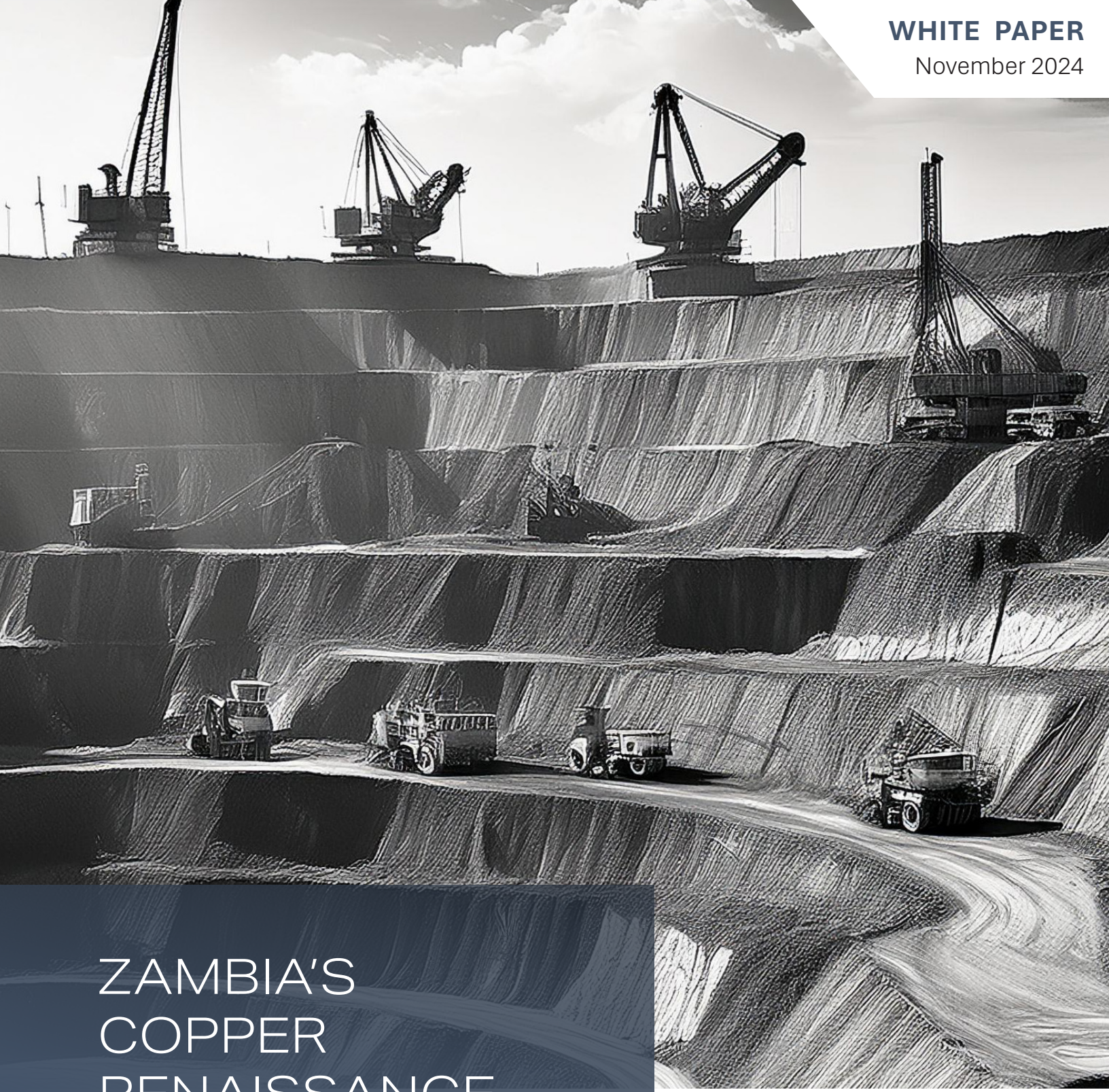


WHITE PAPER
November 2024

ZAMBIA'S COPPER RENAISSANCE

Navigating Opportunities and Challenges in Africa's Most Promising Copper Jurisdiction

MASSIFCAPITAL

INTRODUCTION

Copper is more than just a metal; it is the cornerstone of modern infrastructure and technology. Often referred to as "Doctor Copper" for its ability to diagnose the global economy's health, copper is essential in construction, electrical equipment, machinery, and renewable energy systems.

As emerging markets continue to develop, the demand for copper-intensive goods and infrastructure increases. Urbanization and industrialization in countries like China and India are significant drivers of this growth. The rise of electric vehicles (EVs), renewable energy, and advanced electronics heavily relies on copper. For instance, EVs need up to four times more copper than traditional combustion engines. The global shift towards greener technologies amplifies this demand. Finally, Governments worldwide are investing in infrastructure to stimulate economic recovery and growth. These projects often require large amounts of copper for electrical grids, transportation systems, and construction.

While demand is on the rise, the supply of copper faces challenges. Finding new, economically viable copper deposits is becoming increasingly difficult. Environmental regulations and permitting processes can delay or restrict mining activities. Existing mines are aging, and ore grades are declining, making extraction more costly and less efficient.

These factors contribute to a potential supply-demand imbalance, which could drive copper prices higher in the coming years. Within this context, companies involved in copper mining stand to benefit from favorable market conditions, which could translate into strong financial performance and shareholder returns. The challenge for investors in this context is deciding where to allocate capital. Successfully investing in mining firms requires investors thread a needle and find firms that check all the boxes of our mining firm scorecard:

Macro-Variable	Sub-Variable	Description
Geography	Geology	Scale and Complexity
	Grade	High Grade vs. Low Grade
Political Economy	Infrastructure	Full Supply Chain Infrastructure
	Jursidiction	Political Context of Operations
Company	Company Optionality	What Could Be
	Company Management	The People That Determine What Will Be

For reasons that will be explained, the principal place to look for companies that check all these boxes, at least to some degree, is mining firms exploring for or developing copper assets in frontier markets, specifically in the case of this paper, in Zambia.

WHY INVESTORS SHOULD CARE – DEMAND

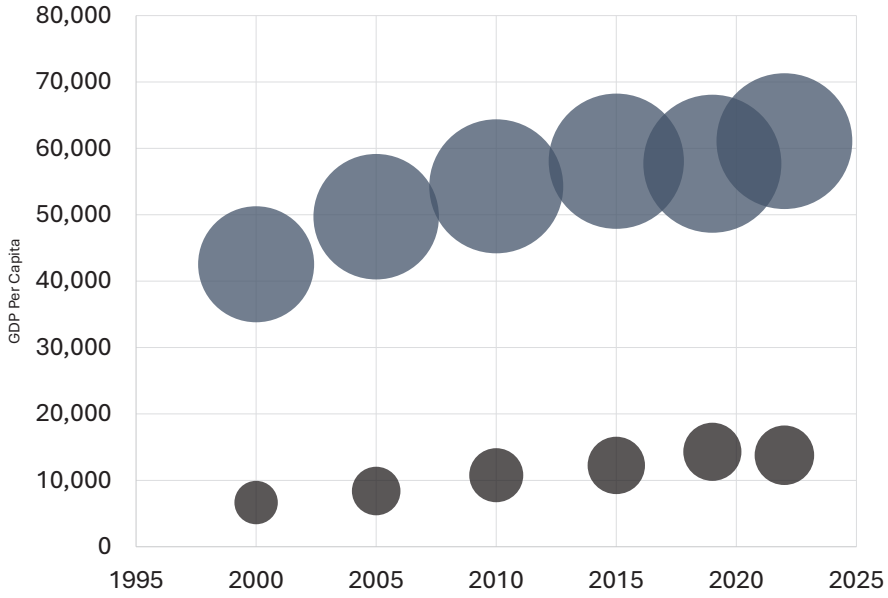
Global copper demand, which has historically grown at a 3.1% annual rate over the past 75 years, slowed to 1.9% in the 15 years up to 2021, but there is a basis for thinking that the growth rate will reaccelerate.[1] Three key factors drive the case for a reacceleration: traditional economic expansion, the energy transition, and digital infrastructure.

Traditional demand underpins the need for further investment and arises from the link between economic devel-

1 BHP Insights: How Copper Will Shape Our Future, BHP

opment, electricity consumption, and copper usage. As nations industrialize and integrate technology further into the day-to-day lives of citizens, demand for copper-intensive products and the infrastructure to produce and distribute them increases. Developing economies—with populations five times larger than high-income countries—are expected to significantly boost copper demand as they seek higher living standards. For instance, despite rapid consumption growth, China still has only half the copper stock per capita compared to developed nations, and countries like India still have electricity consumption per capita significantly below that of countries like Japan or China.[2] India's copper demand is projected to grow fivefold in the coming decades as electricity access expands.[3] In addition to traditional growth, we must consider the concurrent adoption of new copper-intensive technologies in both the energy and digital realms. These accelerants will only worsen long-term supply and demand imbalances but are not necessarily the critical drivers they are often made out to be. The long-term copper supply/demand imbalances exist without them.

Per Capita Electricty Demand - Top Billion vs. The Rest



Blue Bubbles: 1 Billion People with the Highest Average Per Capita GDP
Grey Bubbles: The Rest of the Global Population
Bubble Size: Per Capita Electricity Demand

The Energy transition is primarily a shift towards electrification, a process that increases copper usage compared to a hydrocarbon-driven energy world. Renewable energy sources like wind, solar, and electric vehicles—which use about three times more copper than traditional vehicles—will drive this demand. Energy efficiency technologies such as smart grids, LED lighting, and heat pumps will also contribute. Digital demand for copper is propelled by the expansion of data centers needed for the massive amounts of data generated and consumed daily, especially with the rise of AI technologies. These centers are copper-intensive and require more electricity.

In summary, while traditional economic growth continues to support copper demand (the most significant contributor to the future growth of the three pillars we have mentioned), the energy transition and digitalization will accelerate growth rates in the coming years.

WHY INVESTORS SHOULD CARE – SUPPLY DYNAMICS AND FUTURE CHALLENGES

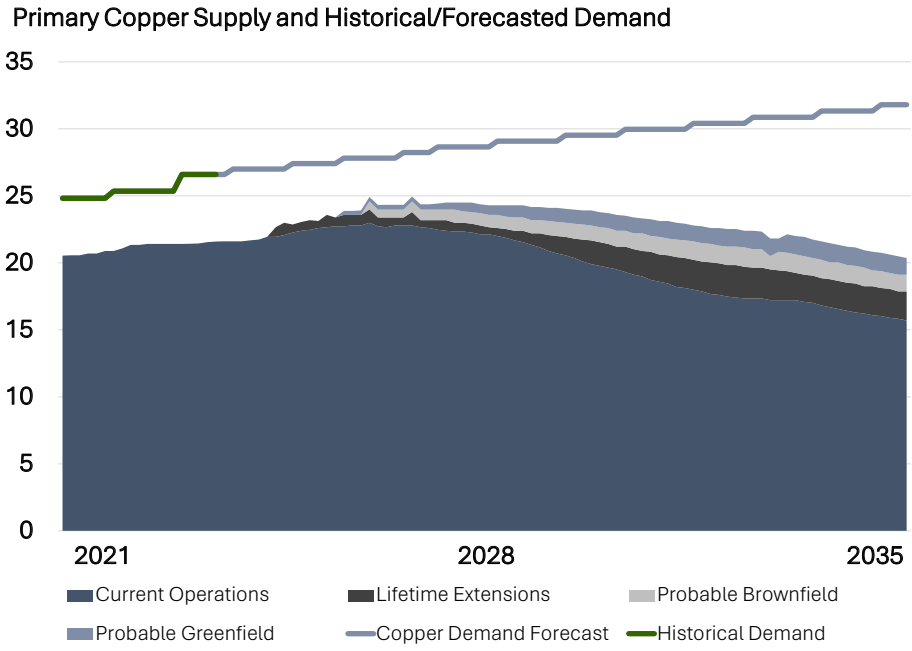
Copper supply originates from two main sources: primary supply from mines and secondary supply from recycled or scrap copper. While mining remains the dominant source, recycled copper is increasingly vital for meeting growing global demand over the next 30 years. The main limitation of recycled copper is the availability of scrap, determined by the average lifespan of copper-containing products, which ranges from months (e.g., batteries, cables) to decades (e.g., construction materials). The average lifespan is about 20 years.[4] In 2021 only 43% of available "old scrap" was

2 World Bank, UN, BHP & Massif Capital Analysis

3 BHP Insights: How Copper Will Shape Our Future

4 Losses and lifetimes of metals in the Economy, Nature Sustainability

collected and recovered, dropping to 40% in 2023 due to lower prices, economic slowdowns, and regulatory hurdles like "scrap nationalism" and waste trade restrictions.[5] Recognizing copper as a critical material will boost scrap collection and recovery rates to 56% by 2035.[6] Scrap supply is projected to increase from about one-third of global copper today to around 40% by 2035 and nearly half by 2050.[7]



Despite growth in recycling, additional mined copper is required due to declining ore grades and mine depletions. Over the last 30 years, global copper production doubled to about twenty-two million tons per annum (Mtpa), driven by significant investments in new projects and the adoption of the leach-solvent extraction-electrowinning (SXEW) process, which now accounts for 20% of mine supply. The industry aims to replicate this volume growth, but existing mines are expected to produce about 15% less copper by 2035 due to aging infrastructure, the need for capital investments, stricter regulations, and declining ore grades (a 40% decline since 1991), necessitating a significant investment in both greenfield mines and brownfield expansion.

Expanding existing mines is expected to contribute up to 30% of the total copper supply by 2035.[8] This theoretical mine supply benefits from existing infrastructure and lower technical risks but comes with increasing capital costs and regulatory complexities. Capital intensities for these projects have risen by approximately 65% since 2010.[9] New mining projects can unlock large, high-grade deposits but face even more significant challenges than brownfield expansion, including long lead times, environmental concerns, and regional uncertainties. Within Greenfield, the biggest successes in the last decade have come from Africa. African greenfield projects, particularly those backed by Chinese investment, have seen a 90% production increase over the previous decade at competitive costs.[10] Worthwhile green field discoveries have also become more challenging to find. The rate of new copper discoveries has slowed, with an average of 17 years from discovery to production. The current global pipeline is filled with high-difficulty projects, challenging timely responses to demand.

The estimated capital expenditure for mine expansion from 2025 to 2034, which will address demand growth and offset existing asset decline, is around $250 billion, up from $150 billion in the previous decade.[11] Regardless of the demand outlook details, the future will require existing mines to operate more efficiently and longer. At the same time, greenfield projects will need to overcome cost and schedule challenges, increased engineering complexity,

5 BHP Insights: How Copper Will Shape Our Future
6 BHP Insights: How Copper Will Shape Our Future
7 BHP Insights: How Copper Will Shape Our Future
8 BHP Insights: How Copper Will Shape Our Future & The Future of Copper, S&P Global
9 World's Top Copper Projects by CapEx, Mining.com & Copper Mines Becoming More Capital Intensive and Costly to Run, Ahead of the Herd
10 BHP Insights: How Copper Will Shape Our Future
11 BHP Insights: How Copper Will Shape Our Future & The Future of Copper, S&P Global

and higher environmental and social standards. Both will be subject to labor constraints that will affect cost and timelines. Companies with strong technical expertise, social value credentials, and robust financial resources are best positioned to succeed in meeting future copper demand.

WHY ZAMBIA?

As noted, we are looking for firms that meet six criteria: Grade, Geology, Infrastructure, Jurisdiction, Company Optionality, and Company Management. To maximize our return, we must, at a minimum, allocate funds to firms performing well across company-related variables (Company Optionality and Company Management). Still, they also must perform well across grade and geology, hence starting our search with these variables, as even a bad management team with a great asset is likely to underperform. If we are hunting for grade and geology, we have a few clear choices as first places to look. We say clear choices because the best place to find economic mineral assets is where you have already found economic mineral assets, even better if the place you are looking for is under-explored. Geological events occur on a large scale,

While traditional hunting grounds like South America have a tremendous economic endowment of copper assets, they have become increasingly difficult places to find new assets. While there will undoubtedly be more tier-one assets in South America, it is nevertheless a well-explored region of the world. There are easier places to look, and Zambia is one of those easier places. The reason for this is the evolution of the mining industry in Zambia, which has resulted in a lack of modern exploration combined with the country's underlying geology.

GEOLOGY

Our rough heuristic for mining is that you can always find more metal where you already have lots of in situ metal. As such, the Zambian portion of the Central African Copperbelt, which accounts for approximately 46 percent of the Central African Copperbelt's production and reserves and hosts some of the largest and highest-grade sediment-hosted stratiform copper deposits on earth, would seem to be an excellent place to look for mining firms with assets that can have highly asymmetric payoffs.

SEDIMENT HOSTED COPPER DEPOSITS

The Central African Copper Belt is principally comprised of Sediment-hosted copper deposits, which are strata-bound deposits of fine-grained copper sulfides. This means copper mineralization is confined to specific layers or strata within a sedimentary sequence. The mineralization is typically disseminated along a "bedding plane," a flat surface separating distinct sedimentary rock strata. The bedding plans represent a boundary where there was a change in the depositional conditions during the rock formation. The mineralization is also epigenetic, meaning it forms after the bedding plane and is diagenetic, deposited before loose sediments are transformed into solid sedimentary rock.

Given the deposits' strata-bound, epigenetic, and diagenetic nature, they are typically laterally oriented and homogenous in grade distribution. The copper in the sediment-hosted deposits is leached from a source rock that forms the bedding plane or from the rock below the bedding plane, with fluid pressure driven by sub-bedding plane compaction as part of lithification, the process by which loose sediment is transformed into solid sedimentary rock. The deposits often reach the status of "supergiants."

This is particularly true of the Central African Copper Belt, which has at least two deposits: Kamoa Kakula and Kansanshi. In the African Copperbelt, treeless areas called 'copper clearings' occur over areas underlain by copper-rich soils. These areas may also contain copper-tolerant and copper-accumulating plants called 'copper flowers,' which typically display a yellow leaf color [chlorosis] in copper clearings. As such, vegetation studies, at least in the African Copperbelt, can augment other exploration efforts; these studies are called geobotanical prospecting.

Sediment-hosted stratiform copper deposits are widespread globally, but economic deposits are rare. Despite the rarity, such deposits still account for as much as 23% of the world's total copper production as recently as 2005 because of the scale and quality of the economic assets that have been found.[12] Three basins are noteworthy as the only known sediment-hosted stratiform deposits known to host supergiant deposits, deposits with more than 24 million tons of copper: the Central African Copper Belt, the European Permian Basin (mainly in southern Germany and Southwest Poland), and the Kodaro-Udokan basin in Siberia.

There are currently three major copper mines (Kansanshi, Lumwana, and Sentinel) in Zambia operated by Western producers (First Quantum and Barrick), several mines owned by Chinese firms, one mine owned by International Holding Company, a subsidiary of UAE conglomerate International Resources Holdings and a mine owned by Indian conglomerate Vedanta. This list does not account for all of Zambia's mines and production but covers the significant operations. What is of note is the scale of these mines; they all produce more than 100,000 tons of copper a year and have reserves and resources over a million tons.

This means the assets will be mined for many years to come. [CALL OUT BOX] What's also missing from this list is the mines on the other side of the border between Zambia and the Democratic Republic of Congo. The Central African Copper Belt extends across the border into the Katanga Region of the DRC, where several mines fit the above profile with impressive grades, such as the Kamoa Kakula mine, operated by Ivanhoe. Discovering assets similar to those below is transformative for a company.

Kansanshi

- Ownership: 80% First Quantum, 20% ZCCM
- Proven and Probable Reserves: 1.1 million tons
- Measured and Indicated Reserves: 1.1 million tons.
- Annual Production 2023: 134,827 tons
- Cash Cost: $1.29 per lb.
- NPV Estimate: $5.3 billion or $6.4 per share

The Kansanshi copper-gold mine is near Solwezi, in the Northwestern Province of Zambia, and has been a flagship asset for First Quantum since 2005. The mine currently has two open pits and was the largest copper mine in Africa until Ivanhoe launched Kaoma Kakula across the border in the Democratic Republic of Congo. Kansanshi is a vein deposit with economic copper and gold mineralization occurring in three ore types: primary sulfide, mixed supergene, and oxide. The Kansanshi copper smelter, commissioned in the first half of 2015, has a nominal capacity of 1.2 million tons per annum of concentrate to produce more than 300,000 tons of blister copper annually.

As currently structured, the mine has a capacity of 150,000 tons per annum but is set to expand through the S3 expansion project, with the first ore expected to start in 2H2025. The S3 project will grow production by 67% and extend the mine's life beyond 2050. The core to the expansion is a capacity expansion of the mine's sulfide processing line, an expansion of the smelter capacity, and the development of a new pit. At completion in 2029, the S3 expansion will have invested $2 billion in the asset; to date, $600 million has been spent. The expansion project has employed more than 1,800 additional skilled workers.

Sentinel (Kalumbila)

- Ownership: 100% First Quantum
- Proven and Probable Reserves: 651.2 thousand tons

12 The Sediment Hosted Stratiform Copper Ore System, Economic Geology 100th Anniversary Volume, Society of Economic Geologies.

- Measured and Indicated Reserves: 754.3 thousand tons.
- Annual Production 2023: 214,000 tons
- Cash Cost: $1.86 per lb.
- NPV Estimate: $3.8 billion or $2.2 per share

In 2010, First Quantum bought Kiwara PLC, gaining control of the Kalumbila copper deposit (now Sentinel) and the Kawako nickel deposit (now Enterprise). The combined project, renamed Trident, began construction in 2012. Sentinel became Zambia's largest infrastructure project since the Kariba Dam, requiring a $2.1 billion investment. Notable features included the world's largest steel ball mill and semi-mobile rope shovel at construction time.

Lumwana

- Ownership: 100% Barrick
- Proven and Probable Reserves: 3.0 million tons
- Measured and Indicated Reserves: 7.1 million tons.
- Annual Production 2023: 118,000 tons
- Cash Cost: $2.29
- NPV Estimate: $3.8 billion or $2.2 per share

Barrick is investing almost $2 billion in an expansion project designed to increase Lumwana's annual production to an estimated 240,000 tons of copper annually over 36 years. The development, although just started, is on pace for its first production in 2028. The expansion involves first doubling the throughput of the existing process circuit and then significantly increasing mining volumes. The plan calls for an incremental year-on-year increase in volume of total material mined (ore and waste) from 150 million tons in 2025 to approximately 240 million tons in 2028 and then to an average rate of 290 tons per annum from 2030 onwards. The expansion will require 2,500 additional workers for three years.

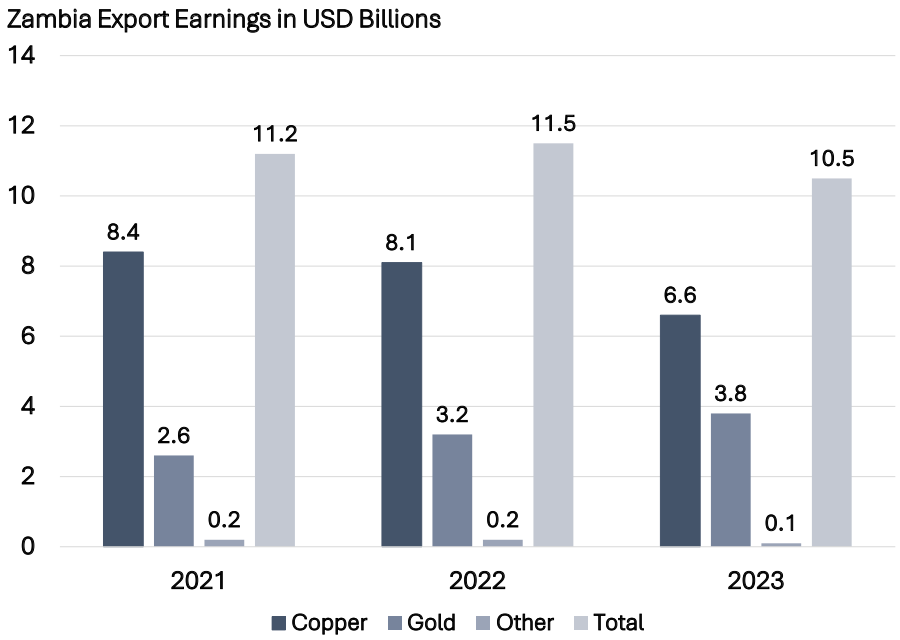
While geology and grade are asset-specific, the presence of many high-value assets speaks to the high prospectivity of the geology underlying the Central African Copper Belt. At a high level, we can check the geology box. There are elephants in the Central African Copper Belt, and more are likely to be found, so we are looking in the right place for asymmetric return opportunities.

AN EVOLVING JURISDICTION

The relationship between mineral extraction and societal and political development is neither linear nor direct. This is true of most countries, but especially African nations, which have benefited little from their natural resource endowments and, as a result, have often failed to develop the legal and political infrastructure that makes for an excellent jurisdiction in which to develop long-lived assets. As such, we are looking for a positive trend in the direction of travel.

Currently, Zambia is the second-largest copper producer in Africa and the ninth largest globally, but at the country's independence (1964), it accounted for 12% of the global copper supply. The country's initial copper success and growth were powered by outside investment during the pre-WW2 era. The country's post-WW2 fall resulted from the nationalization of foreign-owned assets and the rampant mismanagement that followed the nationalization of mining assets. This period of poor oversight has, in part, created opportunities in the present, as during the post-colonial period, foreign miners were excluded from monetizing the country's assets, and as such, the region did not attract the exploration dollars the geology justifies. The recent reemergence of the country as a critical target for

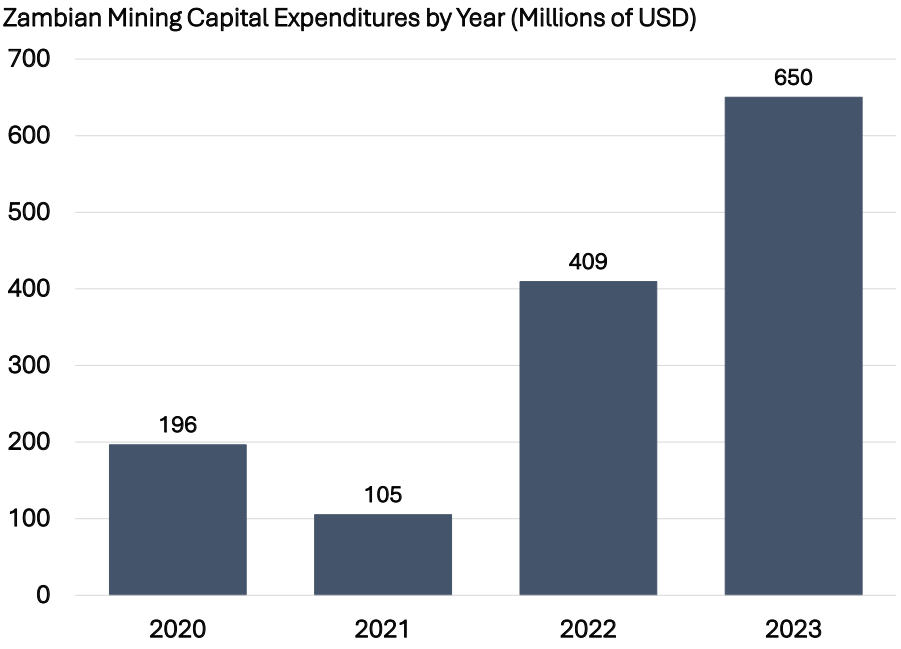
greenfield exploration follows the slow but steady rehabilitation of the jurisdiction as an operating environment. This process is not yet complete but is showing steady progress.



The importance of rehabilitating the country's perception of being friendly to mining firms cannot be overstated. Zambia's economy is highly dependent on mining, particularly copper, which generates 75% of the country's total export earnings. According to the Zambia Statistics Agency, in 2023, Zambia recorded total export earnings of US$10.5 billion compared to US$11.7 billion in 2022.[13] The 10.5% decrease in export earnings is ~100% attributable to a fall in copper export revenue. Copper's significance to the country cannot be overstated. With numerous brownfield and greenfield projects on the Copperbelt, the importance of copper export revenues to the country is likely only to increase.

Since the privatization of ZCCM between 1997 and 2000, the state-owned mining firm resulting from post-independence mine nationalization, the Zambian mining industry has welcomed foreign investment. Foreign investors can own 100% of any enterprise registered in Zambia, with international and domestic investors adhering to the same general registration procedures and requirements. ZCCM-IH is even listed on the Paris, London, Euronext, and Lusaka Stock Exchange, with 12.7% of shares held by private investors and 87.6% held by the government of Zambia.

Since privatization, there has been limited direct government interference in mining operations, but regulatory and tax volatility has made uncertainty a negative feature of the investment environment. In 2019, for example, the rollout of unfavorable policies decreased production despite solid copper prices, with companies withholding over $650 million in investments.[14]



Although slow, government reforms have made Zambia a far more accessible place to operate than much of Africa, but it is not without its challenges, many of which it shares with the rest of the continent. Political instability and corruption are

13 Zambia Statistical Agency

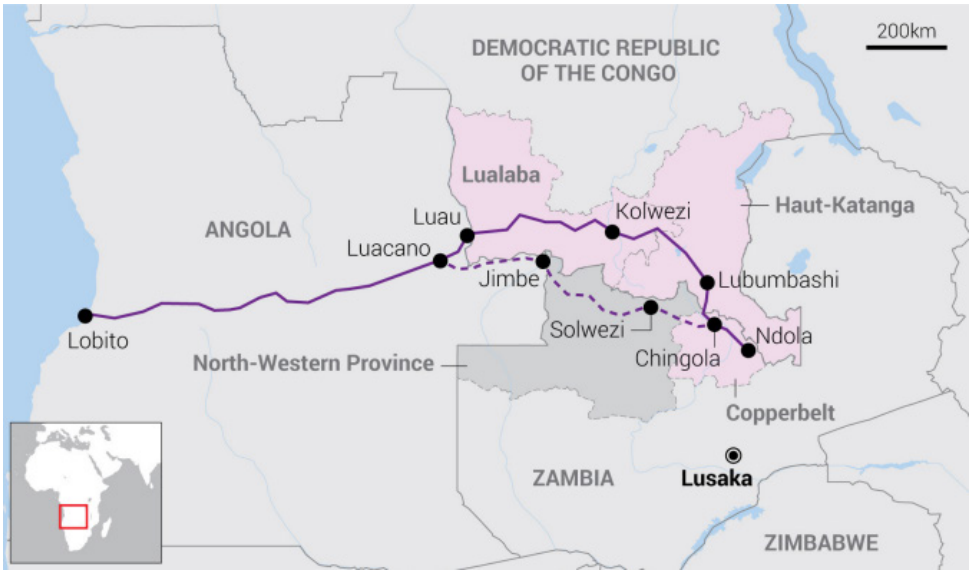
14 Zambia 2019 Copper Output Drop Due to New Mining Taxes, S&P Global

the main deterrents to foreign investment in Africa. Looking at the Zambian case, the country ranks 94th out of 185 countries on the World Bank's Ease of Doing Business rankings. Although this ranking may not seem exceedingly high, in the sub-Saharan African region, where the average ranking is 140, Zambia stands out as a beacon of stability for investors behind only South Africa, Botswana, and Namibia. Since independence, Zambia has adopted a Westminster-style multi-party democracy based on the rule of law and the principles of private property ownership.

The mining regulatory framework in Zambia continues to operate under a royalty-tax system, a common approach in many mining jurisdictions, including neighboring countries such as the Democratic Republic of Congo, Botswana, and South Africa. In this model, the government imposes a mineral royalty alongside a general taxation scheme on mining activities.

As of 2024, Zambia's mining fiscal regime included several elements. The Mineral Royalty Tax is structured to vary by mineral type and, for copper, is adjusted based on price, ranging from 4% to 10%. Cobalt is taxed at 8%, precious metals at 6%, and industrial minerals at 5%.[15] The Corporate Income Tax (CIT) standard rate is set at 30% for mining operations, with a reduced rate of 15% available to companies listed on the Lusaka Securities Exchange. Additionally, individuals involved in mining operations are subject to the Pay-As-You-Earn (PAYE) tax, which ranges from 0% to 37%. The Value Added Tax (VAT) is 16%, while the Property Transfer Tax is 10% on the sale or transfer of mining rights, reduced to 7.5% for exploration companies as of 2023.[16] Investment incentives include deducting the mineral royalty tax for income tax purposes and allowing a 100% capital allowance deduction on mining equipment and related capital expenses. Mining companies can also carry forward losses for ten years, while prospecting and exploration firms can do so for five years.

Recent developments in Zambia's mining sector include introducing a presumptive tax for artisanal and small-scale miners, levied at rates between 4% and 10% based on gross turnover. The government has also taken steps to stabilize the tax regime, offering further relief to mining companies. Plans to conduct a nationwide geophysical survey aim to enhance exploration efforts and ease the path to new mineral discoveries.[17] Zambia faces significant challenges in maximizing its mining potential partially due to incomplete geological mapping. Around 45% of Zambia remains geologically unmapped, and much of the already mapped area was last assessed before 1998, limiting exploration and discovery of new mineral deposits.[18] Fiscal constraints exacerbate this issue: the 2024 budget allocates only 160 million Zambian kwacha (approximately $9.2 million) for mapping, which falls far short of what's needed.[19] This lack of updated geological data has meant few new large-scale mines have



15 Zambia Corporate Taxes Summary, PWC
16 Zambia 2024 Tax Changes, WTS Global
17 2024 Marks a Pivotal Year for Zambia Mining Sector, African Mining
18 Ministry of Mines and Minerals Development, Zambia
19 Zambia's 2024 Parliamentary Budget Speech

been developed, with only sporadic discoveries, despite the apparent potential.[20]

The election of President Hakinde Hichilema in 2021, the country's seventh president, marked a shift toward more investor-friendly policies. The 2023 budget introduced tax reforms, such as reducing the property transfer tax from 10% to 7.5%, allowing mineral royalty tax deductibility, and implementing a presumptive tax for small-scale miners—additional reforms aimed at stabilizing the tax regime and encouraging transparency and investment.

Zambia has significantly improved its jurisdictional quality, but more progress is needed, especially if the country is to reach government copper production goals. The government has outlined an ambitious, albeit improbable, goal of producing three million tons of copper annually by 2031.[21] Quadrupling the country's key export by the end of the decade, at a time of historically high copper prices, could transform Zambia's economy. President Hakainde Hichilema has publicly reiterated the target as a 'new dawn' for the economy and the "key to industrial development and job creation."

The proposal is ambitious and appropriate, but the timeline is a fantasy. Under this strategy, the Ministry of Mines expects that existing copper mines will increase their production by over one million tons over the next seven years. Yet none of the country's mines have expansion plans or announced investments that will collectively reach this level of increase. Furthermore, the strategic plan calls for 800,000 tons of copper from new mines, an even more improbable outcome. Zambia has a history of announcing ambitious mining targets that proved unattainable. In 2014, the Ministry of Mines announced that copper output would reach 1.5 million tons the following year.

This goal was replaced with a more modest aim of reaching one million tons by 2018, but that was never reached. Rather than accomplish any of these lofty and worthwhile goals, Zambia's mining sector has been stagnant for the last decade, and the country has so far failed to take advantage of high copper prices. The current government rightly attributed this stagnation to the inconsistent taxation policies of the previous Patriotic Front government led by President Edgar Lungu. Lungu's government was often antagonistic towards the industry and initiated a protracted legal battle to liquidate one of the country's largest copper producers.[22]

Energy Source	Current Generation Mix	2030 Target
Hydro	80%	69%
Coal	10%	0%
Diesal	3%	0%
Wind	0%	6%
Solar	3%	25%
Heavy Fuel Oil	4%	0%

The lack of credible plans for the country's most important economic sector raises fundamental questions about policymaking and the intended audience for such grandiose targets. Voters will be disappointed by the lack of jobs and economic growth, mining companies and investors will be skeptical, and countries that need copper suffer. As with all frontier markets, the jurisdiction has a problematic history. However, under the leadership of Hichilema, who started his career in politics after a lengthy business career, the direction of travel appears positive.

We cannot give Zambia an A on its jurisdictional quality, but it is improving.

INFRASTRUCTURE

Mining operations exist on two spectrums; on the one hand, they run from operationally and geologically complex

20 Geological Survey of Zambia

21 Three Million Ton Copper Production Strategy by 2031, Ministry of Mines and Minerals Development Zambia

22 Is Zambia Defaulting to Nationalization, Institute for Security Studies

to operationally and geologically simple. Think of diamond mines or deep underground South African gold mines sitting on one end of this spectrum and giant iron ore deposits in Australia on the other. The deep gold mines are challenging operations to run, and Australia's massive iron ore mines are glorified sandboxes. At the same time, there is a post-mining infrastructure spectrum. Australia's giant iron ore mines are straightforward to run but require a mine-specific train and massive port infrastructure to get the material to market. At the other end of the spectrum, a diamond mine can pack its production in a suitcase and fly it out on a helicopter.

Copper mines historically, on average, sat somewhere in the middle. They were complex but not otherworldly complex, and they were large, but the material could still be cost-effectively transported by truck to where it needed to go. In the Copper Belt Region, trucking ore out is still the primary method for getting ore out of the region and to global markets. The region's largest mine, Kaoma Kakula, trucks ore to ports in Durban and Dar es Salaam, with average round trips taking 40 to 50 days at a cost representing 30% of the total cash cost of production. [23] As the mines have become larger and more complex, rather than sitting in the middle of these two spectrums, copper mine complexity has moved to the left, and the surrounding infrastructure needs have started moving to the right. The importance of good surrounding infrastructure is thus increasing, something that the Central African Copper Belt is mostly missing.

To address this issue, the Lobito Corridor Railroad has been proposed. Conceptualized as a 1,300 km stretch of railway line from the port of Lobito, on the Angolan Atlantic Ocean coast, to the town of Luau on the north-eastern border of Angola with the DRC and then would extend a further 400 km into the DRC to the mining town of Kolwezi. This railway would reduce transportation timelines at mines like Kaoma Kakula to around eight days; similar value-added improvements would occur for mines in Zambia. The Corridor has recently been concessioned to a consortium comprising the commodity trader Trafigura (49.5%) and European partners Mota-Engil (49.5%) – construction and Vecturis (1%) – railway operations. There will be inevitable delays and over-run costs, but the agreements have been signed, the money is on the table, and the expectation is that the trains will be running on time and laden with copper by 2029.[24]

While transportation infrastructure weaknesses are concerning, they do not yet prevent the export of copper from Zambia; they only increase the cost. The primary risk to the mining sector in Zambia is limited and unreliable power generation. Zambia's electricity supply heavily depends on hydropower, with ZESCO, the state-owned utility, accounting for over 90% of the country's approximately 3,000 MW of installed generation capacity.[25] However, due to aging infrastructure, Zambia currently struggles to consistently supply even 2,500 MW, leading to frequent shortages that have forced ZESCO to implement load shedding during peak demand.[26] This has serious implications for the mining sector, which consumes about 55% of Zambia's electricity.[27] Firms like First Quantum, which produces more than half of Zambia's copper output, have had to rely on power imports to meet demand, doubling their energy cost per pound of copper produced.[28]

Historically, Zambia was a net exporter of electricity, but increasing maintenance demands on aging hydro plants and drought in 2015, 2016, 2019, 2022, and now again in 2024 have shifted it to a net importer.[29] The country's low electricity tariffs, among the lowest in the region, have further complicated financing for new generation projects

23 Ivanhoe Mines Exports Commence from Kamoa-Kakula Copper Complex Along Lobito Atlantic Rail Corridor, Ivanhoe Mines

24 See https://www.lobitocorridor.org/ for more information. WSJ intro video to the railroad: https://www.youtube.com/watch?v=GGHqSL6IITI&t=67s

25 ZESCO Power Generation

26 Zambia – Utility Increases Duration of Rolling Power Cuts Through September, Crisis24:

27 International Energy Agency (IEA), "Powering Zambia's Future: Electricity and the Mining Industry," 2023.

28 Zambia Asks Mines to Curtail Normal Power Use by 40% Amid Crunch, Mining.com

29 Droughts and Dams, Phenomenal World

as ZESCO struggles to attract private sector investment.[30] In 2023, the Energy Regulation Board (ERB) continued a phased tariff increase to help fund critical power projects. The aim was to stabilize Zambia's power supply and reduce reliance on imports.[31]

The mining sector's energy demands are growing, driven by Zambia's ambition to boost copper production from approximately 698,000 tons in 2023 to 3 million tons by 2032. However, only about 42% of Zambia's 19 million residents currently have electricity access, meaning that balancing industrial and residential power needs will require new, diversified energy projects.[32] Zambia has initiated multiple hydropower and renewable projects to address these issues, including the 600 MW Kafue Gorge Lower project (completed in 2021) and a 120 MW solar project expected online by 2026.[33]

Recognizing Zambia's hydropower potential—estimated at 6,000 MW, with only 30% currently utilized—the government has invited private sector participation through public-private partnerships (PPPs). Major hydro expansions, including the 750 MW Batoka Gorge project (jointly developed with Zimbabwe), reflect this strategy.[34] The Development Bank of Southern Africa (DBSA) has shown confidence in Zambia's potential, supporting projects like the Kariba North Bank Extension, which added 360 MW to Zambia's grid in 2013.[35]

Looking ahead, Zambia aims to position itself as a regional energy hub by exporting surplus power to neighboring countries. Planned projects like the Kalungwishi (240 MW) and Itezhi-Tezhi (120 MW) plants illustrate Zambia's broader vision. The country's extensive water resources—about 28% of the Southern African Development Community's (SADC) total—could enable it to meet domestic demand and export goals, provided ongoing power generation challenges are addressed.[36]

The infrastructure surrounding a mine can make the difference between success and failure. While Zambia lacks excellent infrastructure, the quality of the geology compensates for that weakness, at least at the moment. Transportation and energy infrastructure upgrades will be critical to the continued development of the region's copper endowment. Once again, like jurisdictional quality, the present is middling, but the direction of travel is clear, especially concerning transportation infrastructure.

TWO IDEAS WORTH FOLLOWING

Having established that Zambia's geology is second to none and that the infrastructure and jurisdiction are adequate, we turn to two ideas we believe are worth tracking.

Midnight Sun Mining (MMA CN)[37]

MMA is a TSXV-listed Canadian junior miner focused on exploring and developing a cluster of copper deposits at their Zambian-based Solwezi project. MMA checks all the critical boxes in our mining firm scorecard: the assets have great geology and solid grades, the jurisdiction and surrounding infrastructure is adequate and improving with time, and

30 Energy Sector Report, Zambia Energy Regulation Board (ERB)

31 Energy Sector Report, Zambia Energy Regulation Board (ERB)

32 Zambia – Access to Electricity Changes Lives, World Bank

33 Zambia – Country Strategy Paper 2024-2029, African Development Bank

34 Batoka Gorge Hydro Electric Scheme, World Bank

35 Regional Infrastructure Development Master Plant – Water Sector Plan, Southern African Development Community

36 Water and Energy Resources, Southern African Development Community

37 The Massif Capital Real Assets strategy is currently invested in MMA, and Margot Naudie currently sits on our firm's and Midnight Suns' advisory boards. Massif Capital's investment occurred prior to the appointment of Margot Naudie to the advisory board.

the firm's management and optionality are excellent. We can add another desirable quality to this list: partnerships that can accelerate the route to revenue and cash flow.

Junior miners in frontier markets have lottery ticket-like qualities. Thus, a successful investment is based on firms having a high degree of optionality that can be evaluated. The optionality must be separate and distinct from one's outlook for the underlying commodity, in this case, copper. The more optionality that is commodity price agnostic, the more interesting the opportunity is, and the more downside safety is implicit in the allocation. MMA has significant company and asset-specific optionality, in addition to the optionality created by deep-pocketed partners.

MMA's Solwezi project spans approximately 506 square kilometers. It is in a region renowned for its rich copper and cobalt deposits, which has attracted prominent industry players such as Barrick Gold and First Quantum. From 2005 to 2008, First Quantum owned the exploration licenses associated with the Solwezi project but was forced to drop the permits in 2008 after a revision in the Zambian mining law, which restricted the total landmass one company could hold at any one time. As such, the opportunity that MMA is pursuing exists principally because of political events.

The Solwezi project includes five key exploration targets: Dumbwa, Kazhiba Dome, Mitu, the Crunch Zone, and various instances of copper oxide mineralization throughout the 506-square-kilometer land package. MMA has leveraged partnerships with other mining firms to advance exploration, most notably an agreement with Bill Gates-backed KoBold Metals for the Dumbwa target and a cooperation agreement with First Quantum Minerals at the Kansanshi Mine. These partnerships diversify the company's risk and enhance its resource evaluation capabilities and market position, creating near-term cash flow potential from copper oxide developments.

Strategic Location and Geology: The Solwezi project is positioned in the core of the Domes Region of the Central African Copperbelt, an area containing approximately 14 significant copper deposits, each with at least five million tons of copper and boasting grades up to 4% vs. the current global 0.5% in 2022.[38] The general context in which MMA operates is sufficient to make the company of interest to investors, but the geology makes it particularly attractive. The Solwezi property covers multiple geological formations, including dome structures linked to high-grade copper mineralization. The domes region is one of the most highly prospective geological targets in the search for copper deposits globally, and the domes region of the Central African Copperbelt produces more copper than the traditional Zambian Copperbelt.

At MMA's Kazhiba Dome target, the initial drilling revealed copper grades as high as 5.71% Cu over 14.2 meters, indicating rich copper oxide potential. Similarly, the Dumbwa target, centered over the Solwezi dome, holds a continuous copper-in-soil anomaly along a 20-kilometer stretch. Throughout this 20-kilometer stretch are the hallmark signs of high-grade copper deposits in Zambia: vegetative dead zones due to copper concentrations in the soil being too high to support plant life.[39] These mineralogical characteristics position the overall Solwezi land package among the highest-grade, highest-prospective copper projects globally, with significant value still to be uncovered.

Geological Targets

- *Kazhiba Dome:* 85% owned by MMA with the option to earn 100%. The target area is less than 10km from First Quantum's Kansanshi mine, the 14th largest copper mine in the world, producing 1.7% of global copper production. High copper grades identified in initial drilling suggest strong copper oxide potential, and over 8,000

38 Gold Mine Stripping Ratios Rise on High Prices, Grades Continue to Decline, S&P Global

39 Another common hallmark of high-grade copper zones in Zambia is Copper Flowers, which take on a copper-like hue due to the high levels of copper in the soil.

meters of drilling is planned in 2024. The company aims to develop a substantial oxide resource.
- *Dumbwa Target:* KoBold's innovative AI-driven approach could accelerate discovery, with stacked mineralized horizons resembling nearby Lumwana owned and operated by Barrick.
- *Mitu Trend:* Known for copper and cobalt mineralization, it offers a unique opportunity to diversify the resource base. The geological analog is the First Quantum Sentinel mine, 100km to the west. Sentinel is the 20th largest copper mine globally, producing 1.3% of global copper production.
- *Crunch Zone:* 100% owned by MMA, target for oxide mineralization.

Derisking Partnerships: As with all junior miners, especially those pursuing tier-one copper deposits, investors face a significant risk in betting on a team that lacks the tools, money, and relationships to build a mine. This is not the case with MMA; management has focused early on forming relationships with industry players that can provide both capital and expertise.[40] The strategic partnership with KoBold Metals is a prime example. Under the 75% earn-in agreement, KoBold will spend up to $15 million on exploration, with a 2024 drilling program planned for a minimum of 2,000 meters. KoBold brings advanced data science and Central African Copper Belt-specific geological expertise with a team that has successfully discovered significant regional deposits.[41]

Management has also struck a deal with First Quantum to define copper oxide feed sources for the SX/EW oxide copper circuit at the Kansanshi Mine. The Kansanshi Mine produces a mixture of sulfide and oxide ore, which are treated differently. Sulfide ores are treated via a pyrometallurgical process that yields a sulfur by-product. This environmental contaminant must either be disposed of safely, at a cost, or turned into sulfuric acid and used in other industrial processes. In the case of Kansanshi, sulfuric acid is used to leach copper from oxide ores, and the leached solution is then transformed into copper cathodes via SX/EW. Balancing acid production with leaching needs can be challenging, especially as mines age and tend to move from mining oxide ores that often sit at the top of deposits to the sulfide ores below.

At risk is a new cost associated with the safe disposal of sulfur byproducts, the loss of a revenue stream from oxide ores, and the stranded asset value of the hydrometallurgical infrastructure necessary to heap leach oxide copper ores and turn them into the copper cathode. By partnering with MMA, First Quantum is looking to future-proof its Kansanshi mine by not only finding a new source of oxide ores but also use for its growing sulfur production.

This partnership provides MMA with a pathway to potential cash flows without requiring it to develop oxide processing infrastructure independently. With First Quantum handling assaying, metallurgical testing, and potentially even permitting and operation, this collaboration reduces operational costs and accelerates the timeline for cash flow. The partnership covers the Kazhiba dome and Mitu Trend targets.

This partnership drives the firm's immediate operating goal to delineate 10-20 million tons of copper oxide mineralization at grades above 1% copper at the Kazhiba target by the end of 2024. The mining process for oxides is relatively straightforward, requiring only excavation and shipping of ore to Kansanshi's processing plant. This enables MMA to pursue near-term revenues while maintaining a minimal capital footprint.

Strong Management: The company's leadership team, with experience in major mining firms and extensive backgrounds in exploration, aligns with its focus on efficient, disciplined project advancement. Key personnel include CEO Al Fabbro and COO Kevin Bonel, who both have a long history with successful African mineral projects. Midnight Sun's recent financing raised CAD 10 million, placing it in a solid position to support its 2024-2025 drilling programs

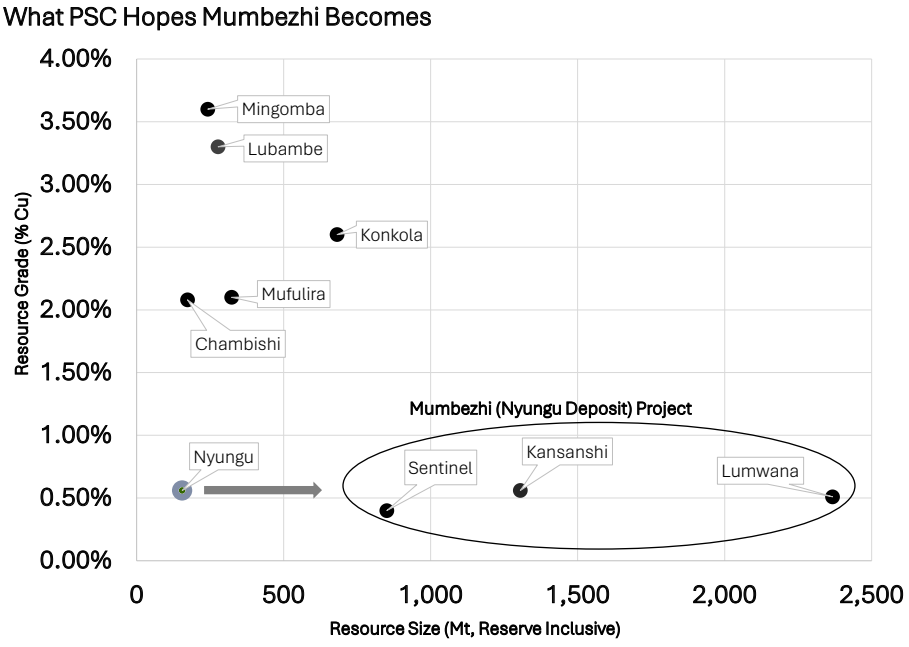
40 MMA COO Dr. Kevin Bonel has more than 25 years of experience at Barrick Gold and Freeport McMoRan in the Central African Copper Belt. He also led the exploration team at Barrick Gold's Lumwana mine, adding more than 25 years of reserves to the asset's life.

41 Kobald's Chief Copper Geologist is David Broughton, Head of Exploration for Ivanhoe and co-leader of the Kamoa Discovery team in 2015.

and use its strategic partnerships without significant capital constraints.

Valuation and Market Position: MMA's market capitalization is CAD 65 million. This valuation is supported by its significant exploration upside, operational partnerships, and positioning in a copper-rich, relative jurisdictional quality. This is a high-optionality investment opportunity with multiple avenues to monetize inground assets. MMA's best comparable regarding future potential over the next 10 to 15 years is Ivanhoe (IVN CN), which currently has a market capitalization of $17 billion.

Midnight Sun Mining Elevator Pitch: MMA's asset portfolio in the Zambian portion of the Central African Copperbelt, combined with supportive partnerships and exploration-driven catalysts, presents a compelling investment opportunity. The Solwezi project stands out as one of the most interesting early-stage copper projects globally due to its proximity to high-grade copper deposits, the potential for near-term cash flow, and a well-funded exploration strategy that mitigates financial and operational risks.



Prospect Resources (PSC AU)

Prospect Resources is an Australian-listed junior miner focused on developing high-value geological targets for sale to other mining firms. The firm has primarily focused on exploring and developing hard rock Lithium assets in Africa but recently pivoted to copper by acquiring an 85% stake in the Mumbezhi Copper Project.[42] Like MMA, Prospect's assets are in a good neighborhood, within 80 km of Kansanshi, Sentinel, and Lumwana.

PSC has already outlined an exploration target for the Mumbezhi Project, the Nyungu deposit, estimated to hold between 130 and 180 million tons of ore with copper grades of 0.45-0.65% and cobalt content of 15 to 20 million tons. But these are early estimates; the potential value is in what the asset might become.

The Lumwana mine, 30km northeast, has a resource of 2.4 billion tons of copper grading 0.52%. This is the goal of Prospect management, which hopes to grow the Nyungu deposit into something like its large tonnage low-cost neighbors. The company aims to release a maiden resource estimate by the end of 2024 and progress towards mine licensing and production plans by 2025. This asset complements PSC's history in Africa, where it previously demonstrated transactional proficiency by divesting its Arcadia Lithium project in Zimbabwe for a substantial return.

Historical drilling data of Mumbezhi and additional assays from recent drill campaigns add to the favorable outlook. The first assay results have confirmed mineralization at workable grades and highlighted intersections at economically attractive depths, adding confidence in the project's potential.[43] With ongoing drilling, PSC can accelerate resource definition while leveraging its local operational experience to streamline project timelines. This contextually positions PSC to capitalize on Zambia's emerging mining-friendly inclinations while advancing its project at a reduced

42 Acquisition of Advanced Copper Cobalt Project in Zambia, Prospect Resources

43 Further Assays Confirm Strong Prospectivity of Mumbezhi Copper Project, Prospect Resources

acquisition cost.

PSC's management has a proven record of creating shareholder value in African resource projects. The company's prior success with the Arcadia Lithium Mine, sold to Huayou Cobalt for $378 million in 2021, shows PSC's ability to execute transactions in Africa and establish its reputation as a proficient operator in emerging markets. This experience is particularly relevant in navigating the logistical, regulatory, and operational challenges that often characterize African projects. PSC is strategically positioned to leverage its operational knowledge to fast-track exploration and development by setting up a capable team on the ground in Zambia.

The African-focused expertise of PSC's team reduces the risks associated with the Mumbezhi project, including potential regulatory or logistical challenges. African credibility should strengthen investor confidence, highlighting PSC's ability to execute its strategic goals in a region that can be challenging for less experienced operators.

PSC's financial profile benefits from a healthy balance sheet, including net cash of AUD 28.6 million, allowing it to sustain its early-stage operations and exploration activities without immediate equity or debt financing. Although the company is pre-revenue and dependent on capital markets for future project funding, its ability to use existing cash reserves for exploratory work reduces financing risk in the near term. Given the firm's focus on finding and selling assets instead of building them, the dilution or debt necessary to take the project to a sale-ready state is also more limited than if the firm aimed to develop the mine.

Prospect Resources Elevator Pitch: Prospect Resources' entry into the Zambian copper sector positions it as a speculative but promising investment opportunity. The Mumbezhi Project, strategically found within Zambia's prolific copper belt, aligns PSC with favorable macroeconomic trends, supported by robust demand for copper and Zambia's newly investment-friendly mining policies.

While risks related to exploration and financing remain, PSC's resource potential, cost advantage, and experienced management team offer compelling reasons for investor optimism. If PSC successfully executes its exploration and development plans, it can gain from the expected copper supply deficits and Zambia's ambition to bolster its mining industry, making it a strong candidate for speculative investment in the copper space.

Furthermore, while not the focus of this review, it is worth noting that Prospect Resources retains multiple lithium projects in various stages of development. Of these projects, the Step Aside project, found in Zimbabwe and 8 Km from the Arcadia Lithium mine that the Prospect team sold for $378 million, is currently being shopped with twelve parties conducting due diligence on the project. The sale of Step Aside could produce an unexpected return for shareholders or help finance the continued development of Mumbezhi. As previously noted, we always want our junior minors to have as much diversified optionality as possible, and this checks that box.

CHALLENGES AND OPPORTUNITIES IN THE CONTEXT OF COPPER MINING

Zambia stands at a critical juncture in its political and economic trajectory. Under the leadership of President Hakainde Hichilema and the United Party for National Development (UPND), the nation is navigating a challenging yet promising path toward recovery and growth after years of mismanagement. The twin pressures of economic reform and political stability define the current landscape, with copper mining remaining the cornerstone of Zambia's economic prospects. While challenges persist, cautious optimism surrounds Zambia's future.

The current political environment reflects a blend of resilience and fragility. Since assuming office, President Hichilema has focused on democratic reforms, economic recovery, and rebuilding trust with international partners.

However, rising living costs, particularly food and fuel, have sparked social discontent. Despite these pressures, the UPND's legislative majority offers the administration a robust platform to implement its reform agenda.

Zambia's economy has been deeply affected by internal and external shocks, including severe droughts, fluctuating global copper prices, and a sluggish global economy. These factors have strained growth, but the country shows signs of resilience and potential recovery.

Economic growth slowed to 2.6% in 2023 due to reduced copper production and global economic headwinds. However, a projected rebound to 4.1% in 2024 signals cautious optimism. This recovery is expected to be driven by the mining sector, alongside gains in agriculture. Inflationary pressures will ease as the government implements fiscal reforms under the IMF's Extended Credit Facility. Zambia's fiscal discipline, reflected in a projected primary budgetary surplus of 0.7% in 2024, is underpinned by improved tax collection and reduced external debt servicing costs.

Despite these positive developments, Zambia's external accounts remain under strain. A current account deficit marked 2023, but recovery is predicted as copper production and exports regain momentum. However, the volatility of global copper prices is still a critical risk to this outlook. Copper mining is the backbone of Zambia's economy, contributing over 80% of export earnings and 12% of GDP. The sector's significance cannot be overstated, and its challenges and opportunities are pivotal to Zambia's economic prospects.

In recent years, copper output has declined due to underinvestment and operational difficulties. However, the return of crucial stakeholders like Vedanta Resources to Konkola Copper Mines, the resolution of ownership issues at Mopani Copper Mines, and significant investments by Barrick Gold and First Quantum provide a foundation for recovery. The government's ambition to triple annual copper production to three million metric tons by 2031 reflects its commitment to revitalizing the sector, even if the timeline is improbable.

The global energy transition amplifies Zambia's importance as a copper supplier. Demand for copper, driven by renewable energy technologies and electric vehicles, positions Zambia to play a vital role in this growing market. However, the nation must overcome challenges, including energy shortages caused by droughts. Zambia's reliance on hydropower makes it vulnerable to climate-induced disruptions, and addressing this vulnerability through energy diversification is critical to sustaining mining operations.

Zambia's journey toward recovery is fraught with risks but equally rich in opportunities, as our two ideas to watch demonstrate. There are few places in the world to look for returns that could be more than 1000%; copper projects in Zambia are one of them. Strategic investments in the mining sector and strengthened relationships with international partners offer pathways to achieve that outcome.

Zambia's political and economic landscape presents a complex yet hopeful picture. Under President Hichilema's leadership, the nation is taking bold steps to stabilize its economy, restructure its debt, and revitalize its cornerstone copper industry. While climate risks, global market fluctuations, and social discontent persist, Zambia's commitment to reform and strategic investment provides a sturdy foundation for recovery. Copper mining will remain central to this journey, offering challenges and immense opportunities in a rapidly evolving global market.

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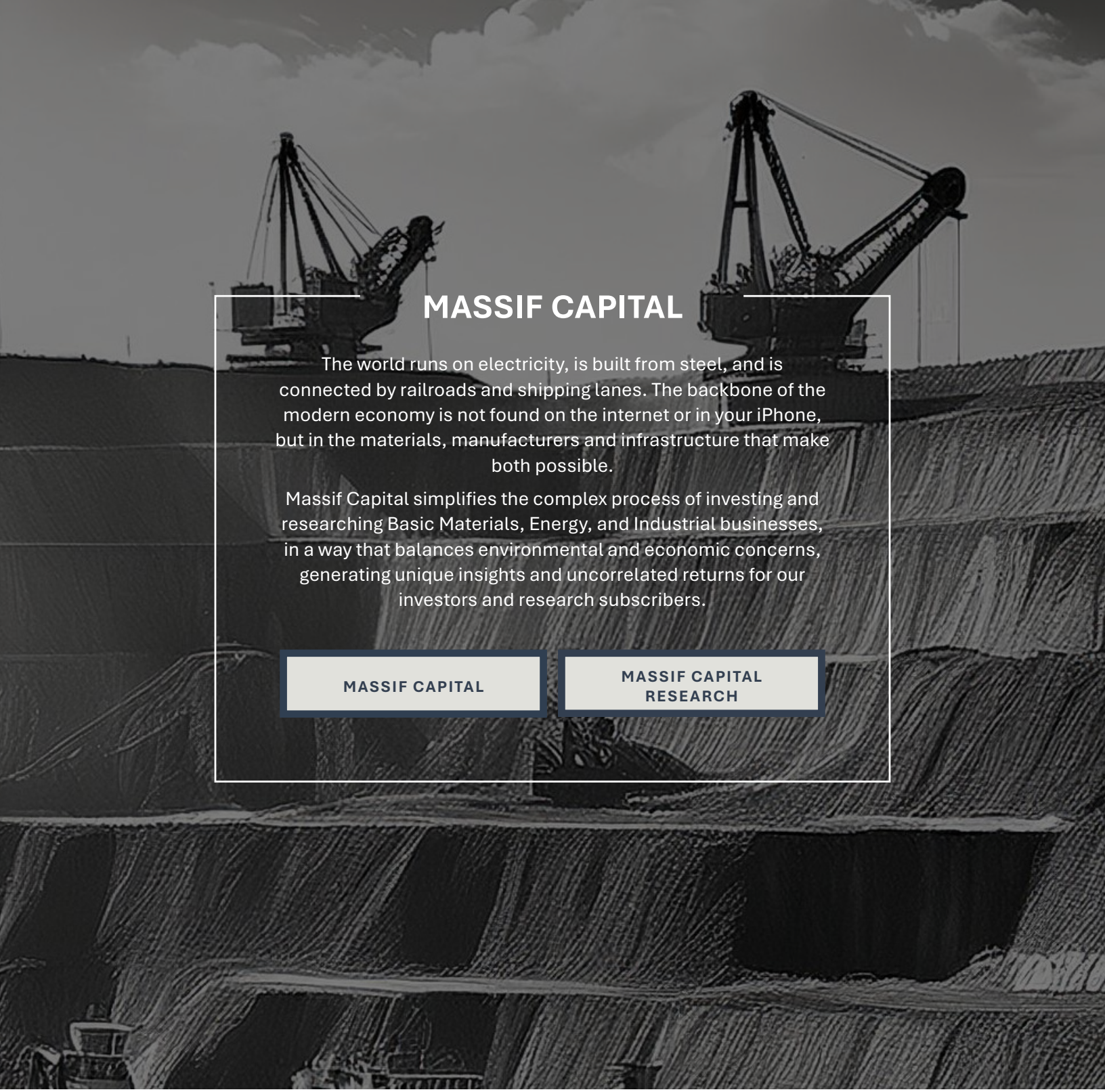

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