on exports as an implicit subsidy to downstream industries, other initiatives can be pursued to increase the value addition of exports and encourage competitive development of downstream industries.⁷⁰

Public investment to support productivity growth

Zambia's ambition is two-fold: expand production of copper ore and create higher value industries along the value chain. Looking first at the increased investment by foreign firms we see a substantial number of benefits, when this investment is crowded in, unlocking positive spillovers. This includes government support for developing linkages with other firms, either through explicit contract agreements, local content requirements, or skill development trainings. Public support, through subsidisation either in a place-based or industry-specific approach is possible.

Figure 10. Copper and other exports, 1997-2022 (PwC 2023)



While Zambia has the potential to identify horizontal and vertical linkages in the supply chain, the country still faces significant challenges to attracting new investment. A key barrier includes contract enforcement and access to electricity for firms. The World Bank Group's Ease of Doing Business index ranks Zambia as 129 and 130, respectively, in a survey of 190 countries on these two indicators.⁷¹ Natural opportunities for investment along the supply chain should be fostered through public support. Potential policies can create favourable investment conditions by improving the skill set of local labour,

70 International Monetary Fund (2023) Challenges of Export Controls <https://www.imf.org/en/Publications/fandd/issues/2023/06/challenge-of-export-controls-chad-bown>

71 World Bank (2020) Ease of Doing Business Report - Zambia. <https://archive.doingbusiness.org/content/dam/doingBusiness/country/z/zambia/ZMB.pdf>

subsidising technology upgrading or encouraging to co-location near other productive sectors to crowd in new investment.

Infrastructure sharing is one key approach to easing the cost of export-led businesses. Firms may co-locate in proximity to each other to save on coordination costs and benefit from complementarities. These place-based activities are one potential solution to expanding along the value chain within mining. For example, Zambia already has smelters co-located at its extraction facilities, which reduce the cost of transportation for mining firms.

To grow secondary industries along the value chain, investments in skill development and training are needed. Skills can be transferred from multinational companies (MNCs) and the investment by MNCs in-country has been shown to yield increased skill development for many locations. In the mining sector, the picture is a bit fuzzier. Only 2% of the total labour force in Zambia is currently employed in the mining sector, far outpaced by agriculture and forestry and services.⁷² There is a clear gap between the needs of mining firms and the skills local workers have in the sector. To increase local hiring and create opportunities for more technical roles, knowledge transfers between the lead firm at a mine and the local government must be undertaken.

The government can invest in skill development and work programmes to train the next generation of workers both in mining extraction, and along the value chain. Additional consideration should be given to training workers in the electricity sector, given the necessary expansion of grid infrastructure and generation capacity will be for furthering mining productivity.

There is ample opportunity for Zambia to sustain economic development through harnessing the value of its resource endowment to catalyse growth across the mining value chain. The design of the policy framework which will guide foreign direct investment (FDI), public investment and training programmes should be clearly defined and create opportunities for increased firm development and productivity across different components of the value chain.

Support for green jobs has already been rolled out in Zambia and can continue to support the development of skills necessary for labourers along the mining supply chain. From 2013 to 2017, Zambia undertook a large intervention to change the way workers viewed 'green' construction, promoted a friendly business environment, and support small and micro-enterprises in 'green' industries.⁷³ This project was focused both on the expansion of new markets and new skills for workers, and early evaluation results indicate it was successful in expanding new SMEs, particularly in building and construction materials.⁷⁴ Lessons learnt from this programme can be applied to future labour market interventions, particularly in the design of training and information sharing for green skills and firms. We will discuss labour policy and training more in the next subsection.

72 ZAMSTAT (2021) Labour Force Participation Survey. <https://www.zamstats.gov.zm/wp-content/uploads/2023/05/2021-Labour-Force-Survey-NHPP.pdf>

73 ILO (2018) Independent Mid-Term Evaluation of the Zambia Green Jobs Programme https://beamexchange.org/uploads/filer_public/15/72/1572e43d-e585-4de7-ae96-419849d1f59a/zambia_green_jobs_evidence.pdf

74 International Labour Organization (2021) Independent Mid-Term Evaluation of the Zambia Green Jobs Programme https://beamexchange.org/uploads/filer_public/15/72/1572e43d-e585-4de7-ae96-419849d1f59a/zambia_green_jobs_evidence.pdf

Industrial policy

Diversification along and outside of the mining sector can position Zambia for a future beyond copper. The government's National Industrial Policy strategy⁷⁵ has defined specific objectives to increase the complexity of its economic activity. The strategy outlines a suite of goals, including:

Increase the manufacturing sector growth to an average of 20%, and increase its contribution of GDP to 15%,

- Grow employment in manufacturing by 100%,
- Upgrade and modernise firm technologies,
- Process raw materials domestically,
- Promote cooperatives and small businesses,
- Increase the production of high quality and sustainable goods,
- Attract domestic and foreign investment in key sectors, and
- Create inclusive growth opportunities.

The government's aim is to achieve expanded and inclusive growth opportunities by 2027. A number of these initiatives can be supported through furthering their concentration in key sectors which either are a part of the mining value chain or, alternatively, can benefit from public investment. The strategy focuses on creating local content strategies and a national technical regulatory framework to upgrade the skills of workers and technologies used by firms.

CASE STUDY: TAKING A CLOSER LOOK AT ZAMBIA'S WOOD AND WOOD PRODUCT INDUSTRY

In 2020, Zambia had about 45,000 hectares of commercial forest plantations.⁷⁶ 85% of these plantations are located in the Copperbelt region.⁷⁷ The plantations suffer from a lack of management and a low level of replanting. Commercial plantations were actually larger in 1990, with 57,000 hectares planted. Today, wood products constitute only about 35 million in export value (or about 1% of total export value) and are traded primarily with China.⁷⁸ But, when you consider the broader forestry sector, such as the wood industry, ecotourism and informal labour by households who plant and use wood products, the value of the economic activity grows significantly. Skilled agriculture and forestry sector employs about 14% of the total Zambian labour force – 500,000 people.⁷⁹ Given so many people are employed in the sector, and the

75 Republic of Zambia (2018) National Industrial Policy <https://www.zda.org.zm/wp-content/uploads/2020/09/National-Industrial-Policy.pdf>

76 FAO (2022) Global Forest Resource Assessment: Zambia. <https://www.fao.org/3/cb0092en/cb0092en.pdf>

77 World Bank (2019) Country Forest Note: Zambia <https://documents1.worldbank.org/curated/en/571651580133910005/pdf/Zambia-Country-Forest-Note-Towards-a-Sustainable-Way-of-Managing-Forest.pdf>

78 OEC (2023) Zambia Country Profile: Exports. <https://oec.world/en/profile/country/zmb>

79 ZAMSTAT (2021) Labour Force Survey. <https://www.zamstats.gov.zm/wp-content/uploads/2023/05/2021-Labour-Force-Survey-NHPP.pdf>

sector is co-located to the country's mineral exploration, there is ample opportunity for the timber industry to increase in its value add and create more sustainable livelihoods for workers.

Firstly, we note the failure of the land tenure system to establish property rights which would ease the ability of new investment in land for forest plantations. Next, 80% of roundwood and wood fuels in Zambia is extracted without a licence.⁸⁰ This is for both export and domestic consumption. Government oversight of granting licenses and enforcing against illegal extraction of wood products are needed to reduce exportation of wood products without revenue generation. Second, regional infrastructure, such as an increase in electricity and road transportation can decrease operating costs for timber firms. Currently, Zambia Forest Industries Corporation (ZAFFICO), a state-owned timber company oversees the majority forest plantations in Zambia, and the processing facilities. Lowering the cost of infrastructure can attract foreign firms to invest in the sector and can increase the revenues generated to the state-owned firm.

Finally, domestic support of new, light manufacturing in upstream industries which can supply both mining firms and plantations could be an opportunity for Zambia to broaden, diversify, and localise two of its key sector's value chains. For example, the establishment of firms to build shovels, hand tools, twine or rope, and garments are examples of light manufacturing firms that could potentially match to buyers in the region. Alternatively, domestic firms providing services such as administration work, banking, auditing, food services could be encouraged. While the government may lack explicit tools to expand into these secondary industries, the government may set up a local content unit (LCU) who serves as a matchmaker between investors and small businesses who can serve as suppliers.⁸¹ This can work particularly well between established MNCs in the region, both in the mining and the timber sector, and small or medium enterprises (SMEs) who can provide upstream goods and services.

We focused here on the timber sector, given its high impact on workers in Zambia and low contribution to economic growth in the country. It is a key priority in Zambia's national industrial strategy, and an overlooked sector for sustainable development. To conclude, the value of natural resources such as forests and the land cleared for timber production is potentially much higher than the current price of timber. As private sector actors and governments in developed countries seek to offset their emissions, the value of the sequestered carbon in native forests continues to increase in both the private market and under regulatory regimes. The forestry sector has the potential to continue to extract revenue from the production of wood products, but in the future, the more valuable commodity may be carbon sequestration, which requires the diligent management and sustainable extraction of timber today.

80 World Bank (2019) Country Forest Note: Zambia <https://documents1.worldbank.org/curated/en/571651580133910005/pdf/Zambia-Country-Forest-Note-Towards-a-Sustainable-Way-of-Managing-Forest.pdf>

81 Crescenzi and Harman (2022) Harnessing global value chains for regional development: How to upgrade through regional policy, FDI, and trade, *Regional Studies*, DOI: 10.1080/00343404.2023.2291248

Industrial policy can also play a role in alleviating market failures and promoting positive externalities. State intervention may promote competition among firms⁸² and increase aggregate productivity.⁸³ More broadly, whether industrial policy can be used to steer economic activity and catalyse positive externalities is an area receiving low but growing attention. More recently, industrial policy as a second-best climate policy has been proposed in the literature as one potential choice for lowering the emissions intensity of highly polluting economic activities. While current evidence suggests that climate policy is best implemented directly to avoid any unwanted secondary impacts, there is an opportunity for industrial policy targeted at low-emissions sectors to foster these nascent industries.

Zambia can support industrial development where existing market failures exist. Often market failures exist at the firm-level, which makes aggregate output at the country level less productive. But, in the case where governments seek to capture spillover effects, or wider externalities (such as economies of scale or human capital development), certain policies can be introduced under the umbrella of industrial policy to help induce these positive spillover effects, including direct subsidies, investment in research and development, investment tax credits, subsidised credit or local content requirements (LCRs).⁸⁴ In Zambia, we believe there is a significant opportunity to leverage the sheer size of the mining sector to induce some of these second order positive impacts.

Identification of the relevant sectors where market failures exist in Zambia is necessary to consider before furthering the green industrial strategy. For example, there is no perfect formula for identifying which sectors or types of firms will grow into the most efficient and productive producers. Recent evidence using the case of China and South Korea's industrial production from 1970s-1990s shows that upstream industries which serve a number of buyers can become sinks for market imperfections – i.e. sectors which provide a number of downstream firms their inputs are more prone to being inefficient.⁸⁵ One caveat is important, as large and influential sectors are not always the sectors with most distortions, and therefore subsidising these sectors may actually amplify the issue.

How do we apply this to the case of Zambia? An analysis of the production networks for both the mining value chain and the manufacturing sector value chains must be analysed. If Zambia is to invest firstly in downstream activities in the mining sector, support for the growing processing sub-sector could potentially reduce existing market distortions and crowd in future investment. There are currently four smelters operating in Zambia, which require ore concentrates that has been separated, primarily through foam flotation. The foam flotation process extracts the copper concentrate for processing.⁸⁶

82 Aghion, Cai, Dewatripont, Du, Harrison and Legros (2015) Industrial policy and competition. *American Economic Journal: Macroeconomics*. 7(4):1-32

83 Liu, E. (2019). Industrial Policies in Production Networks, *The Quarterly Journal of Economics*, Volume 134, Issue 4, Pages 1883–1948, <https://doi.org/10.1093/qje/qjz024>

84 Ann Harrison & Leslie A. Martin & Shanthi Nataraj, (2017). "Green Industrial Policy in Emerging Markets," *Annual Review of Resource Economics*, Annual Reviews, vol. 9(1), pages 253-274, October.

85 Liu, E. (2019). Industrial Policies in Production Networks, *The Quarterly Journal of Economics*, Volume 134, Issue 4, Pages 1883–1948, <https://doi.org/10.1093/qje/qjz024>

86 Wincewics-Bozy (2021) the Supply Chain of the Mining Industry: The Case of Copper. <https://ersj.eu/journal/1958/download/The+Supply+Chain+of+the+Mining+Industry++The+Case+of+Copper+Mining.pdf>

Many of Zambia's mines have concentrators which perform this, but for those which simply mine the raw ore, the expansion of high productivity concentrators may allow for further development of higher-grade processing activities domestically. For example, **in 2019, Zambia produced 638,500 tonnes of smelted copper, but only 262,000 tonnes of refined copper.**⁸⁷ Another upstream sector which government may support is the waste processing and recycling from copper extraction. This often-overlooked component of the supply chain may increase efficiency of upstream sectors by identifying recyclable and processable material to expand availability of raw input and generate positive spillovers for the environment.

How can this change?

- Local content requirement (LCR) policies and whether they can induce positive agglomeration effects and human capital development. Based on the empirical evidence and previous IGC research, implementing an LCR policy would require mining firms to hire a certain share of workers at the mine or to procure materials (from catering to shovels to trucks) from domestic firms.⁸⁸ Currently, only 2.1% of purchases by mining companies appears to be sourced from domestic firms. One of the key barriers to getting people into mining sector jobs is a lack of formal training.
- There is ample opportunity for Zambian firms to ingratiate themselves in the mining sector value chain with policy support. While LCR can have a strong impact on securing spillovers from foreign investment, we also strongly caution against the excessive deployment of LCR. For example, in India, the solar industry required a certain type of technology within the PV panel, designed in India, be used in the production of PV panels. Consequently, China innovated on this design, and given constraints to adoption due to the LCR policy, India lost their comparative advantage in the production of solar panels.⁸⁹ LCR should be designed flexibly, to avoid constraining competitive opportunities within the supply chain.

Zambia's industrial policy can focus on complementary manufacturing and services sectors investments. The case for green industrial policy is strong, given both market failures and environmental externalities,⁹⁰ yet the policies must be designed softly enough to foster competition and reduce the risk of adverse policy effects. Industries which are appropriate for targeting should have the potential for growth and benefit from linkages within the mining industry value chain. The potential policy levers of green industrial policy are further discussed in **Section 6**.

87 Barry, J. (2019) The Mineral Industry of Zambia. 2019 Minerals Yearbook, United States Geological Services. <https://pubs.usgs.gov/myb/vol3/2019/myb3-2019-zambia.pdf>

88 Werker (2023) A strategy for resource-led development in Zambia. Policy Brief, IGC. <https://www.theigc.org/sites/default/files/2023-10/Werker%20Policy%20brief%20September%202023.pdf>

89 Ann Harrison & Leslie A. Martin & Shanthi Nataraj (2017) "Green Industrial Policy in Emerging Markets," Annual Review of Resource Economics, Annual Reviews, vol. 9(1), pages 253-274.

90 Ann Harrison & Leslie A. Martin & Shanthi Nataraj (2017) "Green Industrial Policy in Emerging Markets," Annual Review of Resource Economics, Annual Reviews, vol. 9(1), pages 253-274; Rodrik, Juhasz, Lane (2023) The new economics of industrial policy. Accessed at https://drodrik.scholar.harvard.edu/sites/scholar.harvard.edu/files/dani-rodrik/files/the_new_economics_of_ip_080123.pdf

5. The global energy transition

Zambia is well positioned to capitalise on its existing power as the Africa's second largest producer of copper to further embed itself in the global value chain for emerging, low-emissions products. Copper and other critical minerals are essential for the energy transition, with demand for copper in particular accelerating in the near and medium-term as it is an essential and favoured input for many electrification technologies.

Securing domestic investment and increasing production in copper in Zambia are needed to maintain Zambia's place as a key producer of copper. Recently, copper prices have swung downward since the beginning of 2023 due to inflated capital cost and weak macroeconomic conditions across the globe. There is set to be an estimated supply shortfall in the coming years as demand for copper accelerates under the green transition.⁹¹ **Given recent investments and a recovery in the price in copper, now is the time for Zambia to position itself to benefit from the gains to joining green global value chains.** With this early positioning, long term consideration of industrial development beyond mining should follow closely so Zambia may shift onto a sustainable growth trajectory.

Copper demand in a decarbonised future

The opportunity for sustainable mining of copper and other critical minerals is accelerating as the market for low-emissions technology accelerates. For example, the expansion of electricity networks, building low-carbon power generation, and deploying electric vehicles for transportation will all require an acceleration of critical minerals.⁹² Clean energy technologies are likely to make up 40% of total copper demand by 2040.⁹³

Copper is a necessary input in almost every clean energy technology, with particularly high demand coming from future solar PV production. In 2020, demand for copper from solar PV manufacturers was estimated at 346 kt. Climate scenario modelling by the IEA predicts demand to rise to 510 to 920 kt by 2030, depending on technology adoption and country-level climate policies. In one scenario by the IEA, copper demand for grid expansion alone is likely to double by 2040.⁹⁴

As discussed in **Section 5, electric vehicles are a key area of growth for copper demand, but also an uncertain area.** Cost reductions are needed in battery manufacturing to scale EV adoption to the rates observed in the IEA's future climate scenarios. The raw materials alone account for 50-70% of total EV battery costs, with cathodes costing 25-30% of the total cost.⁹⁵ Given capacity to produce batteries at a lower cost is a goal of manufacturers,

91 Dempsey and Healy for Financial Times (2023) Copper producers warm of lack of mines to meet demand for metals. <https://www.ft.com/content/b3ad2631-f8b9-41df-8e2e-b4493738ded8>

92 IEA (2023) The Role of Critical Minerals in Clean Energy Transitions. <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary>

93 IEA (2023) The Role of Critical Minerals in Clean Energy Transitions. <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary>

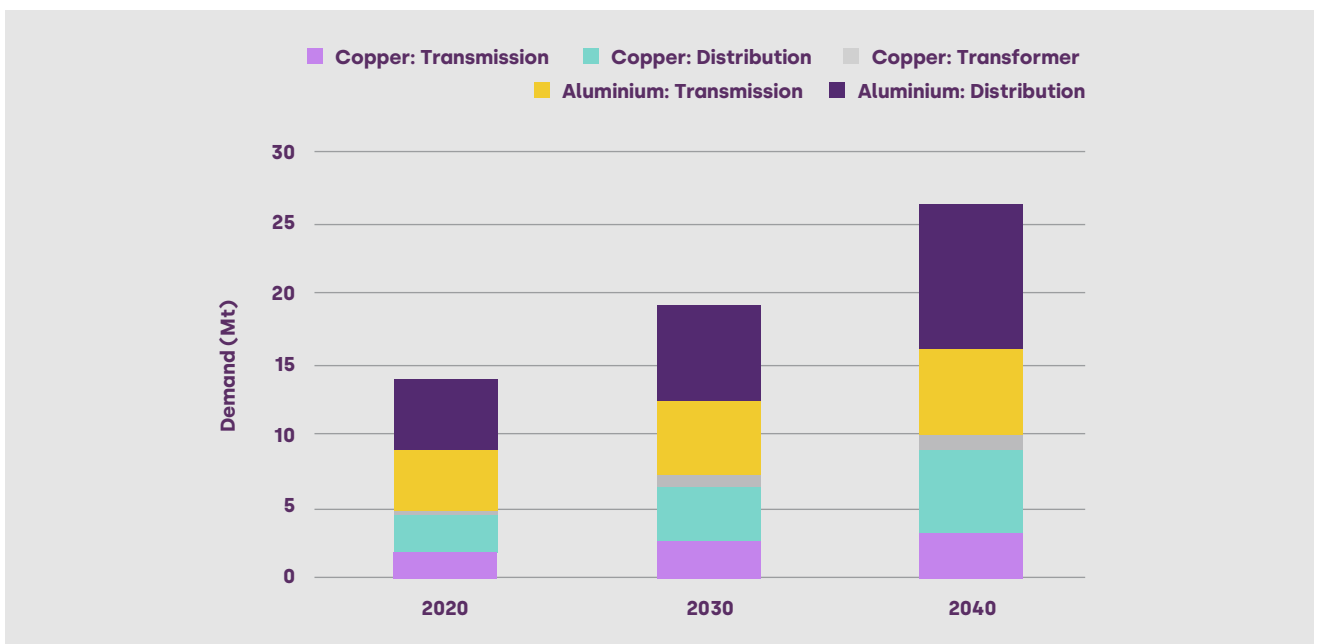
94 IEA (2023) The Role of Critical Minerals in Clean Energy Transitions. <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary>

95 IEA (2023) The Role of Critical Minerals in Clean Energy Transitions. <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary>

there is a significant role in reducing the cost of extraction and processing of copper into cathodes. This potential area for innovation could be a key focus for Zambia - scaling up smelting and processing while increasing firm efficiency. Upgrading technology at smelters could be key to securing a competitive advantage in the production of low-cost cathodes.

Transmission and distribution systems require a significant amount of copper as inputs. Projects for copper for global transmission and distribution networks is set to rise to 2.5 Mt and 3.3 Mt, respectively. Copper will be necessary to help bring grid electricity to more households and businesses, second to aluminium (IEA 2024).

Figure 11. Demand for copper and aluminium for grids in the IEA's Sustainable Development Scenario (SDS)



Zambia will remain a key exporter in copper, given its new findings of high-grade copper and recent investments in existing mining infrastructure. Production at the world's major copper mines have been declining, due to lower ore quality and exhaustion of the resource. This has created tension for buyers of copper who are scrambling to source copper for the projected rise in goods requiring the mineral. Meeting this demand will require building new mines or expanding existing mines, and Zambia's mining and industrial policy should reflect this likely development.

Politics of the energy transition

Climate policies are now instrumental in shaping global international trade. Domestic trade policy by importers may regulate input use, carbon intensity or environmental standards of products. These regulations are likely to grow, causing new market frictions. For example, the palm oil industry has shifted practices as suppliers seek to change their internal practices to align with

EU regulations on the forest use practices.⁹⁶ Other trade policies, such as the Carbon Border Adjustment Mechanism (CBAM) are likely to interrupt and cause additional frictions, unless well prepared for domestically. By entering the green GVC, Zambia will likely face this pressure sooner, and the need for increased transparency and improved environmental performance of its economic activities may come from either shifting trade policies or voluntary pressure by firms within the green GVC. This generates a risk of increased need for transparency across its supply chain in the near term. Adaptation to these evolving policies is necessary, as Zambia risks future exclusion from green GVCs if ignored.

An additional concern is the long run impacts of climate policy in developed nations and the unintended spillover effects. One such example is the pollution haven hypothesis literature which speculates on whether high emissions industries relocate away from countries with strict emissions regulations. While the evidence here is mixed, the short run impact is that emissions can be exported to less stringent economies, leading to a change in the industrial composition of developing economies.⁹⁷ The two are often correlated (i.e. less strict emissions standards and lower development outcomes). Zambia can strategically align itself with low-emissions industrial development to avoid bearing the costs of substantial environmental damage.

While importers will increase their purchase of materials for the energy transition, including copper, this will come with pressure to maintain a transparent and pro-environment supply chain.

Even with growing consumer demand for high quality environmental, social and governance (ESG) policies along the supply chain, there is a short-term risk of high polluting firms locating in Zambia. It is urgent that the government support the growth of the mining industry in tandem with the development of appropriate and enforceable environmental standards in the sector. Without standards of practice with regard to environmental protection, Zambia is at risk of:

- increasing the domestic pollution in highly populated areas,⁹⁸ lowering health outcomes and increasing the chance of morbidity,
- irreversible environmental damage which lowers the value of other natural capital assets, and
- firms leaving or choosing to invest elsewhere where transparency and performance on ESG standards is higher.

It is favourable to develop an environmental policy around mining in tandem with improving the business environment. Undertaking both policy initiatives can secure foreign investment by productive firms which have shielded

⁹⁶ Hsiao (2022) Coordination and commitment in international climate action: Evidence from palm oil. Working paper, Princeton University. https://allanhsiao.com/files/Hsiao_palmoil.pdf

⁹⁷ Levinson, A., & Taylor, M. S. (2008). Unmasking the Pollution Haven Effect. *International Economic Review*, 49(1), 223–254. <http://www.jstor.org/stable/20486793>

⁹⁸ Tanaka, Shinsuke, Kensuke Teshima, and Eric Verhoogen. (2022) "North-South Displacement Effects of Environmental Regulation: The Case of Battery Recycling." *American Economic Review: Insights*, 4 (3): 271-88.

themselves from future climate policy risk. This approach can avoid any future issues related to mine remediation, which can be costly and technically difficult. The government is currently undertaking plans for remediation of a formal lead mine in Kabwe, Central Zambia, in tandem with the World Bank, through the Mining and Environmental Remediation and Improvement Project.⁹⁹ This recently concluding work provided important countermeasures against mining waste contamination from a mine closed in 1994, but also revealed the significant health impact on households from the pollution. Preventative environmental policies can avoid future remediation and relocation costs, while mitigating potential negative externalities from the mining waste on childhood health and education outcomes, and worker productivity.

Zambia also is well placed to develop a strategic copper and critical minerals sector given it is well placed in geopolitics. For example, many countries which mine cobalt, lithium and copper have higher levels of economic and political instability, putting pressure on investors to identify new and reliable sources of minerals. For example, sanctions against Russia have made the country an unattractive place to source minerals; while Chile has created a new nationalisation strategy for its lithium reserves, excluding future private investors. Given the current political dimensions, there is an opportunity for Zambia to demonstrate openness to trade and secure its place in a critical value chain, strengthening unilateral and regional relationships with importing countries.

Restrictions by governments on exports can have potential adverse effects on productivity. Supply restrictions by some producers can lead to an increase in demand for alternative sources. Additionally, unless domestic capacity already exists, restrictions are unlikely to crowd in foreign investment from abroad. Transportation and import costs are a small share of the costs for firms within the mining sector. The highest share of costs of mining is from electricity use - standing at around 30% of total operating costs.¹⁰⁰ Therefore, **supply restrictions can cause demand to shirk, domestic job loss, and the entrance of inefficient or non-competitive firms downstream.**¹⁰¹ This further exacerbates the distance between mineral resource wealth and poverty reduction. Government restrictions, while they may serve a purpose when deployed for national security or health purposes remain limited in their applicability to generate sustained development opportunities.

Zambia in the energy transition

The copper production goals by the Zambian government are ambitious in approach, and necessary to meet growing demand. Predictions for 2023 extract are only 682,000 metric tonnes, lower than 2022's output.¹⁰² Projects in development in the near term are still not sufficient to meet rapidly expanding demand. Additionally, supplies of high-grade copper are gradually falling

⁹⁹ Human Rights Watch (2023) Zambia: 'Green City' Plan Should Focus on Lead Mine Remediation. <https://www.hrw.org/news/2023/03/09/zambia-green-city-plan-should-focus-lead-mine-remediation>

¹⁰⁰ Deloitte (2017) Renewables in Mining: Rethink, Reconsider, Replay. Vol 2. <https://www.cruxinvestor.com/posts/first-quantum-mining-pursues-renewable-energy-in-zambia-to-support-ambitious-copper-production-growth>

¹⁰¹ International Monetary Fund (2023) Challenges of Export Controls <https://www.imf.org/en/Publications/fandd/issues/2023/06/challenge-of-export-controls-chad-bown>

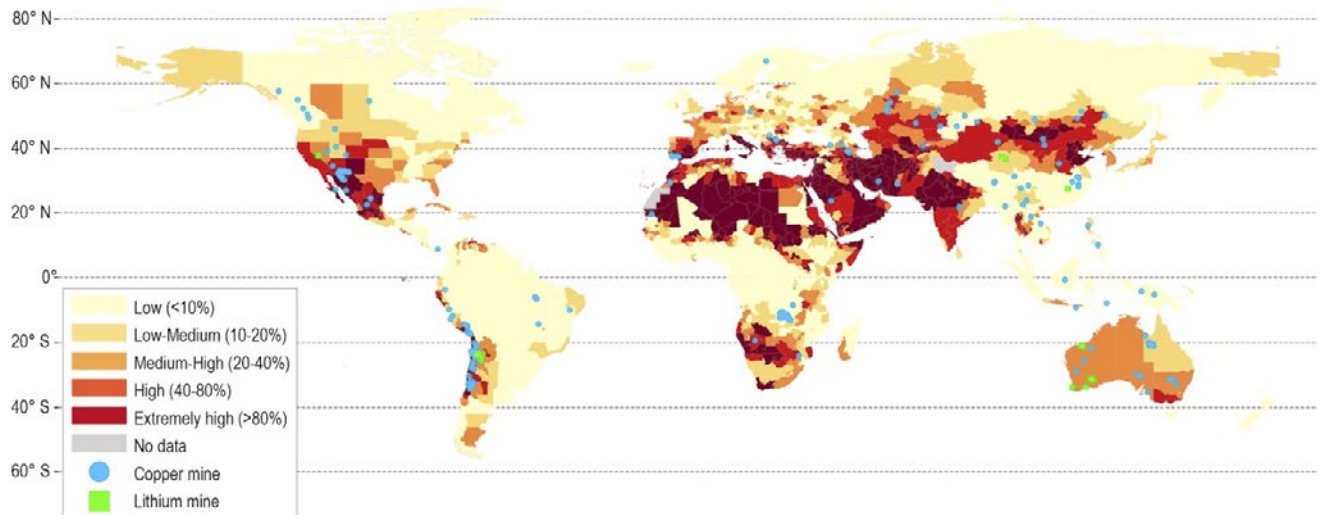
¹⁰² PriceWaterhouse Cooper (2023). Zambia 2023 Mining Report. <https://www.pwc.com/zm/en/assets/pdf/zambia-mining-report-2023.pdf>

across the world. Chile's Escondida mine, the world's largest copper mine, is likely to have reached its peak, and will see production in 2025 at levels at least 5% lower than today.¹⁰³

Demand from customers with pro-social attitudes can have positive effects, including more competition in clean innovation.¹⁰⁴ As Zambia embeds itself into the GVC of companies focused on the production of low-emissions technology, there was a further demand for improvements to performance at all nodes alongside the supply chain. This demand-side push can lead to positive knock on effects, including innovation and potential development of new, lower-emissions technologies. Zambia, if integrated into the green GVC, will have an opportunity to capture the spillover effects of these low-emissions technologies.

While opportunities to improve productivity are available, there are potential obstacles imposed by climate change. Water stress in areas with mining activities can lead to demand shocks, given the water intensity of mining copper. Water shortage may increase investor risk and increase the cost of mining in arid regions. Further extraction of copper deposits will increase energy demand and land pressure is likely to grow. Zambia must balance the expansion of its operations with the efficiency of production to ensure long run production capacity that does not have create knock on effects in other sectors. The potential hazards from climate change may disrupt mining activities in the long run, underscoring the importance of diversification in Zambia's export-oriented activities.

Figure 12. Areas of water stress and active mines (WRI 2023)



103 IEA (2023) The Role of Critical Minerals in Clean Energy Transitions. <https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/executive-summary>

104 Aghion, Philippe, Roland Bénabou, Ralf Martin, and Alexandra Roulet (2023). "Environmental Preferences and Technological Choices: Is Market Competition Clean or Dirty?" *American Economic Review: Insights*, 5 (1): 1-20.

Zambia can play an integral role in supporting decarbonisation efforts globally but must also strengthen and diversify its production. Zambia should take a two-pronged approach: strengthen its role as a key player in the supply chain for necessary decarbonisation technologies - including solar PV, electric batteries, and transmission lines - and reinvest revenues from mining into high value and productive sectors, within and beyond the mining value chain. In the short term, securing a place in the value chain can unlock future opportunities for firm upgrading in other sectors.

A copper-plus future for Zambia

Mining

- There is a significant need to improve data availability in the mining sector to increase clarity for private sector investors and policymakers. Improved transparency on resource assets in addition to disclosure of permitting and project development can reduce uncertainty on future quantity.
- In tandem, mining royalty rates should remain stable to improve the certainty of the investment environment and create certainty in revenue streams for the government.
- The government should focus primarily on the policies which can support strong investment in the mining sector in Zambia, both by domestic firms and international players. We hope to explore the potential policies which can make the mining sector an attractive business opportunity.
- Mining policies must remain consistent and transparent, to attract further investment from large, foreign firms who seek to expand operations along the value chain within the country.
- The IEA's new policy guidelines on the use of critical minerals are geared towards MNCs, and Zambia can undertake early adoption of these standards to remain resilient to shifting trade and climate policies internationally.
- Downstream activities within the mining sector are energy intensive and capital intensive but can potentially benefit from shared infrastructure and place-based incentives.

Energy

- The energy demand for the mining sector is likely to rapidly increase, driven by lower grade copper ore, rising production targets, and development of downstream processing and smelting capacity.
- Public investment in transmission and project generation are necessary to greatly expand available energy.
- In the medium term, market reform is likely to attract new private investment in renewable energy, as prices for solar (and wind) are competitive with traditional energy sources in Zambia.
- Co-located industrial and energy projects to reduce volatility in renewable energy contracts.

Taxation

- Taxation policies are the backbone of good natural resource rent management. Taxes should remain stable and competitive, to balance new investments and revenue generation.
- Zambia's high resource endowments make it subject to volatility in the absence of strong taxation and fiscal measures which contract spending during high commodity price periods to incur savings.
- Potential policies to ensure smoothing of revenues over time include the development of a natural resource charter or sovereign wealth fund to re-invest rents into productive sectors.
- Re-investment of revenues should focus on public investments for human capital generation, including education, vocational training, healthcare and infrastructure.

Industrial strategy

- Industrial policy and its potential gains are being explored more urgently in economics. The evidence is still developing, but there are strong policy cases for public support of sectors which correct for market failures – including underinvestment, information failures or other distortions.
- Industrial policy, as a suite of policies to induce innovation and subsequently, growth in productivity, should target upstream and highly distorted sectors.
- Industrial policy approaches in Zambia should be soft to avoid stifling competition or creating negative knock-on effects.
- Zambia should focus on developing a light-touch LCR program to integrate smaller firms into the mining value chain and harness spillovers from larger MNCs.

The energy transition

- In the near term, copper will provide an essential source of revenue as global demand increases and stock quality falls in other major producing regions.
- Attracting FDI to the Copperbelt and Zambia's other mineral producing regions can secure the country's permanent place in the green global value chain.
- Environmental performance and transparency are increasingly important to producers in the GVC, particularly for minerals, and Zambia will need to upgrade domestic infrastructure to adapt.
- Investment along the mining value chain can generate more local opportunities for workers and firms, but will only be sustained if environmental regulation keeps pace with the shifting demand of buyers in the GVC.
- By investing both across industries and within the mining sector, Zambia can position itself for near-term growth through its natural resource endowment, and long run growth by making productivity improving investments from rents.

6. Conclusion

A number of questions remain open for investigation by researchers and policymakers.

New data collection on the mining and electricity sector can improve our understanding of the relationship between mining activity and electricity consumption. Given the availability of information on the quality, size and potential scope for new mineral extraction is piecemeal, it is pertinent the government pursue a rapid and detailed assessment of copper and other mineral resources in country. This information can allow investors to make informed decisions and support the accurate valuation of future revenues for copper reserves. Next, the spillover effects of renewable energy on the mining sector's overall productivity is needed. Whether renewable energy, such as solar, can improve reliability or offer lower cost sources of electricity for mining firms is supported by a small amount of research. This research is highly country-specific and requires further understanding of the interaction of the electricity market, infrastructure quality and resource availability.

Further research into policy design in taxation and industrial policy can support regulatory design to ensure Zambia's successful trajectory in a copper plus future. The tax regime on minerals in Zambia has undergone significant reform in the last decade. Whether these reforms have crowded in, or reduced investment, could be investigated. Potential policy approaches and rule design is needed to move forward with a fiscal regime to govern resource rents as Zambia moves forward expansion of the copper industry. Which sectors will be supported requires further analysis. The size of potential sectors, current skills of workers within these sectors, and potential spillover effects from infrastructure linkages and knowledge sharing should be considered in the design of an industrial strategy. Resource rent management requires deeper investigation into the most productive industries which can provide long term, aggregate growth for Zambia.



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