

Public Disclosure Authorized

# Repositioning Zambia to Leverage Energy Transition Minerals for Economic Transformation

## A Roadmap

### *Executive Summary*

April 2025



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## ABBREVIATIONS AND ACRONYMS

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AfCFTA	African Continental Free Trade Area
AGOA	African Growth and Opportunity Act
CBAM	carbon border adjustment mechanisms
CEC	Copperbelt Energy Corporation Plc.
CET	Common External Tariff
COMESA	Common Market for Eastern and Southern Africa
DRC	Democratic Republic of Congo
EAPP	East-African Power Pool
ETM	energy transition minerals
IRP	Integrated Resource Plan
MRC	Minerals Regulation Commission
mtpa	million tons per annum
MW	megawatt
RISE	Resilient Inclusive Supply Chain Enhancement
SADC	Southern African Development Community
SAPP	Southern African Power Pool
SEZ	special economic zone
TAZARA	Tanzania-Zambia Railway Authority
TEVET	technical education, vocational, and entrepreneurship training
TEVETA	Technical Education, Vocational and Entrepreneurship Training Authority
ZCCM-IH	ZCCM Investment Holdings
ZDA	Zambia Development Agency
ZEMA	Zambia Environmental Management Agency
ZESCO	Zambia Electricity Supply Corporation Limited
ZQF	Zambia Qualifications Framework
ZRL	Zambia Railways Limited

*All dollar amounts are US dollar, unless otherwise indicated, and all tons are metric tons.*

## EXECUTIVE SUMMARY

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**Zambia aspires to be a prosperous middle-income nation by 2030.** To that end, the Government of the Republic of Zambia (GRZ) set out an aggressive economic diversification and industrialization agenda, driven by the agriculture, mining, manufacturing, and tourism sectors. In the mining sector, the GRZ recognizes that the global energy transition creates opportunities to leverage Zambia's energy transition minerals (ETM)<sup>1</sup> to transform its economy in an inclusive and sustainable manner. Its ambitious targets for mining include:

- Scaling the *production and processing of ETM*, including tripling copper production within a decade, from about 800,000 tons in 2021 to 3 million tons per year (mtpa) by 2031
- Increasing the availability of *geological data* by mapping the whole country
- *Maximizing benefits* for Zambia and expanding Zambian participation in the entire ETM value chain, including through value addition.

**Achieving these ambitious goals requires a comprehensive set of actions**, from identifying mineral resources to accelerating their development; ensuring reliable, cost-competitive, and clean power supply, transport, and logistics services; upskilling the workforce; and strengthening the agencies that monitor environmental and social risks. To maximize benefits for Zambians and share these benefits fairly, Zambia needs to improve revenue capture and management; employment; support for small and medium enterprises (SMEs), including capacity building and access to finance and markets; and community development programs. Only some of the determinants of success are within government control, such as creating a stable, competitive investment climate to attract credible investors; aligning limited public resources to leverage private capital at scale; enforcing the country's social, labor, and environmental laws; and well-functioning public financial management. External factors, like copper prices and investor perceptions, also influence the outcomes.

**Given the importance the government attaches to its vision for mining and the complex set of actions needed** to achieve it, the GRZ requested support from the World Bank Group to jointly prepare a practical roadmap to realize this vision. The World Bank Group mobilized a multidisciplinary team to work with Zambian counterparts to prepare this roadmap, which includes the following chapters:

1. Scaling the production of ETM
2. Maximizing the capture, management, and sharing of benefits
3. Expanding infrastructure and the skilled workforce
4. Addressing social and environmental risks and enhancing sustainability
5. Putting it all together: operationalizing the roadmap.

### 1. Scaling production of ETM

**Although Zambia celebrated 100 years of mining in 2024, mining's contribution to the economy and development has long been suboptimal.** For example, Zambia and Chile produced similar levels of copper in the 1960s and 1970s, but the positions of the two countries are very different today. In 2024 Chile produced 5.5 million tons of copper and Zambia only 700,000 tons. Chile's economy is over 13 times larger

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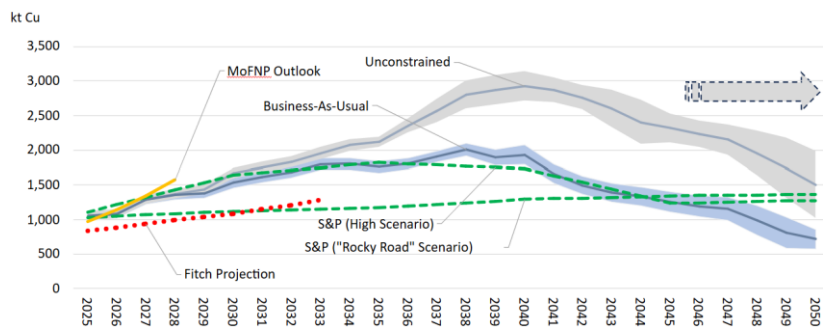
<sup>1</sup> ETM include minerals such as lithium, copper, manganese, graphite, cobalt, nickel, and rare earth elements.

than that of Zambia, and social disparities—measured by indicators such as poverty, infant mortality, and access to basic services—are vast.

**The GRZ is committed to changing this trajectory by scaling the production of ETM and maximizing the benefits for Zambia.** To scale production, it needs to: (a) increase both production and production sources by better understanding the resource base (improve the availability of geological data, review stranded assets, assess the potential for mine waste retreatment, and maximize the recovery of byproducts), and (b) improve the investment climate to attract credible investors to ensure sustainable production at scale.

**The World Bank modeled copper production in Zambia up to 2050 to quantify its potential and the degree to which infrastructure or skills availability could become a constraint.** Two scenarios, the *business-as-usual* and the *unconstrained* case, were considered (Figure E.1).<sup>2</sup> The projections include estimates from various production sources: (a) existing mines as announced or committed to by investors, including extensions of these mines (if economic), based on public information on the remaining undepleted resources; (b) preproduction properties, which include assets at the exploration stages and for which no formal commitment to move to production yet exists; (c) artisanal and small-scale mining (ASM) projections, based on figures from the Ministry of Mines and Minerals Development (MMMD); (d) minerals remaining in mine wastes, including tailings dumps and slag heaps; and (e) undiscovered potential mineral resources (based on the work of the United States Geological Survey<sup>3</sup>) and an “undiscovered plus” category included only in the *unconstrained* case to reflect the limits of the current knowledge of the mineral inventory.<sup>4</sup> Figure E.2 shows the contributions of each production source under these two scenarios.

**Figure E.1. Comparison of Zambia copper production forecasts**



Source: World Bank calculations, Government of Zambia projections, S&P Capital IQ, Fitch ratings.

Note: Confidence intervals represent two standard deviations around mean from Monte Carlo simulations. MoFNP = Ministry of Finance and National Planning.

**The GRZ target of producing 3 mtpa of copper is a driving ambition, already reflected in significant investment plans. However, it is recognized that there are risks to reaching this target by 2031.** The World Bank’s estimates suggest another decade would be needed, provided the necessary conditions are

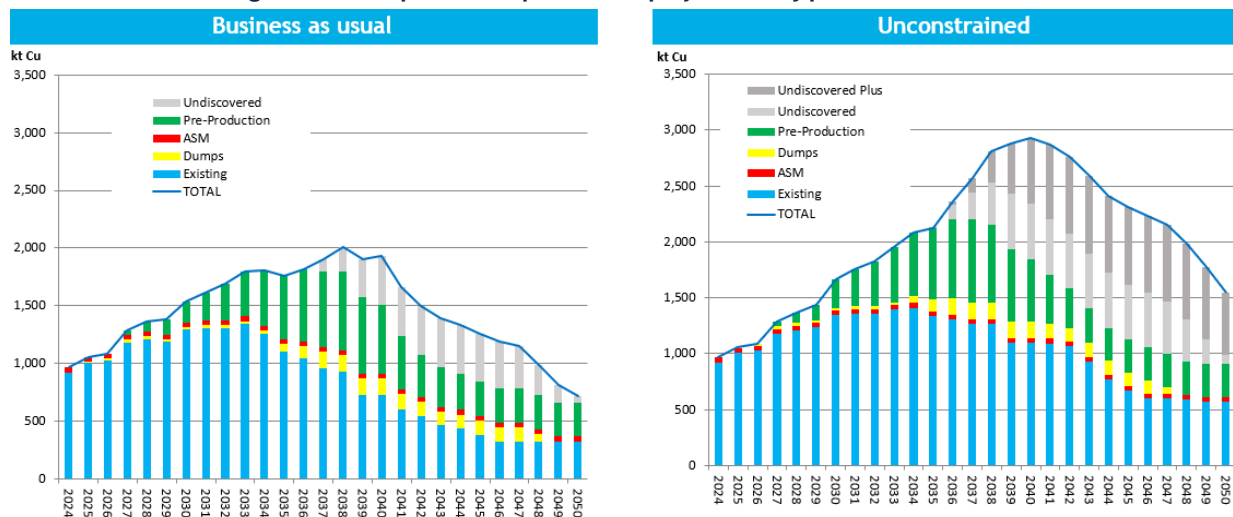
<sup>2</sup> Differences between the scenarios lie in the assumptions on improvements in the investment climate, energy and transport infrastructure, and mine productivity (through innovation).

<sup>3</sup> In 2014 the United States Geological Survey estimated that there remained as much undiscovered mineral potential in the Central African Copperbelt as had been discovered. The World Bank engaged the authors to produce a grade-tonnage curve of the undiscovered mineral potential to allow it to model portions that could be economic, given the cost structure of Zambian mines (Zientek and others 2014).

<sup>4</sup> Stranded assets and mine dumps are good potential sources of production. A deposit may have been stranded for various reasons (infrastructure, technology, and market conditions), and a change in any of these could provide an opportunity to revisit the asset. Moreover, very few mining areas have been closed and rehabilitated, offering opportunities for retreatment mine waste. Retreatment and final disposal and rehabilitation of mine waste may also yield environmental benefits.

in place. The main reasons for the difference in ramping up production between the World Bank’s own projections and those of the GRZ are assumptions on the timelines to develop mines and the degree to which technological innovation and better information from GRZ’s nationwide geological campaign can shorten these.<sup>5</sup> The World Bank’s projections until about 2040 are consistent with those of S&P Mining Intelligence and Fitch. They differ from third-party estimates in the 2040s, as the latter did not consider new sources of production. In the *unconstrained* scenario (Figure E.2), preproduction and undiscovered sources comprise a larger share of production to meet the GRZ target.

Figure E.2. Composition of production projections by production source



Source: World Bank analysis. Note: ASM = artisanal and small-scale mining.

**Given the long lead time to develop mines, the GRZ needs to make decisions now to realize opportunities from those sources.**<sup>6</sup> It can: (a) clean up noncompliant licenses in the cadaster and make them available to the private sector; (b) stabilize the regulatory framework to improve the investment climate; (c) improve the availability of high-resolution geological information; (d) ensure efficient, effective, and inclusive permitting and licensing; (e) avoid lengthy negotiations with the private sector over state equity participation and/or a production share; and (f) ensure a reliable and cost-effective electricity supply.

**For preproduction properties on which exploration and development data are available, significant additional production would start from the mid-2030s.** This timeline assumes a typical (albeit optimistic) horizon to initial production from the current development stage. Based on the latest reserve and resource estimates for these properties, these mines could produce about 700,000 tons per year. However, as they come online after the peak of 1.4 mtpa, the overall tonnage does not increase; rather, the peak is sustained for longer in the business-as-usual case. The ramp-up is sustained in the unconstrained case, as current mines are extended, more greenfield mines come online, and

<sup>5</sup> The World Bank projections optimistically assumed that it would take 11–12 years to bring a mine into production from first discovery. The Luongo Manganese Open Pit Mine in Chipili in Luapula Province took 12 years from exploration to reach first production. On the other hand, the government projections assumed a period of about 5–6 years, which generally only applies to deposits already in the prefeasibility study stage.

<sup>6</sup> Not all conditions are within the GRZ’s control. Important factors beyond its control include: (a) the price of copper; (b) the grades and recoveries of the different mines; and (c) changes in investor risk perception of *other* copper investment destinations.

undiscovered deposits come online sooner. The peak in this scenario is about 3 mtpa by about 2040, with a possibly significant drop-off after that peak if new mines do not come online to replace those that close.<sup>7</sup>

**Zambia’s mineral potential is yet to be well researched, and better, publicly disseminated analysis of its mineral resources is a precondition for attracting investment.** The GRZ commissioned an initiative to digitize the available data (supported by artificial intelligence tools), along with a nationwide geological campaign with a budget of \$70–90 million (financed by the GRZ). The geological campaign was due to be completed within two years, but budget constraints make this unlikely.<sup>8</sup> To fully leverage the new data to attract investment, the GRZ needs to define its investment promotion strategy now. Competitive and transparent processes are likely to yield better terms for the GRZ. A model agreement should be defined, with predefined biddable terms, and weightings should be drawn up even before the geodata have been collected. This preparatory work, ideally with the support of external technical, financial, and legal advisors, will help avoid unnecessary delays.

**Another precondition is creating an enabling environment characterized by strong governance, stability, and predictability.**<sup>9</sup> To improve mining governance, the GRZ is amending the 2015 Mines and Minerals Act and modernizing the mining cadaster. Further considerations for reform include:

- *Mining cadaster reform:* A robust mining cadaster is crucial for effectively managing mineral resources. By streamlining the application and licensing processes, it can accelerate investment and promote fair and transparent access to resources. An accurate cadaster also allows the government to monitor compliance with licensing terms, track revenue, and ensure that operators meet work programs and reporting obligations. Full digitalization of the cadaster is needed, including detailed mapping of workflows, with additional steps such as risk profiling and due diligence on license applicants.
- *Operationalizing the Minerals Regulation Commission (MRC):* The recently approved MRC Act preserves many aspects of the 2015 Mines and Minerals Act, but its main objective is creating a semi-autonomous mining sector regulator.<sup>10</sup> Independent regulators promote good governance and help attract investment by ensuring transparency and consistency in the application of regulations. The MRC should be operationalized with clearly defined roles and responsibilities that do not overlap those of agencies such as the Mining Safety Department (MSD) at the MMMD, the Zambia Environmental Management Authority (ZEMA), and the Zambia Revenue Authority (ZRA). Its independence should also be ensured. Furthermore, independent legal experts should be engaged to prepare detailed regulations to close any gaps and address any uncertainties in the Act.
- *The 2024 Geological and Minerals Development Bill* establishes a framework for managing mineral resources. It authorizes the GRZ to undertake geological surveys and map mineral resources; promotes sustainable ASM development through regulation, technical support, and capacity building; and sets local content requirements.

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<sup>7</sup> The unconstrained scenario shows production dropping significantly from about 2046. This is a limitation of the model, which uses existing information. More resources are likely to be identified in future, which could help sustain production.

<sup>8</sup> The World Bank also anticipates logistical challenges because of safety limitations on the density of planes that can be flown over a given area (using a single airport as a base) and inclement weather.

<sup>9</sup> Zambia has averaged one tax change every 18 months since 2001, when major privatizations were concluded.

<sup>10</sup> Although the MRC Act has been assented to by the President, it will not come into force until a Special Instrument is adopted. The Minister of Mines expects this to take place in 2025.

- *Reform and professionalize state-owned enterprises (SOEs) in the sector:* Mining SOEs often aim to give governments a direct stake in national mineral wealth, potentially allowing them to capture more value from mining and increase revenue from mineral exports. However, SOEs are seldom as efficient as private companies because of underfunding, political interference, or a lack of technical expertise. This ultimately reduces the benefits to the state. Zambia’s experience with its state-owned mining holding company, Zambia Consolidated Copper Mines Investment Holdings (ZCCM-IH), has been similar.
- *Government “free” equity and production sharing:* Although state participation in mining is common (Box E.1), Zambia’s legal framework does not clearly set out the role of the state in mining, and its current role seems inconsistent with the broader policy of attracting investment. Production sharing as envisaged by the GRZ could deter investors, and it should rather focus on state equity, potentially with an option to purchase copper at market prices (initially from ASM production).
- *Local content regulations* need a practical approach with clear targets and enforcement mechanisms to stimulate local participation in mining value chains. But the regulations on their own will not address the challenges SMEs face, and complementary initiatives are required. These include capacity building and access to competitive financing for local SMEs to invest in infrastructure and technology. Financial institutions and government programs can provide favorable loan terms and grants. Incentives such as tax breaks, subsidies, and technical assistance can help SMEs become more competitive. Trade policies that promote fair competition and avoid local suppliers being unfairly undercut by cheaper imports are also important. Targeted support measures are needed to foster the competitiveness of local products in special economic zones (SEZs). The draft 2024 local content regulations have some limitations: the monitoring, reporting, and enforcement mechanism is weak, and the local procurement quota is not informed by analytics. Zambia could draw on international good practices as it finalizes these regulations (Box E.2).

#### Box E.1. State participation in mining

Globally, state participation in mining is common. There are three main types:

- *Free equity*, where the state receives an ownership interest at no cost to itself. It is also not obligated to contribute to the costs of the project but receives dividends or a share of profits. This type is common in Sub-Saharan Africa through a small share of equity, as a form of withholding tax on dividends and board participation.
- *Full participation*, where the state purchases equity and contributes to exploration and development costs in proportion to its shareholding, in return for a share of profits or dividends.
- *Free carried interest*, where the initial purchase of the shares by the state is carried by the private investor and repaid by the state from its share of future profits or dividends.

In Sweden and Finland, state ownership is used strategically to boost innovation and secure access to ETM. In Japan, state ownership aimed to secure a stable supply of minerals for industry. The state has also a stake in mining in Chile (28 percent), China, and Vietnam. In Africa, since the high metal prices of the 2010s, some countries have passed legislation to increase state participation, mainly by free carry access for the government in all mining ventures.

Sources: World Bank, drawing on GIZ (2023), US ITA (2023).



## Box E.2. Examples of local content regulations

Countries like Norway, Brazil, Ghana, and Botswana have implemented effective local content requirements that balance the needs of the industry with national development goals.

- In *Norway* the government established clear guidelines and requirements for local content, coupled with strong support for local businesses through education and training, research and development, and infrastructure.
- *Brazil* has used local content policies to develop a robust local supply chain in its oil and gas sector, ensuring that a significant share of the value created by the industry remains within the country.
- In *Ghana* the government identified 28 items to be manufactured locally. As this was deemed too ambitious, they started with 8 items, which eventually grew to 17. Today more than 50 items are produced locally.
- *Botswana's* local content approach includes both *supply-side* supplier development programs and *demand-side* preferential treatment requirements to the “extent possible” given safety, quality, and economic considerations.

These countries show that with the right mix of policies, support mechanisms, and a focus on building local capabilities, substantial local content can be achieved without compromising mining competitiveness and growth.

Sources: World Bank review.

**Table E.1 summarizes key challenges and actions and proposes a lead agency or agencies to operationalize the recommendations to meet the GRZ’s ambitious 3 mtpa target.**

**Table E.1. Scaling up ETM production: Key challenges, recommendations, and responsible agencies**

Key challenges	Recommendations (short and medium term)	Responsible agency
Mining governance is poorly defined, overlapping, and slow, and enforcement is weak. Onerous and ineffective local content regulations undermine investment at scale.	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Operationalize the Minerals Regulation Commission (MRC) (develop regulations; clear roles and responsibilities; staffing and systems; financial, legal, and operational autonomy; transparency and accountability; board operations and composition).</li> <li>• <i>Short term</i>: Finalize and operationalize the Geological and Minerals Development Bill (with regulations, including appropriate local content regulations).<sup>a</sup></li> <li>• <i>Short term</i>: Clarify roles and responsibilities and ensure coordination among key policy and regulatory agencies, as well as with communities and local governments (licenses and permits, for example).</li> <li>• <i>Short term</i>: Provide comprehensive support to artisanal and small mines (ASM), including formalization and capacity building, improving safety and environmental compliance, and facilitating access to finance and market.</li> </ul>	MoFNP and MMMD co-lead MRC execution MRC, MSD, ZEMA MSMED, MMMD
Limited geological data delay investment in the sector.	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Complete ongoing digitalization of existing geological data, including reinterpreting data using latest technologies (such as artificial intelligence); accelerate ongoing national geological campaign (with adequate budget and quality control to confirm government expectations will be met); and make them freely available online.</li> <li>• <i>Medium term</i>: Review potential of stranded assets and mine waste retreatment for development.</li> </ul>	MMMD
Mining cadaster is poorly managed, and many licenses are not compliant.	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Fully digitalize mining cadaster (map and codify workflows, online interface, online payments) and clean up noncompliant licenses for investment.</li> <li>• <i>Medium term</i>: Link mining cadaster with land and forestry cadasters to facilitate joint enforcement of relevant regulations.</li> </ul>	MMMD (MLNR)

Key challenges	Recommendations (short and medium term)	Responsible agency
Weak state-owned enterprises (SOEs) undermine ETM benefits and crowd out competition.	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Require the ZCCM-IH to publish mine-by-mine financial statements and performance assessments and the IDC to do the same for each subsidiary.</li> <li>• <i>Medium term</i>: Enact SOE law covering IDC activities or a specific ZCCM-IH law to define mandates, board and management activities, performance targets, approval thresholds, dividends, oversight, and transparency.</li> <li>• <i>Medium term</i>: Encourage the ZCCM-IH to co-invest with Zambian nationals to pursue project development, while disposing of its non-mining assets.</li> </ul>	MoFNP (ZCCM-IH, IDC)

Source: World Bank analysis.

Note: ETM = energy transition minerals; IDC = Industrial Development Corporation; MCTI = Ministry of Commerce, Trade and Industry; MLNR = Ministry of Lands and Natural Resources; MMMD = Ministry of Mines and Minerals Development; MoFNP = Ministry of Finance and National Planning; MSMDE = Ministry of Small and Medium Enterprises Development; ZCCM-IH = Zambia Consolidated Copper Mines Investment Holdings; ZEMA = Zambia Environmental Management Authority.

a. See Table E.2.

## 2. Maximizing capture, management, and sharing of benefits

**The GRZ has ambitious plans to maximize its share of benefits from the nation’s ETM endowments.** It has articulated several avenues for achieving this objective, including scaling up production and undertaking value addition locally, promoting the progressivity of its mining fiscal regime to capture more taxes and royalties, supporting Zambians to participate in mining as owners, formalizing and supporting ASM, and proper utilization of mining revenues to promote inclusive economic growth, job creation, and poverty eradication.

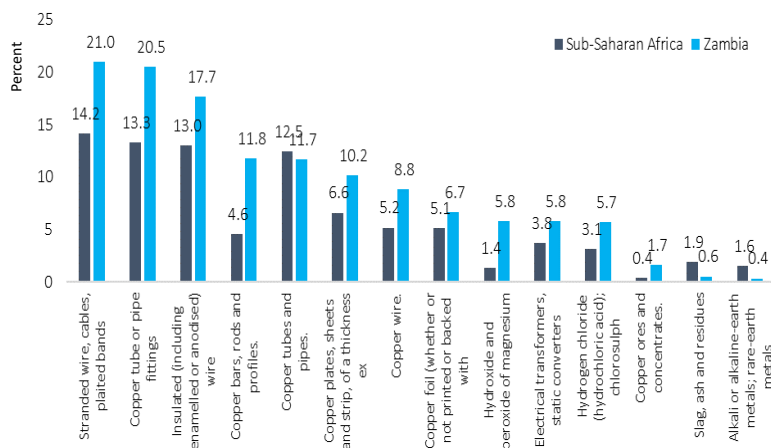
**Zambia has significant comparative advantages for value addition in mining,** including prospects to ramp up ETM production, established links with global markets, proximity to regional export and input markets—South Africa and the Democratic Republic of Congo (DRC)—and opportunities to leverage regional and global trade and investment agreements. Under an infrastructure investment and reform scenario, the country could potentially grow its export revenues six- to tenfold over the next decade.

**Zambia could potentially increase its share of growing regional ETM markets.** Its exports of copper wire and cable have declined steadily since 2012, as the economic slowdown in Southern Africa reduced demand. It also failed to take advantage of growing import demand in its main destination markets (which averaged 213 percent in 2012–23). Instead, it lost ground to imports from the United Arab Emirates and Russia, which accounted for 70 percent of wire and cable imports into South Africa in 2022. In the short run, Zambia can increase its share of the regional market for copper rods, wire, and cables, as well as more sophisticated products such as green wires; medium-, high-, and extra-high-voltage wires; transformers; electric panels; and rewinding motor products. Medium- to longer-term opportunities exist in the component manufacturing stage of batteries, solar panels, and e-motorcycles for the regional market.

**Critical policy reforms and infrastructure investments are needed to enhance competitiveness.** These include: (a) ensuring reliable access to copper through a reference price benchmark; (b) better leveraging Zambia’s participation in regional economic communities to establish a common tariff strategy for ETM goods; (c) implementing a targeted investment strategy for ETM-related businesses in value addition; (d) upgrading the legal and regulatory framework for special economic zones (SEZs) to increase private investment in infrastructure and provide a more competitive business environment, and (e) enabling access to competitive financing through innovative instruments, including equity and blended finance.

**Trade policy reforms can enhance the competitiveness of local firms.** Tariff barriers to imports of ETM value-added products are above the average for Sub-Saharan Africa (Figure E.3). Although such tariffs reduce local producers' exposure to international competition, they are ineffective, as businesses import from South Africa, China, and India. Policy changes to enhance competitiveness could include: (a) progressively reducing the protections for intermediate or final ETM-based goods to reduce the cost of imported inputs; (b) addressing any regulatory bottlenecks, such as overlapping regulations, the role of the border agencies, and various nontariff measures; and (c) negotiating a strategic tariff structure within the Common External Tariff (CET) of the Common Market for Eastern and Southern Africa (COMESA).

**Figure E.3. Average tariffs on ETM products, Zambia and Sub-Saharan Africa**



Source: World Bank staff, based on the Zambia Trade Summary 2022 (database), WITS (World Integrated Trade Solution), Washington, DC. <https://wits.worldbank.org/CountryProfile/en/Country/ZMB/Year/LTST/Summarytext>

**Targeted investment policy reforms can attract new private investment in value addition.** The GRZ could: (a) strengthen the capacity of the Zambia Development Agency (ZDA) to design and implement a targeted investment promotion and facilitation program for the ETM value chain; (b) address gaps in the regulatory regime, especially investor protection and dispute settlement mechanisms; (c) promote access to competitively priced ETM inputs for domestic firms; (d) effectively implement local content policies to facilitate scaling of supplier development programs; (e) implement programs under the National Financial Inclusion Strategy to improve SME access to finance; (f) develop Zambian junior mining exploration firms through capacity building, complementary capital market initiatives, and a set of incentives; and (g) improve the attractiveness of SEZs for new ETM investment by facilitating private investment in infrastructure, better service delivery, and a more competitive business environment in SEZs.

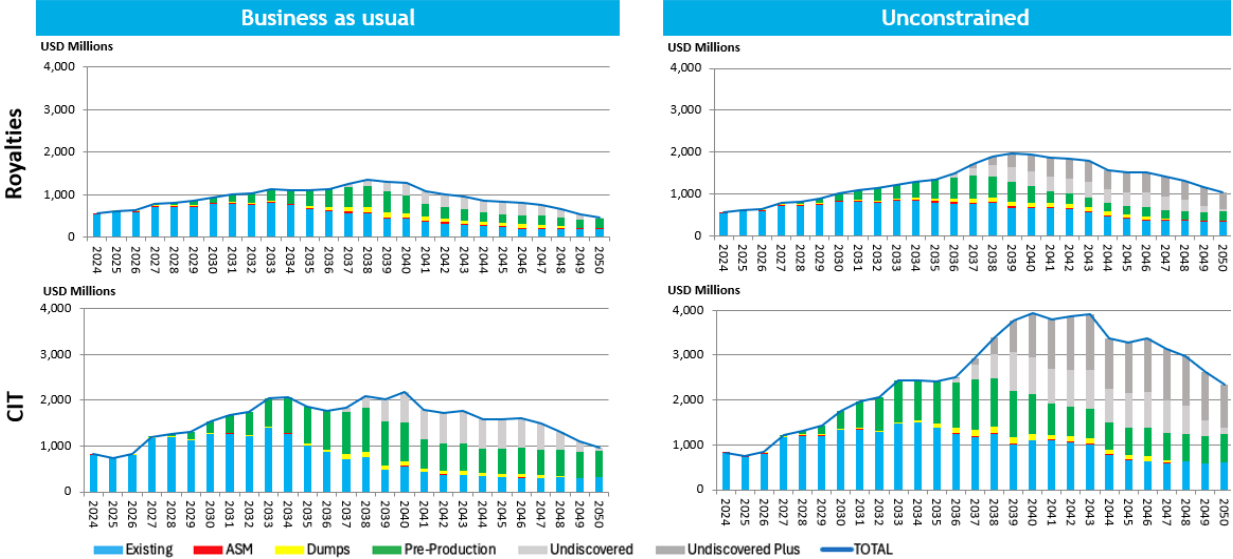
**Zambia is well positioned to leverage regional and global partnerships to develop the ETM value chain.** Partnership agreements such as those with the DRC and the United States could potentially be leveraged to attract new foreign direct investment (FDI) if translated into more concrete action plans for the various parties. Similarly, there are opportunities to strengthen regional collaboration on ETM production and value addition through trade and investment agreements, such as the Southern African Development Community (SADC) Free Trade Area,<sup>11</sup> the African Continental Free Trade Area (AfCFTA), and the African

<sup>11</sup> Efforts within SADC have so far enabled some simplification of customs procedures and the consolidation of the SADC Free Trade Area, but priority areas such as shared infrastructure, harmonizing mining- and beneficiation-related policy frameworks, and sharing technological and knowledge resources remain underdeveloped. Achieving deeper regional integration will require member states to make challenging trade-offs given the wide differences in their economies in terms of structure, resources, size, and political approaches to a regional policy, making the benefits of regional beneficiation projects to countries unequal. A unified framework to guide collaborative strategies, manage benefit sharing among countries, and support coordinated negotiations with foreign partners for regional beneficiation-related activities is important. The framework must provide clear guidelines on the equitable distribution of benefits from potential projects, outline roadmaps for technology and knowledge sharing, and set strategies for cross-border labor mobility and skills development.

Growth Opportunity Act (AGOA), as well as with the European Union, Gulf Cooperation Council (GCC) states, and Asian countries. The ongoing AGOA reauthorization process creates the potential for a regional effort to include ETM-specific investments that mirror those under existing Critical Minerals Agreements between the United States and countries such as Japan and Morocco.

**The projected growth in the production and processing of ETM could bring significantly higher revenues for the state (Figure E.4).** In the *business-as-usual case*, royalties are projected to increase from about \$600 million in 2024 to about \$1.3 billion by 2040 and corporate income tax from about \$800 million to about \$2.1 billion. In the *unconstrained case*, royalties and corporate income tax increase from the same starting base to peak at about \$2.0 billion and \$4.0 billion respectively in the mid-2040s.

**Figure E.4. Fiscal contribution of Zambian copper mining, 2024 to 2050**



Source: World Bank projections. Note: ASM = artisanal and small-scale mining; CIT = corporate income tax.

**Although Zambia has invested heavily in building its tax administration capacity, growing ETM revenues will pose new challenges.** It should build additional capacity, focusing on auditing, laboratories to confirm the metal content of production and exports, systems integration and better tracking and information at border crossings, and interministerial coordination. Once established, the MRC will play an important role. It should be adequately capacitated to work with the ZRA and relevant agencies, such as customs, to minimize revenue leakages. Furthermore, a more progressive fiscal regime could enable the government to capture more revenues from highly profitable mines and reduce the burden on marginal operations. Options for a progressive tax system include extending the sliding scale royalty framework for gold and manganese. In the medium term, the GRZ could consider (with industry engagement) moving from the ad valorem royalty to a profit-based formula, as used in South Africa.

**ETM revenue management, allocation, and utilization should be strengthened.** The GRZ should continue with the implementation of a stabilization fund, along with budget rules for deposits and withdrawals from the fund to support public financial management in the face of cyclical revenues. Concerns around revenue leakage and a lack of clarity on revenue sharing between the central and local authorities could be addressed through better monitoring and enforcement of mineral origin certification requirements, better information sharing among relevant agencies, stronger processes for reporting revenues, a robust

and specialized audit framework, and stronger oversight by the Office of the Auditor General and Parliament. Also important are sector-specific fiscal transfers for districts that host mining activities and improved intergovernmental fiscal architecture transfers to manage mining-related risks faced by local communities. Currently, the output-based national budget is not well costed in terms of the efficiency and effectiveness of spending, and linking the budget to outcomes will better inform the allocation of funds among the regulatory, policy setting, and operations functions. Table E.2 summarizes the key challenges and recommendations for maximizing ETM benefits.

**Table E.2. Capturing ETM benefits and management: Key challenges, recommendations, and responsible agencies**

Key challenges	Recommendations (short, medium, and long term)	Responsible agency
Zambia receives inadequate benefits from its ETM resources, and the participation of Zambian firms in the ETM value chain is insufficient.	<i>Short, medium, and long term:</i> Enhance the stability, transparency, and progressivity of the fiscal regime, and reduce revenue leakages. <sup>a</sup> Ensuring the stability and transparency of fiscal regime is an immediate action and progressivity a medium- to long-term action.	MoFNP, ZRA
	<i>Short to medium term:</i> Strengthen investment and trade policies and the institutional and regulatory arrangements for a more competitive investment climate, including designating the ZDA as a lead agency responsible for ETM investment promotion and facilitation, establishing a policy on stable domestic access to refined copper at competitive prices, strengthening regional collaboration to eliminate tariffs on inputs for ETM processing <sup>b</sup> and developing a clear industrial strategy to attract FDI in value addition.	MCTI, MMMD
	<i>Short to medium term:</i> Translate existing multilateral and bilateral MoUs into credible plans with clear and timebound actions to be monitored and enforced at the highest level of government.	PDU
	<i>Short to medium term:</i> Increase participation of Zambian firms by expanding access to finance and implementing effective local content regulations <sup>c</sup> that facilitate impactful supplier development programs and allow participation of junior miners. <sup>d</sup>	Bank of Zambia, MSMED
	<i>Short to medium term:</i> Enhance Zambian benefits from ETM through comprehensive support for ASM (including formalization, capacity building, and access to finance and markets) and adopting a model community development agreement, learning from good international practices such as the Royal Bafokeng Nation Development Trust in South Africa. <sup>e</sup>	MMMD, MSMED, MLGRD
	<i>Medium to long term:</i> Improve public financial management and procurement by strengthening institutional capacity for oversight and operationalizing the stabilization fund.	OAG

Source: World Bank analysis.

Note: ASM = artisanal and small-scale mining; ETM = energy transition minerals; FDI = foreign direct investment; MCTI = Ministry of Commerce, Trade and Industry; MLGRD = Ministry of Local Government and Rural Development; MMMD = Ministry of Mines and Minerals Development; MoFNP = Ministry of Finance and National Planning; MoU = memorandum of understanding; MSMED = Ministry of Small and Medium Enterprises Development; OAG = Office of the Auditor General; PDU = Presidential Delivery Unit; ZDA = Zambia Development Agency; ZRA = Zambia Revenue Authority.

a. For example, by strengthening monitoring and enforcement at border crossings and airports, as well as coordination among various control agents (police, customs, the ZRA, and the Bureau of Standards) using technology and an interagency information-sharing protocol. b. Within the Common External Tariff of the Common Market for Eastern and Southern Africa (COMESA). c. The current draft of the local content regulations requires significant revisions based on international good practice lessons and analytics, along with an inclusive consultation process with key stakeholders. d. The Musompo Trading Centre in Kolwezi in the Democratic Republic of Congo is a good example of supporting ASM by providing a trading platform to access competitive market for their products. e. <https://www.bafokengholdings.com/home/about-rbh>.

**The ASM sector significantly contributes to the economy by providing employment and livelihoods for many communities, but it faces critical challenges, including informality, limited financing, inadequate technology, and weak regulatory support.** These challenges result in unsafe practices, environmental degradation, and lower productivity, with fatalities in mining accidents rising from 19 in 2023 to 31 in 2024, largely because of illegal mining operations. In response, the government launched reforms to

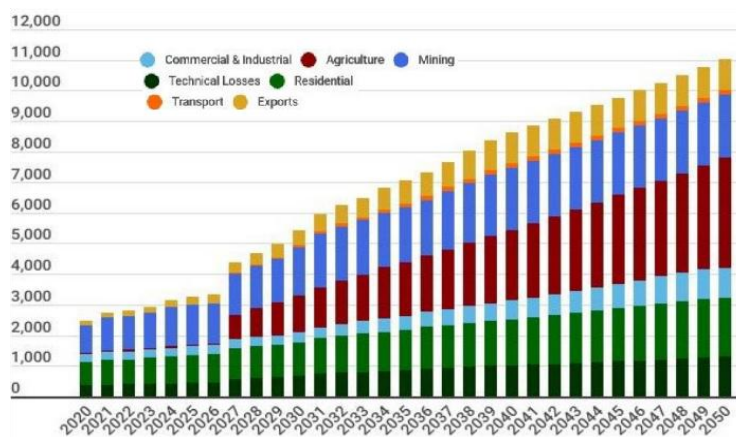
formalize ASM and integrate it into the broader mining strategy. Key initiatives include the establishment of the MRC to strengthen regulation and revenue collection, the proposed Geological and Minerals Development Bill to create an ASM fund to provide financial support, and initiatives to support the formalization of artisanal gold mining through Zambia Gold Company Limited, which acts as a gold aggregator to ensure fair pricing and curb illegal trade. Likewise in copper trading, the government is partnering with Mercuria to establish a metals trading unit under a special purpose vehicle.<sup>12</sup> It could also explore the possibility of acting as aggregator for artisanal copper production, provide incentives for ASM formalization, root out illegal mining, and improve the performance of micro-smelters. Adopting an incremental strategy that starts with ASM would limit the financial risks to the government.

### 3. Expanding infrastructure and the skilled workforce

**Inadequate infrastructure (energy, transport, and logistics) and skills are among the main challenges limiting Zambia’s potential to scale up ETM production and processing.** For example, the latest Logistics

Performance Index (LPI) rating for Zambia was 2.53 out of 5, indicating the need for improvements in all the areas covered by the index: customs, infrastructure, international shipments, logistics competence, tracking and tracing, and timeliness.<sup>13</sup> High transport and logistics costs make Zambia less competitive, and the unreliable power supply hinders investment in ETM. The availability of skilled labor is both a challenge and an opportunity, as employment is one of the ways Zambians can benefit from the ETM value chain. The GRZ has undertaken various initiatives to alleviate these challenges.

Figure E.5. Peak electricity demand (MW) by sector, 2020 to 2050



Source: Zambia MoE 2023.

**The power sector is dominated by ZESCO, and heavy reliance on hydropower (83 percent) leaves it vulnerable to changeable weather.** The ongoing drought, which resulted in an energy deficit of about 1,300 MW, meant load-shedding of up to 20 hours per day. ZESCO’s dominance and its financial and operational challenges contribute to the inadequate power supply. The electrification rate is low, at about 47.8 percent, with large disparities between urban and rural areas. Total installed electricity generation capacity was 3,811 MW in 2023<sup>14</sup> and the peak demand was 2,500 MW.

<sup>12</sup> Although experienced in commodity trading, Mercuria has very limited experience in non-oil and gas trading, which heightens the financial risk for the GRZ. For more information see the Mercuria website at <https://mercuria.com>.

<sup>13</sup> Data in this section are from the Logistics Performance Index (LPI) (database), World Bank, Washington, DC, <https://lpi.worldbank.org/2018>.

<sup>14</sup> This was after the commissioning of the Kafue Gorge Lower Hydro Scheme (750 MW) and the Copperbelt Energy Corporation’s (CEC) solar photovoltaic power plant (33 MW).

**The GRZ has ambitious plans to create a diversified energy mix and a competitive market to ensure a secure and reliable power supply.** The latest Integrated Resource Plan (IRP)<sup>15</sup> projects a massive increase in energy demand—131 percent by 2030 and 349 percent by 2050 (Figure E.5). To meet this demand, equally massive investment is needed in electricity generation, transmission, and distribution: \$11.6 billion by 2030, \$21.53 billion by 2040, and \$30.97 billion by 2050. Significant mobilization of private investment would be required to meet these investment needs. This in turn calls for a truly competitive energy market. Accordingly, the GRZ launched the National Energy Compact for Zambia<sup>16</sup> to achieve universal energy access and the National Vision 2030, which includes tripling copper production. The Energy Compact proposes ambitious reforms (such as an open access policy, net metering, a cost-reflective tariff framework, a transparent and standardized transmission pricing system aligned with regional standards, strengthening the capacity of the Ministry of Energy for energy planning and procurement, and reforming ZESCO<sup>17</sup>) and investments in the energy sector.

**ZESCO cannot remain as a preferred single off-taker without a sovereign guarantee, which is not feasible in the current fiscal climate.** Reforming ZESCO will take time, and urgent solutions are needed to address the power emergency in the meantime. A different business model is required, which allows electricity producers and buyers to trade freely in an independently regulated market. In addition to the reforms highlighted above to promote power trading within Zambia, faster investment in transmission infrastructure, including in regional interconnectors, is critical to enable power trade with the Southern African Power Pool (SAPP) and the Eastern Africa Power Pool (EAPP).<sup>18</sup>

**The IRP’s ambitious plan for a reliable power supply is not aligned with the GRZ policy on mining, but Zambia’s National Energy Compact is aligned.** The IRP assumes the target of producing 3 mtpa of copper can be reached by 2040, whereas policies from the Presidency and the MMMD aim to reach it by 2031. As noted, the World Bank modeled the power demand of projected ETM production (Figure E.6).<sup>19</sup> Its energy projections under both the *business-as-usual* and the *unconstrained* scenarios are consistent with the IRP’s policy case (in which the target of 3 mtpa copper is reached in 2031) until the early 2030s, but they deviate from the IRP’s base case. After the mid-2030s, the World Bank projections under both scenarios are consistently higher than those of the IRP. They suggest that more rapid investment in energy generation and transmission infrastructure may be needed to support Zambia’s ambitious mining vision without limiting energy availability for other sectors. The key driver for energy demand after 2030s is the Mingomba mine, which is likely to be energy-intensive given the need for significant dewatering.

**The World Bank recommendations for the energy sector are consistent with those prioritized under the National Energy Compact (Table E.3).**

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<sup>15</sup> The IRP is a least-cost investment strategy for electricity generation, transmission, and distribution infrastructure that aims to ensure national energy sufficiency and surplus (Zambia, MoE 2024).

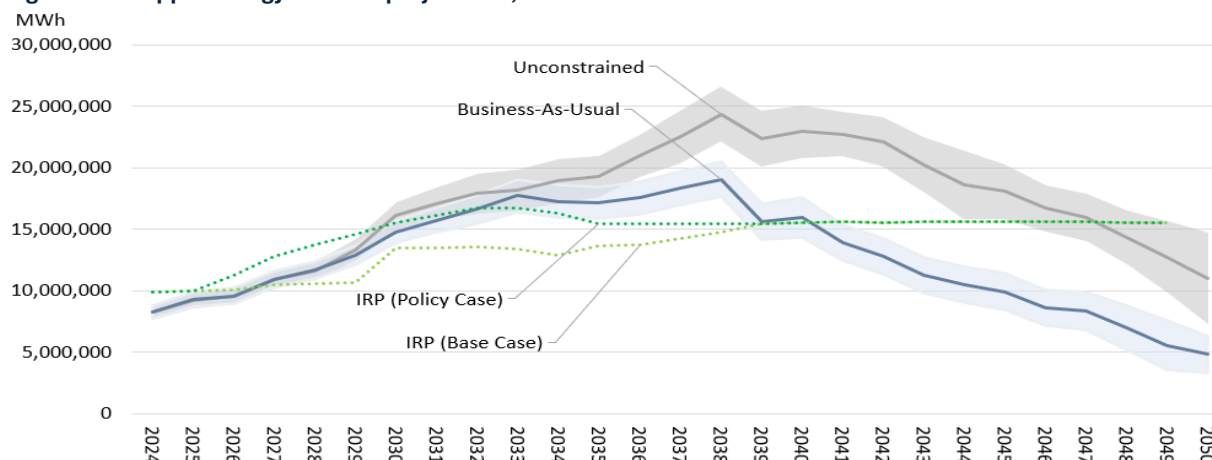
<sup>16</sup> Government of Zambia (2006; 2025).

<sup>17</sup> Unbundling ZESCO into production, transmission, and distribution; and improving its financial and operational efficiency.

<sup>18</sup> The IRP aims to increase transmission lines from 12,705 km in 2023 to 23,072 km by 2050 and the aggregated cross-border interconnection capacity from 2,090 MW in 2023 to 6,890 MW by 2050.

<sup>19</sup> The projections assume a constant energy mix but vary energy intensity based on detailed mine-level information and distinguishing between lower-intensity open pit mines and higher-intensity underground mines. Changes in the type of mine over time account for the declining trend in energy demand in the business-as-usual case, as the older, underground mines close without enough new, open pit mines being established to meet the growing energy demand.

**Figure E.6. Copper energy demand projections, 2024 to 2050**



Note: Confidence intervals represent two standard deviations around mean from Monte Carlo simulations

Source: World Bank projections. Note: IRP = Integrated Resource Plan.

**Table E.3. Energy: Key challenges, recommendations, and responsible agencies**

Key challenges	Recommendations (short and medium term)	Responsible agency
Energy policy is not aligned with GRZ policy on scaling mining and value addition.	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Align the Integrated Resource Plan (IRP) with the overall policy on mining value chain development and update it regularly to reflect new knowledge and technology.</li> <li>• <i>Short to medium term</i>: Strengthen MoE and ZESCO energy planning and procurement to implement the IRP and Energy Compact, including scaling up the share of independent power producers.</li> </ul>	MoE (ZESCO)
Power supply is inadequate and unreliable because of overdependence on hydropower, ZESCO’s monopoly and poor performance, and the lack of a cost-reflective tariff.	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Accelerate implementation of open access policy and net metering to promote power trading and scale up renewable (non-hydro) generation.</li> <li>• <i>Short term</i>: Implement a multiyear, cost-reflective tariff framework.</li> <li>• <i>Short to medium term</i>: Accelerate implementation of ongoing ZESCO reform (the 10-year Strategic Plan).</li> </ul>	MoE ERB ZESCO
Lack of transmission infrastructure and pricing system limit private investment and access to power from SAPP and EAPP.	<ul style="list-style-type: none"> <li>• <i>Short to medium term</i>: Develop a transparent, standardized transmission pricing system aligned with regional standards to allow buyers and sellers to trade freely.</li> <li>• <i>Short to medium term</i>: Invest (also through public-private partnerships) in key regional interconnectors to facilitate power trading with neighboring countries within the SAPP and EAPP framework.</li> </ul>	MoE ZESCO

Source: World Bank analysis. Note: EAPP = Eastern Africa Power Pool; ERB = Energy Regulation Board; MoE = Ministry of Energy; SAPP = Southern African Power Pool.

**Zambia relies heavily on key transport corridors for its imports and exports** (Figure E.7). The North-South and Dar es Salaam corridors account for over 65 percent of all traffic, and the total export volume from the DRC and Zambia is an estimated 3.5 million tons. The Dar es Salaam rail-road corridor is the busiest by traffic volume and the most important by freight value. It carries almost all of Zambia’s and about 40 percent of the DRC’s copper production, along with fuel imports and agricultural exports. The North-South Corridor, which extends from the DRC border to Livingstone, is a key route for imports, such as sulfur into Zambia and the DRC. Most traffic uses the road corridor, while the rail corridor underperforms.



The transport network and logistics services face various barriers and challenges, and unreliable and expensive freight movement undermines Zambia’s competitiveness:

- *Long stretches of road are in poor condition*, which contributes to low speeds, travel delays, and accidents. Poor road conditions along the Dar es Salaam, North-South, and Trans-Caprivi corridors result from poor maintenance, overloading, and more extreme weather events.
- *The institutional capacity of the rail sector is limited*. Zambia has one of the oldest railway systems in Africa, but its capacity and national and global competitiveness have not been maintained. Its operational efficiency, commercialization, and institutional arrangements need to be revitalized.

Figure E.7. Key corridors and the connecting ports



Source: World Bank 2024.

- *Insufficient funding hampers rehabilitation and maintenance efforts*. Despite initiatives such as the dedicated National Road Fund Agency (NRFA), toll collection, and higher levies, the available resources are still insufficient—the NRFA collects only 20 percent of the estimated resources required every year. In the rail sector, the operations and maintenance cost of the large railway system is high relative to the transported tonnage, resulting in operational deficits and losses. Years of underinvestment have undermined system capacity, and rail transport is now more expensive than road.
- *Asset management systems remain weak* despite efforts to improve the planning and prioritization of maintenance, implementation modalities, monitoring systems, and preventive approaches.
- *Key border facilitates and nodes are inefficient*, with police checkpoints, toll plazas, weighing stations, and border crossings causing long delays. Border clearance documentation and procedures are largely manual (beyond customs) and often duplicated, with little coordination among agencies.
- *Climate change poses a major risk to the transport network*. Heavy rainfall, floods, erosion, and extreme temperatures damage roads and rail and disrupt the movement of key supplies. They also increase the need for maintenance, rehabilitation, and the development of a rapid response capacity.<sup>20</sup>

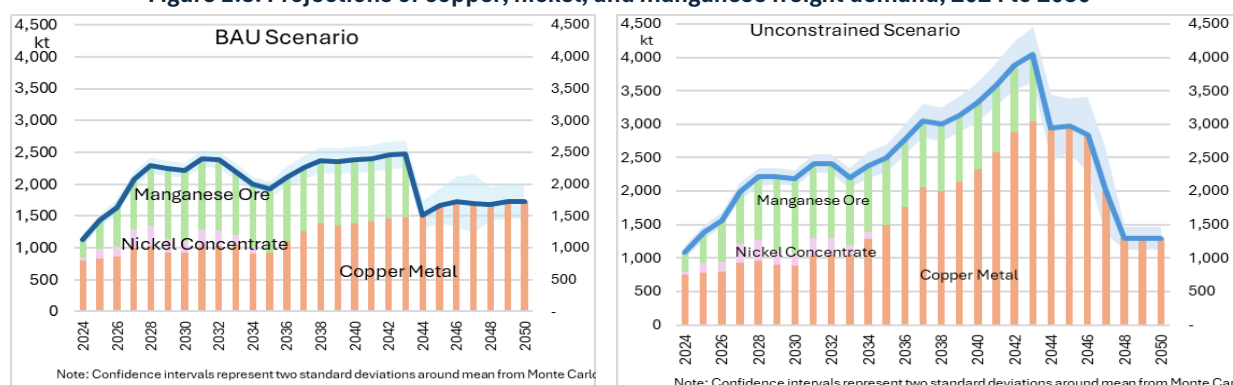
The GRZ is implementing several initiatives to address these challenges, including rehabilitating the Dar es Salaam Road Corridor, reconfiguring the use of the Tanzania-Zambia (TAZAMA) pipeline, reforming the rail sector, rehabilitating and properly operating the Tanzania-Zambia Railway Authority (TAZARA) and Zambia Railways Limited (ZRL) lines, introducing weigh-in-motion systems and streamlining axle load control procedures, and upgrading cross-border facilities to improve efficiency and speed at the borders.

Upscaling ETM production would significantly increase freight volumes, but the infrastructure should accommodate this growth if the announced transport and logistics reforms, upgrades, and rehabilitation

<sup>20</sup> Only 25 percent of the core road network is paved, and it receives less than \$2,000/km for maintenance per year—less than a third of the recommended level.

projects are implemented successfully. Figure E.8 shows projected freight volumes of copper, nickel, and manganese from 2024 to 2050 under two production scenarios.<sup>21</sup> In the *business-as-usual case*, demand grows from the current 1 mtpa to peak at nearly 2.5 mtpa by about 2030, driven mainly by a modest increase in copper and nickel concentrate freight and a significant increase in internal demand from manganese ore transporters. In the *unconstrained scenario*, demand grows much faster, with copper freight driving the total to about 4 mtpa by 2043. This is well within the combined capacity of the refurbished TAZARA and ZRL lines and the rehabilitated road corridors. TAZARA and ZRL alone could move over 6 mtpa by 2043, leaving spare capacity for transporting other minerals and goods. Thus, Zambia should carefully evaluate the need for additional greenfield transport infrastructure projects. Table E.4 outlines key challenges and recommendations for the transport and logistics services.

**Figure E.8. Projections of copper, nickel, and manganese freight demand, 2024 to 2050**



Source: World Bank projections. Note: BAU = business-as-usual.

**Table E.4. Transport and logistics: Key challenges, recommendations, and responsible agencies**

Key challenges	Recommendations (short, medium, and long term)	Responsible agency
Transport planning and prioritization is weak; rail sector underperforms significantly; key road networks are in poor condition or missing sections; and logistics is costly, hampering competitiveness.	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Develop a planning and prioritization framework to optimize investment in the large and poorly resourced road and rail sectors.</li> </ul>	MTL, RDA, TAZARA
	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Accelerate the conclusion of the TAZARA concession agreement and expedite ongoing reform of the rail sector.</li> </ul>	MoFNP, MTL, ZRL
	<ul style="list-style-type: none"> <li>• <i>Short term</i>: Develop the enabling environment for PPPs to attract private sector investment in infrastructure at scale.</li> </ul>	RDA, MTL
	<ul style="list-style-type: none"> <li>• <i>Short to medium term</i>: Accelerate implementation of key ongoing PPP concessions for major road infrastructure (such as dualling of the Ndola-Lusaka highway and Dar e Salaam Road corridor) and the TAZAMA pipeline reconfiguration.</li> </ul>	PPP units of MoFNP, RDA
	<ul style="list-style-type: none"> <li>• <i>Short, medium, and long term</i>: Harmonize regulations and standards among countries and implement one-stop border posts at key border crossings to harmonize border processes and simplify trade procedures.</li> </ul>	MCTI

Source: World Bank analysis. Note: MCTI = Ministry of Commerce, Trade and Industry; MoFNP = Ministry of Finance and National Planning; MTL = Ministry of Transport and Logistics; PPP = public-private partnership; RDA = Road Development Agency; TAZAMA = Tanzania-Zambia pipeline, TAZARA = Tanzania-Zambia Railway Authority.

**Zambia needs enough workers with the right skills if it is to realize its ETM potential.** The availability of sufficiently skilled workers does not appear to be a major constraint at current production levels, but the intended expansion of ETM production, processing and, in time, downstream manufacturing and services

<sup>21</sup> Copper is transported as blister, anode, and cathode; manganese is internal freight; and nickel is transported as concentrate.

will result in substantial increases in the demand for mid-level and highly skilled workers. Despite high unemployment and underemployment,<sup>22</sup> the availability of adequately skilled labor among Zambia's workforce is limited, and targeted interventions are needed to avoid skills shortages constraining the growth of the mining sector and its benefits to Zambians.

**Meeting the GRZ's target for copper production could see a fourfold increase in mining employment, from 56,000 to 200,000 employees, and a further 300,000 indirect and induced jobs.**<sup>23</sup> The number and nature of jobs that will be created depend on factors such as the volume of and speed at which production is expanded, its technology and labor intensity, and the scope and nature of the downstream activities. In the *unconstrained* scenario, employment could increase from about 56,000 direct employees and contractors in 2022 to over 200,000 by 2040. In the *business-as-usual* scenario, the numbers would be 106,000 direct employees and contractors. These numbers exclude indirect and induced jobs.<sup>24</sup> Estimates of job multipliers vary significantly but are generally positive, assuming trade openness and the availability of relevant skills, infrastructure, and other resources (Lopes and others 2023). Using a modest multiplier of 1.5, the economic spillover could result in an additional 160,000 jobs in the *business-as-usual* scenario and 300,000 jobs in the *unconstrained* scenario. Additional jobs created through midstream processing and downstream value addition require more sophisticated training and skills development support to meet the shortage of skilled workers at that level.<sup>25</sup>

**Further down the value chain, the production of copper wire and cables would mostly require workers with mid-level skills.** Given Zambia's limited production of copper wire, data on skill needs for copper wire production are sparse. The available information from a few firms shows that most jobs in plants that are fully operational are for machine operators working in casting or wire and cable production. They tend to have a secondary qualification plus a trade or craft certificate, usually obtained through a TEVET institution. These firms also have some employees in commerce (with certificate-level qualifications) and in engineering maintenance (with a degree or diploma, mostly through universities). When a company is being established, additional skilled workers may be required, with diploma and degree qualifications and experience in areas such as engineering, commerce, and logistics.

**Workers in the mining sector are relatively well educated and often employed in occupations that require high or medium skill levels** (Figure E.9). Most workers in core mining (60 percent), processing (54 percent) and auxiliary services (76 percent) are technicians, associate professionals, and craft or trades workers (orange bars in the figure). They are considered highly skilled and would require diplomas (from

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<sup>22</sup> People are underemployed when they are in low-skill, low-paying jobs, not by choice, or work only part-time because they cannot get full-time jobs that use their skills.

<sup>23</sup> Mining jobs are mostly in core mining activities, with fewer workers in processing (smelting) and auxiliary services. Employment data from a large mine in Zambia show that two-thirds of their workers perform core mining activities, which include areas such as mining engineering, operations and maintenance, site services, and ensuring health and safety. Around a quarter of employees work in processing, and the remaining 12 percent perform auxiliary activities in areas such as corporate and commercial affairs, financial and human resource management, and business development.

<sup>24</sup> *Indirect* jobs are generated by companies supporting copper mining and production off-site (such as transport and logistics) or further upstream or downstream from the main projects. *Induced* jobs are created, for example, when people in direct and indirect jobs spend their income on services such as food and housing.

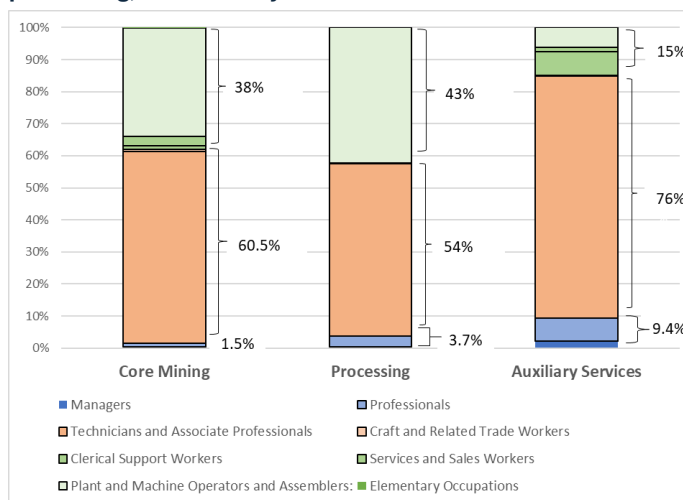
<sup>25</sup> Studies by the International Council on Mining and Metals show that for every \$1 generated by mining, at least another \$3 are generated elsewhere in the local economy, and that for every direct mining employee, as many as 15 more jobs are created elsewhere in that economy. Source: <https://www.icmm.com/document/8264>.

universities) or advanced certificates (from technical and vocational education and training—TEVET colleges), the equivalent of levels 6 and 5 on the Zambia Qualifications Framework (ZQF).

**Zambia benefits from a strong tradition in skills development for mining, but the system for developing mid-level skills has weaknesses, and universities will struggle to maintain quality when increasing student numbers.**

Large mining firms build their own mining-specific skills through on-the-job training and by operating their own training centers.<sup>26</sup> The Copperbelt University (CBU) and the University of Zambia (UNZA) are generally considered to provide a solid foundation of mining and engineering skills. However, the enrollment of women is low, and the universities face challenges in keeping up with the fast-changing technological development in the industry. Moreover, the recent rapid growth in enrollment may have adversely affected the quality of education; this underscores the need to maintain quality in the future when demand from the mining sector rises.<sup>27</sup>

**Figure E.9. Share of workers by category in core mining, processing, and auxiliary services**



Source: World Bank analysis based on data from a large mining company in Zambia.

TEVET training also face challenges, including the small number of graduates with higher-level qualifications (ZQF levels 4–6). Another is the poor quality and relevance of training in several public TEVET institutions where curricula are not aligned with industry needs; instructors lack up-to-date theoretical knowledge and practical skills; students have limited opportunities to benefit from work-based learning; and equipment and learning materials are insufficient and outdated. Overall, collaboration between mining firms and TEVET providers appears limited. Given these concerns, only a few of the over 300 TEVET institutions are deemed by mining firms to deliver graduates with sufficient skills.<sup>28</sup>

**Overall, for Zambia to meet its ETM ambitions, it needs to increase the availability of mid- and high-level skills.** This means expanding skills development mechanisms that already function well (such as industry-provided training and university programs), while maintaining their quality and strengthening the TEVET sector. Table E.5 outlines key challenges and recommendations related to employment and skills development.

<sup>26</sup> These include the Kitwe Trades School (operated by Konkola Copper Mines), Kwambula Training Center (operated by First Quantum), and the Mopani Central Training Centre (run by Mopani Copper Mine).

<sup>27</sup> Enrollment at the CBU schools of engineering and mining rose from about 310 in 2019 to 760 in 2021, and then jumped to 2,400 in 2023, after a policy change that delinked the number of placements from the number of government scholarships; admission criteria have also been relaxed.

<sup>28</sup> An estimated 6,400 students were enrolled in TVET programs related to mining in 2023, but only about 3,800 were in institutions “preferred” by mining companies. These training providers tend to be in urban areas or relatively close to the mining hubs (Copperbelt and Solwezi) and tend to offer courses that are more specific to mining, such as process instrumentation and plant fitting.

**Table E.5. Employment and skills: Key challenges, recommendations, and responsible agencies**

Key challenge	Recommendations (short, medium, and long term)	Responsible agency
Insufficient high-quality labor to support Zambia's ambitious ETM development	<ul style="list-style-type: none"> <li>• <i>Short to medium term</i>: Introduce financial incentives (such as vouchers) to promote industry engagement in the design and delivery of mining and engineering skills development programs, and focus the delivery of high-quality, relevant programs in one or more centers of excellence.</li> </ul>	MLSS
	<ul style="list-style-type: none"> <li>• <i>Short to medium term</i>: Incentivize highly skilled Zambian expatriates to return (for example through competitive pay and benefits).</li> </ul>	MOTS
	<ul style="list-style-type: none"> <li>• <i>Short to medium term</i>: Increase awareness among young people and women about mechanization and automation in mining (which improve both safety and physical workloads) to improve their participation in the sector.</li> </ul>	HEA
	<ul style="list-style-type: none"> <li>• <i>Medium to long term</i>: Improve policy making in workforce development by using data to inform policy, adopting a workforce development strategy, and using a TEVET management information system to allow policy makers and training providers to plan effectively.</li> </ul>	TEVETA

Source: World Bank analysis.

Note: HEA = Higher Education Authority; MLSS = Ministry of Labour and Social Security; MOTS = Ministry of Technology and Science; TEVETA = Technical Education, Vocational and Entrepreneurship Training Authority Zambia; TEVET = technical and vocational education and training.

#### 4. Addressing environmental and social risks and enhancing sustainability

**Despite Zambia's long mining experience, environmental and social governance in the sector faces major challenges.** The regulatory framework is extensive, but implementation challenges, especially around enforcement, are significant. Many environmental and human health violations have been reported in municipalities such as Kitwe, Mufulira, Chingola, Kabwe, and most recently Kitwe, some with lasting damage.<sup>29</sup> Copper smelting, tailings dumps, and mining waste polluted the air and water, affecting soil, crop yields, and water quality. Tailings dumps cause heavy metal contamination, and sulfur emissions contribute to soil acidification and respiratory illness. Moreover, many old mines remain unrehabilitated, posing ongoing health and safety hazards. Despite this lived experience, ZEMA faces significant capacity constraints (including staffing, institutional capacity, and equipment).<sup>30</sup> To avoid the GRZ's ambitious ETM vision leaving it even more constrained, ZEMA should urgently be capacitated. Its coordination with the MSD (and eventually the MRC) should be strengthened to facilitate alignment, the collective enforcement of regulations, and permitting and licensing. It should work with the Ministry of Local Government and Rural Development and communities affected by mining or mine closure and rehabilitation to ensure that key stakeholders are closely involved in environmental, social, and local development programs.

<sup>29</sup> Kabwe is a cautionary example of unchecked mining, with dangerous levels of lead and zinc still affecting local populations.

<sup>30</sup> ZEMA and other overseeing agencies have limited staff numbers, and their personnel often lack the specialized training needed for ETM. ZEMA also faces infrastructural and technological challenges, as regional offices and laboratories lack essential equipment and tools for inspections, such as air and water quality monitoring. The widespread deposition of mine waste across the Copperbelt complicates monitoring, leading to some inspections being postponed or cancelled, which allows noncompliant mining operations to continue without facing immediate repercussions. Even in regions where ZEMA maintains a presence, the absence of well-equipped laboratories and specialized equipment for testing hazardous materials, such as heavy metals in tailings dams and the toxic components in mine waste, further limits its capacity. Its technology is outdated, especially given the complex environmental impacts of ETM mining and the growing volume of waste that needs proper disposal and control.

**The Environmental Protection Fund (EPF) is the only financial surety mechanism for mine closure, but compliance has been weak.**<sup>31</sup> Its operationalization should be a priority. Full compliance with the EPF should be a condition of license transfers, as some mine liabilities (mainly tailings dams) are increasingly being transferred from large companies (with strong balance sheets) to small, speculative investors (with small balance sheets). This poses a growing risk of those liabilities eventually falling to the state.

**The carbon intensity of Zambia’s copper production is relatively low, and it remains a supplier of choice.** However, upscaling ETM production means rising energy demand, which in turn is likely to mean higher greenhouse gas (GHG) emissions. Total sector GHG emissions are projected to quadruple in the *business-as-usual* case and increase by seven times in the *unconstrained* case, from both higher electricity use and the liquid fuels used to power mining fleets. The growing carbon footprint of mining will make it more difficult for Zambia to achieve its Nationally Determined Contribution under the Paris Agreement. As carbon border adjustment mechanisms (CBAM) become more common, higher emissions will jeopardize the attractiveness of Zambia’s copper.<sup>32</sup> To mitigate this, the GRZ should focus on decarbonizing the sector, with a backup plan of levying a local carbon tax equivalent to the carbon price in the CBAM.

**Table E.6 summarizes key challenges and recommendations related to sustainability.**

**Table E.6. Sustainability: Key challenges, recommendations, and responsible agencies**

Key challenges	Recommendations (short, medium, and long term)	Responsible agency
ZEMA is poorly equipped to manage environmental and social risks, and coordination with local government and communities is weak or nonexistent; overlapping jurisdictions between ZEMA and others lead to inconsistent enforcement of regulations.	<ul style="list-style-type: none"> <li>• <i>Short term:</i> Capacitate ZEMA through staffing, further training, regional offices, and a well-equipped laboratory.</li> <li>• <i>Short to medium term:</i> Ensure ZEMA works closely with local government, communities, and law enforcement agencies in monitoring and enforcing regulations.</li> <li>• <i>Short term:</i> Provide clear and consistent roles and responsibilities for ZEMA, the MSD, the MRC, and the RPA in regulations to operationalize the Environmental Management Act and the MRC Act.</li> </ul>	ZEMA  MGEE, local governments, communities  MMMD (MSD, MRC), RPA
Legacy mines remain open and are not safely rehabilitated.	<ul style="list-style-type: none"> <li>• <i>Short to medium term:</i> Develop and adopt a national mine closure and rehabilitation plan; operationalize the Environmental Protection Fund and link compliance with the transfer of mining licenses.</li> </ul>	ZEMA MMMD (MSD, MRC)
Zambia lacks a carbon emissions strategy for the mining sector.	<ul style="list-style-type: none"> <li>• <i>Medium to long term:</i> Develop a carbon emissions strategy for the mining sector and mainstream decarbonization in mining development plans (including feasibility studies and environmental and social impact assessments).</li> </ul>	ZEMA MRC MMMD

Source: World Bank analysis.

Note: MGEE = Ministry of Green Economy and Environment; MMMD = Ministry of Mines and Minerals Development; MRC = Minerals Regulation Commission; MSD = Mine Safety Department; RPA = Radiation Protection Agency; ZEMA = Zambia Environmental Management Authority.

<sup>31</sup> The EPF is an escrow account linked to individual mining licenses, where the holders need to keep cash and a bank guarantee equivalent to the assessed liabilities in the event of a sudden mine closure. Guarantees are the preferred option for compliance, as large cash contributions tie up capital; however, the regulations require companies to secure guarantees from Zambian banks. Local banks are not large enough to effectively guarantee billions of dollars and only offer guarantees at a high cost.

<sup>32</sup> Companies selling products made with Zambian copper pay the CBAM in the final importing countries. This results in a lower price offered for Zambian copper and effectively transfers Zambia’s mineral wealth to the country levying the CBAM.

## 5. Operationalizing the ETM Roadmap

**The GRZ has embarked on several ambitious initiatives to achieve its Vision 2030—to be a prosperous middle-income nation by 2030.** Achieving this vision requires massive, well-coordinated efforts from all stakeholders (public, private, civil society, and development partners). Although various sectors have been identified to lead the GRZ’s economic diversification and industrialization agenda (agriculture, mining, manufacturing, and tourism), the enabling infrastructure (energy, transport and logistics, and water), institutional capacity, investment climate, and access to finance and markets are important common denominators. It is critical for the GRZ to coordinate, prioritize, and sequence these initiatives.

**In the mining sector, realizing the ETM roadmap requires a better understanding of the current state of play and the set of interventions needed (prioritized and sequenced), as well as financing and agency.**

Table E.7 summarizes the current context, key areas of focus, and the potential outcomes of operationalizing the roadmap. Recommended actions<sup>33</sup> under each focus area and the agency or agencies responsible for implementing those actions were discussed above and are summarized in Table E.8. Fully implementing the roadmap could result in higher investment (\$20 billion by 2030 and another \$34.6 billion by 2040), reaching the GRZ’s 3 mtpa target in copper production, higher employment (500,000 people in mining alone),<sup>34</sup> a six- to tenfold increase in export revenues over the next decade, and significantly improved fiscal revenues (by \$3.4 billion to \$6.0 billion by the mid-2040s).

**Table E.7. State of ETM development, key roadmap activities, and expected outcomes**

Current context	Roadmap focus areas and key activities	Expected outcomes
<ul style="list-style-type: none"> <li>Established mining sector</li> <li>Untapped mineral resources</li> <li>Strong investor interest</li> <li>Higher global demand for ETM</li> <li>Strong government commitment and reform agenda</li> <li>New trade and investment partnership opportunities</li> <li>Massive gap in infrastructure and skilled workforce</li> <li>Low participation by Zambians in ETM value chain</li> <li>Misalignment among key policies to realize ETM objectives</li> <li>Lack of prioritized actions and accountability matrix</li> <li>Limited finance</li> </ul>	Scaling production <ul style="list-style-type: none"> <li>Improve geological knowledge</li> <li>Scale production</li> <li>Strengthen sector governance</li> </ul>	<ul style="list-style-type: none"> <li>Higher employment—up to 500,000 jobs in mining, and more jobs with value addition</li> <li>Increased investment, upwards of \$20 billion in the next decade</li> <li>Increased exports—six- to tenfold rise over the next decade</li> <li>Higher fiscal revenue—royalties and corporate income tax rising by \$3.4 billion to \$6.0 billion by mid-2040s</li> <li>Increased participation of local firms in ETM value chains</li> <li>Enhanced workforce skills and firm capabilities</li> <li>Higher household incomes</li> <li>More economic opportunities for local communities</li> <li>Better public financial management</li> <li>Better ESG risk management</li> <li>Stronger accountability and coordination framework</li> <li>Improved financing of the roadmap</li> </ul>
	Improving capture, management, and sharing of benefits <ul style="list-style-type: none"> <li>Deepen value addition</li> <li>Expand Zambian participation</li> <li>Enhance mobilization of revenues and benefit sharing</li> <li>Improve public financial management</li> </ul>	
	Expanding infrastructure and skilled workforce <ul style="list-style-type: none"> <li>Ramp up energy generation and distribution</li> <li>Enhance transport and logistics services</li> <li>Increase employment and upgrade skills</li> </ul>	
	Enhancing sustainability <ul style="list-style-type: none"> <li>Manage ESG risks</li> <li>Promote sustainable and low-carbon mining</li> </ul>	

Source: World Bank staff. Note: ESG = environmental, social, and governance; ETM = energy transition minerals.

<sup>33</sup> Actions that are deemed to have a high impact and must be implemented in the near term (within a year or two).

<sup>34</sup> Total employment includes direct, indirect, and induced jobs, but not jobs related to processing and refining, nor midstream and downstream manufacturing.

**Successful implementation of the roadmap requires a whole-of-government approach with clear roles and responsibilities and a defined coordination framework and accountability matrix.** Although individual ministries and agencies will remain responsible for implementing recommendations that fall within their respective mandates (Table E.9), they would require significant additional resources to enhance their implementation capacity and capability. More importantly, an overall coordination mechanism and accountability matrix should be established to ensure timebound actions are taken to avoid delayed decisions and uncoordinated actions.

**The MoFNP, the PDU, and the Cabinet Office have overarching mandates** and could be empowered to perform coordination roles to ensure actions are implemented as planned, with a framework to monitor progress and correct course when needed. For example, the PDU could be supported to develop a monitoring and evaluation framework and provide regular updates on progress, whereas the Cabinet Office and the MoFNP could be empowered to perform the coordination role. The Public-Private Dialogue Forum (PPDF) is another important multistakeholder platform that provides structured and inclusive public-private engagement on policy matters to address market failures hindering the private sector. The PPDF should be strengthened to effectively facilitate private sector participation in the ETM value chain.

**The GRZ has established a coordination framework to operationalize the MRC.** It is chaired by the Cabinet Office, with the MMMD as the Secretariat; several working groups have been set up to lead individual workstreams. However, there is no clear institutional framework for implementing the roadmap. It is recommended that a cabinet steering committee be established, chaired by the minister of the MoFNP and co-chaired by the minister of the MMMD. It should include a limited number of key ministries and agencies and be supported by strong secretariat to facilitate coordination and overall implementation of the roadmap.

**Implementing the roadmap is estimated to cost about \$14 billion by 2030 and about \$32 billion by 2040<sup>35</sup>** (Table E.8). Nearly 90 percent of the investment is expected to come from the private sector, covering most mining and value addition activities, as well as large energy and transport infrastructure. This underscores the need to improve the investment climate for the ETM value chain. Various financing options could be considered, including project, concessional, and blended finance.<sup>36</sup> The GRZ is working with key partners, such as the World Bank Group, the African Development Bank, the European Union, and bilateral agencies to

**Table E.8. Estimated cost of implementing the ETM roadmap**

Project type	Estimated cost (\$, billion)	
	By 2030 <sup>a</sup>	By 2040
Electricity (generation, transmission, distribution)	2.74 (82%)	5.40
Transport and logistics (rail, road, logistics and border facilities)	4.10 <sup>b</sup> (90%)	7.05
Scaling up mining (geological mapping, exploration, mining, and processing) <sup>c</sup>	7.12 (98%)	19.63
Workforce and skills development	0.05 (20%)	0.09
Safeguarding the environment (staffing, laboratory and equipment)	0.05 (1%)	0.11
<b>Total</b>	<b>14.06 (89%)</b>	<b>32.28</b>

*Source:* World Bank estimates. *Note:* a. Numbers in brackets denote the share of investment by the private sector. b. Includes the Kapiri to Ndola Railway link (\$75 million). c. Public investment ranges from \$120 million to \$200 million; the remainder is from private sector investment in mine development.

<sup>35</sup> Although significantly larger investments are needed to provide energy and transport for sectors such as agriculture and manufacturing, the estimates given here are for implementing actions needed under the ETM roadmap.

<sup>36</sup> Project finance involves securing the funds for a standalone economic unit based on the financial viability of the project. Blended finance involves limited public and concessional finance being used to facilitate private investment at scale.



implement priority infrastructure projects in sectors such as energy (for example, Mission 300), transport and logistics, and skills development.

**The strategic use of concessional finance can unlock significant private capital by derisking private investment** across the ETM value chain and supporting infrastructure. In view of its important role in the global energy transition, Zambia could negotiate better access to concessional financing, such as grants, credits, and low-interest climate and sustainability loans. The Resilient Inclusive Supply Chain Enhancement (RISE) initiative and climate-resilient mining could be good sources of such financing. However, Zambia would need to prepare and position itself properly to maximize the potential benefits from these opportunities.

**The GRZ could also mobilize FDI by leveraging partnership agreements such as those with the DRC, the United States (including AGOA), the European Union, GCC states, and Asian countries to attract new FDI.** Realizing this opportunity requires translating existing and new agreements into realistic action plans that are regularly monitored and enforced.

**Table E.9. Summary of key challenges, priority actions, and recommended agencies**

Key challenges	Priority actions	Responsible agency
<b>1. Scaling ETM production</b>		
Weak investment climate for mining and insufficient enforcement of laws and regulations	<ul style="list-style-type: none"> <li>Operationalize the Minerals Regulation Commission (MRC) with appropriate implementing regulations; clear roles and responsibilities; staffing and systems (including cadaster<sup>a</sup>); financial, legal, and operational autonomy; transparency and accountability; and board operations and composition.</li> <li>Invest in geological data and make the information freely available online.</li> </ul>	MoFNP and MMMD co-lead implementation of the MRC
<b>2. Maximizing the capture, management, and sharing of benefits</b>		
Inadequate benefits from ETM and insufficient participation of Zambian firms in the ETM value chain	<ul style="list-style-type: none"> <li>Enhance the stability, transparency, and progressivity of the fiscal regime, and reduce revenue leakages.</li> <li>Strengthen investment and trade policies and the institutional and regulatory arrangements to create a more competitive investment climate.</li> <li>Increase the participation of Zambian firms by expanding access to finance and implementing effective local content regulations<sup>b</sup> (informed by analytics and well-defined opportunities) that facilitate impactful supplier development programs and allow the participation of junior miners.</li> <li>Improve public financial management and procurement by strengthening institutional capacity for oversight and operationalizing the stabilization fund.</li> </ul>	MoFNP, ZRA MCTI, MMMD OAG
<b>3. Expanding infrastructure and the skilled workforce</b>		
Mobilization of large financing and strong coordination among key players needed to implement Energy Compact	<ul style="list-style-type: none"> <li>Expedite implementation of the Zambia National Energy Compact, including ZESCO reform, the open access policy, net metering, investment in transmission and distribution infrastructure (including regional interconnectors), cost-reflective tariff reform, a transparent and standardized transmission pricing system aligned with regional standards, and stronger MoE capacity for energy planning and procurement.</li> </ul>	MoE MoFNP ZESCO, ERB
Competitiveness hampered by weak transport planning and prioritization, underperforming rail sector, poor road networks, and costly logistics	<ul style="list-style-type: none"> <li>Develop a planning and prioritization framework to optimize investment in the large and poorly resourced road and rail sectors.</li> <li>Accelerate the conclusion of the TAZARA concession agreement and expedite ongoing reform of the rail sector.</li> <li>Accelerate implementation of key ongoing PPP concessions for major road infrastructure (such as dualling of the Ndola-Lusaka highway and Dar e Salaam Road corridor) and the TAZAMA pipeline reconfiguration.</li> <li>Harmonize regulations and standards among countries and implement one-stop border posts at key border crossings to streamline border processes and simplify trade procedures.</li> <li>Develop the enabling environment for PPPs to attract private sector investment in infrastructure at scale.</li> </ul>	MTL, RDA, TAZARA MoFNP, MTL, ZRL RDA, MTL PPP units of MoFNP, RDA MCTI
Too few Zambians with the right skillsets for scaling up ETM and value addition	<ul style="list-style-type: none"> <li>Facilitate and incentivize industry's engagement in the design and delivery of skills development programs for the mining sector, aligning supply and demand.</li> <li>Expand TVET training of technicians and artisans with ZQF levels 4–6.</li> <li>Address quality and relevance gaps in university education for mining and engineering.</li> </ul>	MOTS (and TEVETA) MLSS HEA

Key challenges	Priority actions	Responsible agency
<b>4. Addressing E&amp;S risks and enhancing sustainability</b>		
Insufficient capacity at ZEMA for managing environmental and social risks, and poor coordination with MMMD, local government, and communities	<ul style="list-style-type: none"> <li>• Capacitate ZEMA through staffing, further training, regional offices, and a well-equipped laboratory.</li> <li>• Ensure ZEMA works closely with local government, law enforcement agencies, and communities in monitoring and enforcing regulations.</li> <li>• Provide clear and consistent roles and responsibilities for ZEMA, the MSD, and the MRC in regulations to operationalize the Environmental Management Act and MRC Act.</li> <li>• Develop and adopt a national mine closure and rehabilitation plan, accompanied by financing.<sup>c</sup></li> </ul>	MGEE, ZEMA, MMMD Local government Law enforcement agencies Communities
<b>5. Operationalizing the ETM Roadmap</b>		
Weak alignment and coordination of actions and large financing gap	<ul style="list-style-type: none"> <li>• Develop a clear implementation plan, starting with milestones for 2025, and a monitoring and evaluation framework for the ETM roadmap with roles and responsibilities clearly defined (including the apex agency to coordinate implementation of the roadmap) and the coordination framework fully mapped.</li> <li>• Develop PPP capacity in key ministries and agencies and adopt a competitive procurement framework to allow private sector investment in sectors such as energy and transport.</li> </ul>	Cabinet committee co-chaired by MoFNP and MMMD <sup>d</sup> MoFNP, MoE, MTL, RDA

Source: World Bank analysis.

Note: ERB = Energy Regulation Board; HEA = Higher Education Authority; MCTI = Ministry of Commerce, Trade and Industry; MGEE = Ministry of Green Economy and Environment; MLSS = Ministry of Labour and Social Security; MMMD = Ministry of Mines and Minerals Development; MoFNP = Ministry of Finance and National Planning; MoE = Ministry of Energy; MOTS = Ministry of Technology and Science; MRC = Minerals Regulation Commission; MSD = Mine Safety Department; MTL = Ministry of Transport and Logistics; OAG= Office of Auditor General; PDU = Presidential Delivery Unit; PPP = public-private partnership; RDA = Road Development Agency; TAZAMA = Tanzania-Zambia pipeline, TAZARA = Tanzania-Zambia Railway Authority; TEVETA = Technical Education, Vocational and Entrepreneurship Training Authority Zambia; ZEMA = Zambia Environmental Management Authority; ZQF = Zambia Qualifications Framework; ZRA = Zambia Revenue Authority.

a. Cleanup non-complaint licenses and fully digitalize mining cadaster (map and codify workflows, ensure audit functionality, online interface, online payments, links to land and forestry cadasters).

b. The current draft of the local content regulations requires significant revisions based on international good practice lessons and informed by analytics as well as ensuring that there is an inclusive consultation process in place with the key stakeholders.

c. This requires operationalizing the Environmental Protection Fund and linking compliance with the transfer of mining licenses.

d. The Cabinet Committee should ideally be supported by a strong secretariat (such as the PDU or the planning department at the MoFNP) and key technical working groups.

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