TRANSITION PATHWAYS TOWARDS INCLUSIVE CLIMATE-COMPATIBLE GROWTH: MODELLING, FUTURES, AND DECISION-MAKING IN ZAMBIA – TRAP-ZM

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Abbreviations

AGS	Accelerated Growth for SMEs in Zambia
CCG	Climate Compatible Growth programme
CE	Circular economy
CEEEZ	Centre for Energy, Environment and Engineering of Zambia
CIGZambia	Cities and Infrastructure for Growth Zambia
CLEWs	Climate, Land-use, Energy and Water Systems
COP	Conference of the Parties
EMA	Environmental Management Act
EPC	Energy Planning Centre
EPR	Extended Producer Responsibility
FCDO	Foreign, Commonwealth & Development Office
GDP	Gross Domestic Product
GHG	Greenhouse gas
GNI	Gross National Income
GtR	Greening the Recovery project
IFPRI	International Food Policy Research Institute
IRENA	International Renewable Energy Agency
LMIC	Lower middle-income country
MGEE	Ministry of Green Economy and the Environment
MIC	Middle-income country
MLGRD	Ministry of Local Government and Rural Development
MoE	Ministry of Energy
MoFNP	Ministry of Finance and National Planning
NDC	Nationally Determined Contribution
NDP	National Development Plan
NGO	Non-governmental organisation
NISIR	National Institute for Scientific and Industrial Research
OSeMOSYS	the Open Source energy MOdelling SYStem
PEA & PI	Political Economy Analysis and Policy Influence
R&D	Research and Development
SAM	Social Accounting Matrix
SDG	Sustainable Development Goal
SI	Statutory instrument
SME	Small and Medium Enterprises
SWRMA	Solid Waste Regulation and Management Act
TRAP-ZM	Transition pathways towards inclusive climate-compatible growth: modelling, futures and decision-making in Zambia
UCL	University College London
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WESM	Whole Energy System Model
ZIPAR	Zambian Institute for Policy Analysis and Research
8NDP	Eighth National Development Plan

Executive Summary

Zambia is rich in human capital and abounds with natural and environmental riches. The country aspires to become a prosperous middle-income country by 2030, lifting living standards by improving the 'efficiency and competitiveness of the economy' (MoFNP, 2022, p.3). The government has resolved to transition to a green economy and foster sustainable, resilient, low-carbon development that promotes resource efficiency and social inclusion (MGEE, 2024).

A holistic and concerted approach is fundamental to charting the course for a green transition while at the same time attaining middle-income status. Examining the technical and resource implications of these targets is also fundamental and will help highlight any physical and socio-economic constraints or challenges. This entails an understanding of the political economy and the social realities within which these transitions will take shape for them to be successful. Specifically, it is crucial to ensure that coordinated efforts are made to include diverse stakeholders in decision-making.

This report presents the **"Transition pathways towards inclusive climate-compatible growth: modelling, futures and decision-making in Zambia"** (TRAP-ZM) research project. TRAP-ZM was carried out between 2022 and 2024 as a sub-project of the Climate Compatible Growth (CCG) programme, which is funded by the UK's Foreign, Commonwealth & Development Office. TRAP-ZM was a collaboration between the Zambia Institute for Policy Analysis and Research (ZIPAR), Tec Analytics, the Centre for Energy, Environment and Engineering Zambia (CEEEZ), Imperial College London (ICL), and University College London (UCL), with support from the University of Zambia (UNZA).

Using an interdisciplinary approach, the TRAP-ZM project combined participatory, qualitative, and quantitative methods, aiming to inform and advance climate-compatible transitions in Zambia. Scenarios exploring centralised, decentralised and hybrid versions of national development pathways were co-developed with stakeholders from various government ministries, civil society organisations, academia, and development partners (Section 3). This provided an overarching framework within which to discuss and analyse future system changes.

To provide quantified perspectives of the opportunities for, and implications of, change in the wider energy system, an initial Whole Energy System Model (WESM) of Zambia was developed and enhanced (Section 4). A new economic analysis based on a Social Accounting Matrix quantified the economy-wide repercussions of corresponding investments in green energy (Section 5). A bespoke land-use change analysis was developed to further explore the land and biomass implications of the scenarios (Section 6), while policy analysis and interviews were used to assess opportunities and challenges for enhancing the circular economy in Zambia (Section 7). Finally, bespoke training was developed to strengthen the capacity of technical stakeholders working at the science–policy interface (Section 8).

The research presented here, and its underpinning approach, has the potential to support energy planning and wider sustainable development in Zambia. Achieving this relies on capacity building and effective knowledge transfer between the project team and wider stakeholders. To ensure technical modelling capabilities and model ownership are retained locally, the WESM of Zambia was co-developed with local practitioners who were trained in developing Whole Systems Approaches and in model building over the course of iterative analytical workshops. In order to support capacity building of non-state actors and technical experts with the necessary knowledge and skills to effectively engage with the policymaking process, TRAP-ZM also co-designed and delivered bespoke training on Political Economy and Policy Influence to influence evidence-based decision-making. Upon reflection, three features were essential to deliver the project, and can be fostered in future sustainable development research that aims to empower local energy system stakeholders: (1) an interdisciplinary research design that encompasses quantitative, qualitative, and mixed-methods; (2) an inclusive approach with diverse stakeholder groups; and (3) a systemic outlook to ensure trade-offs, synergies, and complexities are taken into account.

"The research presented here, and its underpinning approach, has the potential to support energy planning and wider sustainable development in Zambia"

1 OVERVIEW OF TRAP-ZM

Climate Compatible Growth (CCG) is a research and technical support programme funded by the UK's Foreign & Commonwealth Development Office and delivered through a consortium of universities[1]. It aims to support low-carbon development by fostering policies for, and encouraging investment in, sustainable energy and transport systems to meet development priorities in partner countries, including Zambia.

The CCG project **"Transition pathways towards inclusive climate-compatible growth: modelling, futures and decision-making in Zambia"** (TRAP-ZM) has contributed to a growing evidence base to support sustainable development[2]. TRAP-ZM focused on informing sustainable, resilient, and just transitions to a modern and green development pathway. This was done by bringing together an integrated programme of quantitative and qualitative workstreams, including participatory scenario development, energy system modelling, macro-economic and land-use toolkits, and circular economy and project bankability assessments.

As shown in **Figure 1**, these activities were interlinked, and had a strong capacity-building component with training in both quantitative and qualitative skillsets. TRAP-ZM applied co-creation and participatory processes to ensure that all analysis was strongly driven and informed by national stakeholders.

The aim of TRAP-ZM was, therefore, to highlight the potential for mixed-methods approaches to support inclusive, informed, and robust policymaking to underpin future development pathways. By applying participatory and codesign-based methods, the objective was to support in-country needs across a wide range of interconnected energy topics, exemplifying how inter-disciplinary approaches can foster expertise in planning self-sustaining transition pathways.

Participatory scenario development built on existing narratives described in Nyambe-Mubanga *et al.* (2023). This used multiple workshops with diverse stakeholders, interspersed with semi-structured expert interviews, to co-create different visions of Zambia's green transition.

Analytical building blocks were designed to assess the implications of this scenario framework. Together they form a modelling toolkit that can support integrated planning across energy, land, and economic systems[3], which includes the OSeMOSYS-Zambia Whole Energy System Model (WESM), which is linked a power sector model called Antares; a model of the economy to provide estimates of scenario impacts on GDP, income, and employment; and a land-use change model that estimates land-use change, biomass resources, and greenhouse gas emissions consistent with each scenario.

Finally, a study on the emerging topic of circular economy was undertaken using a qualitative approach. This activity explored the policy environment in Zambia to understand if, and how, circular principles of reduce, reuse, and recycle

[1] More information on both the programme and its partner institutions is available at https://climatecompatiblegrowth.com

[2] Note that the CCG programme Logical Framework implicitly defines the notion of "Growth" by clarifying that the impact of its work is to achieve "Improved climate compatible growth for developing countries in Africa, Asia and other regions through breakthrough increases in the level of investment – or reorganisation of spend patterns – in infrastructure, services and policy. These accelerate economic growth, and decelerate GHG-emissions per unit of growth". This Logframe is available online and may be subject to periodic updates (FCDO, 2022).

[3] Resulting tools are made available under an open license to enable their use by interested institutions (see Tembo and Pye, 2024 and forthcoming OSeMOSYS and Land-Use papers).

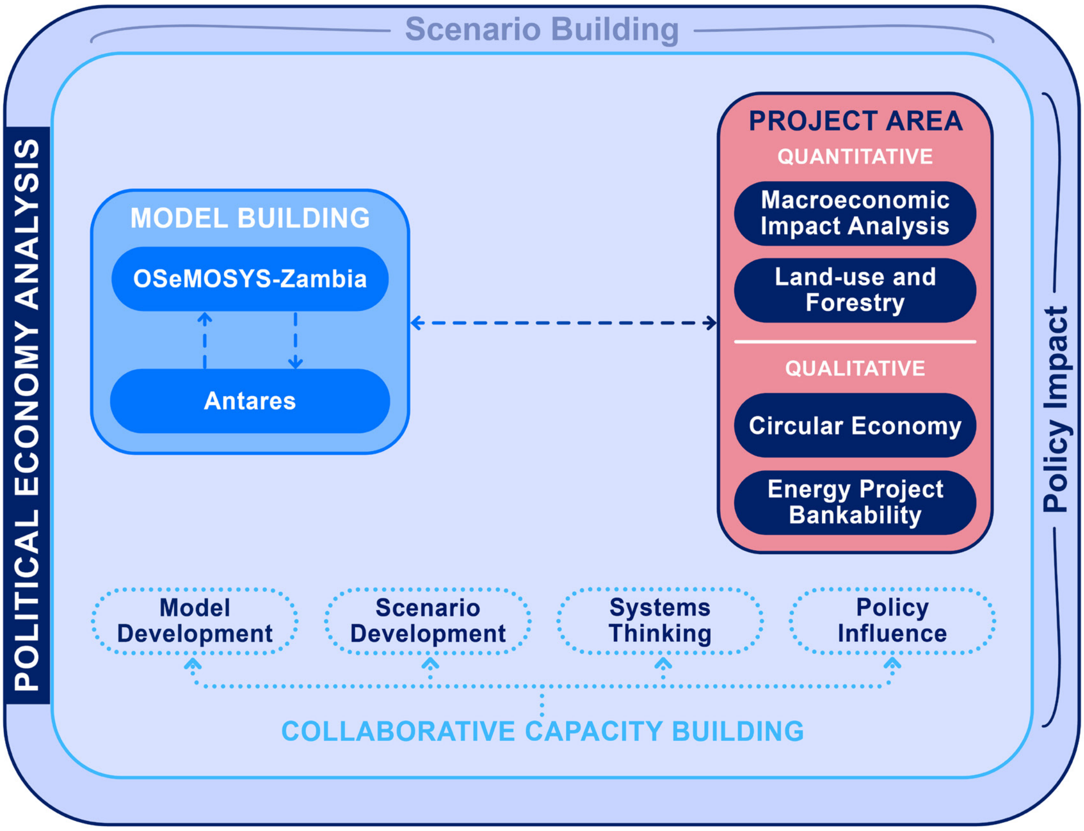
are embedded into the policy landscape. Taken together, these elements describe a potential institutional environment within which consistent and inclusive thinking about the future of Zambia can be developed. The outcome is a set of consistent potential future pathways that can support structured and informed policy conversations. Note that ongoing work regarding the project bankability assessments will be discussed in future TRAP-ZM reports.

This report presents the results of the different components of TRAP-ZM. The section that follows describes the national context, including current challenges and ongoing policy developments (Section 2). Thereafter the report is structured as an edited collection of chapters, each one focusing on a nested component of TRAP-ZM. These are:

- Introduction to and use of scenario thinking (Section 3)
- Development and use of whole energy system modelling (Section 4),
- Energy investment analysis using a social accounting matrix approach (Section 5),
- Exploring and quantifying future pathway implications for land use (Section 6)
- Taking a closer look at a circular economy case study (Section 7)
- Looking into evidence-based decision-making, political economy, and policy influence (Section 8).

The report closes with some reflections on the research and analysis process involved in when looking to support long-term, sustainable, and evidence-based policymaking processes.

***Figure 1:** Components of the TRAP-ZM project showing: (i) How the OSeMOSYS-Zambia WSM (OSeMOSYS-ZM) is linked to power sector modelling with Antares; (ii) How soft links to Energy–Economic–Land modelling toolkits for Zambia are co-developed; (iii) How qualitative research developed deep contextual insights to ensure policy and sectoral relevance of any quantitative outputs; and (iv) How project components were shaped by stakeholder interactions and co-developed through capacity building.*



2 CONTEXT

Zambia has the potential to develop a climate-compatible, prosperous future in line with its stated policy ambitions: for example, Vision 2030 (Republic of Zambia, 2006), the National Green Growth Strategy (MGEE, 2024), and the Nationally Determined Contribution (NDC) (Republic of Zambia, 2021), etc. The country is rich in both human capital and natural resources, yet high levels of poverty and inequality persist against a complex socio-economic backdrop where clean water, health services, energy, and other essential services are not universal or evenly accessed across the country. This often leaves citizen needs unsatisfied and exposed to adverse impacts from climate change (Hughes et al., 2024).

As outlined in its Vision 2030 strategy, Zambia aspires to reach a prosperous middle-income country status by 2030[4]. The Vision is underpinned by values of socio-economic justice and is supported by strategies to address aspects of gender, sustainable development, economic prosperity, the democratic rule of law, and respect for human rights[5]. This Vision aims to create opportunities for improving livelihoods and wellbeing for all, noting the need for affordable energy and equitable opportunities across urban and rural populations. Importantly, while it recognises the need for universal access to abundant and affordable resources, Vision 2030 also places the social and environmental costs of these resources in the balance alongside economic objectives.

Vision 2030 has been operationalised through five-year National Development Plans (NDP), starting with the Fifth NDP (2006–2010). The country is currently guided by the Eighth NDP (8NDP) 2022–2026, which aims 'to improve the efficiency and competitiveness of the economy to sustainably lift the living standards of the people' (MoFNP, 2022, p.3). However, economic challenges are making parts of Vision 2030 difficult to deliver in real terms. While initial targets set a goal of 6 to 8% annual real economic growth, real GDP growth fell short at 5.2% on average between 2006 and 2021. Successive declines from strong rates of 8.7% seen until 2010 have led to slower economic growth in recent years (1.4% between 2017 and 2021). This decline is due to several factors including unfavourable weather conditions which impacted the agriculture and energy sectors; the COVID-19 pandemic which disrupted supply chains and required lock-down measures, leading to a 2.8% contraction in the economy; and a worsening fiscal position that resulted from increased domestic borrowing and crowded out the private sector.

While GDP growth recovered somewhat in 2021, the country remains weighed down by a significant debt burden which has seen it undergo debt restructuring through the International Monetary Fund Extended Creditor Facility programme. A Debt Treatment Agreement was reached with the country's official creditors in June 2023.

[4] Middle-income countries (MICs) are those whose Gross National Income (GNI) per capita falls between levels used to define low- and high-income countries. In the current fiscal year this diverse group is made up of 108 states with GNI/capita between US$1,136 and US$13,845. MICs are further split into lower- and upper-middle income categories. In 2006, Vision 2030 outlined the ambition of moving from lower income into the higher end of the MIC group by 2030. Zambia has been classified as a lower middle-income country since 2018.

[5] The exact principles that underpin the Vision 2030 are: '(i) gender responsive sustainable development; (ii) democracy; (iii) respect for human rights; (iv) good traditional and family values; (v) positive attitude towards work; (vi) peaceful coexistence and; (vii) private-public partnerships' (Republic of Zambia, 2006, p.2).

Key aspects of these economic setbacks are strongly linked to Zambia's vulnerability to adverse effects of significant changes in climate, with increased climate variability continuing to negatively affect Zambia's development and the wellbeing of citizens. In a country where food production is dominated by rainfed agriculture and hydropower provides 91% of centralised electricity (IRENA, 2023), recent droughts and floods have had severe negative impacts on livelihoods, access to energy, and infrastructure. In early 2023, the worst floods the country had experienced in 50 years resulted in flooded houses, damaged national infrastructure (roads and bridges), and evacuations of people in Lusaka and Southern and Eastern Provinces. Severe droughts in 2015/2016, 2018/2019, and 2023/2024 have negatively impacted the agriculture, water, and energy sectors. Together, these climatic events have led to a decrease in hydroelectricity generation, heightened food insecurity, and limited access to clean water.

These impacts have been compounded by the unsustainable exploitation of the country's natural resources. According to the 8NDP, deforestation has been a major factor, with the country losing an estimated 172,000 hectares of forest cover per year since 2018 (MoFNP, 2022). The 8NDP further identifies land degradation, the expansion of both human settlements and unsustainable patterns of consumption, production, or natural resource use (eg fishing) as key factors in the ongoing erosion of natural capital and loss of biodiversity. In particular, the expansion of mining operations, the growth in agricultural uses of land, and the collection of biomass from forested areas are linked to environmental degradation (MoFNP, 2022). Poor environmental management practices exacerbate these dynamics, increasing the threat of air, water, and land pollution.

An initial response to these threats and environmental degradation effects has been suggested as part of Zambia's 2021 NDC to the United Nations Framework Convention on Climate Change (UNFCCC). This includes undertaking mitigation actions through, for example, sustainable forest management, sustainable agriculture, and renewable energy and energy efficiency.

The Green Growth Strategy, released in April 2024 by the Ministry of Green Economy and the Environment (MGEE, 2024), offers a further response to these challenges. The document advocates for 'a model of development that promotes low carbon and resilient economic growth, social inclusion and human well-being, and efficient use of resources' (p.4). Five explicit development pillars describe a framework that foregrounds resilient and climate-compatible growth, enhanced resource efficiency, enhanced natural capital, and improved inclusivity, and creating an enabling environment for green growth. Inclusivity and equity are here entwined. In the context of the Green Growth Strategy, "inclusive" futures are futures where economic benefits derived from green growth accrue equitably across all levels of society and where access to basic services and livelihood opportunities are distributed fairly across the country[6]. This pillar is of particular interest in the Zambian context where decentralisation of decision-making has been built over time into a national strategy[7] and where it is therefore increasingly reflected in institutional structures.

[6] More generally, inclusive growth refers to an economic strategy that consciously addresses poverty levels and income inequality; promotes socially inclusive development by creating decent jobs; ensures benefits and opportunities reach both urban and rural populations; strengthens social protection by emphasising economic, social, and environmental sustainability; and enhances access to basic services (water, electricity, sanitation, housing, healthcare, education, and skills development). It involves social dialogue and includes vulnerable groups in decision-making processes.

[7] Zambia reviewed its Decentralisation Policy (2004) in 2013 and identified functions to be devolved; signed African Charter on the Values and Principles of Decentralisation, Local Governance, and Local Development in 2016; enshrined a devolved system of governance into Act No. 2 of its Constitution in 2016; and used the Local Government Act No. 2 of 2019 to establish a platform for citizen participation at a sub-district level through Ward Development Committees.

3 SCENARIO THINKING

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Research Highlights:

- This research used a participatory scenarios approach to consider possible future pathways for Zambia.
- Three scenarios were developed, representing different positions along a governance spectrum ranging from Centralised to Decentralised. These were used as a basis for discussion with stakeholders.
- The findings suggest that stakeholders preferred a "hybrid" between Centralised and Decentralised approaches, but further consideration is needed to understand the balance between the benefits of economies of scale and local decision-making in different sectors.
- The scenarios framework applied helped broaden the perspective from a single-problem, siloed view to instead recognise the interconnectedness between sectors and issues, as well as the risks and opportunities of different future pathways.

Introduction

Scenarios provide a framework for improving decision-making in the context of an uncertain or undecided future. They help us to think through the implications of different choices and can reveal how resilient these choices may be to different future risks or stresses. As an exercise undertaken within a community or group of people, they can also form the basis for a constructive collective conversation about these choices, identifying areas of consensus as well as allowing for areas of difference.

Methods

In a previous project, *Greening the Recovery* (GtR), the project team co-developed participatory scenarios that considered contrasting pathways to future climate-resilient prosperity in Zambia. The process and outcome of GtR are reported in detail in Nyambe-Mubanga *et al.* (2023). TRAP-ZM continued this participatory approach by taking the scenarios back to stakeholders, and using them as a basis for further structured conversations about opportunities and risks in future climate resilient development pathways. These conversations took the form of 30 semi-structured interviews with representatives of local and national government, NGOs, industry and private sector, finance, academia, and traditional leadership. The participants were based in Lusaka, and Central, Northern, and Southern provinces. Three[8] scenario focused workshop events were conducted to share and discuss the contents of the scenarios and the scenario building approach.

Findings: exploring and expanding the scenarios

Under GtR, three scenarios were developed: (1) centralised; (2) decentralised; and (3) hybrid (**Table 1**). The *Centralised* scenario imagines

[8] The workshop took place in October 2023 in Lusaka, Zambia, and was solely focused on scenario thinking. The following two workshops were one-day scenario training workshops held in February 2024 in combination with the second OSeMOSYS training workshop (Section 4) and the second Political Economy and Policy Influence training (Section 8).

Table 1: Summary of the Greening the Recovery Scenarios (please see "further readings" below for more information and in-depth scenario descriptions)

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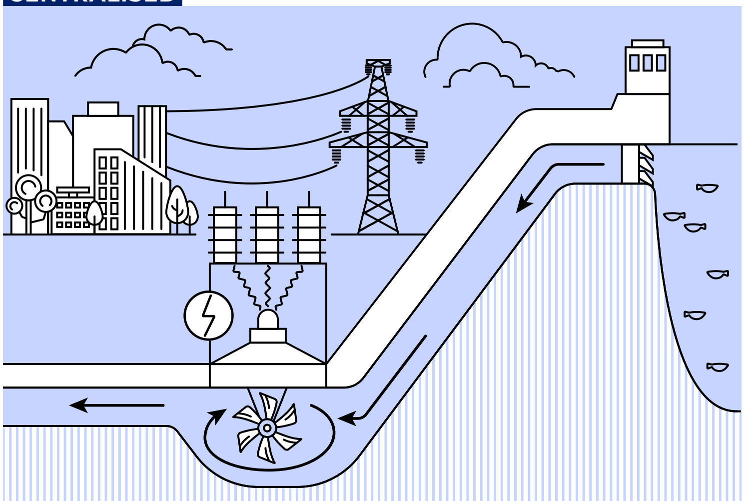
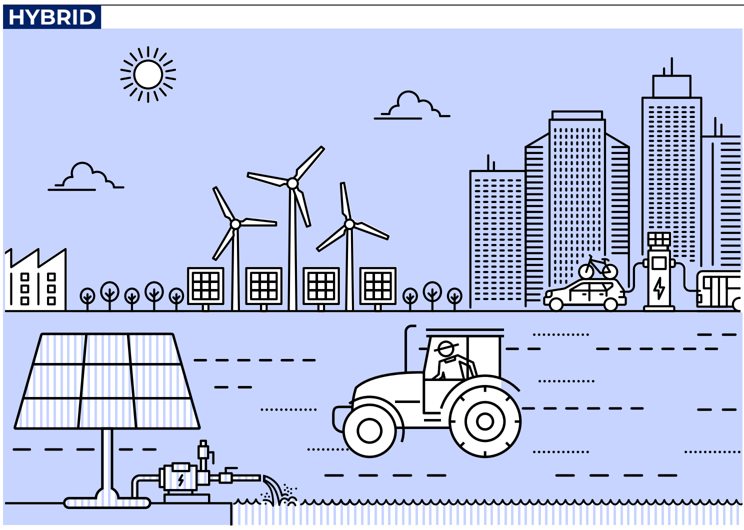


- Export-led trade strategy
- Investments in large-scale infrastructure
- Enabling environment for mining
- Large-scale electricity generation and transmission infrastructure, grid connections, and export
- Public–private partnerships for investments in bulk transportation infrastructure
- Agricultural intensification for food security, exports, and biofuels
- Continued rural–urban migration

DECENTRALISED

- Decentralisation and devolution of governance
- Mining companies make greater fiscal contributions and invest in value addition
- Development of skills for manufacturing of low-carbon technologies for value addition
- Growth in small-scale agriculture and fostering of sustainable rural livelihoods
- Regional markets and value-adding activities
- Small-scale renewable energy hubs supporting productive activities
- Clean cooking through sustainable biomass, biogas, and electricity

HYBRID



- Pursuing elements of Centralised and Decentralised in tandem
- Off-grid energy hubs and large-scale power plants where each make sense.
- Investments in bulk transportation corridors and regional networks
- Large-scale agriculture and small-scale rural livelihoods
- Circular economy at both large and small scales

large-scale production in mining, agriculture and biofuels, large scale electricity generation and export, and centralised approaches to governance. The *Decentralised* scenario imagines small-scale investments in energy hubs and value-adding activities to sustain livelihoods in rural areas, lower rural–urban migration, and strong investment in internal knowledge development and skills. The *Hybrid* scenario considers whether elements of both can be combined.

The scenarios are not predictions, and they are not "set in stone"; rather they provide a flexible framework for having open conversations about possible future options. Our work in TRAP-ZM builds on, extends, and deepens these three scenarios.

A clear majority of interview participants preferred a form of Hybrid scenario when assessing the merits and challenges of each option. The Centralised scenario was desirable because of the ambition and scale of its output, including in energy and agricultural produce. An industry representative spoke of the *"merit"* of an *"export-led trade strategy"* and of *"bulk energy production."* At the same time, aspects of the Decentralised scenario were favoured for their inclusiveness in respect of lower income and rural citizens, with a participant from the finance sector feeling that such approaches would better *"support the local farmers and cooperatives to grow into larger SMEs [small and medium enterprises] that form [...] part of the supply chain that we're looking to expand and grow"*. A government ministry representative felt such an approach could also enable regions to focus on *"what [they] do well... according to the regional strength"*. However, there were different views on which sectors should be decentralised. Some suggested that a pragmatic approach that accounts for advantages of potential economies of scale could help to make sense of which areas were best suited for one approach or another, with a representative of finance suggesting that *"depending on the sector that you're dealing with, one model might be well suited in this one sector than the other sector"*.

> Future changes to the climate threaten continued disruption in rainfall patterns

The need for resilient climate-compatible growth was seen as critical. Outputs from rainfed agriculture and a power sector dominated by hydropower have been affected by severe droughts, and future changes to the climate threaten continued disruption in rainfall patterns. A representative of a regional utility noted that *"now with these climate change issues [...] we need to start thinking of other energy sources"* and that resilient strategies for small-scale farmers should be considered, as for such people if *"the rain goes you lose out completely"*. Both Centralised and Decentralised scenarios substantially reduce the electricity system's relative dependence on hydropower, but because of the larger overall size of the energy system in Centralised, this scenario still needs to add substantial quantities of new hydro in absolute terms.

Limiting dependence on hydropower can mitigate climate risks in the electricity sector; but a system dominated instead by variable renewables may face other challenges – in particular, attention must be paid to measures to balance supply and demand, such as investments in storage and demand-side response (Sinsel *et al*., 2020). The northern regions of the country experience higher average rainfall and are expected to continue to experience relatively less water scarcity than other parts of the country even if water scarcity increases overall across the country with future climate change impacts (MoE, 2024). Consequently, it has been suggested that future development of hydropower (MoE, 2024) and of agriculture (Chisalu, 2024) could move into the less water-stressed northern regions. It will be important to consider interacting water needs between energy, agriculture, and land use, and whether future developments could create new resource stresses – especially if both hydro *and* agriculture tend to move into northern regions due to increased water scarcity in the south[9].

Inclusive growth requires capacity and value addition at all scales and economic levels. Historically Zambia's growth has been intermittent and not inclusive. Our discussions suggested the need for coordinated interventions that provide alternative energy and sustainable resource solutions. At the same time, these interventions should nurture value-addition and productive activities that use the energy or resources in a way that generates income. Finance representatives spoke of the importance of building *"capacity, value chains, linkages"*.

Several participants, including representatives of local government, regional utilities, the planning and finance sectors, and NGOs, spoke of **the importance of coordinated regional planning**. This can identify local needs as well as economic opportunities and link these to resource availability and infrastructure requirements. One local government representative gave the example that intervening on clean cooking requires a location-specific understanding of resources and alternative economic opportunities, so that *"we find alternative income-generating activities"* and for the alternative cooking fuel we *"provide a solution that is easily accessible"*. The same participant added that local-level surveys are crucial to understand *"what are the problems,*

“Historically Zambia's growth has been intermittent and not inclusive”

what are the gaps". Many districts have already developed *"Integrated Development Plans"*, which may provide important vehicles for integrated planning, as they provide an opportunity for spatial analysis combined with identification of resources and economic opportunities at the local level. These could be further enhanced by integrating energy, water, and transportation planning, identifying which kinds of investments are critical to enabling this vision. These priorities could then be used as a basis to guide the Constituency Development Fund or other investments.

It was argued that ***"intermediaries"* or *"aggregators"* could help to channel finance from larger, more conventional financial institutions to support income-generating activities**. This was a point emphasised by representatives of the finance sector and NGOs, who highlighted the importance of entities, such as coordinating agencies, cooperatives, and SMEs, in unlocking the productivity of entrepreneurs who have limited access to capital.

Building knowledge, skills, and innovation is key to any scenario. Past transitions show that technology transfer combined with clear domestic long-term investment strategies can play an important role in increasing incomes and skill bases (Watson *et al*., 2019). Numerous stakeholders, including from industry, NGOs, local and national government, and finance emphasised the importance of these aspects,

[9] Note that these water uses should be understood as fitting within a sustainable resource use pattern that also provides for the ecosystem and natural environment's water needs.

for example a finance representative summarised that *"the need for knowledge transfer is high"*. Articulating technology and knowledge transfer wish-lists and long-term research and development (R&D) plans, based on Zambia's comparative advantages (eg minerals), is fundamental. Developing a long-term vision within a scenario framework can be useful to help external partners see their role in this process. Zambia should also nurture existing knowledge institutions. This could include investing in universities and research institutes such as the National Institute for Scientific and Industrial Research (NISIR); developing accelerator labs, which link universities to market commercialisation; or seeking in-kind contributions to skills, training, and knowledge transfer from external partners, such as foreign private companies and investors in Zambia or multilateral or bilateral donors.

Most participants felt that 'Green' and 'Growth' could or should go hand in hand, but that this would require planning and consultation. One finance representative called for *"a solid plan"*, and another for developing strategies that are *"relevant to our country"* by engaging communities. Choices between mining and preserving natural areas display these green versus growth tensions. This was a topic about which there were diverse opinions including among local and national government representatives, NGOs, traditional leaders, and others; it was not straightforward to associate a particular view on the issue with a particular group of participants. While some emphasised that preserving the environment would itself unlock longer-term growth potential, for example through tourism, others felt that the prospect of local jobs from mining in the near term was important. In any scenario, however, attention to inclusiveness and longevity of jobs, along with the need to build capacity in key skills, were seen as important to enable local participation.

Most participants agreed that Zambia suffers from an "implementation gap", in that while there are good policies "on paper", they suffer from a lack of successful implementation. Explanations for this gap varied, with some attributing it to lack of funding, lack of human capacity to administer the funding, or lack of institutional accountability. A finance representative emphasised, *"if you don't implement, there should be a problem with that. Somebody should call you up and say, well, this hasn't been done, why? But you don't see that sort of aggression […]"*. Government departments and agencies were seen by an NGO representative to lack *"mandate"*, *"capacity"*, and *"autonomy"* to implement successfully, or that there was a lack of legislation and the ability to enforce. For some, including from the finance community, overly complex policy arrangements were slowing down implementation. Representatives of industry and academic research highlighted the lack of joined up cross-sectoral linkages and stakeholder engagement, whereas some representatives of NGOs emphasised the lack of political continuity and political will spanning changes in government administrations.

Overall, scenarios can provide a constructive framework for considering future strategic options and resilience to future threats. Participants emphasised the importance of scenarios to identify alternatives, and

> "Attention to inclusiveness and longevity of jobs, along with the need to build capacity in key skills, were seen as important to enable local participation"

the implications of pursuing them. Some emphasised the importance of scenario thinking in planning for resilience against future external threats. As summarised by a representative of a regional utility: "we need to prepare in advance so that it doesn't become a surprise to us". A representative of Traditional Leadership emphasised the potential use of scenarios in facilitating discussions about future development at a community level: *"answers are with the community themselves [...] people need to be consulted"*.

Useful scenarios are always a work in progress. Future work could build on the scenarios developed under TRAP-ZM, for example as part of ongoing planning processes. This could include examining alternative sets of driving forces in addition to decentralisation issues, reviewing other external risks, or investigating risks in more detail, considering outcomes against ranges of different climate change outcomes. Future scenarios could also explore different spatial scales, which would require expanding the scenario exercise to engage with communities at regional, municipal, or local scales; cross-sectoral interactions, such as climate-energy-water-land use; or the effect of economic opportunities on issues such as charcoal production. Future collaboration between the Zambian Institute for Policy Analysis and Research (ZIPAR) and the Ministry of Energy's (MoE) newly established Energy Planning Centre (EPC) could be ideally placed to drive this future use and development of scenario-based methodologies for energy system planning in Zambia.

Discussion – relevance of scenarios to the Green Growth Strategy

The discussions with stakeholders about possible future scenarios can also be used as a basis for exploring further each of the five pillars of the green growth strategy.

Zambia is seeking to pursue future **growth that is resilient and climate-compatible**. This includes considering resilience to global market dynamics. Dependence on copper extraction[10] has historically been associated with variable rates of growth. In contrast, diversifying economic activity and pursuing greater value addition could deliver more stable and inclusive growth. It may be worth reconsidering the value of setting growth targets in terms of tonnes of mineral extraction. A different focus could instead look at developing long-term partnerships with private sector investors that are as much about equitable investment in skills development and domestic supply chains, as they are about tonnes of extraction and associated profit taxation. Resilience to climate impacts is also a crucial consideration. Energy planning should be cautious about adding hydropower, and it should engage with stress tests based on extreme as well as moderate climate scenarios.

The current drought conditions, as well as the threat of future low rainfall, emphasise the importance of **resource efficiency** for **enhancing and preserving natural capital**. Dissemination and incentivisation of precision irrigation techniques and promotion of drought resistant crop varieties among both small-scale farmers and large-scale commercial farmers were expected to be essential.

Growth must not be at the expense of **inclusiveness**. Investments should reflect needs and priorities of communities, but

[10] Zambia has significant mineral resources including deposits of copper, cobalt, manganese, gold, and gemstones. The mining sector is a strong driver of economic growth averaging a 14.8% share of GDP between 2011 and 2020 and contributing 30% of government revenue in 2023. This share is poised to increase as future national strategies expect (eg copper) extraction to move from 800 thousand to 3 million metric tonnes annually by 2031 (MGEE, 2024; MoFNP, 2022).

within a strategic regional framework. There is an important role for intermediaries and aggregators to support SMEs and channel finance from larger financial institutions.

In the longer term, **creating an enabling environment for transformative green growth** requires strategic and forward-looking action to put in place knowledge, skills, and external partnerships required to build innovation. These processes take time and require consistent long-term frameworks, rather than only seeking returns within short-term political cycles. Reducing the "implementation gap" can be achieved through nurturing a culture of transparency and accountability. Scenarios may be a useful tool for framing conversations with external partners, identifying their role in helping to support such longer-term transitions.

Policy Recommendations

The research provides a variety of policy-relevant insights and recommendations, including:

- Zambia should seek to pursue future growth that is resilient and climate-compatible. This includes considering resilience to global market dynamics, as well as to future climate stresses, and it requires building "testing for resilience" into future scenario thinking in Zambia.
- Growth must not be at the expense of inclusiveness. Investments should reflect needs and priorities of communities, but within a strategic regional framework.
- Navigating between Centralised and Decentralised futures should account for their diverging opportunities for skills development and value addition, and their different balances between economy of scale and local decision-making.
- In the longer term, creating an enabling environment for transformative green growth requires strategic and forward-looking action to put in place the knowledge, skills, and external partnerships required to build innovation.
- Holistic scenario development activities[11] encourage creative thinking about the future, moving from siloed views of the world towards an understanding of the trade-offs and synergies that different sectors could experience across different future pathways.

> “Investments should reflect needs and priorities of communities, but within a strategic regional framework”

Further reading and resources:

- Final Research report written by ZIPAR and University College London (UCL) looking into "Greening the Recovery in Zambia". Available here.
- Forthcoming journal publication by Nick Hughes *et al*. "Towards Green Development in Zambia: A Mixed-Method Participatory Scenario Approach". Preprint available here.
- Note that delivering new scenario building workshops focused on co-development of potential energy system transition pathways can be discussed upon request.

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[11] This can also be referred to as "Whole Systems Thinking". This does not imply complete compliance with the clear Systems Thinking literature definition of Whole Systems Thinking methodologies as in Meadows (2008) or Checkland (1999). For example, while our approaches explicitly use the Systems Thinking philosophy – eg by looking at the political economy structure and conditions that can lead to emergent system properties – we do not explicitly explore causality between system elements and how they evolve over time.

4 WHOLE ENERGY SYSTEM MODELLING

AUTHORS: Bernard Tembo (Tec Analytics), Yanda Hamilemba (Tec Analytics), Leonhard Hofbauer (UCL), Ariane Millot (ICL), Jen Cronin (UCL), Steve Pye (UCL), Nick Hughes (UCL)

Research Highlights:

- CCG collaborated with Cities and Infrastructure for Growth Zambia (CIGZambia) and Tec Analytics to further develop the OSeMOSYS-Zambia whole energy system model, focused on the power, industry, transport, and residential sectors.
- Local capacity-building workshops, including gradual participatory approaches to model development, were utilised to establish a whole energy system modelling community of practice (Energy Planning Special Interest Group) that can support future policy and energy investment decision-making.
- Scenario approach discussions ensured modelling was seen within the wider context of transition pathways, discussing important connections between, for example, energy, land use, and water.
- Collaborative analysis continues to focus on supporting the clean cooking strategy – with MoE, United States Agency for International Development (USAID) and Modern Energy Cooking Services (MECS) – and on assessing energy planning needs by linking power sector analysis to whole systems modelling – with MoE, ZESCO, and CIGZambia.

Introduction

Quantifying the energy system that underpins the scenarios outlined in Section 3 can provide crucial insights for energy system planning and help inform clean investment priorities. Building on the initial work of the *Greening the Recovery* project (Nyambe-Mubanga *et al*., 2023), the scenario modelling work under TRAP-ZM has established key building blocks of a modelling infrastructure that can support integrated energy planning in Zambia. This effort complements the comprehensive, power sector-focused work of the Integrated Resource Plan (MoE, 2024) and expands the analytical boundary to the entire energy system. Specifically, it establishes a framework for integrated planning that captures interactions between and dependencies across different sectors of the energy system, and it helps facilitate coordination across relevant ministries and other institutions.

OSeMOSYS-Zambia is one piece of this modelling infrastructure. The OSeMOSYS framework is a modelling platform for exploring the different energy system futures required to meet specified energy service demands (Howells *et al*., 2011). OSeMOSYS-Zambia is a whole energy system model that covers all major sectors of the Zambian energy system. It includes a representation of the energy supply system, including the power sector, as well as all major demand sectors, including transport, residential, and mining. It can provide insights under different scenarios as to the level of energy supply needed, the types of technologies

> “Discussions ensured modelling was seen within the wider context of transition pathways, discussing important connections between, for example, energy, land use, and water”

Group photo from workshop, February 2024, QT Lodge, Chilanga.

> "The workshop series was cohosted with the University of Zambia, CIGZambia, and ZIPAR and organised in collaboration with the Ministry of Energy"

needed, the investment requirements of those future systems, plus how this impacts CO_2 emissions. It uses a linear optimisation approach to determine least cost pathways, taking account of policy objectives and other factors, such as resource and technology availability. This section describes the progress to-date of this ongoing activity, as well as information on how to find future updates.

Co-development and capacity building

A modelling ecosystem based on the toolkit, specifically the OSeMOSYS-Zambia model, was built around two closely linked strands of activities – a series of training workshops, as well as model co-development activities.

The training workshop series focused on building capacity in whole energy system modelling using OSeMOSYS, specifically OSeMOSYS-Zambia, but also incorporated other related aspects, including data management and scenario thinking. The series started with a 1-day scoping workshop in Lusaka in April 2023, followed by a 2-day hybrid introductory workshop and two 4-day OSeMOSYS training workshops held in Lusaka in October 2023 and February 2024[12]. The workshop series was co-hosted with the University of Zambia, CIGZambia, and ZIPAR and organised in collaboration with the MoE. It included participants from a wide range of governmental, academic, and other institutions, including the MoE, the Ministry of Finance, the Ministry of Infrastructure, Housing and Urban Development, the national power utility ZESCO, the University of Zambia, and others.

The second strand of work involved the further development of the OSeMOSYS-Zambia model, working closely with local consultancy Tec Analytics. This included general updates and refinements to the model across different sectors, with an analysis focus on clean cooking and ongoing technical work with CIGZambia in establishing a soft-link between the OSeMOSYS-Zambia and Antares model[13].

The capacity building and model development work are documented on a dedicated GitHub

[12] The February 2024 OSeMOSYS training workshop incorporated a one-day Scenario Training workshop as part of work developed in Section 3.

[13] For further information on the Antares model for Zambia please see "Section 3 – Generation Modelling: Methodology" of the Integrated Resource Plan – Generation Planning report: https://www.moe.gov.zm/irp/?wpdmpro=generation-planning (MOE, 2024).

repository (see *Further Reading* at the end of this section) which will house documentation, model development notes, and more advanced scenario results forthcoming under continued CCG activities in Zambia.

Impact and next steps

The scenario modelling activities under TRAP-ZM have established a foundation for Zambia-based modelling to support integrated energy planning. In particular, they have contributed to:

- The further development of the whole energy system model OSeMOSYS-Zambia,
- Improved energy modelling capacity using OSeMOSYS in a range of institutions, and
- Increased interest in whole energy system modelling as a tool to support integrated energy planning.

Building on this foundation, CCG, CIGZambia, and MoE have formalised the capacity building on the OSeMOSYS-Zambia model, which will be further intensified in support of the MoE's EPC. Moreover, the OSeMOSYS-Zambia model, along with other tools, is being used to support the Ministry's Clean Cooking Strategy and Action Plan that is currently being facilitated by the USAID-funded Alternatives to Charcoal programme. This systems modelling will also integrate other strands of the TRAP-ZM project, in particular the scenario and land-use work and macroeconomic modelling, further leveraging and strengthening links between the different TRAP-ZM elements.

In support of a new project to provide further systems integration, the OSeMOSYS-Zambia model will provide the energy model for the Climate, Land-use, Energy and Water Systems (CLEWs) framework that is being developed by the Royal Institute of Technology (Stockholm), in collaboration with the United Nations Department of Economic and Social Affairs.

Policy recommendations

This is an ongoing activity within CCG, so specific policy recommendations are still under development. However, some broad policy takeaways have been identified:

- Energy planning should be developed to consider the whole system to inform linkages between energy supply and demand, such as how much electricity generation is needed to meet future demand, and to assess broader energy policy areas including clean cooking, energy imports, and industrial demand.
- Whole energy system planning therefore should be prioritised, with sustainable capacity put in place to support relevant ministries.

Further reading and resources:

- Training workshop materials are open source and freely available for download. Please visit Zenodo for documentation registered under record 8398341 (July 2023); record 10723537 (October / November 2023); and record 10719840 (February 2024).
- The OSeMOSYS-Zambia model is freely available. Please visit Zenodo record 10880002 for the July 2023 version or go to https://github.com/ClimateCompatibleGrowth/osemosys_zambia for versions maintained up-to-date and uploaded as they are developed. Note that this repository will be updated on an ongoing basis with further documentation, model versions, and scenario-based results as they are finalised under ongoing CCG programme work in Zambia.
- Note that delivering new capacity-building training workshops focused on Whole Energy Systems modelling can be discussed upon request.

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5 THE MACROECONOMIC BENEFITS OF ENERGY INVESTMENTS

AUTHORS: Bernard Tembo (Tec Analytics), Steve Pye (UCL)

Research Highlights:

- This study developed an extended Social Accounting Matrix database for 2019 to underpin new capability for testing macroeconomic implications of future transition pathways.
- The approach showcased capability by assessing broader economic impacts of policy intervention and investment in clean energy technologies resilient and climate-compatible growth.
- The findings point to significant macroeconomic benefits of clean energy investment, with little variation between benefit size for different renewable energy technologies. This suggests there is scope to consider other framings for decision-making (eg around inclusivity).

Introduction

As described in Section 3, Nyambe-Mubanga *et al*. (2023) co-developed centralised and decentralised transition pathways for Zambia, highlighting how clean investment in the energy sector could help meet longer-term development objectives and help 'green' the recovery from the COVID-19 pandemic. The scenarios demonstrated how sizable investments in electricity sector capacity could meet future energy demand growth while minimising emissions. This includes up to a ten times expansion in electricity generation, largely through investment in renewable capacity. The GtR analysis did not provide insights on the broader economic implications of these investments. Thus, this project has developed an approach for filling this gap, through the estimation of macroeconomic impacts of energy sector investments in Zambia.

Under TRAP-ZM, a multiplier analysis using a Social Accounting Matrix (SAM) was developed and applied, enabling estimation of the broader economic impacts of the energy sector investments. By definition, a SAM is an economy-wide database recording data on transactions between economic agents in a certain economy during a certain period of time, typically a year. This section provides a summary of macroeconomic analysis of the impacts of energy sector investment in Zambia, published in Tembo and Pye (2024).

Methodology

SAM based multiplier analysis

Understanding the socio-economic and employment outcomes of clean energy investments is essential for policymakers. Policymakers want to know such outcomes, for example to design strategies that can maximise job creation, minimise job losses, and ensure a just transition in the process of restructuring to a clean and green economy. Tools such as a SAM can help in quantifying, qualifying, and projecting the social and employment outcomes of such climate-related policy alternatives. In particular, the SAM is well suited to analysing the impact on labour outcomes and income distribution. The SAM makes it possible to analyse direct, indirect, and induced job effects at the sector level, via a multiplier analysis.

To assess the impact of a given intervention, such as clean energy investment, the SAM maps the effects for different sectors of the economy. These include both direct and indirect effects, with direct being those pertaining to the sector that is directly affected by the shock. Indirect linkages can be separated into production and consumption linkages, associated with impacts on other sectors. Combined, these lead to a measure of the shock's multiplier effect, or how much a direct effect is amplified or multiplied by indirect linkage effects (Breisinger *et al*., 2009).

A multiplier analysis allows one to understand the relative impact of an investment in one sector instead of another, as a larger multiplier indicates that an investment will bring greater benefit to the economy. This is important when a government is resource-constrained and exploring where to focus investment. The size of the multiplier effect depends on the structural characteristics of an economy. For instance, a key factor is the share of imported goods and services in households' consumption demand. If households consume domestically produced goods, then increasing household incomes will benefit domestic producers and the circular flow of income will lead to further rounds of indirect linkage effects.

Application of multiplier approach to Zambia

Zambia's extended 2019 SAM used in this analysis is based on the SAM that was developed by the International Food Policy Research Institute (IFPRI) (Pauw *et al*., 2021). The 2019 SAM was preferred to the 2021 SAM (Pauw *et al*., 2022) because 2019 was considered to offer a better representation of Zambia's economy as it was before the COVID-19 pandemic. In addition, this new extended SAM (based on the 2019 SAM), developed under the TRAP-ZM project, provides an improved disaggregation of energy activities and commodities necessary for a detailed macroeconomic analysis of the implications of the energy sector investment. Beyond the disaggregation of the energy activities and commodities, the SAM has disaggregated agricultural sector activities (capturing all major crops and livestock) and households by region (with a rural–urban split). In total, it has 55 economic activities , a total of 10 household types and a total of three labour types.

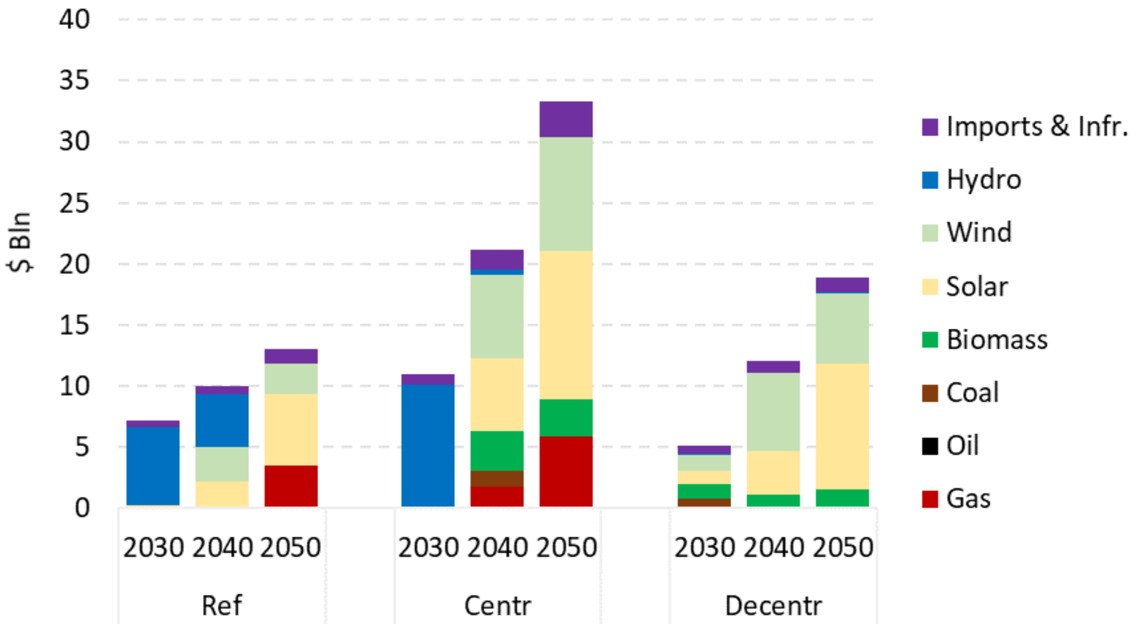
The purpose of constructing a SAM Multiplier Model is to assess the impact of energy investments on the wider economy, as captured under the GtR project. Two scenarios, centralised and decentralised, provide the investment profiles that are used as input into the multiplier analysis (**Figure 3**)[15]. For the power sector, centralised represents significant investment in grid-scale generation plants, with a focus on wind and solar. Post-2030, a five-fold increase in the total electricity production is observed, due to strong demand growth, particularly from the mining sector. Decentralised sees lower levels of electricity demand due to lower use of electric vehicles, a more diverse mix of cooking fuels, more uptake of efficiency measures, and a smaller mining sector (see Nyambe-Mubanga *et al*., 2023 for more detail on the GtR scenarios).

> “Decentralised sees lower levels of electricity demand due to lower use of electric vehicles, a more diverse mix of cooking fuels, more uptake of efficiency measures, and a smaller mining sector”

[14] Based on the 2019 SAM (Pauw et al., 2021), these include the extension of the Mining, Chemicals and Petroleum, and electricity, gas, and water sectors, replacing three activity and commodity sectors with a total of sixteen sectors providing further disaggregation and detail.

[15] Note that project timeline constraints meant that the Hybrid scenario (discussed in Section 3) was finalised after the SAM analysis (discussed here), which is why it was not assessed.

Figure 3: Investment profiles derived from OSeMOSYS-Zambia model for use in multiplier analysis. Each year represents the cumulative investment for the previous 10-year period eg 2030 represents 2021–30. "Ref" case included to represent a continuation of current trends with respect to underlying drivers of energy demand. Full details on modelling assumptions can be found in Annex 2 in Nyambe-Mubanga et al. (2023).



Results of multiplier analysis

Table 2 below summarises the macroeconomic impacts of specific energy sector investments. The average yearly capital investment from 2020 to 2050 is US$977 million, US$2,116 million and US$1,272 million for the reference , centralised, and decentralised scenarios respectively. The results indicate that for every unit of investment in the energy sector, the centralised scenario offers stronger multiplier effects across the economy than both the reference and decentralised scenarios. It should be noted, however, that the difference in multiplier effects across scenarios is minimal for all selected macroeconomic indicators (GDP, income, output, and total demand – see ratios in Table 2), and therefore the results show strong benefits across all scenarios. This is primarily because both the centralised and decentralised scenarios are dominated by solar and wind (centralised at 52% and decentralised at 72%), as highlighted in Figure 3.

[16] The reference scenario maintains historical and current trends, rather than making significant changes of the order seen in the Centralised and Decentralised scenarios (Nyambe-Mubanga *et al.*, 2023).

Table 2: Macroeconomic impacts of energy sector capital investments (USD 2019, Millions)

Variable	Reference	Centralised	Decentralised
Investment level (input)	977	2,116	1,272
GDP	1,087.4	2,347.8	1,393.0
Income	728.3	1,588.2	940.0
Output	1,822.1	4,151.6	2,479.3
Total Demand	2,598.2	5,884.2	3,520.2
GDP / Investment (ratio)	1.113	1.110	1.095
Income / Investment (ratio)	0.746	0.751	0.739
Output / Investment (ratio)	1.866	1.962	1.950
Total Demand / Investment (ratio)	2.660	2.781	2.768

Policy insights

This SAM multiplier analysis provides a useful tool for assessing the macroeconomic impacts of new scenarios that will be developed in the future. For the GtR scenarios, the impact of investments on macroeconomic indicators shows that even though the total capital investment across scenarios is different, per unit investment effects are similar. This is not surprising given the investment profiles of the scenarios are similar and are dominated by solar and wind technology. Crucially, renewable energy investments present strong effects on all the four macroeconomic indicators, indicating that investing in the energy sector should be encouraged whether it is focused on centralised or decentralised technologies.

This similarity in macroeconomic impacts of investing in renewable energy infrastructure should offer policymakers and investors the confidence to widen decision criteria typically used to assess new projects. Specifically, looking beyond technology type and typical investment metrics to instead look to maximise ambitious project co-benefits – ensuring investment supports a broader spectrum of the workforce – provides more spatially equitable benefits across regions and meets other energy sector objectives. This is important because there is some evidence that investment in the Zambia economy disproportionately benefits higher skilled, educated parts of the labour force.

An additional insight from the analysis concerns the relative higher importance of hydropower on the economy, as a driver of the economy, relative to other parts of the energy sector. Given the potential climate impacts on hydro generation, diversifying the electricity system away from dominance of hydro is important for further safeguarding socio-economic development in Zambia. Considering the future impacts on hydro potential and the declining cost of wind and solar power, investment in the direction of non-hydro renewables is likely to deliver a more economically competitive and resilient system over the coming decades.

> “The macroeconomic benefits of energy sector investments are clear, with significant economic multiplier effects for the wider economy”

Policy recommendations

- The macroeconomic benefits of energy sector investments are clear, with significant economic multiplier effects for the wider economy. It is important to prioritise a strategy that accounts for these multiplier effects and promotes the investment the sector needs to meet Zambia's growing energy demands.
- In future strategy development, given the limited variation between multiplier effects of different technologies, other criteria for technology choice can be given stronger prominence, including sustainability, regional distribution of jobs, and resilience.

Further reading and resources:

- Additional detail on the Social Accounting Matrix work is freely available online.
- Please visit Zenodo records 10808640 and 10808457. These refer to the working paper “Developing a SAM Multiplier Analysis for the Zambian economy: Energy Investments”, which describes the extension of the SAM, and to the corresponding “Extended 2019 SAM for Zambia” dataset that underpins the analysis.

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6 LAND USE ANALYSIS

AUTHORS: Jen Cronin (UCL), Prof. Francis D. Yamba (CEEEZ), Clement Njobvu (CEEEZ), Nancy Chama Serenje (CEEEZ), Nick Hughes (UCL), Oliver Broad (UCL)

Research Highlights

- This research takes a holistic look at land use in Zambia, exploring synergies and trade-offs between policy areas including agriculture, forestry, and clean cooking.
- The study develops the elements of the scenarios described in Section 3 which affect land use and land-use change.
- TRAP-ZM is developing an open-source Excel tool to quantify the land-use change, greenhouse gas (GHG) emissions, and biomass resources associated with these scenarios.
- Emerging findings explore the ways in which the Centralised and Decentralised scenarios could achieve sustainable crop yield improvements, diversify rural livelihoods, and engage traditional leaders, in order to increase agricultural production while reducing forest loss. The importance of integrating energy and land policy regarding bioenergy and cooking strategies is highlighted.

Introduction

In recent decades, Zambia's land use has undergone substantial change, mainly from clearance of forest for agricultural expansion and for cooking fuels (Vinya *et al*., 2011; Phiri *et al*., 2019). Changes will continue, as food and fuel production, mining, energy technologies, and other infrastructure all require increasing land. Ecosystems are at risk from overexploitation of resources and climate change, and soil degradation is a major challenge.

While there is a common perception that land is abundant, there are potential tensions between different policies. Importantly, there are questions over whether priority should be given to: a) increasing agricultural production, allowing for the expansion of cropland; or b) stemming the loss of forest cover. Substantial expansion of mining activities (MoFNP, 2022) will drive further land clearance for infrastructure and agriculture in surrounding areas. Ambitious plans to boost biofuel production, biomass for power, and other bioenergy applications could present valuable opportunities for farmers and others in the value chain, but also drive further forest clearance, depending on the feedstocks used. Several interventions are planned and underway to address these issues, though challenges related to policy coherence and implementation exist.

This research aims to bring together the current discourses relating to land use in Zambia. It is exploratory in nature, as it considers how land use might evolve in the coming decades. It further develops the land-use aspects of the scenarios described in Section 3. The research is also developing analytical methods for studying the implications of these changes for land cover, GHG emissions, and bioenergy. It improves understanding of potential synergies and trade-offs between policy areas relating to land.

> “There are questions over whether priority should be given to increasing agricultural production, allowing for the expansion of cropland, or stemming the loss of forest cover”

Methods

The study consists of two main parts:

- **Scenarios:** Scenarios describing future land-use change have been developed collaboratively using iterative meetings and workshops with local partners from CEEEZ[17]. These are consistent with the Centralised and Decentralised scenarios presented in Section 3, with further development of the aspects relating to land-use change. The trends and interventions specific to agriculture, forestry, clean cooking etc that would be consistent with each scenarios' rationale are explored in more detail.
- **Quantitative modelling:** An open-source Excel-based model to quantify some elements of the scenarios is under development. Based on assumptions describing elements such as population growth, urbanisation rate, crop yield improvements, and forestry programmes, the model estimates the land-use change that is depicted in each scenario. From this, the model derives corresponding land-based GHG emissions and biomass resource availability.

By developing these scenarios, we explore the consistency and compatibility of different aspects of future development pathways in terms of their implications for land use. By translating the scenarios into inputs for an open and transparent modelling tool, this approach can then offer important insights on the quantified implications of experts' qualitative understanding regarding how different goals might be achieved. Future work will use these tools to engage with policymakers and further stakeholders across land-related policy areas.

Scenarios

Key elements of the scenarios are summarised below. Full details will be discussed in a forth-coming paper

In the Centralised scenario, it is envisaged that elements such as the focus on agricultural exports, rising urban population, and rising income levels in urban areas will lead to substantial increases in demand for agricultural products. Small-scale farmers respond to the strong market by investing in agricultural inputs such as fertilisers, pesticides, and irrigation. This, along with the increased role of large-scale commercial producers leads to significant improvements in crop yields over the next few years, and a reduction in the rate at which agricultural land expands. Charcoal production is commercialised, and its sustainability improved, through a roll-out of efficient kilns and government-led coupe forestry projects. These lead to a strong reduction in the rate of forest loss, and an increase in the price of charcoal. Increased production of bioethanol is achieved by expansion of sugarcane and cassava plantations, and plantation crops are grown for large-scale biomass electricity generation.

In the Decentralised scenario, the greater focus on supporting sustainable rural livelihoods is achieved via much improved extension services using information and communication technology, providing small-scale farmers access to soil condition maps, weather forecasts, and information about best farming practices. Along with well-managed outgrower schemes and farm blocks, this provides farmers with good information, timely and affordable inputs, and access to markets. Conservation agriculture and agroforestry practices are promoted and adopted successfully. Yield improvements are potentially more moderate than in the Centralised scenario, but are more sustainable in the long-term,

[17] A working group combining colleagues from CEEEZ and UCL met online for shorter meetings and longer workshops to discuss and develop these scenarios. An in-person team workshop was also held in February 2024, in Lusaka, Zambia, independently from other workshop events described in other sections.

as soil degradation is slowed. Household and community-level biogas production increases, along with small-scale biomass-electricity generation, using crop residues. Increased production of bioethanol uses cassava provided by outgrower schemes. Sustainable forest practices are established on abandoned cropland, and some natural regeneration also occurs, which then supports opportunities for beekeeping and the collection of mushrooms and wild fruits.

Modelling

To quantify the implications of these scenarios, an estimate is made regarding how each of their elements leads to a change in land use practices and land cover change. The focus is on aspects of the scenarios which affect the sources and sinks of greenhouse gas emissions, as well as biomass resource potential.

Changes to built-up land area are estimated based on the projected population increase and rate of urbanisation. For agricultural land, future yields are estimated based on the scenario elements including the levels of fertiliser use, mechanisation, and uptake of agroforestry or conservation agriculture techniques. These also lead to changes in land-use emissions and biomass produced at household level. The expansion of crop land is projected based on future demands for food, fibre, fodder and energy crops, and yields. The conversion of grassland and forests to built-up land and crop land is thereby estimated. Further deforestation is driven by demands for wood fuel and charcoal, which are

> “The principle of the modelling exercise is to make these assumptions fully transparent, so that they can all be examined and their impact on the results can be tested and discussed”

estimated for each scenario based on changes to cookstove and kiln technologies, and combined with the scenario elements relating to forestry interventions to determine the levels of forest loss associated with cooking fuels.

For each scenario, the elements which affect land-use and land cover change are identified, then translated into an estimate of the land cover in 2030, 2040, and 2050. This requires numerous assumptions, such as the level of yield improvements that could be achieved as a result of certain interventions, and the degree to which forest management changes could reduce or reverse deforestation. The principle of the modelling exercise is to make these assumptions fully transparent, so that they can all be examined and their impact on the results can be tested and discussed.

Emission factors resulting from land use and land use change have been derived based on analysis of biomass content for different types of land cover and agricultural inputs. These, along with biomass production factors, are applied to the areas of each type of land cover in order to estimate the total land-based GHG emissions and biomass resource potentials at national scale.

Emerging findings

The scenarios explore alternative approaches that could reconcile the goals of increasing agricultural production while stemming loss of forest, by depicting different ways that yield improvements might be achieved. They envisage how these alternative approaches could be logically combined with different approaches on charcoal, infrastructure, and mining.

The goal of enhancing resilience in the agriculture sector through improving climate resilience of crop production and diversifying livelihoods is examined. We consider the roll out of conservation "climate-smart" agriculture techniques, as well as integration of food and energy crop production by small-scale farmers and increased commercialisation of the charcoal supply chain.

This method examines the linkages and knock-on impacts of the various trends and interventions in the sectors affecting land. Most importantly, the strength of the agriculture sector, in terms of yield improvements, climate-change resilience, and value addition, is expected to have strong implications for the rates of cropland expansion, rural livelihoods, and urbanisation. *How* crop yield improvements are achieved (eg through greater use of chemical fertilisers or conservation agriculture) will affect both land-use emissions and the long-term sustainability of soil quality and water management.

The research will highlight important links between energy and land policy as they intersect with clean cooking strategies. Programmes that reduce demands for wood fuel and charcoal by increasing uptake of other cooking technologies, increasing the wood efficiency of charcoal production through improved kilns, and increasing the sustainability of wood production through improved forest management all contribute to reducing forest loss. To achieve sustained long-term social and environmental benefits, the scenarios make clear the importance of supporting and integrating these with development of alternative sustainable rural livelihood options. Understanding these combined effects will provide insights that can contribute to improved design of future extension services and policy.

The process has highlighted important uncertainties around how different kinds of farmers will respond to various changes, such as increased access to information, inputs and markets, support for conservation agriculture, and new demands for energy crops. Whether those elements lead farmers to intensify their production and/or expand their crop land will largely determine forest loss. Another key uncertainty is the potential for expanding different types of irrigation; this should be assessed in the context of climate change causing increased water scarcity. Finally, well-informed, estimates of the potential to expand the various sustainable forest management practices, and the degree to which these might reduce deforestation, are needed. Further understanding of these dynamics would help improve the estimates of land-use change.

Work on the land-use analysis framework we present here has so far focused on building a detailed understanding of the potential land-use implications of different future energy system pathways for Zambia. The quantitative modelling that reflects this understanding remains under development as part of ongoing work in the CCG programme and will be presented in the forthcoming working paper listed below under "Further Reading".

Policy Recommendations

This work is producing the following emerging recommendations for policymakers:

- There is potential tension and trade-offs between targets to increase agricultural production and reducing forest loss. Framing land as a limited resource under pressure to support energy, food, social, and environmental systems is essential for exploring pathway implications for

> "How crop yield improvements are achieved will affect both land-use emissions and the long-term sustainability of soil quality and water management"

climate resilience, sustainable system design, and resource allocation.

- Holistic analysis of land-use change, including integration of land and energy analysis, with a focus on rural and urban livelihoods, agricultural practices, and climate resilience can provide insights that are needed to improve policy coherence.
- The work addresses elements of the green growth agenda, with insights on ways to enhance resilience in the agriculture sector and resource efficiency.

Further reading and resources:

- Forthcoming working paper looking into the links between land, the energy system and its implications for both greenhouse gas emissions and resources in Zambia: “Land-use change in Zambia: Energy, GHG emissions and development”.

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7 CIRCULAR ECONOMY

AUTHORS: Rebecca Clube (UCL), Malonga Hazemba (ZIPAR)

Research Highlights

- The Circular Economy (CE) is an under explored topic in the Zambian context but is gaining momentum elsewhere in the region.
- This study sought to qualitatively explore the policy landscape for transitioning towards a CE by reviewing policy documents and engaging with local experts.
- The findings highlight five key policy challenges that currently impede the circular shift, relating to policy ownership and coordination, inadequate regulatory implementation and enforcement, a restrictive licensing approach, limited sectoral innovation, and a lack of inclusion of the informal sectors.
- The findings lead to recommendations for policymakers to overcome these challenges and embrace an inclusive CE.

Introduction

This research explores the issue of waste, which is a global sustainability challenge. Demographic shifts (eg population growth, rising incomes, and urbanisation) mean sub-Saharan Africa is expected to experience the highest growth in future waste burdens: waste is expected to almost triple by 2050, reaching 516 million tonnes per year (Kaza *et al*., 2018). Reflecting this regional picture, Zambia is experiencing both growing waste volumes and increased complexity in terms of composition (eg growing proportions of technical wastes, such as plastics). Inadequate waste management can produce negative environmental, social, and economic impacts. For example, this has recently come to the forefront in Zambia where the ongoing cholera crisis has been linked to inadequate sanitation and waste practices. There is increasing pressure in Zambia to improve waste management practices to meet climate commitments and the Sustainable Development Goals (SDGs). For instance, reducing reliance on landfill and dumping is essential for the country achieving its NDC commitments, which are linked to reduced GHG emissions from improved waste management practices (Republic of Zambia, 2021).

There is growing interest in moving towards a CE in order to tackle waste challenges. A CE reframes waste from a burden to a resource by embracing reduce, reuse, and recycling principles to lower reliance on virgin materials, extend resource lifecycles and minimise waste entering the environment (Hazemba, 2023). Circularity strategies can be designed to create local economic opportunities while being environmentally sustainable and socially inclusive; hence circularity has linkages to wider development goals (Clube and Tennant, 2023). Proponents suggest that the CE could be an important strategy to achieve inclusive green growth in Zambia (AGS, 2022; Banda *et al*., 2023), and this has been made explicit in the recently published National Green Growth Strategy (MGEE, 2024). Policy can be an enabler of shifts towards circularity: the sub-Saharan region has seen an influx of policies and legislations being adopted to promote a CE approach. So far, Desmond and Asamba (2019) note that Africa's circularity frontrunners are Nigeria, South Africa, Rwanda, and Kenya, but both policy and private sector-led agendas are gathering place elsewhere in the region.

This research sought to explore the policy environment in Zambia to understand *if* and *how* circularity principles are embedded into the policy approach. In doing so, the aim was to identify policy challenges as well as areas for policy development to support a transformative CE for Zambia.

Methods

This study was exploratory in nature as there is an underdeveloped research base with regards to waste and the topic of CE. Therefore, a qualitative approach was deemed appropriate. Specifically, the study consisted of three main activities:

- **Document review:** A document review focused on grey literature, including government strategies, policies, and legislative documents, was carried out to identify key policy documents.
- **Semi-structured key informant interviews:** In total, 14 semi-structured interviews were held with 15 stakeholders involved in the waste and CE sectors (eg environmental consultants, NGOs, private sector)[18].
- **Validation workshop:** a workshop was held in Lusaka in November 2023 to present the emergent findings, to receive feedback from a variety of stakeholders to ensure reliability of data, and to obtain additional insights.

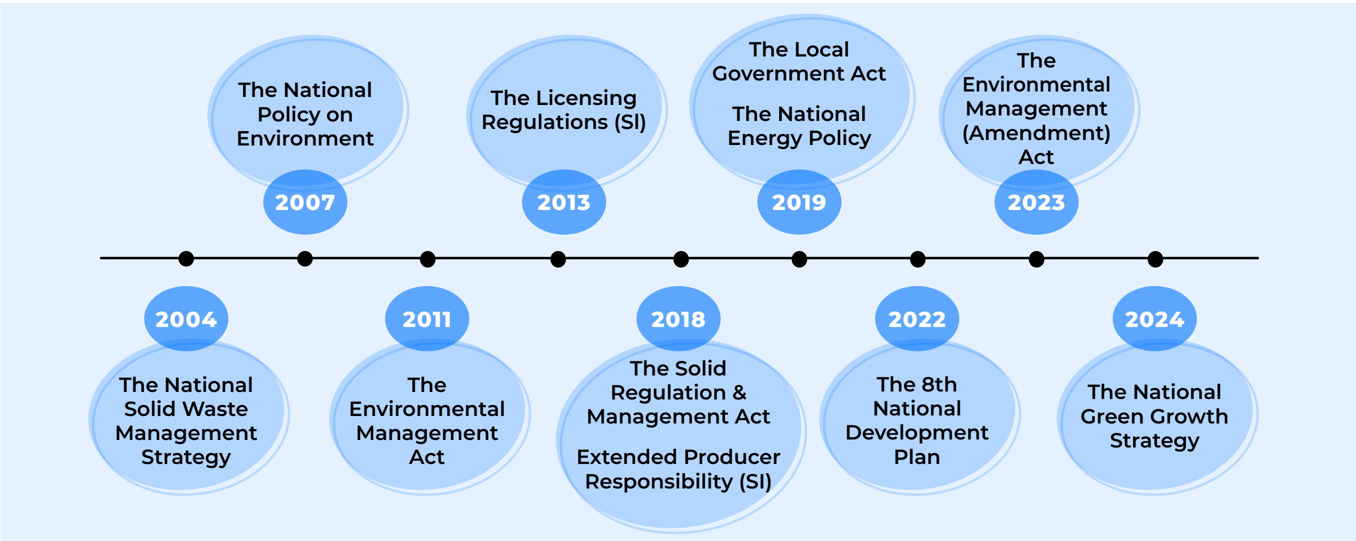
Findings

Policy landscape

The research identified Zambia's current policies that relate to the waste and CE agenda (**Figure 4**). These policies determine how waste is governed and practically managed. Some of the policies also contain circular principles, suggesting a progressive approach (eg waste is described as a *resource* in the Solid Waste Regulation and Management Act (SWRMA)). The interviews determined that the Environmental Management Act (EMA) of 2011 (amended in 2023) and the SWRMA of 2018 are the two most relevant legal documents referencing circular principles – focused on the waste hierarchy – whereas the Extended Producer Responsibility (EPR) is a key statutory instrument[19]. Both the EMA and EPR are currently under the mandate of

[18] Note that these interviews were conducted separately, with different people and following a different semi-structured question structure to those run in Section 3. For more detail on the interviews conducted in this Section, see the full paper by Clube and Hazemba (2024).

***Figure 4:** Summary of policies and legislations – including statutory instruments (SIs) identified through document review. Please note this review was undertaken in 2023, prior to the publication of the National Green Growth Strategy in May 2024*



the Ministry of Green Economy and Environment, whereas SWRMA outlines that the Ministry of Local Government and Rural Development (MLGRD) is responsible for managing municipal waste. The 8NDP was the first policy document to *explicitly* mention the CE (MoFNP, 2022, p.64). Here, the CE offers a framework for the promotion of sustainable consumption and production, which has since been augmented in the National Green Growth Strategy (MGEE, 2024).

Relevance of the CE

In general, the CE is becoming a more relevant concept in Zambia, as signalled by the primary and secondary data (Clube and Hazemba, 2024). Participants suggested that the CE helps reframe waste from being viewed as a burden to a business opportunity with wider sustainability impacts. For example, according to a participant, a CE framing helps create a balance between economic, social, and environmental aspects of development. Nevertheless, despite positive sentiment regarding the prospect of a circular shift for Zambia, the current approach is overwhelmingly linear. Notably, waste collections are limited and lack affordability for some segments of society; single waste streams are collected, preventing high-value recycling which means most waste continues to be mismanaged or end up in dumpsites across the country. Against this backdrop, opportunities are currently being missed for waste revalorisation. The data pointed to various policy challenges that are perceived to impede the transition from a linear to circular economy of waste.

Policy challenges

Discussions with experts identified various policy challenges that exist in the waste landscape that likely hinder the transition to a CE. These are summarised on **Table 3** and discussed fully in the publication (Clube and Hazemba, 2024).

[19] Full details of relevant policies introduced in Zambia in the last 20 years, including references, are found in Table 2 in Clube and Hazemba (2024).

***Table 3:** Overview of policy challenges identified in the study (table adapted from a policy brief by Hazemba and Clube, 2024)*

Challenge	Overview
Policy ownership and coordination issues	▪ The mandated institutions for handling waste have changed over time (ie the Zambia Environmental Management Agency or MLGRD), but there is no cross-ministry strategy. This is perceived as causing co-ordination challenges. ▪ Some believe the ownership of current waste and future CE agendas is unclear. This is further complicated by high private and informal sector involvement.
Inadequate implementation & enforcement	▪ There is a general sentiment that the policies and legislations (eg EMA, SWRMA) are clear on paper, but are not effectively implemented or enforced in practice. ▪ There are limited statutory instruments (SIs) to support policy goals. An exception is the EPR (2018), which aims to implement aspects of SWRMA, but it lacks operational guidelines and is currently not enforced.
Restrictive licensing approach	▪ Licensees are rarely held accountable for sub-optimal service provision. ▪ If citizens cannot afford to pay service providers, then their waste is not collected. ▪ The licensing approach perceived as inflexible. Recycling companies have barriers to obtaining licences since the current focus is on mixed waste collection services without incentives to collect separated waste streams.
Limited support for innovation	▪ There are limited SIs to support CE business models, so high-value recycling opportunities are realised outside of Zambia (eg in South Africa or China). ▪ A lack of accurate waste data can reduce investment appeal due to unknown future pipeline (eg waste-to-energy plants and high-value recycling facilities).
Failure to include informal sector	▪ Low-value waste sorting happens retrospectively by informal workers at dumpsites. Certain materials (eg plastics and metals) are picked to sell to aggregators but others (eg organic waste) are not sorted. ▪ Informal workers carry out hazardous and arduous work but are not provided for in official policy documentation, neglecting the opportunities that might arise from them being legitimately involved in the sector.

Open dumping in Lusaka, Zambia (2023)

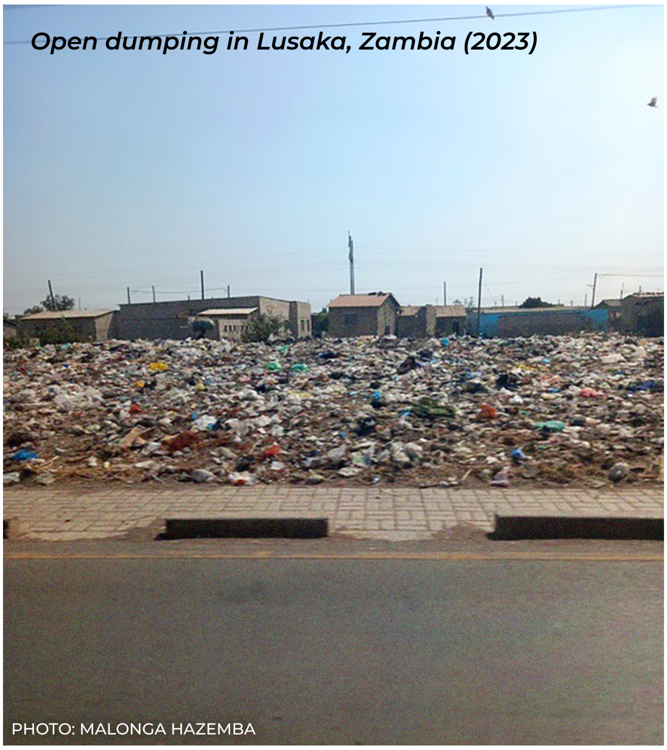


PHOTO: MALONGA HAZEMBA

Policy Recommendations

After evaluating the feedback and reflections from the validation workshop, priority recommendations for policymakers were identified (based on Hazemba and Clube, 2024):

- Enabling waste infrastructure is required for a circular system. Policymakers should focus on developing an affordable and effective waste service, which prioritises the collection of separated waste streams. As such, the licensing approach requires redesigning to support separate collections for different waste streams to produce high-quality recycling feedstock.
- Given the identified coordination and oversight challenges, it is necessary to streamline policy coordination at the ministry level. Effective coordination between ministries, agencies (eg the Zambia Environmental Management Agency and MLGRD) is essential, since mandates are interrelated and overlapping. Implementation and enforcement must be robust to ensure policies achieve their aims. Hence, an effective cross-ministry strategy is imperative.
- Inclusivity is an important foundation for an equitable, socially transformative CE, so there is a need to develop an effective multistakeholder strategy. An explicit CE strategy can identify the roles of different policy and non-policy stakeholders, including citizens and the informal sector.
- Given the private sector's crucial role in scaling CE approaches, there is a need to boost incentives to stimulate commercial ventures. Top-down financing and policy support can encourage private-sector involvement in CE. Policies and SIs can be developed to help upscale the CE. Entrepreneurship in the sector can be fostered through policy-supported business incubation and mentorship schemes.

Further reading and resources

- "From waste to resource: demystifying the policy challenges and identifying opportunities for a circular economy in Zambia" (Clube and Hazemba, 2024), published in Frontiers in Sustainability as part of a special issue collection titled '*Accelerating the Circular Economy Transition: Innovations and Developments from Africa*'. Available here.
- Chapter published in *Waste management in the Circular Economy:* "Integrated Waste Management and Circular Economy" (Hazemba, 2023). Available here.
- "From Waste to Resource: Creating an Enabling Policy Environment for a Circular Economy in Zambia" (Hazemba and Clube, 2024). Available here.

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8 POLITICAL ECONOMY & POLICY INFLUENCE

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Highlights:

- There is an urgent need to build capacity of diverse technical experts to engage with the policymaking process.
- This capacity-building activity, developed by CCG and ZIPAR, designed and delivered a bespoke training course to build capacity for technical actors to effectively engage in Zambia's policy process.
- Under TRAP-ZM, two residential workshops provided training for 44 technical actors, equipping them with practical knowledge and tools to proactively engage with the policy process in the future.
- The training exercises received positive feedback from participants, highlighting the value in capacity building in political economy topics for technical actors.

Introduction

The relationship between science and policy can be described as complicated and non-linear (Keeley and Scoones, 2003). Decision-making is often highly complex in the context of sustainability and climate change since pathways generally involve conflicting stakeholder interests; economic, environmental, and societal trade-offs under uncertain conditions; and time-constrained implementation options (Levin *et al*., 2012). In lower middle-income country (LMIC) contexts this may be exacerbated due to complex political economy factors, limited evidence, low government capacity, institutional weaknesses, donor involvement, and budget constraints, among other complexities (Sinharoy et al., 2019; Adeyemo, 2023; FitzGibbon and Mensah, 2012). As such, evidence must be relevant, but also compellingly framed, well-timed, and effectively communicated in an appropriate format to policymakers (Zougmoré *et al*., 2019).

Various actors, including technical stakeholders, have a role to play in supporting government decision-making and influencing policy development. However, certain stakeholders may have limited formal training regarding how to engage in the policy process, especially actors who have more technical or analytical backgrounds (eg engineering, technology, or finance). This challenge, along with the availability of appropriate training programmes, was identified by Tec Analytics and ZIPAR. As such, TRAP-ZM included a work package to support capacity building, empowerment, and skills development for policy engagement, aimed at a technical audience.

Course content and workshop protocol

ZIPAR and CCG co-curated a set of bespoke training sessions, which were delivered in a multi-day residential workshop format. There were two Political Economy Analysis and Policy Influence (PEA & PI) workshops: the first was held in April 2023 and lasted two and a half days; and the second in February 2024, lasting three days[20]. The aim was to build on reflections and

[20] Note that (i) the February 2024 PEA & PI workshop incorporated a one-day Scenario Training workshop as part of work developed in Section 3, and that (ii) both PEA & PI workshops are separate to the OSeMOSYS training workshop series described in Section 4.

lessons learnt from the first workshop using an iterative approach. The training was attended by a diverse set of actors including government, public sector and quasi-governmental institutions, NGOs and associations, as well as private sector and consultancy. The first workshop hosted 28 participants, while the second workshop was attended by 19 participants, with a total of 44 people receiving training across both events.

The training provided an opportunity for participants to deeply engage in various policy topics in an interactive, reflexive, and supportive learning environment. The objective was not to prescribe information, but rather to provide a variety of skills and perspectives as a means of enabling positive engagement in policymaking in the future (Scoones *et al*., 2020).

The course structure and content were developed after discussions between subject experts within the team. The objective was to deliver practical, but academically grounded, material suitable for technical actors in Zambia. This included designing group activities to ensure approaches and tools could be practised on real-world cases. ZIPAR's on-the-ground expertise helped ensure that the content and activities were appropriate and locally relevant, while CCG researchers from University College London (UCL) provided input to ensure theoretical and academic rigour.

Examples of core sessions delivered are summarised in **Table 4**. The workshop schedule was designed to allow for intermittent critical discussions between participants, as well as ample time for questions and reflections. Feedback was also obtained at both the start and end of the workshops.

***Table 3:** Examples of core sessions delivered during the workshops.*

Session	Topics covered
Climate Policy	▪ The session aimed to introduce climate change terminology to ensure participants shared a common basic understanding on this overarching issue. ▪ Key policy discussions around climate change in Zambia, and more broadly, were introduced. This included discussing the role of COP meetings, NDCs, and SDGs for Zambia.
The Policy Process	▪ The session aimed to introduce how policies are designed, implemented, and monitored, in both an ideal situation and in reality. The challenges and barriers to effective policymaking were also discussed. ▪ The session identified the roles of different actors in the policy process and asked participants to reflect on where they fit in the policy cycle.
Politics and Political Economy	▪ The session aimed to explore the origins of 'politics' and 'Political Economy' concepts and discussed their critical importance to contemporary policymaking, in Zambia and elsewhere. ▪ Issues such as power, legitimacy, and governance conflicts were introduced.
Political Economy Analysis	▪ This session aimed to present the goals of a political economy analysis and share how it can support day-to-day decision-making and strategic thinking. ▪ A practical approach to political economy analysis was described (eg problem identification, diagnosis, and solutions). Participants were exposed to different tools (eg stakeholder analysis) throughout, with opportunities to apply them to case studies.
Using Scenarios and Modelling for Decision-making	▪ The session aimed to provide insights into how both qualitative scenarios and quantitative modelling can be used to support evidence-based decision-making. ▪ The steps to identify and develop scenarios were presented, and participants had the opportunity to develop future scenarios using the framework.
Policy Communication	▪ This session aimed to share practical advice and best practice approaches for developing clear, concise, and effective policy messaging. ▪ A step-by-step guide to writing an effective policy brief was presented, focusing on how to effectively communicate evidence to policymakers and other stakeholders.

Two-day workshop in Zambia

> "Under TRAP-ZM, two residential workshops provided training for 44 technical actors, equipping them with practical knowledge and tools to proactively engage with the policy process in the future"

Outcomes

Responses to post-workshop surveys were positive, with 100% of participants stating that they would recommend the training to a colleague. Word-of-mouth recommendations led a ZIPAR expert to deliver, upon request, a condensed version of the training to the Zambia Institute of Architects at the International Conference on 'The Development of Climate Sensitive Building Regulations for Zambia: The Need for a Collaborative Effort by all Stakeholders'.

Looking forward, and based on participant suggestions, there is opportunity to expand this training to other parts of Zambia, since it was noted that the geographical scope was largely limited to the Lusaka vicinity. There is also potential to deliver similar trainings in other countries in the region, as well as globally. This could, for example, involve developing an online version of the course residential programme to allow for, for example, self-paced delivery to wider groups of stakeholders.

Policy Recommendations

The following policy recommendation stems from this activity:

- Robust evidence must be compellingly communicated by technical actors and understood by the receiving audience. Therefore, supporting the development of 'soft' skills of stakeholders can help translate scientific evidence into action. Training courses can be delivered by specialist organisations (eg ZIPAR) to influence evidence-based decision-making.

Further reading and resources:

- Rebecca's blog post: "UCL Institute for Sustainable Resources researchers co-host policy training workshop in Zambia" offering reflections on a two-day policy training workshop. Available here.
- CCG's Open University Course developed in November 2023, exploring the links between analytical modelling and the policymaking process: "Modelling, Policy and Political economy". Available here.
- Note that delivering new capacity-building training workshops focused on Political Economy and Policy Influence can be discussed upon request.

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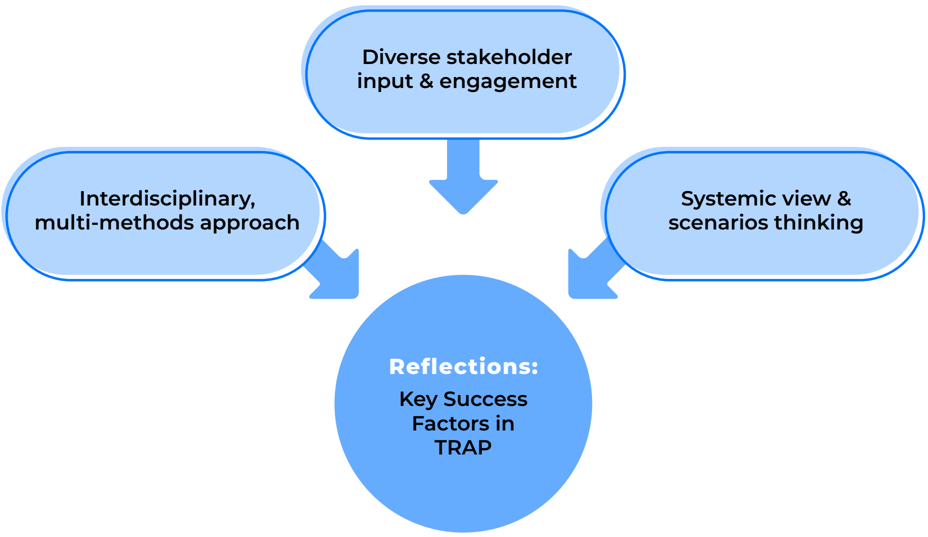
9 FINAL REFLECTIONS ON TRAP-ZM: the value of an interdisciplinary, participatory and systemic approach to support climate-compatible futures

TRAP-ZM sought to support inclusive, informed, and balanced policymaking to underpin future climate-compatible development pathways. It did so through a variety of complementary approaches that resulted in robust evidence and policy insights to support decision-making in Zambia. However, the overall project process produced equally pertinent methodological and process-related insights. Three key characteristics of the research emerged as particularly useful, namely: an interdisciplinary approach; the inclusion of diverse stakeholders; and the adoption of a systemic lens (**Figure 5**). These features are described and reflected upon in the following sections.

Figure 5: *Reflecting on three key success factors of TRAP-ZM*



1. Adopting an interdisciplinary multi and mixed-methods research design helps to embrace complexity

Interdisciplinarity is increasingly framed as an essential component in projects that are seeking to tackle complex sustainable development challenges (Leal Filho *et al*., 2017). Hence, the research was designed to encompass quantitative, qualitative, and mixed-methods approaches. The specific methods included energy modelling, economic analysis, interviews, policy review, and workshops. This was possible as the research team was highly diverse, encompassing Zambian and UK researchers with different subject expertise (eg energy modelling, politics, economics, and climate change). We found the interdisciplinary skills of the core team to be indispensable to delivering the wide span of activities with scientific and policy relevance.

Successful interdisciplinary collaborations require effective coordination of activities, positive information exchanges (including between researchers and other stakeholders) and, ongoing critical reflections on the research objectives and process (Leal Filho *et al*., 2017;

Romm, 1998). As such, TRAP-ZM focused on flexibility, reflexivity, and iteration to ensure the research was relevant and continually developed based on local needs. This was supported through regular meetings between the core research team, including presenting emergent findings and discussing bottlenecks.

This approach utilised and combined different methodologies depending on the research questions being addressed, the levels of subject matter maturity, data availability and other needs (Harris, 2021). Quantitative or qualitative approaches were applied independently or combined when appropriate. Modelling was centrally placed within TRAP-ZM, with a focus on co-creating important models to support policy and sectoral decision-making. On the other hand, qualitative approaches were most useful for developing deep contextually relevant insights, especially when the area has limited data. The latter issue is a common challenge in LMIC contexts. Multi and mixed-methods approaches were useful in the scenario activities, by combining qualitative discussions with quantitative modelling (Sections 3, 4, and 6). This enabled an inclusive discussion using stakeholder insights that were translated into numerical representations.

2. Bringing diverse groups together helps ensure an inclusive, critical, and relevant dialogue

Best practice recommendations for supporting inclusive sustainable development agendas often highlight the merits of adopting multi-stakeholder approaches (eg Haelewaters et al., 2021; Scoones *et al*., 2020). Embracing a plurality of perspectives can help overcome the risks associated with narrow stakeholder engagement, such as delivering overly simplistic, inappropriate, or unimplementable results (Fuchs *et al*., 2024; Reed et al., 2017). As such, TRAP-ZM closely involved stakeholders in the design and delivery of the research; this was critical to obtaining reliable insights, especially as the topics were inherently complex (Reed et al., 2017).

The multi-stakeholder and participatory approach to scenario development enabled diverse views to be discussed and negotiated, then integrated into subsequent research efforts such as the energy and land-use modelling. Engaging a broad stakeholder base also provided ample opportunities for formal and informal knowledge transfer. Formally, capacity-building components provided useful skillsets that individuals would be able to apply in the future (Scoones *et al*., 2020). Formally and informally, bringing stakeholders together in various workshop and other meetings enabled actors to share experience and identify overlaps in professional priorities, contributing to the development of informal networks.

In terms of limitations, although effort was made to ensure a diverse range of participants, most engagements were limited to Lusaka. In the future, we would aspire to engage with expert communities in other regions. Greater national reach is important to uphold principles of participatory justice, and it would also offer opportunities to tailor analysis to different regions and thus align, where appropriate, with the decentralisation agenda.

3. Taking a systemic outlook helps to identify risks as well as opportunities in future transition pathways

An overarching feature of the TRAP-ZM project was a consistent effort to view sustainability challenges through a whole systems lens. Such a holistic viewpoint can help to overcome reductionism in policymaking, which is important since policy decisions are often made in silos. By contrast, a whole systems approach aims to understand how different sectors, geographies, knowledge domains, and actors interact, and to identify the synergies and trade-offs between them (Scoones *et al*., 2020). This approach supports the development of sound policy recommendations that are cognisant of the interconnectedness of things. This is essential when considering profoundly cross-cutting and interrelated issues, such as the sustainable use of natural resources and the circular economy.

As the report has shown, the topics covered and approaches utilised under TRAP-ZM were diverse. They included qualitative scenarios (Section 3), whole system energy modelling (Section 4), economic modelling (Section 5), land-use change (Section 6), circular economy (Section 7) and political economy (Section 8), and enabled the research team to assess, independently and collectively, the complex and interrelated challenges associated with different future pathways in Zambia. The different approaches also enabled the consideration of the technological, economic, social, and institutional dynamics that impact decision-making.

Such holistic and whole system approaches can be challenging, requiring different disciplinary and sectoral knowledge and the participation of different actors, as highlighted above. However, they encourage stakeholders to think broadly and creatively about the future, and to work collectively towards the realisation of a green and inclusive future for Zambia.

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