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Future Scenarios for Transport and Energy Transitions in Zambia: Participatory Scenarios for Policy and Planning

Climate Compatible Growth (CCG) Programme in collaboration with the Zambia Institute for Policy Analysis and Research (ZIPAR).

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Key Transport and Energy Pathways Takeaways

- Zambia's energy–transport planning is constrained by the dominance of existing road infrastructure, unregulated transport, and a climate-vulnerable energy mix.
- The two scenarios from the participatory workshop explore opportunities and challenges in Zambia's transport future and serve as basis for modelling.
- Sustainable outcomes depend on integrating effective governance with inclusive planning—not just on financing or income—since high growth pathways still produce traffic congestion and emissions.
- Trade-offs must be managed: expanding electricity for clean transport requires balancing grid reliability and affordability for existing users.

Traffic in Chipata Town, Zambia

- Participatory scenario-building facilitates stakeholder alignment, fills data gaps for modelling, and helps to stress-test policies and long-term planning.

Introduction

Efficient and fair transport and energy systems are essential for economic development opportunities and long-term sustainability as well as addressing urgent problems such as income inequality, gender disparities, and healthcare access. However, the intersection of transport and energy planning is complex, as it is dependent on an array of factors ranging from individual needs and behaviours, rules and local conditions, to infrastructure priorities. For these

reasons, planning sustainable and equitable outcomes for transport and energy in low and lower-middle income countries (LLMICs) poses a challenge in terms of data availability that often limits the effectiveness of government actions, recommendations of international agencies, and initiatives of local industry and service providers, constraining coordinated efforts towards development goals.

This policy brief presents the findings, methodological insights, and policy implications from a scenario-making exercise conducted in Lusaka in February 2025. The workshop brought together key stakeholders from government, local and international organisations, and the private sector to co-create future pathways for Zambia's transport and energy systems. The scenarios themselves, along with the collaborative process of developing them, can be used as a practical tool for overcoming data and coordination constraints in modelling and long-term planning.

The scenario exercise was structured around two core strategic objectives:

- **Enhancing service provision and equity:** Ensuring universal, reliable and affordable access to transport and energy is a fundamental prerequisite for meeting basic service needs, expanding economic opportunities, and reducing intersectional gender, disability and spatial inequalities.
- **Advancing sustainable development:** Managing rapid urbanisation and population growth requires directing infrastructure investment towards inclusive, resilient, and low-carbon systems that protect the population's health and the environment, which ensure long-term and shared prosperity and avoid lock-ins to unsustainable development pathways.

To attain these objectives, the Zambia Institute for Policy Analysis and Research (ZIPAR) spearheaded the development of the transport–energy scenarios presented in this brief, working with diverse stakeholders to construct narratives about Zambia's transport system and how policy, technology, and investment shape its future. The Climate Compatible Growth (CCG) programme provided methodological support drawing on previous scenario experience in Kenya and other LLMICs to enable local ownership. This collaboration ensured that the scenario-making process remains locally led, methodologically sound, and aligned with Zambia's development priorities.

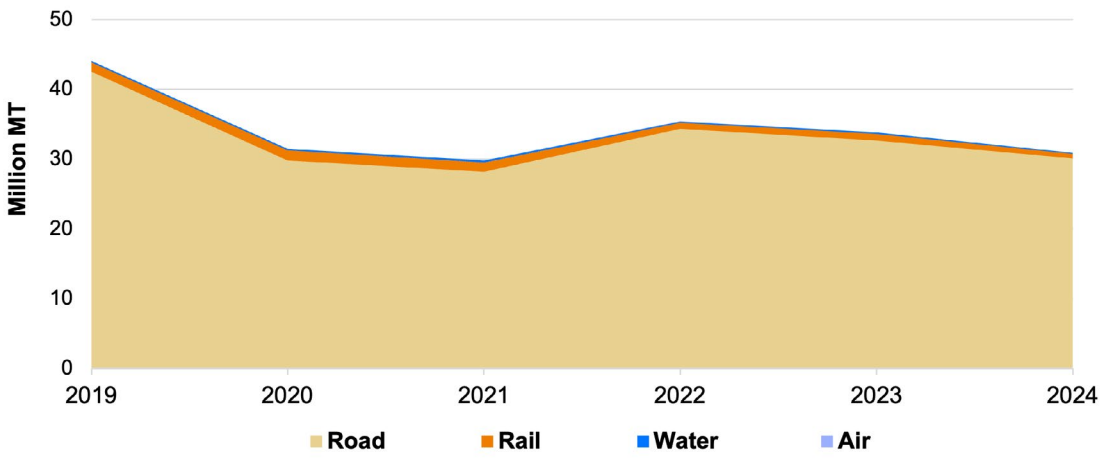
Context: Transport and Energy in Zambia

The institutional and policy framework for Zambia's transport sector is fragmented, with several institutions responsible for policy planning and implementation often reporting overlaps of mandates and responsibilities. Key among these are government ministries and agencies such as the Ministry of Transport and Logistics, Ministry of Infrastructure, Housing and Urban Development, the Road Development Agency, National Road Fund Agency, and the Road Transport and Safety Agency (RTSA). Similarly, Zambia Railways Limited (ZRL), Tanzania-Zambia Railway Authority (TAZARA), and Zambia Airports Corporation Limited are key in the railway and aviation sub-sectors. In the energy sector, the Energy Regulation Board (ERB) is the main regulator. Key service providers include Zambia Electricity Supply Corporation Limited (ZESCO) for electricity and various independent oil marketing companies for petroleum products.

Given the interconnectedness of transport, land-use, and energy supply, the Zambia Environmental Management Agency is another critical institution that oversees environmental regulation and sustainability, including emission monitoring and control.

Being a landlocked country, Zambia's transport sector relies predominantly on land transport, particularly via road. According to annual economic reports by the Ministry of Finance and National Planning, an average of 96% of the country's total freight volume has been moved by road over the last decade [1, 2]. This has partly resulted in congestion on key highways across the country. Consequently, high traffic loads on major highways have induced high spending to maintain, rehabilitate, and upgrade roads, with allocated spending for road infrastructure averaging 37% of total economic affairs budget between 2013 and 2023; thereby crowding out other spending priorities [3, 4]. Key planned transport infrastructure projects include the upgrading of the Lusaka-Ndola dual carriageway, as well as the rehabilitation and upgrading of TAZARA and several greenfield projects by ZRL to increase the mode share of rail, which currently constitutes less than 4% of Zambia's annual total freight volume (see **Figure 1**).

***Figure 1**: Zambia's Total Freight Volume by Mode*



Source: Constructed by authors from Zambia's Annual Economic Reports [2, 5, 6]

For urban transport, the absence of a dedicated Public Transport Authority (PTA) means Zambia's public transport service is largely unregulated and provided by fragmented individual service providers operating small 12-to-16-seater mini-buses (Toyota Hi-ace). This has resulted in challenges in transport provision, such as cost fluctuations, reliability, and unmet safety standards, especially affecting vulnerable members of society including women and children, older adults, and persons with disabilities [7]. Plans by government, announced since the early 2010s, to introduce regulated public transport services using large occupancy vehicles with assigned specific routes and demand matching operating schedules have yet to materialise [8]. The import and usage of private cars have been increasing, with an estimated 30,000–40,000 cars imported quarterly into the country [9]. In addition, the number of two and three-wheeler vehicles has been increasing rapidly post pandemic, especially for urban delivery. Consequently, congestion during peak hours has worsened in major cities like Lusaka and Ndola, with noise pollution and carbon emissions

levels escalating due to the limited uptake of electric vehicles (EVs). With approximately 60% of the urban population predominantly commuting by walking, coupled with inadequate walkways and cycle lanes, vulnerable road users such as pedestrians and cyclists are at great risk of being involved in road traffic accidents, which claim more than 2,000 Zambian lives annually [10].

Finally, Zambia's total installed electricity generation capacity of about 3,811 megawatts (MW) is dominated by hydro (83%), with thermal, diesel, and other technologies accounting for 8.7%, 2.2%, and 6.1%, respectively [11]. This undiversified energy mix has made the country vulnerable to droughts, resulting in long periods of power rationing, ranging from 12–24 hours daily. With the high upfront cost of EVs and lack of public charging infrastructure, this energy deficit will affect Zambia's transition to e-mobility. That stated, the Integrated Resource Plan (2023) envisions to increase the electricity generation capacity to 23,000 MW by 2050, with 1,000 MW of renewable solar energy targeted by the end of 2026 [12]. Policies to support the transition to e-mobility include the zero rating of tax on the import of EVs as well as the government's decision to transition its motor vehicle fleet to EVs, thereby sending a strong signal about the country's intention to decarbonise the transport sector [13]. Therefore, partnerships between the government, various private sector institutions, and Development Finance Institutions like the World Bank Group and the African Development Bank Group (AfDB) will be critical in facilitating the required financing to support Zambia's energy transition.

Linking Scenarios to Modelling

The term 'scenario' broadly refers to any description of a plausible future [14].The scenarios in this policy brief are process-based: they emerge from collective deliberation among diverse stakeholders in Zambia's transport and energy sectors. Deliberative scenarios are a stepping stone for more precise and subsequent policy planning analysis. Rather than predicting a single outcome, this methodology emphasises preparing for multiple plausible futures, valuable for interconnected fields like transport and energy sectors. Used as narrative frameworks, scenarios inform and improve quantitative modelling. The scenario process helps overcome modelling limitations by:

- **Updating model boundaries:** expanding futures considered beyond "business-as-usual" projections.
- **Identifying new variables:** highlighting social, behavioural, or intuitional factors absent from existing models.
- **Defining critical levers:** selecting specific, plausible combinations of conditions (eg policy shifts, technology adoption rates) that are meaningful for targeted modelling.

In addition, such scenarios can capture contextual knowledge, priorities, and aspirations. These are translated into qualitative and quantitative inputs for transport models, guiding what variables and assumptions are tested. The modelling process then explores how transport systems respond under different futures, generating evidence on impacts, trade-offs, and co-benefits. These insights help stakeholders assess the consequences of their choices and refine policies, plan investments, or revise regulations. For example, in Kenya deliberative scenarios on transport and energy were developed to use in modelling [15]. The resulting scenarios there served a dual purpose: they directly informed national transport policy published in the National Strategy and provided a reference for transport modellers. Modelling

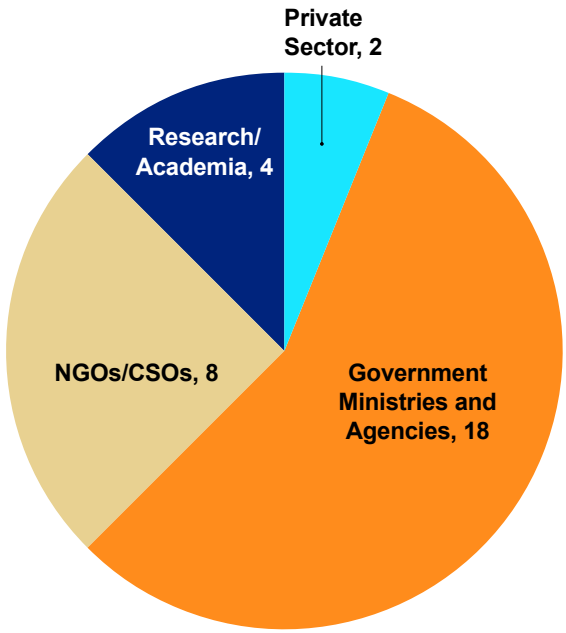
teams within CCG and Strathmore University used the scenarios to establish modelling levers for variables where data was unavailable. Combining deliberative scenarios with modelling helped overcome data limitations in Kenya and foster local ownership of modelling. Scenarios as a planning tool can help ensuring priorities reflect local needs and visions, making technical recommendation more viable for implementation [16].

The Ministry of Transport and Logistics in Zambia has been a key consulting partner for the scenarios' development and workshop. This institutional anchor provides a coherent future vision that other stakeholders can reference. While reflecting diverse perspectives, the aim is for the scenarios to remain grounded in a shared, long-term vision for Zambia's transport-energy future.

Participatory Process

The scenario development workshop was held in Lusaka in February 2025. The workshop engaged 32 representatives from across Zambia's transport and energy sectors, including government ministries and agencies, academia, industry, and civil society. The pie chart below provides a breakdown of participant representation (**Figure 2**).

***Figure 2:** Stakeholder Distribution*



Before the workshop and to inform the scenarios, ZIPAR conducted nine expert interviews, focusing on the current state of transport, challenges, institutional frameworks, and the future of transport and energy technology.

Key insights which informed the scenario-making process and interpretation.

Negative developments

- Import of second-hand vehicles (30 to 40 thousand per quarter) with negative implications for congestion and emissions.
- Mass transit and non-motorised projects lack private investment, as seen in the limited amount of private sector participation and publicly tendered projects.
- Lack of public resources due to the country's high debt.
- Inadequate institutional coordination among major stakeholders.
- Insufficient participation of women in transport planning and employment (less than 5% of women were employed in the transport and storage sector as of 2019) [17].

Positive outlook

- Infrastructure development projects across road, rail, and aviation aimed at easing traffic congestion in Lusaka and improving national connectivity.
- Progress on EV adoption such as battery-driven hybrid dump trucks by Hitachi in Northwestern Province.
- Bus Rapid Transit (BRT) and rail systems are seen as suitable for busy urban areas like Lusaka, supported by Non-Motorised Transport (NMT) infrastructure like walkways and cycle lanes to improve pedestrian and cyclist experiences.
- Potential for local manufacturing of EV components such as batteries, charging infrastructure, and vehicle parts.

Scenario Development: The Future of Transport and Energy in Zambia

The workshop followed a structured, sequential process to develop the scenarios [18]. Working in two groups, the participants identified and defined the most important factors and actors influencing Zambia's transport and energy future, as summarised in the **Table 1**.

The groups then selected two critical factors to serve as the axes for the scenario sets. These two key factors—each defined by a specified spectrum, from "High" to "Low"—create a matrix of four distinct, contrasting future conditions.

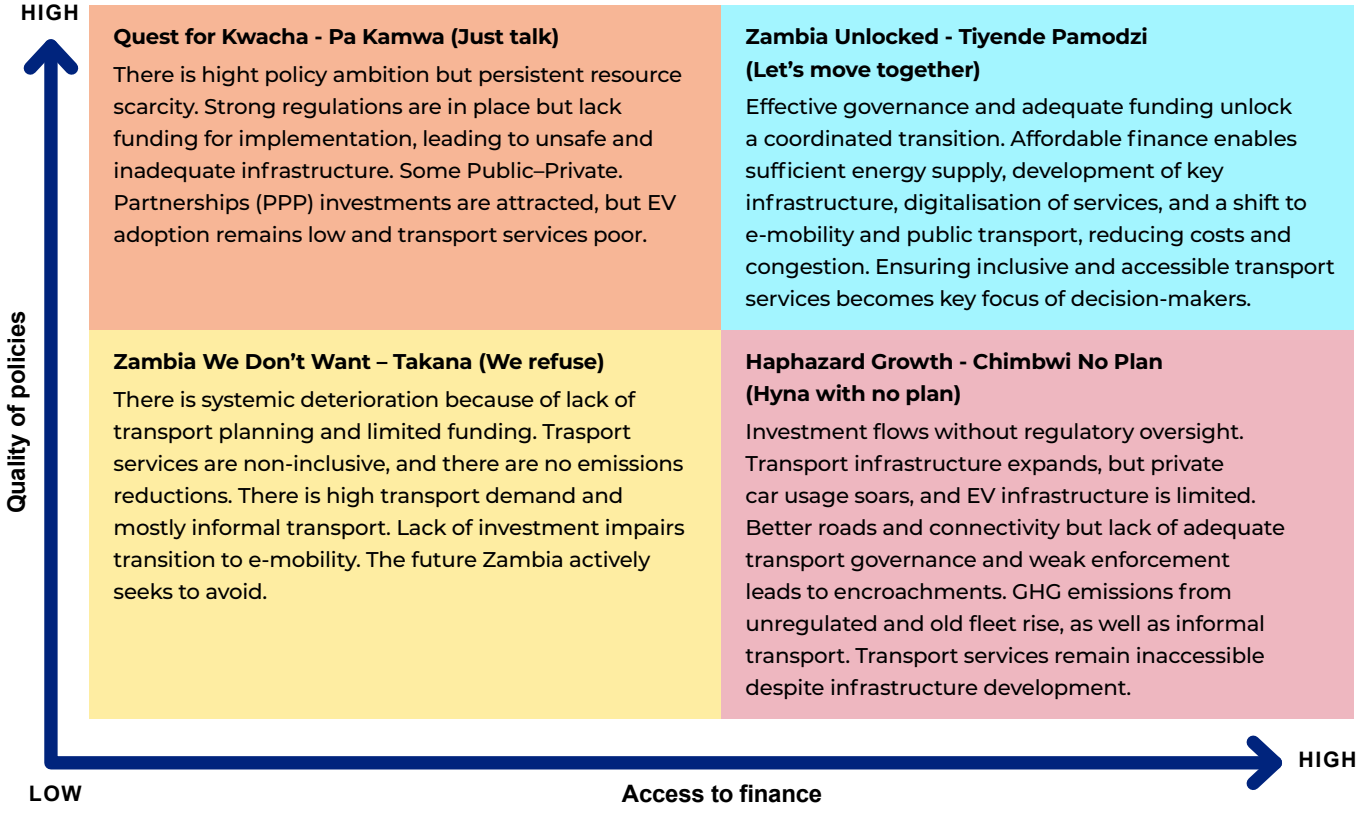
The final scenarios are designed to be developed further beyond the workshop.

Figure 3 presents the scenario set produced by Group One, built on the axes of Quality of Policies and Access to Financing.

Table 1: *Key factors and actors identified as central to Zambia's transport-energy sectors.*

Key Factors	Main Actors
▪ Transport–energy policies/regulations	▪ Ministry of Transport and Logistics
▪ Access to finance	▪ Ministry of Energy
▪ Energy supply	▪ Road Development Agency (RDA)
▪ State of transport infrastructure	▪ Road Transport and Safety Agency (RTSA)
▪ Quality of public transport services	▪ Energy Regulation Board (ERB)
▪ Digitalisation of transport services	▪ Zambia Electricity Supply Corporation (ZESCO)
▪ Stakeholder collaboration	▪ Development Finance Institutions (eg AfDB)
▪ Income and economic growth	▪ Private sector institutions

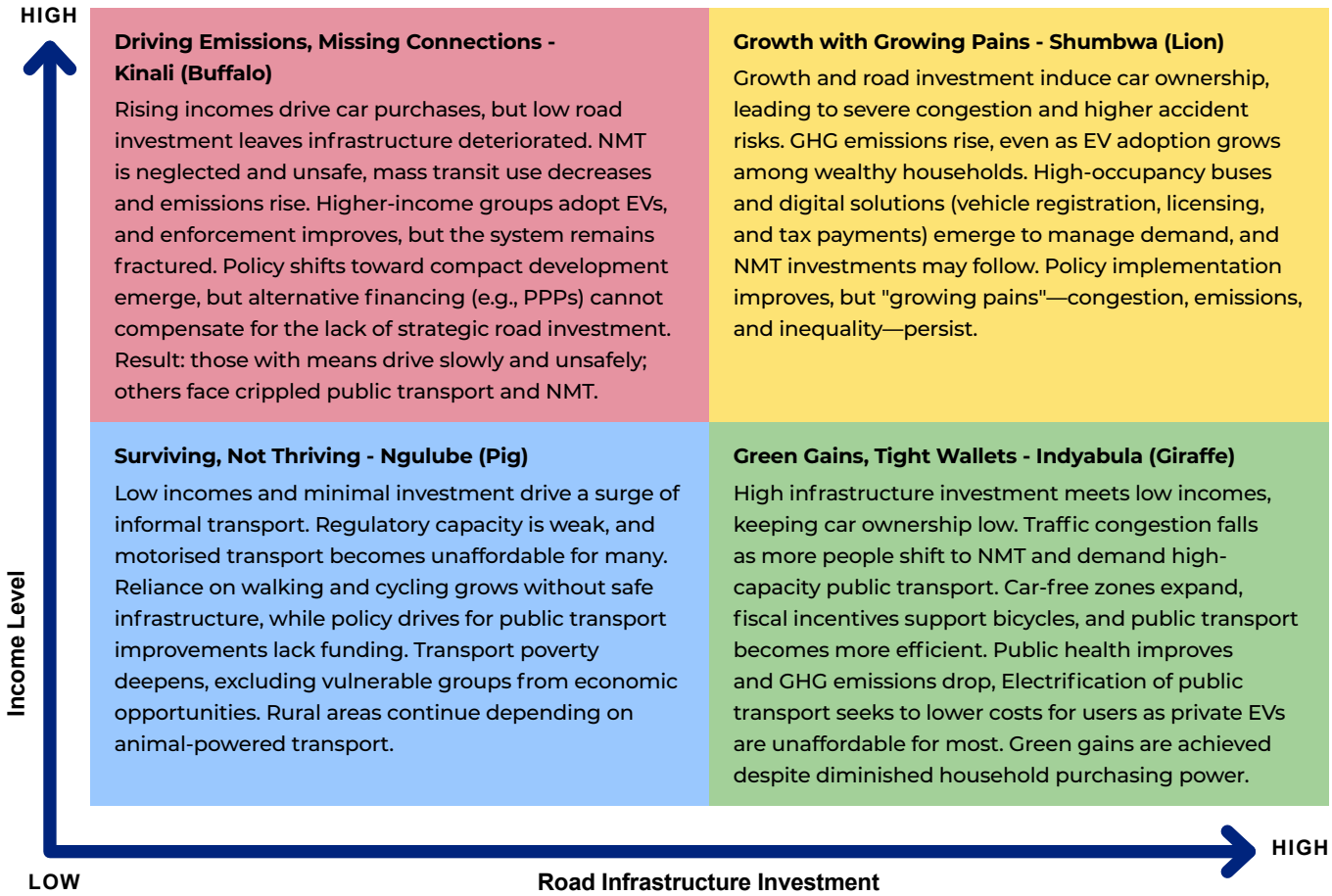
Figure 3: *Scenarios Set from Group One*



The scenario set for Group Two is presented in **Figure 4**. Group Two structured their scenarios around two key uncertainties: the income level of the population and the extent of road infrastructure investment.

These scenario sets show that even a future of High Income and High Investment presents significant challenges. The scenario description includes outcomes like increased congestion and a higher risk of road traffic accidents—referred to as "growing pains." Highlighting these potential negative consequences provides critical insights for modellers and, more importantly, delivers a nuanced message for policymakers about the need for integrated and proactive planning beyond only investment.

***Figure 4:** Scenarios Set from Group Two*



To trace the path of change, participants developed narrative storylines that connect the present to the year 2040 for each scenario, in this case, based on that specific combination of conditions.

The groups developed the stories for two scenarios each. Below are the storylines for scenario Zambia Unlocked and Haphazard Growth from Group One's scenario set in **Table 2**, and Growth with Growing Pains and Green Gains, Tight Wallets developed by Group Two, in **Table 3**.

***Table 2:** Storylines from two scenarios from Group One*

SCENARIO	Zambia Unlocked "Tiyende Pamodzi"	Haphazard Growth "Chimbwi No Plan"
Start of story	More finance for infrastructure development and strong policies for sustainable transport	More finance for infrastructure development but weak policies for sustainable transport
Development	High energy demand for e-mobility, especially for public transport services	Disorganised growth, congestion, high emissions, vandalism, and encroachment from unplanned urban developments
Middle of story	Efficient, safe, reliable, and cost-effective public transport services and infrastructure for pedestrians and cyclists	Unsafe, inaccessible, and unregulated public transport services
End of story	Low-emission, inclusive and accessible public transport services; 20–30% mode shift from cars to public transport by 2050	Continued private car usage, high pollution and congestion, and limited transition to e-mobility by 2050

***Table 3:** Storyline from two scenario from Group Two*

SCENARIO	Growth with Growing Pains "Shumbwa (Lion)"	Green Gains, Tight Wallets "Indyabula (Giraffe)"
Start of story	Increased public finance and household incomes leading to significant road infrastructure investments and private car purchases	Policies prioritise NMT facilities while limited public finances constrain infrastructure development and low household incomes reduce private car purchases
Development	Induced transport demand and private car usage lead to high congestion. Public frustration grows as public transport services remain undeveloped and vulnerable users remain underserved	Expansion of NMT infrastructure, decline in car ownership and increased mode shift to walking and cycling, alongside growing demand for high quality public transport services
Middle of story	Steady shift to EVs by wealthy households supported by government incentives. Poor households left behind with crowded informal public transport services and unsafe walking footpaths	Reduced traffic congestion, improved efficiency of public transport services and better public health outcomes due to high rates of walking and cycling
End of story	Widening inequality as mobility becomes a function of income, resulting in mounting external pressure from sustainability agreements (eg Paris Agreement) alongside internal push to re-think transport priorities. Eventually, sustainable transport policies emerge, including integrated land use	Lower GHG emissions, accessible, walking and cycling friendly urban centres, and efficient public transport services; but limited large-scale electrification by 2050

Both scenario sets—Zambia Unlocked and Haphazard Growth from Group One, and Growth with Growing Pains and Green Gains, Tight Wallets from Group Two—illustrate how policy choices and economic conditions shape mobility outcomes and what areas need solutions. Among the strategic areas that require further innovation are affordable EV technologies accessible to low-income users, decentralised renewable energy to power transport without straining the

grid, adaptable and resilient NMT infrastructure that serves vulnerable groups, digital platforms to organise popular transport without displacing livelihoods, and better integration of urban planning with transport planning.

Via the exploration of integrated solutions such as combining e-mobility with renewable energy, scenarios and their narratives helped identify possible strategies for addressing multiple challenges, including those related to gender equality, disability, and social inclusion (GEDSI), and innovation needs. With this structured yet flexible exploration of the future, scenarios are adaptable as conditions and factors change.

Scenarios Results and Implications for Zambia

The scenarios on transport and energy in Zambia presented in this brief show at least three conditions that participants considered to be critical in determining future outcomes in these sectors: i) policy effectiveness, ii) investment targeting, and iii) socio-economic conditions. Stakeholder collaboration and the energy and transport infrastructure were also thought as relevant.

A future with high investment but inadequate policies like Haphazard Growth leads to unsustainable, inequitable development. Equally, strong policy can be severely limited by financing constraints, as seen in Quest for Kwacha. Ultimately, the resulting scenarios show that an integrated approach—combining regulatory clarity, strategic finance, and inclusive design—is essential to achieve the more sustainable and equitable transitions envisioned in Zambia Unlocked or Green Gains, Tight Wallets scenarios.

Strategic Implications

- **Beyond mere infrastructure investment:** Simply building more roads, such as in the Growth with Growing Pains and Haphazard Growth scenarios, may exacerbate congestion, emissions, and safety risks if not paired with robust policies for public transport, NMT, and demand management. Investment plans must be directed toward multi-modal, low-carbon systems.
- **Policy and governance are central:** Effective regulation and implementation are crucial leverage points in all scenarios. The scenarios show that effective policies are needed to ensure private investment, guarantee service quality, protect NMT infrastructure, and manage the transition to e-mobility.
- **Equity as a core objective:** The scenarios reveal there is a tension between motorisation and inclusion. Futures with high car ownership (Driving Emissions, Missing Connections) often correlate with neglected public transport and NMT, which disproportionately affects low-income populations. Thus, policy in the form of regulations and urban planning is required to ensure that mobility improvements and new technologies like EVs do not deepen existing social inequalities nor worsen inclusion.
- **Plan for trade-offs:** The scenarios help anticipate subsequent effects and potential conflicts between policy goals. For example, a successful shift to e-mobility (Zambia Unlocked) would reduce emissions and long-term operating costs, but it also creates new demands on an already strained electricity grid, requiring parallel investments in renewable energy generation to ensure the grid is stable and affordable to users. Similarly, digitalisation offers more efficiency in transport use but risks excluding informal workers and low-income users who lack access to smartphones or digital literacy, requiring capacity building and an inclusive platform to ensure its access is equitable and inclusive.

These scenario results do not predict the future but map out the field of possibility. Hence, scenarios provide policymakers and stakeholders in Zambia with a tool to stress-test strategies, identify early warning signs of undesirable pathways, and align actions toward a collectively preferred future. Accounting for trade-offs is an essential part of integrated planning, where scenarios help identify not only synergies but also the unintended consequences of otherwise desirable policies.

Conclusion

In Zambia, planning for transport and energy sectors is defined by deeply interconnected challenges. The transport sector is saturated, unregulated, and disjointed, and the energy sector has severe electricity shortages due to persistent droughts. Scenario planning and modelling can help address these challenges by aiding robust, adaptable long-term planning and strategic recalibration.

Participatory Scenario Building

This policy brief demonstrated a structured and participatory approach to scenario building, involving a workshop that engaged multiple stakeholders in identifying issues and exploring plausible futures. By involving policymakers and institutions in workshops and deliberative exercises, the process:

- Fosters collective understanding and stakeholder ownership.
- Increases relevance to policymakers, making results more likely to be used.
- Identifies priority challenges, areas for intervention, and potential trade-offs.

Key Insights for Transport and Energy in Zambia

This participatory scenario-building process examined the transport and energy sectors and identified priority areas relating to policy, income, and investment levels. The scenarios offer actionable insights for policymakers:

- Effective planning must go beyond infrastructure investment and prioritise strategic direction.
- Strong governance and policy frameworks are critical to successful implementation.
- Equity is non-negotiable, as it is crucial in the long run.
- Integrated planning is needed to anticipate trade-offs

These scenarios provide a resource for policymakers, modellers, and stakeholders to guide long-term decision-making. For example, the Ministry of Local Government and Rural Development and Lusaka City Council could use them to facilitate stakeholder dialogue. They can be updated through new modelling, additional participatory engagement, or emerging evidence such as the work of the Sustainable Urban Mobility Committee (SUMAC) in validating NMT pilot projects. This iterative scenario-building approach, when combined with modelling, policy debates, and stakeholder deliberation, will help policymakers to shape more sustainable and equitable outcomes.

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