

UNIVERSITÉ DU QUÉBEC À MONTRÉAL

CLIMATE AND ENERGY PLANNING CAPACITY IN EAST AFRICA: A COMPARATIVE STUDY

MEMOIRE

PRÉSENTÉ

COMME EXIGENCE PARTIELLE

DE LA MAÎTRISE EN SCIENCES DE GESTION, RSE

PAR

MAISSA MHIRI

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LA CAPACITÉ DE PLANIFICATION CLIMATIQUE ET ÉNERGÉTIQUE
EN AFRIQUE DE L'EST : UNE ÉTUDE COMPARATIVE

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DÉDICACE

I dedicate this thesis to myself. It was a long, challenging journey filled with moments of doubt, frustration, and exhaustion. But despite all the obstacles, I kept going. I faced every hurdle with determination and resilience, and in the end, I came through stronger than I ever imagined. This work stands as a reminder that, no matter how hard it gets, perseverance and belief in yourself can carry you through. You did it – and you should be proud.

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LIST OF ABBREVIATIONS AND ACRONYMS

ARDL	Autoregressive distributed lags.
BAU	Business As Usual.
ECM	Error correction models.
EPRA	Energy and Petroleum Regulatory Authority.
ERA	Electricity Regulatory Authority.
GDP	Gross Domestic Product.
GHG	GreenHouse Gas.
HPPs	hydroelectric Power Plants.
IEA	International Energy Agency.
KNBS	Kenya National Bureau of Statistics.
LCPDP	Least Cost Power Development Plan.
LEAP	Low Emissions Analysis Platform.
LULUCF	Land Use, Land-Use Change and Forestry.
MEF	Ministry of Energy and Forestry.
MtCO₂eq	Million-ton CO ₂ equivalent
NCCAP	National Climate Change Action Plan.
NDC	Nationally Determined Contribution.
PV	PhotoVoltaic.
RES	Renewable Energy Sources.
UNFCCC	United Nations Framework Convention on Climate Change.
UQAM	Université du Québec à Montréal.
TANESCO	Tanganyika Electric Supply Company of TANZANIA.
VAR	Vector AutoRegressive.

RÉSUMÉ

Résumé

Mon mémoire examine la relation entre la capacité de l'État et la crédibilité de la planification énergétique et climatique, en se concentrant sur trois pays d'Afrique de l'Est : le Kenya, l'Ouganda et la Tanzanie. L'étude vise à déterminer si une capacité d'Etat plus élevée est corrélée à une plus grande crédibilité de la planification, en particulier dans le contexte du développement du secteur de l'énergie et des politiques de lutte contre le changement climatique. À travers une combinaison d'évaluations qualitatives et quantitatives, incluant une analyse des documents de planification du secteur énergétique et des exercices de modélisation indépendants, le mémoire évalue la cohérence, la faisabilité et l'alignement des stratégies énergétiques et climatiques de chaque pays. Les résultats révèlent que, contrairement aux attentes initiales, le Kenya et l'Ouganda présentent des niveaux similaires de crédibilité de la planification, malgré une capacité étatique plus élevée au Kenya. Les deux pays montrent une fiabilité modérée dans leurs politiques énergétiques et objectifs climatiques, reflétant un niveau moyen de crédibilité. En revanche, la Tanzanie affiche le niveau de crédibilité le plus bas, avec des écarts importants entre ses plans énergétiques et ses engagements climatiques. Ce manque de cohérence suggère que d'autres facteurs que la capacité de l'État jouent un rôle essentiel dans la formation de la crédibilité de la planification énergétique et climatique. Une approche plus nuancée est nécessaire, prenant en compte l'interaction de plusieurs facteurs qui influencent la crédibilité de cette planification.

Mots clés : **Capacité de l'État, Planification climatique et énergétique, Crédibilité des politiques, Émissions de gaz à effet de serre (GES), CDN**

ABSTRACT

My thesis investigates the relationship between state capacity and the credibility of energy and climate planning, with a focus on three East African countries: Kenya, Uganda, and Tanzania. The study aims to determine whether higher state capacity correlates with greater planning credibility, particularly in the context of power sector development and climate change policy. Through a combination of qualitative and quantitative assessments, including a review of power sector planning documents and independent modeling exercises, the thesis evaluates the consistency, feasibility, and alignment of each country's energy and climate strategies. The findings reveal that, contrary to initial expectations, Kenya and Uganda exhibit similar levels of planning credibility, despite Kenya's higher state capacity. Both countries demonstrate a moderate reliability in their energy policies and climate goals, reflecting a medium level of planning credibility. In contrast, Tanzania shows the lowest level of credibility, with significant gaps between its energy plans and climate commitments. This lack of coherence suggests that factors other than state capacity play a critical role in shaping the credibility of energy and climate planning. A more nuanced approach is needed, considering the interplay of multiple factors that influence the credibility of energy and climate planning.

Keywords: **State capacity, climate and energy planning, policy credibility, GHG emissions, NDC**

INTRODUCTION

1.1 Background

There is strong consensus about the relationship between Earth's rising atmospheric temperature and greenhouse gas (GHG) emissions within the scientific community (IPCC, 2021). By trapping the sun's heat within the Earth's atmosphere, GHGs play a pivotal role in the delicate balance of our planet's climate. Rising GHG emissions from human activities such as the combustion of fossil fuels and deforestation has led to an alarming rise in atmospheric GHG levels. This heightened concentration of GHGs intensifies climate change, accelerating weather pattern disruptions, rising sea levels, and ecological imbalances.

The production of heat and electricity marked the largest absolute sectoral increase for the year.

Though developed countries are the largest historical source of emissions, they are on the rise in the developing world. Indeed, emissions by developing countries have more than doubled since 2010 and per capita emission levels are approaching those of developed countries (GCB, 2023). It is increasingly apparent that developing countries need to also tackle climate change in a more substantive manner, which leads to a host of complex questions about simultaneously addressing climate change, economic development and environmental justice (Hoffman et al., 2021; Swilling et al., 2016, 2022). Though there is an ongoing debate whether countries can decouple growth from emissions (Hickel & Hallegatte, 2022), there is an enduring consensus that developing countries should consider environmental ramifications while also pursuing economic development (Abdollahi, 2020; African Union, 2021; Xu et al., 2021). While emissions from deforestation and land-use change remain important, emissions from the energy sector experienced a noteworthy uptick in 2022, escalating by 1.8% (equivalent to 261 MtCO₂e) and ultimately reaching an unprecedented 14.6 GtCO₂e (IEA, 2023a). Among developing countries, those of sub-Saharan Africa stand out as contributing less than 10 percent of global GHG emissions, yet remain the least equipped to withstand the adverse effects of climate change (UNEP, 2021; WMO, 2023).

Several factors contribute to GHG emissions across countries. These include population size, economic efficiency, economy structure, energy consumption and energy mix (McCurdy & Rhodes, 2023). As highlighted by the IRENA (2022), countries that actively transition from non-renewable to renewable energy resources, particularly in electricity generation, demonstrate significant reductions in GHG emissions. This shift implies a move toward a low carbon economy characterized by greater supply of

renewable energy to reduce a country's carbon footprint. On the demand side, it is essential to prioritize energy efficiency through the implementation of demand-side management strategies for electricity (Kurdziel et al., 2020; Ozcan, 2016; Stafford & Faccar, 2014). By actively engaging in measures that address both energy supply and demand, a nation can significantly mitigate its climate impact.

Achieving such a transition suggests an enhanced need for energy system planning, particularly in the power sector (Yuan et al., 2024). Firstly, by anticipating demand trends accurately, stakeholders can optimize resource allocation and mitigate issues such as overproduction or shortages (Pruckner et al., 2014). Secondly, detailed electricity modeling provides invaluable insights for anticipating future energy system transitions. This includes shifts towards sustainability, enhanced energy efficiency, and strategies for climate protection. By simulating various future scenarios, policymakers and energy planners can evaluate the impacts of different policies, technologies, and investment decisions on the electricity grid (Lee et al., 2022). Finally, electricity modeling supports the integration of renewable energy sources into the grid, facilitating the transition towards cleaner energy sources and reducing dependence on fossil fuels. By harnessing the power of data-driven insights, stakeholders can make informed decisions that pave the way towards a more efficient, resilient, and sustainable electricity system.

Numerous countries took an important step forward by ratifying the Paris Agreement in 2015, which set a collective goal of keeping a rise in global average temperatures of this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius (UNFCCC, 2024). The Paris Agreement is centred on national climate action plans, which are formally known as nationally determined contributions (NDCs) (Laudari et al., 2021; Levin et al., 2015; Siriwardana & Nong, 2021). In their NDCs, countries outline measures they intend to implement to diminish their GHG emissions, aligning with the Paris Agreement's objectives, as well as strategies to enhance their resilience and adapt to the consequences of increasing temperatures. This international agreement serves as a crucial framework for orchestrating international climate action: every five years, each nation is required to present an enhanced NDC.

However, an essential aspect of NDCs that demands scrutiny is the credibility of these documents as climate and energy planning instruments. In a recent survey of diplomatic and scientific experts, Victor et al. (2022) define credibility as expected compliance. Nemet et al (2016) define "policy credibility as the level of confidence that non-government actors have that governments will fulfill future commitments as specified in policies" (p. 48). In this thesis, by "climate and energy planning credibility" I mean the capacity

of developing countries to achieve goals made in domestic energy policies and NDCs. My notion of “climate and energy planning credibility” encompasses considerations such as data accuracy, transparency in modeling methodologies and the overall accuracy of the measures outlined in the NDCs. This thesis seeks to understand the political factors producing credible energy and climate plans.

The literature suggests planning credibility is related to state capacity. According to Baker et al. (2020), climate policy necessitates radical adjustments to energy systems, such as the switch from fossil fuels to renewable energy sources, the creation of new energy infrastructure, and the reconfiguration of energy markets and consumer habits. Strong regulatory frameworks, administrative capabilities, and policy frameworks are needed for these changes to be implemented and coordinated amongst different stakeholders, including government organizations, energy firms, investors, and local populations. To develop and carry out policies that support the deployment of renewable energy, encourage innovation, mobilize investments, and guarantee equal access to energy benefits, strong state capacity is required (Sovacool and Dworkin, 2014).

It is possible to obtain a clearer understanding of the importance of state capacity for energy transitions by looking at the experiences of various countries. On one hand, countries like China, Germany, and Denmark have demonstrated how state capacity can facilitate the successful adoption of ambitious renewable energy policies and drive the transition to sustainable energy systems. These nations have established administrative capabilities, financial resources, and regulatory frameworks to facilitate the growth of renewable energy (Baker et al., 2020; Sovacool and Dworkin, 2014). They also have efficient stakeholder engagement procedures in place to win over a variety of stakeholders (Hvelplund, 2017). It is essential that various government agencies, stakeholders, and tiers of government work together effectively. The need of institutional capability and coordination among multiple stakeholders, including government, business, and civil society, is demonstrated, for example, by Denmark's experience in switching to renewable energy. Prioritizing institutional capacity building and encouraging stakeholder coordination should be top priorities for policymakers (Jordan et al., 2018).

In contrast, putting energy and climate policies into practice might be difficult for nations with lesser state capacities, like emerging economies and lower-income countries in Africa and Southeast Asia. Limited resources for policy implementation, a lack of technical know-how, shoddy regulatory frameworks, and a lack of involvement with local communities and civil society organizations are a few examples of these difficulties (Karekezi et al., 2002; UNDP).

1.1.1 Problem statement

The present thesis aims to provide a more thorough theoretical and empirical contribution to the ongoing discussion on climate and energy planning credibility in developing economies by introducing state capacity into the analysis. In the context of climate change and the need to transition to sustainable energy, understanding the intricate relationship between state capacity and reliable climate and energy planning becomes crucial. State capacity, encompassing the state's administrative, financial, and institutional capabilities, significantly influences the development, implementation, and success of climate and energy policy. Sufficient research is lacking about how variation in state capacity across different countries impacts the formulation and execution of climate and energy plans. This impedes the ability to craft tailored and effective strategies that can address the unique challenges of individual countries. Consequently, there is a pressing need for analysis that helps us bridge this gap. In response, this thesis delves into the relationship between state capacity and energy and climate planning credibility, examining how the strength of a state's institutions and administrative capabilities influences its ability to produce reliable energy and climate plans.

1.1.2 Research Question

The literature suggests that states with higher capacity are better positioned to conduct comprehensive research, gather accurate data, and engage in more sophisticated energy system modeling. This leads us to the central research question of this thesis: does state capacity influence the credibility of climate and energy planning? By exploring this relationship, the study aims to uncover how state capacity (independent variable) impacts the credibility of climate and energy strategies plans (dependent variable).

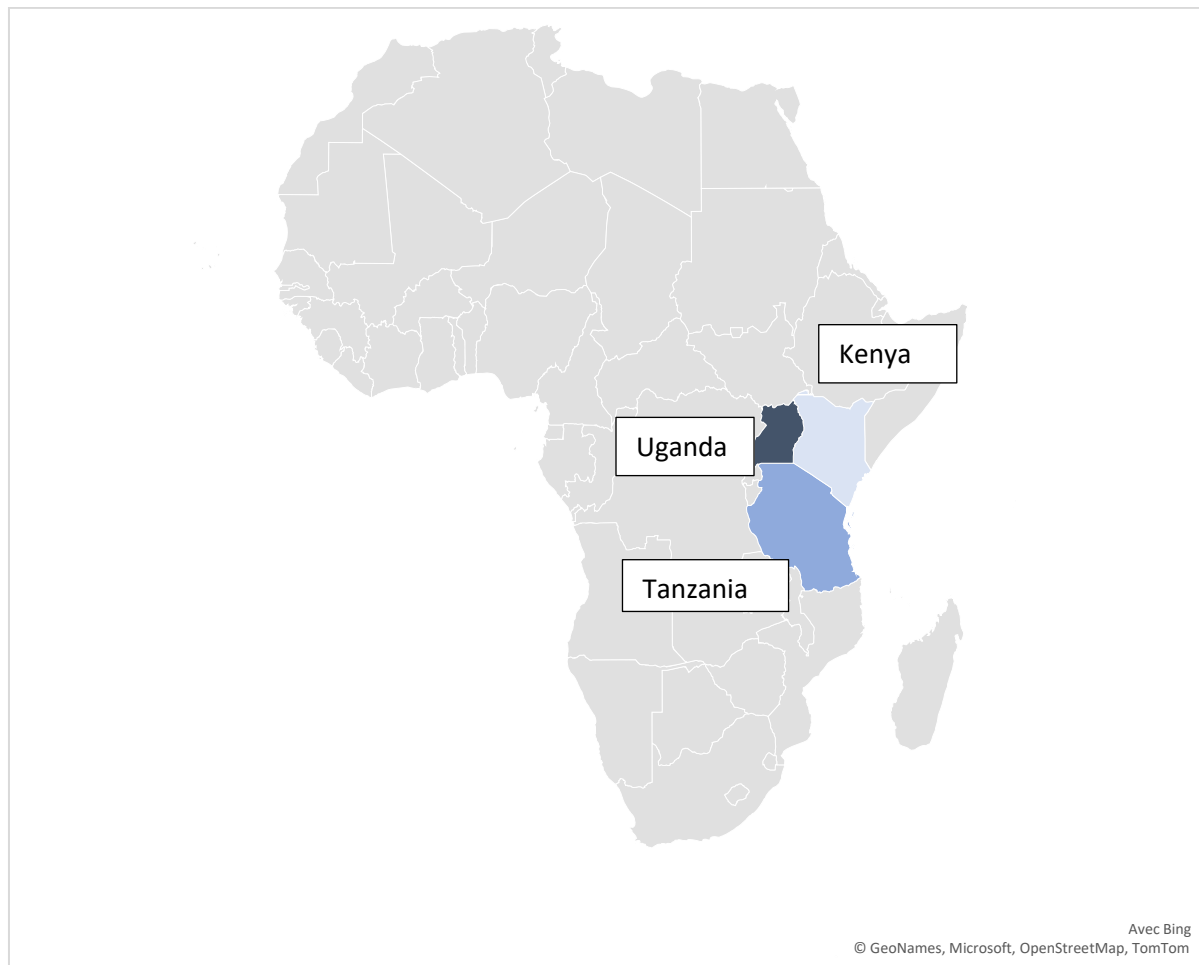
I focus on such concerns in the East African region (Kenya, Uganda and Tanzania), one of the most climate-vulnerable regions due to its fragile ecosystems and relatively low levels of economic development (Ribot, 2014; Saeed et al., 2023). While relative to a developed country like Canada, all three countries might appear to have similar low-levels of state capacity, upon closer inspection substantial variation is apparent that distinguishes relatively higher state capacity in Kenya from that in Tanzania and Uganda. For example, only the latter two countries are officially recognized as least developed countries by the UN. Similarly, Kenya is categorized as being part of the medium HDI category of the UN's Human Development Index (HDI) while Tanzania and Uganda are of the low HDI category (UN, 2023; Wikipedia, 2023). As I show later below, other indicators point to higher state capacity in Kenya relative to Tanzania and Uganda. Overall,

my three-country comparison adheres to a most-different-system research design. Consequently, I endeavor to show whether, despite disparities in state capacity, there exist common factors that explain patterns of energy and climate planning credibility across countries.

1.1.3 Argument

Based on study of planning documents and technical modeling capacity for climate and energy planning in Tanzania, Uganda and Kenya, I argue that state capacity is not aligned with climate and energy planning credibility. Indeed, climate and energy planning credibility were similar between Kenya and Uganda while appearing more credibility than in Tanzania— despite differences in state capacity observed. This suggests that factors other than state capacity shape climate and energy planning credibility—issues I explore in the conclusion of this thesis.

Figure 2.1:Tanzania, Uganda and Kenya map



CHAPITRE 2

LITERATURE REVIEW

In this chapter, I present the conceptual framework for my analysis and associated literature, introducing pertinent theories along with the existing knowledge about them. The aim is to provide a comprehensive understanding of the theoretical underpinnings that inform my research. This begins by exploring the literature on electricity consumption, economic growth and GHG emissions. The foundation of my conceptual framework lies in the nexus between state capacity as well as climate and energy planning credibility. By reviewing scholarly articles and other relevant sources, I aim to contextualize my research within the broader research discourse.

2.1 Conceptual framework

To explore whether state capacity explains the credibility of energy and climate planning, this thesis employs a conceptual framework that examines the interplay between state capacity and planning credibility. State capacity—encompassing institutional effectiveness, regulatory efficacy, financial and human resources as well as technical proficiency—serves as the independent variable in this thesis. This capacity significantly influences the ability of the state to undertake climate and energy planning by shaping the government's ability to acquire, analyze, and interpret data to undertake energy system modeling, which occupies an important role in the planning process. But climate and energy planning cannot be simply reduced to techno-economic modeling. State capacity also underpins climate and energy planning processes by impacting the government's ability to provide an appropriate institutional framework. In, my thesis, I focus mainly on administrative capacity, which refers to an organization's ability to collect and manage information in order to design and implement policy (Hendrix, 2010; Savoia & Sen, 2015). State capacity is often posited to be a crucial determinant of the credibility of energy and climate plans. By comparing countries and existing climate plans through this lens, the thesis aims to uncover if and how state capacity relates to the perceived credibility of energy and climate strategies.

Figure 2.1: Conceptual framework



2.2 Climate and energy planning credibility

2.2.1 Defining climate and energy planning

NDCs suggest a need to consider climate change effects when planning energy systems. Energy system planning often involves determining how energy should be generated over the medium to long term within a specific geographic area, often national in scope. Energy system planning encompasses a range of definitions. Some scholars offer narrow definitions, such as (Hiremath et al., 2007), who describe it as the process of identifying a set of energy sources and conversion devices to efficiently meet energy demands, whether centralized or decentralized. In this view, energy planning focuses primarily on achieving an optimal, usually cost-minimal, supply mix for a given demand scenario.

However, the concept of energy planning has evolved to encompass broader considerations. For example, other scholars argue that energy system planning involves multiple decision criteria, making it unlikely to find a simple global optimum (Loken, 2007; Rojas-Zerpa & Yusta, 2014). This expanded perspective recognizes that energy system planning must address complex factors beyond mere cost optimization, including environmental impact, social considerations, and resilience to uncertainties. And while costs are a crucial factor, other considerations such as the level of external dependence on energy resources, corresponding energy security, efficiency in different regions, and the societal and environmental impacts associated with available technologies are equally important (Omer, 2008). This diversification extends to the strategic integration of renewable energy sources facilities, aiming to optimize energy efficiency (Victor, 2011).

As a subset of energy system planning, power systems planning aims to anticipate electricity consumption accurately in a specific area in order to mitigate the risks of either a surplus or insufficient electricity supply. This is done by gathering historical data on electricity consumption and developing predictive models based

on this information. These models can then be refined for greater accuracy in order to better inform electricity planning decisions (Tokunaga et al., 2020). Electric power systems are crucial for modern societies, characterized by their large-scale, dynamic nature and significant spatio-temporal complexity. Ensuring the credibility and security of these systems is paramount in regional and global energy policies (Abdin & Zio, 2020). Electricity planning, enables the strategic, long-term formulation of an optimal electricity generation mix that ultimately balances supply security, sustainability and competitiveness (Hickey et al., 2010; Khatib, 2003). The timeframe under examination is influenced by the extended service life of power generation assets and the inherent high level of uncertainty. The extended service life of power generation assets means that decisions made today can have long-term implications, as these assets remain in operation for many years. Additionally, there is a high level of uncertainty surrounding factors such as technology advancements, regulatory changes, environmental considerations, and market dynamics—all of which can impact various variables involved in decision-making processes related to power generation. Consequently, the planning process serves to mitigate uncertainty associated with future asset requirements, laying the groundwork for enhanced electricity supply security, access to the most cost-effective solutions, efficient resource utilization, and environmental sustainability (DeLlano-Paz et al., 2017).

Research in this area is conducted by governments and power system operators to facilitate future system-wide expansion and to develop optimal policies and regulations. Additionally, in countries with a liberalized energy sector, privately owned power utilities engage in power system planning and contribute to developing strategies for future investments (Abdin & Zio, 2020). Power systems planning in developing nations has encountered numerous challenges, ranging from forecasting future load growth amidst uncertainty, to the emergence of intermittent renewable energy (Abdullah, M., 2020; Pohekar & Ramachandran, 2004). The least-cost alternative approach is widely employed as the predominant methodology for choosing power generation assets in the energy sector, focusing on a single criterion of cost (Awerbuch, 2006). This approach involves assessing each alternative technology based on its levelized cost of electricity which involves calculating the average cost of generating electricity over the lifetime of a power plant or energy project, expressed per unit of electricity generated. The preferred technology is the one with the lowest cost and production coefficient (DeLlano-Paz et al., 2017). Recent goals for environmental sustainability and the challenges posed by climate change are increasingly affecting the

credibility levels of power systems. This evolving landscape necessitates the development of adapted planning methods to ensure continued credibility and resilience (Abdin & Zio, 2020).

In contrast to energy planning, climate planning refers to the strategic process of developing and implementing measures to address the impacts of climate change at various levels, from local to national, with the aim of reducing greenhouse gas emissions, enhancing resilience, and promoting sustainability. This comprehensive approach involves a wide range of actions, including promoting clean energy, decarbonizing buildings and transportation, managing resources sustainably, and incorporating adaptation and mitigation measures into urban and rural development plans (Matthews & Baker, 2021; Pokhrel, 2013). Key elements of climate planning include setting specific goals, such as achieving carbon neutrality, and defining strategies to meet these objectives. Monitoring progress is essential to ensure the effectiveness of these strategies, allowing for adjustments as needed. Climate planning also emphasizes the importance of social equity by addressing the needs of vulnerable populations and ensuring fair distribution of benefits. The economic viability of climate plans is considered by balancing costs and benefits, fostering growth, and creating green jobs, while environmental integrity is maintained by protecting natural habitats and biodiversity. Additionally, community participation is crucial, involving public engagement and incorporating local knowledge into decision-making processes. By integrating these elements, climate planning aims to create resilient, sustainable communities capable of effectively combating climate change. Integrating climate change into development planning and decision-making requires a multifaceted approach that includes the development and enforcement of robust policy frameworks aligned with international agreements and strengthening institutional capacities through targeted training and interdisciplinary collaboration (Kim et al., 2017).

But there is also clearly an overlap between climate and energy planning. Governments and academics working towards the adoption of an integrated and adaptive energy and climate strategy have recently become interested in this topic. In order to establish Europe as a leader in sustainable development for the twenty-first century, the European Union has put out a competitive and sustainable climate-energy policy. The European Commission has set three energy targets (20-20-20 targets) to be met by 2020 in this regard (Pasimeni et al., 2014).

This overlap is increasingly recognized as essential for achieving sustainability goals. Local initiatives, like France's Climate and Energy Territorial Plans (PCET), demonstrate the importance of adopting holistic strategies that address multiple sectors, such as housing and transportation, to effectively combat climate change (Klein, 2013). Likewise, Italy's experiences emphasize the need to integrate energy planning with urban development to improve both efficiency and sustainability (Zanon & Verones, 2013).

2.2.2 Modeling future energy consumption and GHG emissions

Techno-economic modeling has emerged as a key tool in climate and energy planning. Projecting future energy consumption is crucial for analyzing economic, energy, and environmental policies. Integrating economic and demographic factors into energy planning is considered an option for designing effective policies, incentive programs, and urban planning tools, ultimately promoting sustainable energy goals and reducing global energy consumption (Aydin, 2014). The causal relationship between electricity consumption, economic growth and GHG emissions has been a topic of significant interest in various countries. Several studies have used a multivariate framework to examine the causal relations between economic variables, electricity consumption and GHG emissions.

In both Nigeria and Vietnam, empirical evidence suggests a positive correlation between electricity consumption and economic growth, over both the short- and long-term. This indicates that as the economy expands, there is a concurrent increase in electricity usage, contributing to overall economic development (Badamasi, 2023; Huong Lan & Thanh Cong, 2023). In Jordan, findings indicated a positive association between energy consumption and factors such as industry, urbanization, GDP, and water consumption (Al-Bajjali & Shamayleh, 2018). Furthermore, a global panel study across 67 countries demonstrated that economic growth has a positive and statistically significant effect on electricity consumption, emphasizing the impact of GDP on electricity usage (Saidi et al., 2017). In Kenya, utilizing the Autoregressive distributed lags method bound empirical framework, there is evidence of a unidirectional causal relationship from GDP to electricity consumption at a 10% confidence level (Njenga, 2024). A positive correlation was found between Kenya's increasing GDP growth rates and a corresponding surge in electricity needs (Mabea, 2014). Research conducted in the Ugandan context, as exemplified by (Sekantsi & Okot, 2016), delved into the relationship between electricity consumption and GDP, employing the ARDL bound test and the Granger

causality framework. Their findings indicated a unidirectional causal flow, highlighting the effect of economic growth on electricity consumption. Similarly, (Mawejje & Mawejje, 2016) conducted a parallel study utilizing vector error correction techniques and Granger causality tests. In their analysis, they identified a unidirectional causal link, illustrating the impact of electricity consumption on GDP. Also, gross domestic product per capita was found to increase CO₂ emissions when investigating the impact of both energy consumption and per capita gross domestic product on carbon dioxide emissions (Otim et al., 2022).

Contrastingly, findings from India suggest a negligible impact of electricity consumption on output per capita point to a more complex economic relationship than might be expected. This suggests that, within the Indian context, other factors might play a more dominant role in driving economic growth, overshadowing the direct influence of electricity consumption. Wolde-Rufael (2006) investigated the causal and long-term connections between GDP and electricity consumption in seventeen African countries. The empirical findings indicate the presence of a long-term relationship between electricity consumption per capita and real GDP per capita in more than half (9 of 17) of the countries. Among these, six countries exhibit a positive unidirectional causal relationship leading from real GDP per capita to electricity consumption per capita, an opposing causality for three countries (electricity consumption → GDP), and a bidirectional causality for the remaining three countries. Similarly, research conducted in Indonesia revealed a mixed pattern, where electricity consumption exhibited a significant positive effect on economic performance in the short term. However, over the long run, its impact on economic indicators diminished, suggesting a more complex relationship influenced by various temporal factors. In Pakistan, the correlation between electricity consumption, electricity price, and real GDP seems to vary significantly across different sectors (agricultural, commercial, industrial, and residential) (Abbasi et al., 2021). Moreover, analysis of the West African Economic and Monetary Union (WAEMU) countries unveiled a multifaceted interplay between economic growth, international trade openness, capital formation, and electricity consumption over the long term. This underscores the intricate dynamics at play, where multiple variables collectively shape the electricity consumption patterns within these regions (Moussavou, 2022).

In East African context, Nyangena et al (2019) investigated the factors influencing CO₂ emissions, utilizing panel data spanning from 1960 to 2014. Employing the STRIPAT model—a regression equation designed

to assess the impacts of population, affluence, and technology on environmental outcomes, with carbon dioxide emissions serving as a proxy—the study aimed to discern the presence of the Environmental Kuznets Curve (EKC) within this region. The findings of the study revealed that economic growth, urbanization, and population expansion were associated with adverse environmental effects.

Overall, the divergent conclusions drawn from various studies underscore the complexity of the relationship between economic growth and electricity consumption, with some indicating a direct influence of economic growth on electricity consumption, while others fail to establish clear evidence of causality. These findings highlight the nuanced nature of the relationship between economic growth and electricity consumption, emphasizing the importance of considering specific socio-economic contexts and a wide array of factor. This section is crucial for later in my modeling exercise to account for the various factors that influence electricity demand projections.

2.2.3 Climate and energy planning credibility

Climate economists have long identified policy credibility as a key area of research (Toman, 1998), emphasizing that without credible policies, long-term climate targets are unlikely to be achieved. In a recent survey of diplomatic and scientific experts, Victor et al. (2022) define credibility as expected compliance. Nemet et al (2016) define “policy credibility as the level of confidence that non-government actors have that governments will fulfill future commitments as specified in policies” (p. 48). Credibility in climate policy is a crucial factor influencing the success of international agreements like the Paris Agreement. Research indicates that the credibility of national commitments to combat climate change is closely tied to the quality of political institutions, with countries boasting strong institutions demonstrating higher credibility (Victor et al., 2022). These authors argue that countries making the boldest pledges are also making the most credible pledges.

The literature suggests that addressing credibility issues in climate policy requires balancing the need for commitments that stimulate transformation while retaining flexibility to adapt to new information (Nemet et al., 2016). This balance is crucial because overly rigid policies may fail to account for evolving scientific insights and technological advancements, while excessively flexible policies might undermine the

perceived seriousness and credibility of the commitments. Emphasizing the importance of credible long-term commitments, it becomes evident that effective climate action hinges on policies that are both ambitious and adaptable. Long-term credibility ensures that stakeholders, including governments, businesses, and the public, have the confidence to make significant investments and behavioral changes necessary for sustainable progress. To meet objectives set out in their NDCs, countries must adjust not only the level but also the time frame and scope of their domestic climate targets. Currently, some countries have not yet adopted domestic emission targets consistent with their NDCs (Nemet et al., 2016). For the Paris Agreement to succeed, countries must also prioritize ensuring the credibility and faithful implementation of their commitments. This success requires a more systematic assessment of the adequacy of domestic efforts and improved national processes for monitoring, reporting, and verification (Averchenkova & Matikainen, 2017).

For example, the European Union's emissions trading system illustrates how policy credibility, demonstrated through ambitious reforms and long-term climate target commitments, can significantly impact carbon prices and shape investment decisions in decarbonization efforts (Sitarz et al., 2024). Corporate perceptions of policy credibility, as demonstrated in Germany, are primarily influenced by the coherence and consistency of policymaking and implementation, including national targets and specific policy instruments. This underscores the importance of these factors in promoting low-carbon investment and innovation (Rogge et al., 2017). The credibility of climate policy commitments is essential due to the long-term nature of carbon dioxide's impact and energy infrastructure, requiring a sustained commitment to climate action (Nemet et al., 2016).

2.3 State capacity

2.3.1 Conceptualizing state capacity

State capacity is a fundamental idea in political science studies and related disciplines, and it is well known that state institutions have a significant impact on outcomes including international security, civil unrest, economic growth, and democratic consolidation. However, scholars have grappled with how to conceptualise and quantify state capacity. Much of the literature shares the central idea that state capacity relates to the state's ability to implement its policies or goals. This serves as a starting point for a definition

of state capacity that avoids confusion with other concepts and is conducive to a reliable comparative measurement (Cingolani, 2013).

The concept of state capacity, as articulated by (Skocpol, 1985), underscores the pivotal role of a government's ability to achieve official objectives, particularly when confronted by actual or potential resistance from influential social groups domestically or internationally. Strong states not only demonstrate the capacity to execute coherent policies but also possess the crucial capability to independently formulate strategies, free from the influence of distributional coalitions (Doner, 1992; Dye, 2021; Rugaimukamu et al., 2023). The concept of state capacity extends beyond the ability to formulate policies; it encompasses the government's aptitude to implement, monitor, and adapt these policies over time. Robust intra-governmental coordination is essential for streamlining efforts across various departments, ensuring a cohesive and well-coordinated approach to climate action (Winanti & Mas'Udi, 2022).

Scholars have explored various dimensions of state capacity and their relationship with different policy outcomes, such as economic development, governance legitimacy, etc. This exploration has led to the emergence of several subsidiary concepts aimed at capturing specific attributes of state capacity:

- Coercive capacity (Fearon & Laitin, 2003; Geddes, 1996; Skocpol, 1985; Tilly, 1975), fiscal (Besley & Persson, 2009; Geddes, 1996; Levi, 1988; Tilly, 1975),
- Administrative capacity (Centeno, 2002; Geddes, 1996; Huntington, 1968; Skocpol, 1985),
- Transformative capacity (P. Evans, 1995; Weiss, 1998),
- Territorial capacity (Fearon & Laitin, 2003; Migdal, 1988),
- Legal capacity (Acemoglu et al., 2011; Besley & Persson, 2009; Fukuyama, 2004),
- Infrastructural capacity (Mann, 1986; Soifer & vom Hau, 2008),
- Strategic capacity (Meckling & Nahm, 2018) and
- Political capacity (Acemoglu et al., 2011; Centeno, 2002).

In an important recent contribution, Hanson & Sigman (2021) decompose state capacity into three inter-related dimensions that are: (1) most logically separate from one another; and (2) minimally necessary to fulfil the roles of modern states : extractive, coercive, and administrative capacity. The coercive capacity

of a state focuses on maintaining external security and internal order through military strength, law enforcement, and a functioning judicial system, ensuring the rule of law and protection against threats. Extractive capacity pertains to the financial resources available to the state, encompassing efficient taxation, revenue generation, borrowing, and sound economic management to fund public services and activities. On the other hand, administrative-bureaucratic capacity relates to the quality of administrative and bureaucratic institutions within the state, including a competent civil service, robust regulatory frameworks, adequate infrastructure, and mechanisms for transparency and accountability. When these three dimensions are highly developed, it characterizes a high-capacity state capable of pursuing diverse policy objectives.

In this thesis, my primary focus will be on administrative capacity as I evaluate the internal resources of the countries under study.

2.3.2 State capacity and climate and energy planning credibility

As states endeavor to craft effective climate policies, the global landscape reveals a diverse range of efforts with varying degrees of success in achieving greenhouse gas (GHG) reduction goals. The perceived connection between state capacity and the effectiveness of climate and energy policy has been a foundational principle guiding capacity-building endeavors in the field of climate change for several decades. This link is often encapsulated by specific terminology such as "mitigative capacity," a term coined by (Yohe, 2001). The term "mitigative capacity" emphasizes the capability of a state to undertake policy measures that contribute to climate mitigation efforts. This includes the ability to implement and enforce regulations, monitor emissions, and establish comprehensive plans for addressing climate mitigation and adaptation. It also involves the integration of climate considerations into broader development planning processes. An integrated approach to climate and development policy planning is crucial to leverage synergies amongst different goals and to prevent the pursuit of some objectives from undermining others.

Research shows that despite advances in recognizing the importance of integrating climate change adaptation into national planning for overall development goals, challenges remain in translating policy into practice. These challenges stem from conceptual diversity, organizational prerequisites, and tensions between expert and general knowledge within development organizations (Wagner et al., 2022).

Additionally, (Victor, 2011) has contended that the regulatory capabilities of governments to control emissions are closely intertwined with their interests. In essence, the existing literature suggests that countries that exhibit enthusiasm towards addressing climate change tend to possess robust systems of administrative law, well-established regulatory frameworks, and efficient mechanisms for collecting data and associated information necessary for decision-making. On the contrary, nations that display reluctance towards climate action often have less developed systems in these domains.

Furthermore, state capacity plays a pivotal role in the effective navigation of the intra-governmental policy landscape (F. Matthews, 2012). Intra-governmental capacity refers to the capabilities and efficiency of different government agencies working collaboratively and is increasingly recognized as a determining factor in the success of climate policy (Garrett, 2023; Winanti & Mas'Udi, 2022). This capacity involves not only the technical expertise and resources available within individual agencies but also the strength of inter-agency communication, coordination, and cooperation. Effective intra-governmental capacity ensures that policies are coherently developed and implemented across various sectors, preventing fragmentation and redundancy. It also facilitates the alignment of climate policies with broader development goals, ensuring that efforts in climate adaptation and mitigation are synergistic and mutually reinforcing. By fostering a collaborative environment, states can better manage the complexities of climate policy implementation, address cross-cutting issues, and respond more flexibly to emerging challenges and opportunities.

A government's ability to respond promptly and efficiently to the evolving dynamics of climate change is contingent upon its administrative and extractive capacity. This includes the availability of skilled personnel, adequate financial resources, and advanced technological infrastructure. These factors collectively contribute to the agility of the government in implementing and adjusting climate policies in the face of emerging challenges. State capacity also plays a key role in the successful adoption and implementation of policies, reducing the gap between policy creation and achieving the desired results (Guillén & Capron, 2016). When a government possesses the necessary resources, expertise, and organizational structures, it is better positioned to ensure that policies are not only introduced but also effectively translated into tangible actions and results.

For example, a comparative analysis of energy infrastructure policy in Brazil, Russia, India, and China (BRIC) over the past two decades underscores the significance of state capacity in coordinating policies, leveraging public financing instruments, and fostering bureaucratic cohesion for effective policy implementation (Santana & Vieira, 2015). Winanti & Mas'Udi (2022) propose the concept of “energy-democracy theory” that includes “socio-technical capacity”, “community engagement” and a rigorous state’s capacity to make energy transitions possible in developing nations where the involvement of state actors is crucial in resource management.

Overall, the literature suggests that state capacity plays a pivotal role in facilitating sustainability transitions, particularly for countries in the Global South (Garrett, 2023). The capacity of sub-state governments also plays a crucial role in influencing their ability to enact climate policies. Furthermore, the planning of power systems necessitates extensive amounts of information related to the costs of various types of energy technologies as well as their availability, human resource requirements, infrastructure needs, environmental impacts as well as associated uncertainties (Royles & McEwen, 2015).

2.4 Conclusion

The literature revealed that state capacity is indeed a multifaceted concept, and different dimensions and definitions have been proposed to understand it. At its core, the concept is linked to the state's ability to implement and enforce policies effectively. The literature highlights that state capacity is a crucial determinant for the climate and energy credibility as it has a significant importance to use public funding tools, promote bureaucratic cohesiveness, and coordinate policies for efficient policy execution.

CHAPITRE 3 : METHODOLOGY

In this chapter, I delve into the intricacies of my research design, elucidating the rationale behind the chosen methods and their relevance to the study's goals. By detailing my approach to data collection, analysis, and interpretation, I aim to ensure transparency and rigor in the research process. I first describe my research design, including more detailed presentation of my independent and dependent variables underpinning my study, state capacity and climate and energy planning credibility, in each of my three case-study countries. In the second part, I elaborate on the modeling methodology employed in this study to forecast electricity demand and GHG emissions in Tanzania, Uganda, and Kenya.

3.1 Research design

In my study, I aim to understand the influence of state capacity on climate and energy planning credibility through comparative investigation of three case study countries: Tanzania, Uganda and Kenya. This was operationalized by identifying indicators of my independent and dependent variables, for which both qualitative and quantitative data were collected (Table 3.1). The indicators to be explored were determined through a review of the literature on state capacity and policy credibility. In particular, I conducted in-depth analysis of national electricity development plans and GHG emissions policies in Kenya, Tanzania, and Uganda. This entailed scrutinizing official government documents, policy papers, and legislative frameworks to extract key insights into each countries' approach to climate and energy planning.

Table 3.1: Indicators for dependent and independent variables

Independent variable: state capacity	Dependent variable: climate and energy planning credibility
• GDP per capita • Tax revenue • Government effectiveness • Electricity access	• Power sector planning credibility • NDC's credibility

The distinctive aspect of my approach lies, in part, in the emerging acknowledgment that small-N comparative methods can serve as valid means for drawing causal inferences. While large-N analyses have their place, small-N studies recognize the contextual intricacies and unique characteristics of each country (Purdon, 2024). This is especially pertinent in the context of exploring novel policy initiatives like those related to climate and energy policy, where the country-level modeling process is intricate and time-intensive. As articulated by Steinberg (2007), "Policymakers and others working in the public interest want to learn about the art of the possible, and the risk of the unthinkable, not just the trend line of the probable" (p. 185).

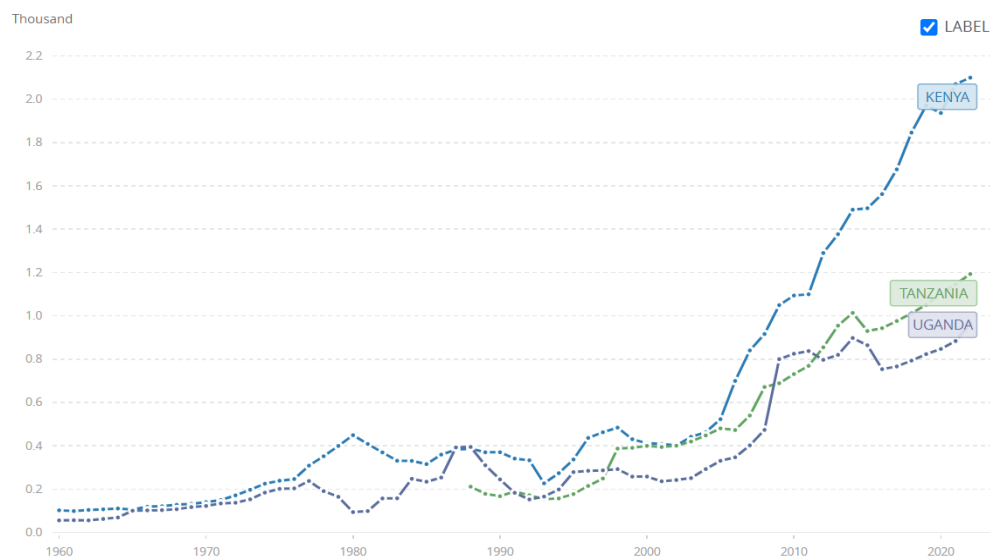
The case study countries were initially chosen to accommodate variation in state capacity. Across the three East African countries, a number of indicators suggest that Kenya has greater state bureaucratic capacity than in the other two East African countries investigated. Embracing a most-different-systems research design (Ankar, 2008; Przeworski & Teune, 1970), my primary objective has been to explore the extent to which variation in state capacity affects climate and energy planning credibility. A most-different-systems design allows me to draw more robust conclusions regarding the role of state capacity in climate and energy planning than if I had focused only on a single case-study or if I did not have variation in state capacity across countries.

3.2 Independent Variable: Indicators of State Capacity

In this section, I describe how my independent variable, state capacity, was operationalized. The concept of state capacity is notably characterized by its multidimensionality and recognized to be comprised of an array of interrelated capacities inherent to a modern state, including extractive, coercive and administrative capacities (Hanson & Sigman, 2021). While it would be anticipated that administrative capacity would be most directly related to climate and energy planning credibility, the literature suggests a broad array of indicators are appropriate for characterizing state capacity between countries. In this study, I opted for specific indicators including GDP per capita, tax revenue extraction, electricity access and an indicator on government effectiveness retained by the World Bank as part of its Worldwide Governance Indicators. These serve as the foundational elements validating the level of state capacity in each of my respective case study countries.

Using GDP per capita as an indicator for state capacity is a common approach in assessing the level of economic development of a country. It provides valuable insights into the average income and standard of living of a country's citizens. As can be seen in Figure 4.1., Kenya exhibits a significantly higher GDP per capita compared to both Tanzania and Uganda. A higher GDP per capita suggests greater resources available to the state for supporting interests' groups supportive of climate and energy policy and quieting opposing groups (see Meckling & Nahm, 2022).

Figure 3.1: GDP per capita (current US\$) - Kenya, Tanzania, Uganda

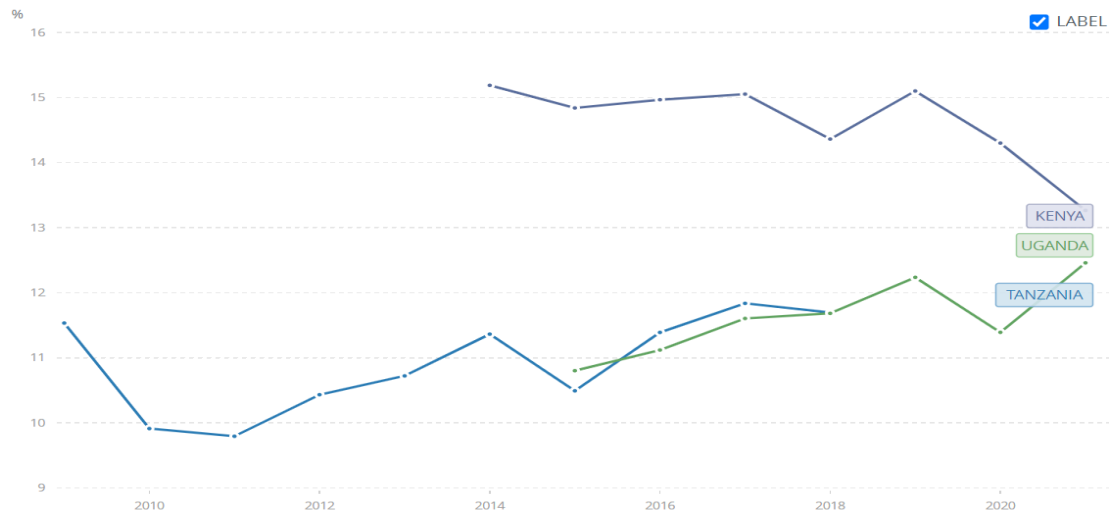


Source: World Bank Development Indicators

An additional measure of state capacity involves tax extraction, as emphasized by Skocpol (1985). As Skocpol has argued: “A state’s means of raising and deploying financial resources tell us more than could any other single factor about its existing (and immediately potential) capacities” (Skocpol, 1985: 17). Examining Figure 3.2 presents available data on tax revenue as a percent GDP. It reveals a notable discrepancy among the three countries, with Tanzania and Uganda demonstrating considerably lower tax extraction capabilities compared to Kenya. However, the more recent data suggest a convergence, as Kenya’s capacity is declining and Uganda’s increasing. In this light, variation in tax extraction among

Tanzania, Uganda, and Kenya illustrates their divergent state capacities in government revenue mobilization.

Figure 3.2 : Tax revenue (% of GDP)

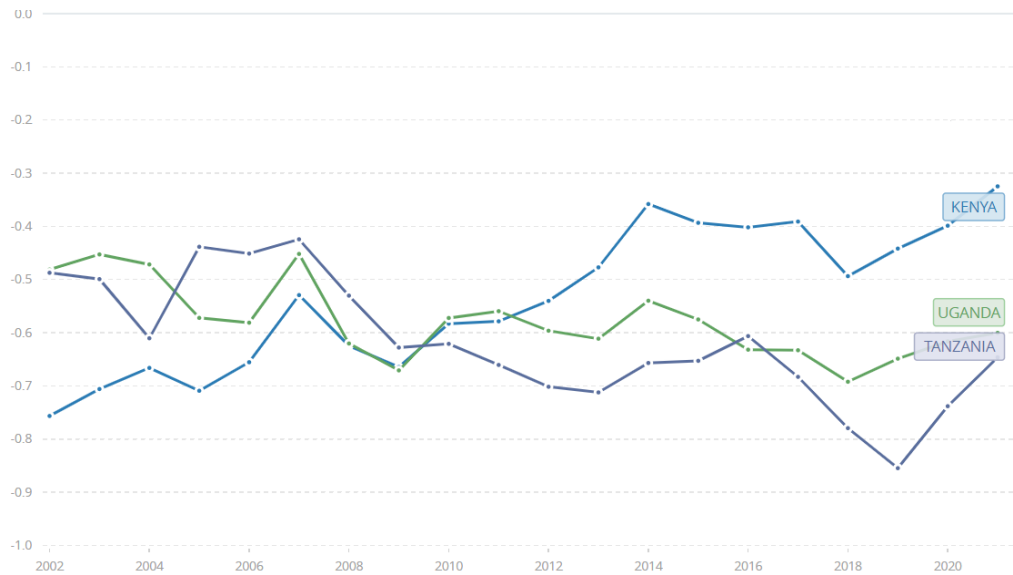


Source: World Bank Development Indicators

An indicator for the quality of administrative capacity is government effectiveness. The Worldwide Governance Indicators maintained by the World Bank track six aggregate governance indicators over 200 countries over the period 1996 to 2022. Their concept of "Government Effectiveness" combines various factors related to the quality and efficiency of public administration (World Bank, 2024). It encompasses assessments of public service provision, bureaucratic performance, the competence of civil servants, the autonomy of the civil service from political influence, and the government's credibility in upholding its policies (World Bank, 2024). This indicator primarily emphasizes the foundational elements for government to formulate and execute effective policies and provide essential public services (Kaufmann & Kraay, 2023).

In terms of this measurement, Kenya stands out with a notably higher level compared to both Uganda and Tanzania (Figure 4.3). In contrast, both Uganda and Tanzania, while making strides in terms of governance effectiveness, face certain challenges that result in comparatively lower government effectiveness.

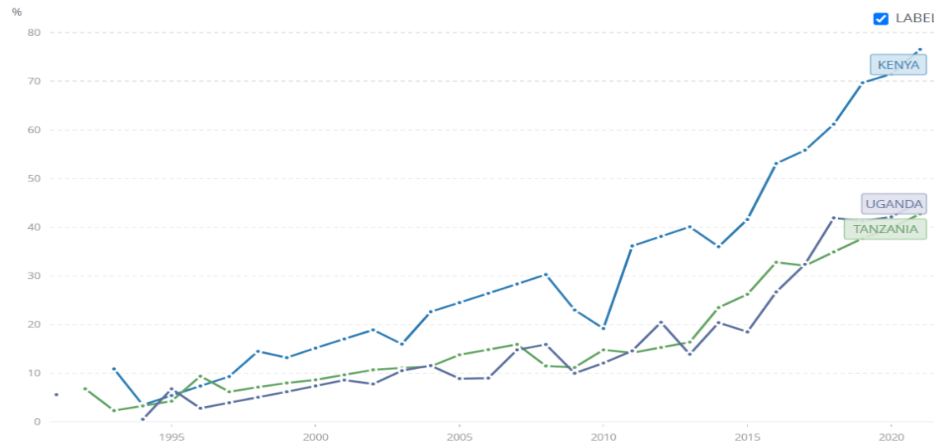
Figure 3.3: Government effectiveness



The Worldwide Governance Indicators

A final indicator of state capacity is access to electricity, which enhances the capacity of states to act. Kenya has made significant strides in improving electricity access over the years. As of the early 2020s, the country had achieved relatively high rates of electrification, with the government implementing various initiatives to increase access in both urban and rural areas. The percentage of the population with access to electricity was over 76%. Tanzania and Uganda have also been working on expanding electricity access, particularly in rural areas, but the percentage of the population with access to electricity was lower than in Kenya, at 42% and 45%, respectively (World Bank, 2023b). In terms of consumption per capita, Kenya had the highest electricity consumption per capita in 2021 (171kW), likely due to its higher level of economic development and significant investments in energy infrastructure. Tanzania followed with moderate consumption levels (113.1kW), reflecting its economic status and ongoing efforts to expand electricity access. Uganda had the lowest electricity consumption per capita (72.4kW), reflecting its lower economic development and challenges in electricity access and credibility (Country economy, 2024).

Figure 3.4 Access to electricity (% of population) - Kenya, Tanzania, Uganda



Source: World Bank Indicators

3.3 Dependent Variable

To assess the credibility of climate and energy planning, I conducted a comprehensive evaluation combining both qualitative and quantitative assessments. The qualitative assessment involved a review of key documents related to the power sector and the country's Nationally Determined Contributions (NDCs). Following this, I conducted a quantitative assessment through a modeling exercise to further evaluate the credibility of the country's climate and energy plans. This involved conducting an independent modeling exercise to project future electricity demand and greenhouse gas (GHG) emissions. I then compared the official governmental projections with my independent projections.

3.3.1 Qualitative Analysis: Indicators of climate and energy system planning credibility

I first offer qualitative indicators of power sector planning credibility as well as NDC planning credibility—two dimensions of my dependent variable—that might be ascertained from review of power sector planning documents. See Table 3.2. Each indicator refers to a power sector planning process: independence ensures objectivity, long-term planning secures future readiness, flexibility allows for

adaptation to change, data availability underpins informed decision-making, the presence of detailed and well-articulated plans reflects a commitment to sustainable energy practices. Inspired by (Olazabal et al., 2019), the indicators in Table 3.2 form a comprehensive framework for assessing the credibility of power sector planning.

Second, I consider NDC credibility through factors such as inclusivity, adaptability and past performance. These metrics ensure that commitments are comprehensive, realistic, and effectively integrated into broader national and international efforts to combat climate change. Inclusivity guarantees that all sectors, including the power sector, are considered in the national climate strategy, while adaptability allows for responsiveness to changing circumstances, ensuring long-term relevance. Evaluating past performance of NDCs provides a reality check and fosters accountability by comparing previous commitments with actual achievements. So-called Intended Nationally Determine Contributions (INDCs) were prepared in the run-up to the 2015 UN climate change conference in Paris while NDCs are the formal commitments countries make after ratifying the Paris Agreement and are updated periodically to reflect increased ambition.

Table 3.2: Indicators of climate and energy planning credibility

Component	Indicator	Indicator description
1. Power sector planning credibility	1.1. Electric utility independence	This indicator considers whether power sector utilities operate independently from government control. Independent utilities can often manage resources, set prices, and plan for future needs more effectively than those under strict governmental control.
	1.2. Power Sector Flexibility /Adaptative planning	This indicator assesses how frequently planning documents are updated and whether they are aligned with updates in national projects. Frequent updates and alignment with national projects ensure that plans remain relevant and can adapt to new developments and changes in priorities.
	1.3. Data availability	This indicator evaluates whether historical data and revised plans are accessible. The availability of such data is crucial for transparency, accountability, and informed decision-making,

		allowing stakeholders to track progress and adjust strategies as needed.
2. NDC planning credibility	2.1. Power Sector Inclusivity	This indicator considers whether a country's NDC includes specific details about power sector targets. Inclusivity in the NDC ensures that all sectors, including the power sector, are considered in the national climate strategy, providing clear targets and accountability.
	2.2. NDC Flexibility/ Adaptive Planning	This indicates whether the NDC is updated according to global climate change updates. Regular updates to the NDC in response to global climate data and international agreements help a country stay aligned with global efforts to combat climate change.
	2.3. Past NDC performance	This looks for evidence of emissions reductions related to previous, Intended Nationally Determined Contribution (INDC). Evidence of past performance provides insights into the effectiveness of previous strategies and helps in refining future plans.

3.3.2 Quantitative Analysis: Consistency with independent modeling of future electricity demand and GHG emissions

The quantitative analysis serves to verify credibility through independent modeling. This refers to the extent to which a country's official plans are consistent with or validated by external, independent models or analyses. This plays a critical role in assessing whether a country's official plans align with or are validated by independent models or analyses. This process involves comparing the country's internally developed projections and policies with predictions made by external organizations, research institutions, or international bodies.

Furthermore, in order to gauge the credibility of official commitments made in their climate and energy planning documents, I conducted an independent modeling exercise of electricity demand and GHG emissions for each case study country. The modeling exercise involved initially projecting the electricity

demand for each of the three countries, followed by estimating the corresponding GHG emissions based on various scenarios for the electricity supply mix. By scrutinizing modeled energy demand and emissions in comparison to established reduction goals, I was able to gauge the credibility of current policies and initiatives in steering each nation towards meeting its climate and energy commitments. This process not only serves to bolster confidence in the planning and decision-making processes but also acts as a vital compass for navigating energy and climate capacity planning endeavors.

3.3.2.1 Theory on the conduct of electricity demand modeling

Before going further, it is important to understand how electricity demand modeling is conducted. Demand for energy is considered a derived demand meaning that it shaped by economic drivers like income and price, alongside exogenous factors, influencing energy consumption for services like lighting, heating, and transportation (Evans & Hunt, 2009). Market demand for a commodity—representing the aggregate quantity of a commodity sought by consumers—is influenced by various factors such as the price of the commodity itself, related commodity prices, population size and composition, and government policies...etc. In terms of energy, market demand is a function of economic variables like GDP, income, and price as well as a function of demographic factors such as urbanization and population growth rates (Aziz et al., 2013; Mirjat et al., 2018). Consequently, there is a general consensus in the planning literature that electricity demand projections are related to demographic and socio-economic parameters (Aziz et al., 2013; Mirjat et al., 2018). The demand for electricity can be expressed as:

$$ED = f(E_p, GDP, U, Pr) \quad (3.1)$$

Where ED is electricity demand, E_p is price of electricity, GDP is Gross Domestic Product, U is urbanization rate, and Pr is population growth rate. According to this equation, electricity demand is expected to exhibit a negative correlation with its price and a positive correlation with GDP and rate of urbanization.

Evans & Hunt (2009) and Kimuyu (1988) propose a logarithmic specification of the electricity demand model in Equation 3.2, represented as:

$$\ln ED = a_0 + a_1 \ln E_p + a_2 \ln GDP + a_3 \ln U + a_4 \ln Pr + \mu \quad (3.2)$$

In this formulation, the natural logarithm is applied to each variable. The log transformation is the most popular among the different types of transformations used to transform skewed data to approximately conform to a normal distribution. The equation includes parameters representing coefficients associated with each respective variable, and μ as the error term. This logarithmic transformation allows for a more nuanced identification of the determinants of electricity demand.

Considering these dynamics, it is crucial for policymakers to anticipate and plan for future electricity generation needs. By developing different scenarios for electricity generation, policymakers can assess the potential environmental impacts associated with different power generation pathways. This involves considering factors such as the types of energy sources utilized (renewable vs. non-renewable), the technologies employed, and the level of energy efficiency achieved. These scenarios serve as valuable tools for decision-making, enabling policymakers to make informed choices that balance economic growth with environmental sustainability. They also help in identifying opportunities for transitioning towards more sustainable and environmentally friendly energy generation methods. Overall, electricity generation scenarios provide a strategic framework for policymakers to navigate the complex landscape of energy planning and management in the context of evolving economic and environmental priorities.

3.3.2.2 Empirical methodology for the modeling exercise

My empirical modeling methodology was comprised of two main steps: (1) estimating future electricity demand from which (2) GHG emission were estimated. See Figure 3.5.

Figure 3.5: Empirical methodology

1/Determining future Electricity demand

1.1/ Regression model: Relating electricity demand to socio-economic parameters

1.2/ Forecasting 2030 Electricity Demand based on the regression model

2/Determining GES emissions using LEAP

The first step of my modeling exercise was to determine future electricity demand, which is comprised of two substeps. I used a sophisticated regression method to determine the relationship between the electricity demand and other factors, as indicated in equation 3.2. Please see below for more detail on the regression techniques used. For the moment, I point out that regression analysis required collecting available historical data on economic and demographic factors, as well as electricity consumption, as shown in Table 3.3. The result of the regression analysis was an Error Correction Model of future electricity demand. The second step was to forecast future energy demand for each country up to year 2030 using coefficients extracted from the regression techniques.

Second, projected electricity demand was used to estimate GHG emissions using the Low Emissions Analysis Platform (LEAP) model, where different electricity generation scenarios were created. LEAP is a software tool developed by the Stockholm Environment Institute (SEI) that is widely used for energy policy analysis and climate change mitigation planning (Heaps, 2022). LEAP is a flexible, scenario-based modeling tool designed to help countries and organizations track energy consumption, production, and greenhouse gas emissions and explore strategies for achieving low-carbon and sustainable development goals. The principal greenhouse gases that were given priority were carbon dioxide, nitrous oxide, and methane. Using the IPCC's estimations of the 100-year global warming potential (GWP), these GHGs are converted to carbon dioxide equivalents (CO₂eq).

Each scenario represents a plausible future mix of electricity generation sources for my three case-study countries. The LEAP model considers both the projected electricity demand and the different generation scenarios. Using its internal coefficients for transforming different fuel consumption into corresponding emissions, the LEAP model calculates the level of GHG emissions corresponding to each scenario. Finally, results from the LEAP model were compared to emission reductions in climate and energy policy documents. Comparing research results from LEAP to those in key climate and energy planning documents for each country is a vital step to establishing the credibility and credibility of climate and energy planning.

Table 3.3: Data for the regression model

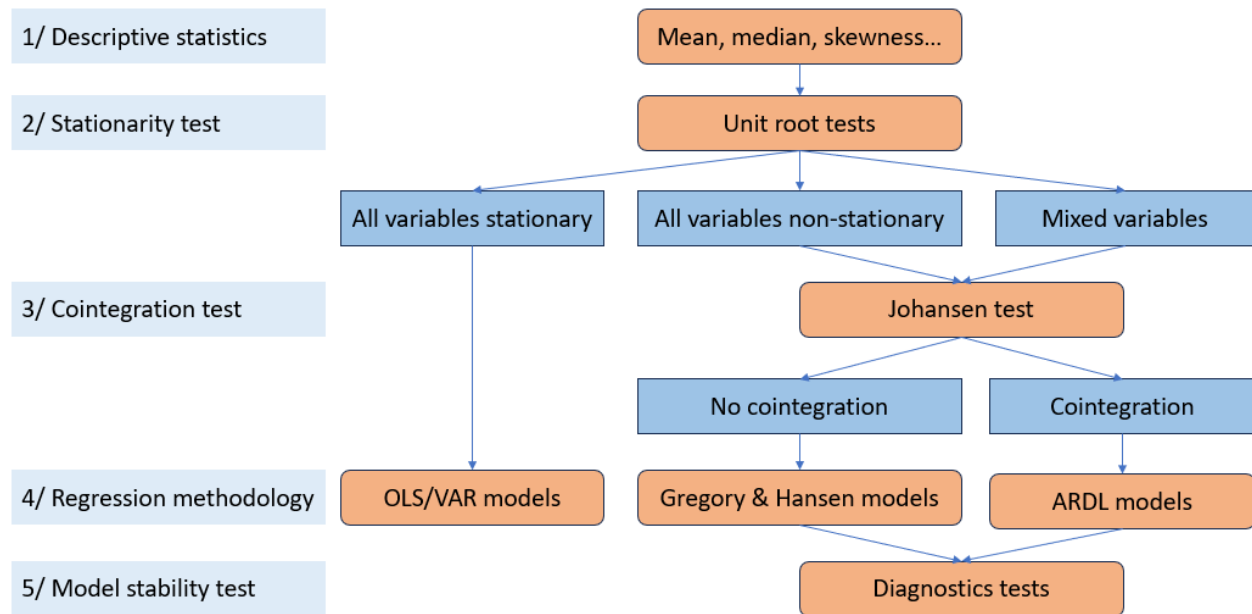
Variable	Measurement	Country	Availability	Source
Total Electricity demand	GWh	Uganda	1980-2018	(Country economy website, 2024)
GDP per capita	Current US\$	Tanzania		World bank indicators,2024
Urbanization growth rate	Annual %	Kenya		
Electricity price	Ksh	Kenya	1980-2018	EPRA,2023
	Ush	Uganda	1991-2021	ERA,2023
	Tsh	Tanzania	2007-2021	TANESCO,2023

3.3.2.2.1 Determining future electricity demand

3.3.2.2.1.1 Regression model: Relating electricity demand to socio-economic parameters

There are five steps that need to be taken to credibility derive electricity demand from variables indicated in Equation (3.1): electricity price, GDP per capita, urbanization growth rate and population growth. These steps are outlined in Figure 3.3 below.

Figure 3.6: Steps of independent modeling exercise of future electricity demand



First, descriptive statistics are used to describe the basic features of the data in a study. Descriptive statistics (mean, median, SD, skewness, kurtosis...) allow researchers and analysts to organize, simplify, and present data in a meaningful way, aiding in the interpretation and communication of findings. Second, is to examine the stationarity of time series using a statistical procedure called a 'unit root test' (Shrestha & Bhatta, 2018). A time series data is deemed stationary if its value tends to revert to its long-run average value and properties of data series are not affected by the change in time only. If a non-stationary series is used in the analysis, it can result in spurious regression. The Augmented Dickey–Fuller (ADF) test is the most common method for unit root testing. Differencing was done to the non-stationary series to make them stationary. After conducting stationarity test, there are three possible outcomes: (1) Series are stationary and integrated of order 0 $I(0)$; requires no differencing; (2) Series are integrated of order 1 $I(1)$, that is, stationary after first difference; (3) Series are integrated of different orders-mixed variables-, that is, having a combination of $I(0)$ and $I(1)$. Differences here have implications for the appropriate third step to take.

If all variables of a series are stationary, then regular OLS regression might be conducted. However, if series are integrated of different orders or are non-stationary, performing a cointegration test is necessary to establish a long-run relationship. A series is considered cointegrated if it exhibits a long-run relationship implying that the series are related and can be combined in a linear fashion. Johansen's co-integration test is used in a multivariate framework. If all the variables used in this study are $I(1)$ variables, Johansen's cointegration test can be used to determine the number of cointegrating relationships between dependent and independent variables.

Fourth, pending results of Johansen's test, different regression methods are suggested for non-stationary series. Selecting the correct methodology for analyzing time series data is paramount as an inaccurate model specification or the utilization of inappropriate methods can lead to biased and unreliable estimates. For this step, I have opted for two alternatives. The first alternative is the ARDL bounds testing procedure. The Johansen cointegration test cannot be applied directly if variables of interest are of mixed order of integration or all of them are non-stationary; the Johansen cointegration test requires all the variables to be $I(1)$. An autoregressive distributed lag (ARDL) model is an ordinary least square (OLS) based model which is applicable for both non-stationary time series as well as for series with mixed orders of integration. This model requires a sufficient numbers of lags to capture the data generating process in a general-to-specific modeling framework. ARDL allows for determining the long run relationship between variables—even when the series is non-stationary—by reparametrizing the series into an Error Correction Model (ECM). This allows for incorporation of both the short-run and long-run relationships (Nkoro & Uko, 2016).

The alternative to ARDL is the Gregory-Hansen testing procedure. To address the lack of cointegration, which is a critical assumption for ARDL, a first solution is to increase the data length—though this is not possible in our case given the data availability problems I have (especially with Tanzania). Consequently, a second solution here was to conduct Gregory and Hansen test that considers breaks because there may be a significant break in the series. Gregory and Hansen (1996) demonstrate that structural fractures have substantial implications for cointegration analysis because they cause the null hypothesis of no cointegration to be rejected. As a result, one can mistakenly conclude that cointegration relations do not exist, even though they are existent with structural changes. The cointegrating regression might have a trend or not, and it can have a break in either the intercept or a break in all coefficients. The unknown

break point t_0 is determined by minimizing the ADF statistic on the residuals from the broken cointegration regression.

The fifth and last step involves conducting diagnostic tests on the time series model. This is crucial for ensuring the robustness and unbiasedness of the estimated model. Diagnostic tests include an autocorrelation test, which assesses the presence of residual correlations, a normality test to verify if residuals are normally distributed, and a model stability test to ensure that the model's parameters remain consistent over time. These diagnostic tests collectively provide insights into the credibility and validity of the time series model.

3.3.2.2.1.2 Forecasting 2030 Electricity Demand based on the regression model

The forecasting process involved using the coefficients from the previously developed Error Correction Model (ECM) for future energy demand. To forecast future energy demand, I first need projections for the independent variables within the equation 3.1 (Electricity price, GDP per capita, urbanization growth rate). They were projected to grow at a rate consistent with the average annual growth rate observed in the historical data. For example, if GDP per capita has historically grown at an average of 2% per year, I would project it to continue growing at this rate in the forecast horizon.

3.3.2.2.2 Determining GHG emissions for each scenario

To determine the future GHG emissions, I used the LEAP modeling platform. A number of scenarios were developed, including business-as-usual (BAU) scenarios for the power sectors of all three countries in addition to two alternative scenarios for Kenya and one each for Tanzania and Uganda.

The BAU represents the anticipated government plan and is thus constructed based on current power generation policies, with the assumption that future electricity generation would follow trends indicated in these policies and that no new policies will be adopted in the future. Alternative scenarios encapsulate the energy pathways diverging from the BAU scenario, encompassing a spectrum of options. These alternatives may involve the inclusion of forecasted projects currently undergoing feasibility studies, presenting opportunities for their integration into the overarching plan. Another alternative is to minimize

negative impacts on the environment and promote renewable energy. The presence of two alternatives in Kenya and one in Tanzania and Uganda reflects the differences in electricity infrastructure and government policy. Kenya has a diverse electricity portfolio, as well as multiple expansion projects allowing for different pathways or alternatives. After scenario development, I compare the GHG emissions associated with the different scenarios to evaluate the environmental impact of the scenarios.

3.4 Conclusion

In my research, I compare three case study nations—Tanzania, Uganda, and Kenya—in order to better understand how state capability affects the credibility of climate and energy plans. In order to evaluate the credibility of energy and climate planning, I carried out an extensive analysis that integrated qualitative and quantitative evaluations. A review of important papers pertaining to the electricity industry and the NDCs was part of the qualitative assessment. After that, I used a modelling exercise to perform a quantitative assessment in order to gauge the legitimacy of the nation's energy and climate policies.

CHAPITRE 4: COUNTRY ENERGY PROFILES

In this chapter, I will provide an in-depth analysis of the energy and climate profile to offer contextual understanding for the study. This entails exploring the current energy mix, sources of energy generation, consumption patterns, and associated environmental implications such as greenhouse gas emissions and climate vulnerability. This will serve to justify my chosen approach, which is the most different system.

4.1.1 Recent trends in power generation across Kenya, Uganda and Tanzania

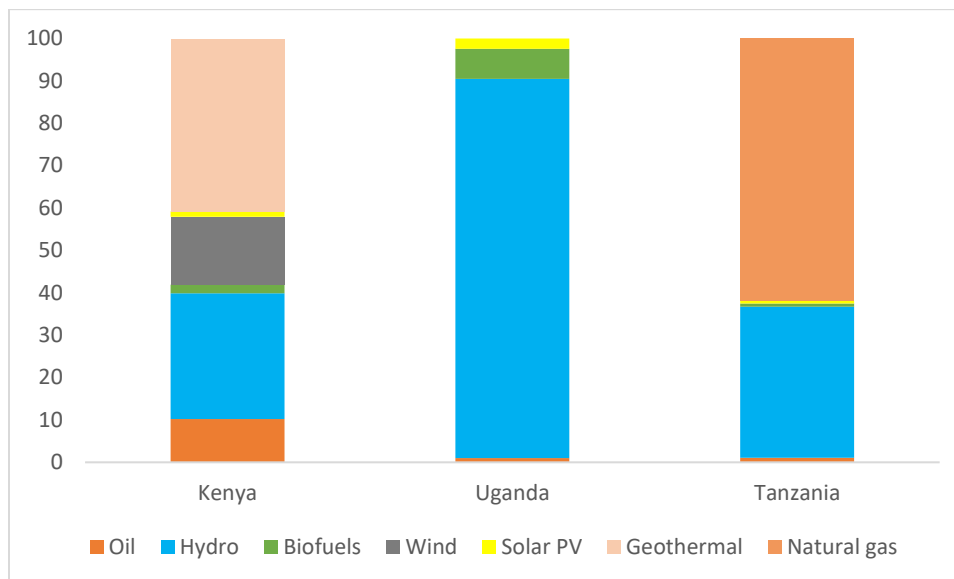
Sources of power generation vary considerably between my three case study countries (Figure 4.5). In contrast to trends in state capacity between case study countries, in terms of power generation I see greater similarities between Kenya and Uganda, where renewable energy plays a larger role relative to the situation in Tanzania.

Kenya has made substantial strides in embracing renewable energy, accounting for 90% of its electricity generation (IEA, 2023c). The primary sources contributing to electricity generation in Kenya are geothermal, hydro, and thermal, collectively constituting 98% of total electricity output under normal hydrological conditions. In turn, Uganda stands out as a global leader in renewable energy adoption, with an impressive 99% share of renewables in its electricity generation. Most of the electricity generated in 2021 originated from hydroelectric power plants, accounting for 89.5% of Uganda's total power production (IEA, 2023b). Co-generation plants, utilizing sugar cane bagasse, contributed the second-largest share at 7%, followed by solar photovoltaic plants at 2%, and thermal plants operating on fuel oil at 1%. The annual distribution of these shares is notably influenced by the available hydropower capacity, which, in turn, is dependent on factors such as rainfall and water levels, especially from Lake Victoria (Fashina et al., 2019).

Tanzania, on the other hand, exhibits a unique energy profile with a noteworthy reliance on natural gas, which contributes to a substantial share of its electricity generation. The technological composition of Tanzania's electricity sector primarily includes hydro and thermal power plants, specifically those utilizing gas and heavy fuel oil (Ministry of Energy, 2020). Historically, overreliance on hydropower plants has posed challenges to the security of power supply due to unpredictable weather patterns. It has led to power

interruptions and rationing during periods of severe drought, as observed in previous decades (Mdee et al., 2018).

Figure 4.1: 2021 electricity mix in Kenya, Uganda and Tanzania

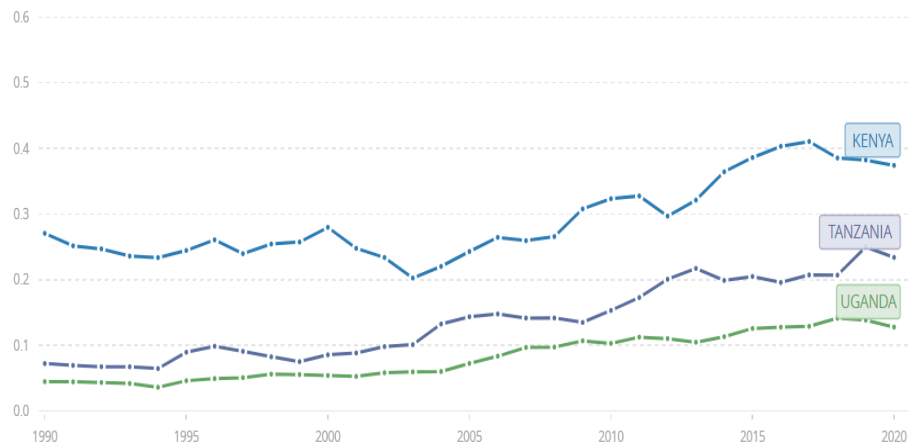


Source: Author's construction based on IEA data

4.1.2 Recent trends in GHG Emissions

Similar to its East African counterparts, Tanzania, Kenya and Uganda have relatively low per capita emissions historically compared to developed countries such as Canada (13.6 tonnes CO₂e (tCO₂e) per capita) or emerging economies like China, India, Brazil or South Africa with 7.8, 1.6, 1.9 and 6.7 tCO₂e per capita, respectively. As of 2020, Kenya recorded the highest level of greenhouse gas emissions per capita among the East African countries, standing at 0.4 metric tons per capita then Tanzania with 0.2 and lastly Uganda with the lowest level of 0.1 metric tons per capita (World Bank, 2023a).

Figure 4.2: Emissions per capita in tCO₂e (including LULUCF) - Kenya, Uganda, Tanzania



Source: Climate watch

It is also important to point out that, while the energy sector contributes to greenhouse gas emissions in Uganda, Tanzania, and Kenya, it is overshadowed by the dominant role of emissions from Agriculture, Forestry and Other Land Use (AFOLU) in all three countries. In Uganda, the energy sector holds the position of the third-largest contributor to greenhouse gas (GHG) emissions, constituting 11% of the country's total emissions. However, the primary source of emissions lies within the LULUCF sector, accounting for a substantial 60% of the total emissions (Twinomuhangi et al., 2021). While the energy sector plays a notable role, it is overshadowed by the dominant contribution of the LULUCF sector. Similarly, in Tanzania, the primary contributor to greenhouse gas (GHG) emissions is the LULUCF sector. Emissions stemming from LULUCF activities account for approximately two-thirds of the total greenhouse gas emissions in the country. Turning to Kenya, both the agriculture sector and LULUCF are identified as the main contributors to emissions. While the energy sector also contributes to emissions, it is not the primary driver compared to agriculture and land-use activities.

4.2 Conclusion

Uganda leads globally in renewable energy adoption, with 99% of its electricity generated from renewables, mainly hydropower. Kenya has a diversified electricity mix, including geothermal, wind, solar, oil and

hydropower. In contrast, Tanzania relies primarily on natural gas and hydropower (See Appendix A for more details). Kenya recorded the highest per capita greenhouse gas emissions among the three countries, yet historically, Tanzania, Kenya, and Uganda have maintained relatively low per capita emissions compared to developed nations.

CHAPITRE 5

RESULTS: Planning Document Review

5.1 Introduction

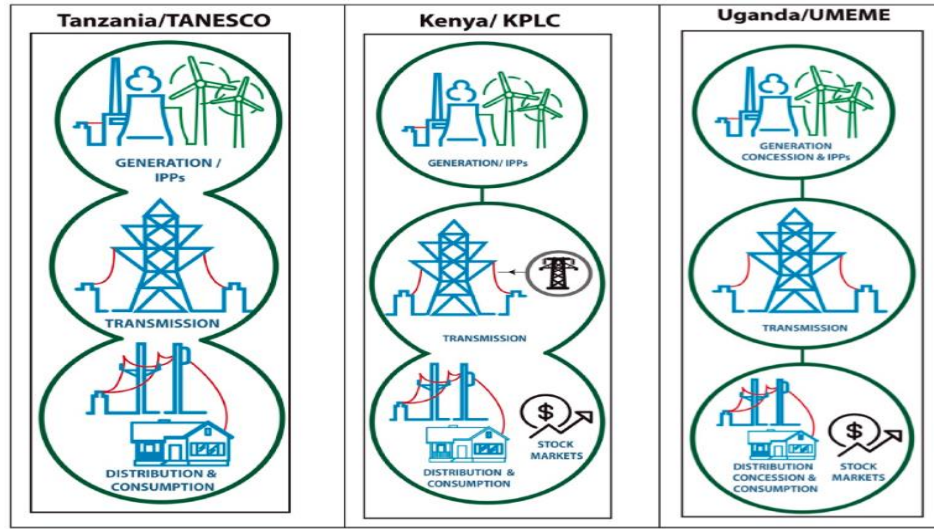
In this chapter, I examine the credibility of climate and energy planning across various countries through qualitative review of key planning documents in light of indicators of planning credibility indicators set out in Chapter 3. The investigation begins with a review of electric utilities history and key planning documents, providing a foundational understanding of each country's approach to energy. Next, I evaluate UN climate change policies to assess their inclusivity, adaptability and the extent to which these international guidelines are integrated into domestic strategies. Finally, the chapter concludes with an assessment of the overall credibility of climate and energy planning based on each planning credibility indicator across countries.

5.2 Indicators of power sector planning credibility

5.2.1 Electric Utility Independence

The power sectors in Tanzania, Uganda and Kenya showcase a variety of governance structures and regulatory frameworks (Mburamatatare et al., 2022). This is particularly evident in the roles retained by electricity utilities for power generation, transmission and distribution (Twesigye, 2022). See Figure 5.1 below which decomposes these across my three case-study countries.

Figure 5.1: Governance of Power Systems in Tanzania, Kenya, and Uganda



Source : (Twesigye, 2022)

In Tanzania, the Ministry of Energy is responsible for managing electricity production and distribution in Tanzania. The Rural Electrification Agency, under the Ministry of Energy's purview, works to facilitate the transition from non-electric to electric energy sources. Importantly, the Tanzania Electric Supply Company Ltd (TANESCO) stands as a classic example of a vertically integrated state-owned utility, retaining control over generation, transmission, and distribution (Felix & Gheewala, 2012). Despite various policy announcements indicating Tanzania's intention to restructure its power sector, TANESCO has persisted as a traditional vertically integrated state monopoly, despite permitting a few Independent Power Producers (IPPs) to participate in the market. Twesigye (2022) asserts that this governance structure allows the Tanzanian central to exert direct influence over crucial operational, management, and technical decisions, which undermines the utility's ability to make independent techno-economic choices.

In contrast, KPLC in Kenya has undergone restructuring, having divested from generation and focusing solely on transmission and distribution functions. KPLC is further distinguished from TANESCO in Tanzania, given that it has undergone a partial privatization; this is reflected in its listing on the Nairobi stock exchange (Twesigye, 2022).

Finally, the Uganda government has privatized almost all energy elements. Umeme in Uganda operates under a concession model, having divested from both generation and transmission, and is now privately owned and operated (Maclean et al., 2016). It is listed on both the Uganda and Nairobi stock exchanges.

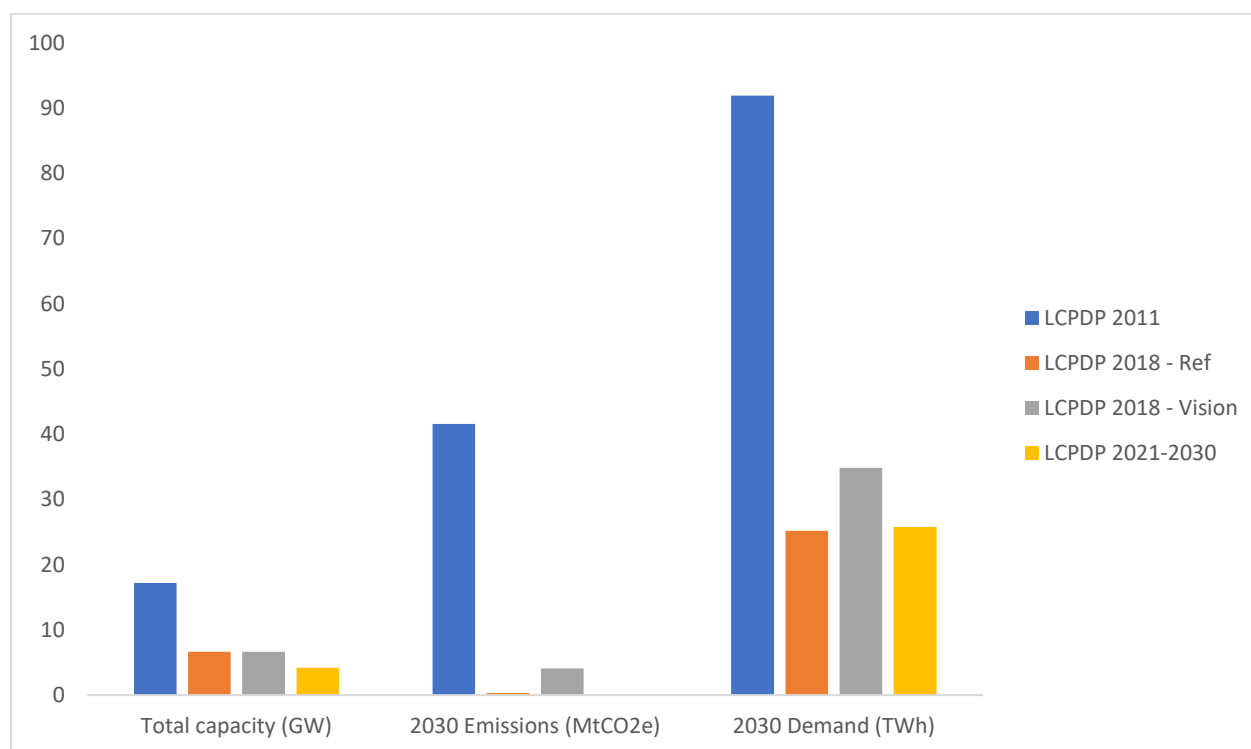
5.2.2 Power Sector Flexibility /Adaptative Planning

5.2.2.1 Kenya Energy Planning Documents

In pursuit of Kenya's electrification goals, the central government has instituted a series of planning procedures outlined in various official documents. The primary planning process revolves around the Least Cost Power Development Plan (LCPDP), initiated in 2009 and overseen by the Energy and Petroleum Regulatory Authority (EPRA). This committee comprises relevant stakeholders in Kenya's electricity sector planning. The core responsibility of the LCPDP Committee is to formulate an updated LCPDP biennially, addressing capacity planning, demand projections, and transmission investment requirements over a 20-year horizon. The latest plan from the LCPDP Committee is the 2021-2030 LCPDP.

When examining the 2030 projections from the 2011-2031 LCPDP, the 2017-2037 LCPDP and the 2021-2030 LCPDP for installed capacity, electricity generation, and peak demand, it becomes evident that, across all three parameters, the more recent LCPDP projections are approximately one third of those from the earlier LCPDP, as outlined in table 5.1. This has noteworthy ramifications for the sector. The reduction in electricity demand forecasts can be attributed, in part, to lower than expected economic growth rates and delays in the implementation of the Vision 2030 flagship projects. In the 2018 LCPDP, there was a projection for a 981 MW coal plant to commence production in 2024. However, this particular project was subsequently canceled in the 2021 version.

Figure 5.2 : Comparison of the forecasts of the 3 versions of LCPDP of Kenya



5.2.2.2 Uganda Energy Planning Documents

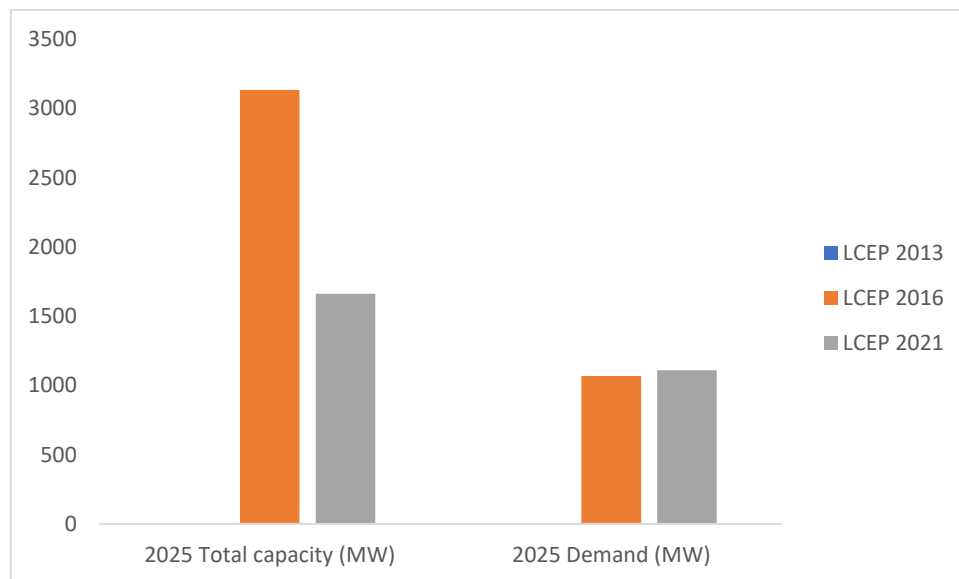
The Ugandan government has also formulated planning documents to guide the electricity sector. In 2013, the Electricity Regulatory Authority (ERA) introduced the initial Least Cost Expansion Plan (LCEP), the first of which extend from the five-year period of 2013-2018 (ERA,2021). This plan has since been updated to cover a ten-year period from 2016 to 2025 with the latest update in 2021 extending the coverage to the period from 2020 to 2030.

The ERA revises the LCEP on an annual basis to accommodate the evolving landscape and advancements in the electricity supply industry, taking into account factors such as growth and the introduction of new technologies. Given Uganda's abundant reserves of both renewable and non-renewable energy resources, the nation has the potential to fulfill all the energy requirements of its citizens if these resources are effectively developed. However, many challenges have been identified. These include limited resources,

high investment and operational costs, bureaucratic hurdles, the overlapping responsibilities of government agencies, insufficient human capacity and training, and a fragile private sector.

However, comparing the 2030 forecasts in Uganda's context is not possible due to the lack of consistent data, so I compared the 2025 projections instead to assess their consistency. Note that while the total capacity has nearly halved, the demand projections remain almost the same in both versions. With a reduced capacity but unchanged demand projections, there is a risk of a supply-demand imbalance. If the available capacity is insufficient to meet the projected demand, this could lead to power shortages, blackouts, or the need to import electricity from other sources. It suggests a disconnect between capacity planning and demand forecasting. This can lead to doubts about the accuracy and reliability of the planning process.

Figure 5.3: Comparison of the forecasts of the 3 versions of LCEP Uganda



*The data for LCEP 2013 was not available

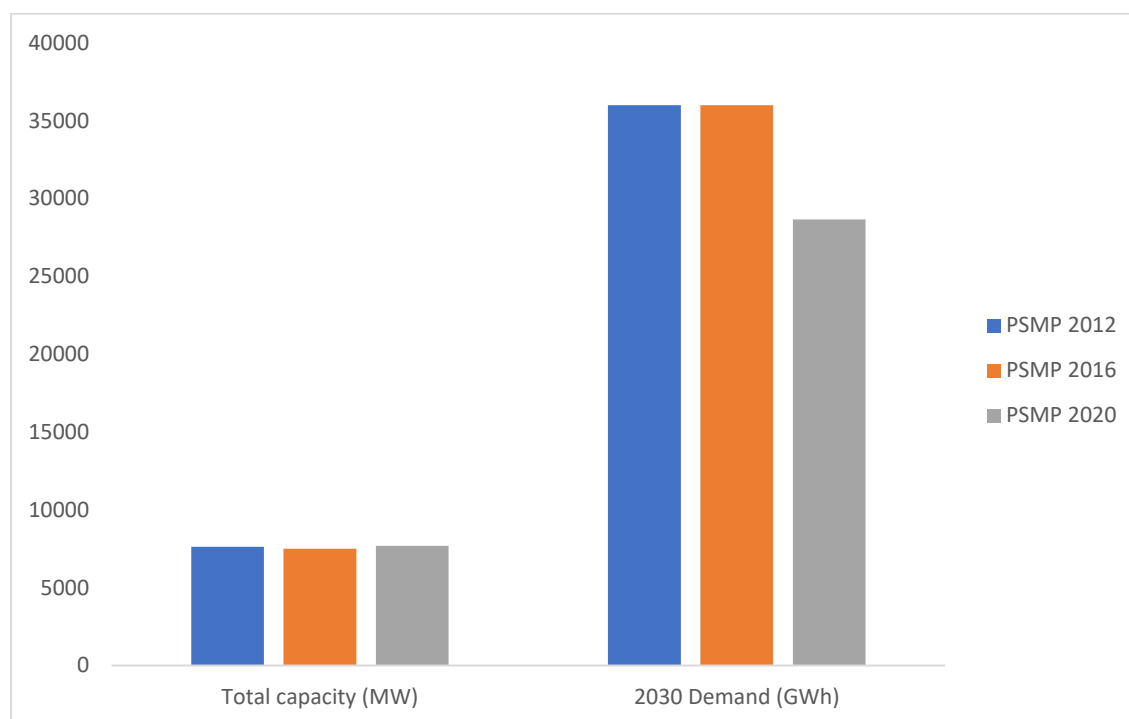
5.2.2.3 Tanzania Energy Planning Documents

The Power System Master Plan (PSMP) is the official document of the Ministry of Energy (MoE) in Tanzania. Recognizing the dynamic nature of both the economy and energy requirements, the MoE made the strategic decision to produce a PSMP. Tanzania conducted its first PSMP drawing in 1980, and then additional ones in 1985, 1999, 2009, 2012, 2016 and 2020. It is a critical document for Tanzania's energy sector, providing a roadmap for sustainable development, economic growth, and increased access to electricity as well as directing the public and private sectors in putting into action a strategy to meet the demand for electricity over the short, medium, and long terms (Felix & Gheewala, 2012).

The PSMP 2020 has been developed by utilizing data on electricity demand collected through an extensive industrial survey conducted across the entire country. This updated plan also draws insights from the methodologies and procedures employed in the 2008 PSMP, along with its subsequent revisions in 2009, 2012, and 2016. These reviews were deemed necessary to address the evolving changes in the Tanzanian economy and the corresponding shifts in electricity demand (Ministry of Energy Tanzania, 2020).

When comparing the three versions of the PSMP (2012/2016/2020), the first noticeable difference is the availability of past versions. The 2012 version of Tanzania's PSMP is no longer available on TANESCO's website, necessitating the use of a review document describing the plan instead. In contrast to the different versions of Kenya's LCPDP, Tanzania's PSMP versions show remarkably similar forecasts for the horizon of 2030, indicating a less flexible planning outlook despite the updates. A lack of flexibility and adaptability in energy planning can undermine the effectiveness and credibility of the plan, making it less responsive to changing technological, economic, and regulatory environments.

Figure 5.4: Comparison of the forecasts of the 3 versions of PSMP Tanzania



5.2.3 Data Availability

The availability of accurate and comprehensive data is foundational for effective planning and ensuring the credibility of climate and energy planning. The four subindicators I used are:

1. Electricity Price Historical Data which refers to records of the cost of electricity over time. This data includes information on how much consumers (households, businesses, and industries) have paid for electricity in different years.
2. Electricity Sector Emissions Projections: projections on emissions specifically from its electricity sector.
3. Energy Power Emissions Projections: Beyond just electricity, projections for overall energy power emissions such as industry that also use energy.

4. Electricity Supply Per Technology Projections Per Year : detailed projections on how different technologies (like hydroelectric, solar, wind, thermal) will contribute to electricity supply in the future

Kenya has the most extensive and diverse set of data. This availability suggests robust data collection and planning capabilities within the energy sector. The comprehensive coverage indicates that Kenya is actively managing its energy policy with an eye to both economic and environmental factors. Only Kenya provides detailed forecasts specifically for electricity power emissions which enables the development of forward-looking strategies that address anticipated GHG emissions reduction.

Uganda's data availability is also extensive, but projections are somewhat limited. While there is an understanding of past electricity prices and overall energy emissions, there is a gap in planning for future electricity supply diversification where Uganda's projections extend only until 2025, and notably, there's a lack of explicit implementation deadlines for projects identified under feasibility studies. This could indicate areas for development in strategic energy planning and environmental impact assessments.

Tanzania has the least amount of data available, with only energy power emissions projections accessible. The absence of detailed electricity sector data suggests limited planning or data collection capacity in these areas. One pivotal aspect crucial for the success of the modeling exercise revolves around the determination of electricity prices. However, despite concerted efforts, acquiring adequate historical data for Tanzania posed considerable challenges—including direct engagement with TANESCO through professors at the University of Dar es Salaam. This discrepancy in planning raises concerns regarding the credibility and precision of climate and energy forecasts in Tanzania.

Table 5.6: Data availability

Variable	Kenya	Uganda	Tanzania
Electricity price historical data	X	X	

Electricity sector emissions projections	X	X	
Energy power emissions projections	X	X	X
Electricity supply per technology projections per year	X	X	X

5.3 Indicators of NDC planning credibility

5.3.1 Power Sector Inclusivity

Kenya's NDC reflects a moderate focus on the power sector, with a mix of general commitments and specific measures. Kenya's NDC acknowledges the need to reduce GHG emissions in the power sector but provides limited detail on specific strategies or targets. The emphasis is on general commitments rather than detailed plans for emissions reduction from the power sector.

Uganda's NDC demonstrates a strong focus on the power sector, highlighting its pivotal role in achieving the country's climate and sustainable development goals. Uganda aims to reduce greenhouse gas (GHG) emissions through a combination of renewable energy expansion and energy efficiency improvements. The power sector is central to these efforts, with specific targets for reducing emissions intensity and increasing the share of clean energy.

Tanzania's NDC includes some measures related to the power sector, but the level of detail and commitment compared to Kenya is less comprehensive. While the NDC discusses reducing GHG emissions broadly, it does not provide detailed targets or strategies specifically for the power sector. The focus appears to be more on broader mitigation actions without a clear delineation of power sector responsibilities.

Overall, Uganda's NDC stands out for its detailed integration of power sector measures, while Kenya could benefit from more specific and ambitious plans to fully leverage the power sector's role in achieving its

climate goals. In contrast, Tanzania's NDC lacks specific power sector targets and measures to enhance the effectiveness of its climate plan.

5.3.2 NDC Flexibility/Adaptive Planning

When it comes to international initiatives, the East African NDCs were predominantly submitted in the aftermath of the Paris Agreement, a pivotal event during the Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (UNFCCC) in 2015. According to Article 7.10 of the Paris Agreement, each Party is obligated to periodically submit a communication outlining priorities, implementation and support needs, plans, and actions.

Kenya initially submitted its INDC in July 2015, which was transformed into an NDC in December 2016 after signing the Paris Agreement. Kenya's NDC underwent revisions in 2020. Tanzania ratified the Paris Agreement in 2018, initially submitted its INDC in 2015, and subsequently updated and resubmitted it in August 2021. Uganda submitted its INDC in 2015 and later presented the updated NDC in 2021.

To implement NDCs, many East African countries have sought external support. For instance, Kenya sought external assistance to finance 90% of measures identified in its NDC while Uganda requested 70% from its development partners. These NDCs, considered as voluntary and not legally binding responses to climate change impacts, are expected to align at the national and domestic level with the distinct priorities, policies, plans, and programs of countries affected by climate change. Although NDCs are not meant to strain the economies of developing countries, there is a crucial need for commitment by appropriately allocating resources to facilitate their implementation.

It is noteworthy that, while NDCs hold significance for the Paris Agreement and broader collaborative endeavors in climate change, the actual NDC documents are relatively concise and lack intricate details. They primarily serve as planning framework documents, signaling to the international community how countries plan to address climate change in terms of both mitigation and adaptation efforts (Purdon, 2024).

Table 5.4: Climate change Commitments Submitted to the Paris Agreement

Country	INDC Commitment	Updated NDC Commitment
Tanzania	Conditional: 10-20% reduction relative to BAU emissions levels	Conditional: 30-35% reduction relative to BAU emissions levels
Uganda	Conditional: 22% reduction relative to BAU emissions levels	Conditional: 18.8% reduction relative to BAU emissions levels Unconditional: 5.9% reduction relative to BAU emissions levels
Kenya	Conditional: 30% reduction relative to BAU emissions levels	Conditional: 27.84% reduction relative to BAU emissions levels Unconditional: 4.16% reduction relative to BAU emissions levels

Source: UNFCCC 2024

Another pertinent gauge of international commitment lies in the production of technical climate policy reports, including National Communications (NC) and Biennial Update Reports (BURs). These reports are key elements of the “enhanced transparency framework” of the UN climate change regime (Gupta & Van Asselt, 2019). Kenya, Uganda, and Tanzania, as parties to the UNFCCC, submitted their First National Communications in 2002, 2002, and 2003, respectively. Uganda has submitted more National Communications than both Kenya and Tanzania, which have submitted an equal number of communications. The last submitted NC for Kenya and Tanzania were in 2015 whereas Uganda submitted its last NC in 2022.

Table 5.5: Technical climate policy reports

	Kenya	Uganda	Tanzania

National communications	2	3	2
Biennial update reports	0	1	0

Source: UNFCCC

5.3.3 Past NDC Performance

All three countries—Kenya, Uganda, and Tanzania—have experienced a significant increase in emissions from 1990 to 2022. This suggests that all three nations have undergone substantial economic growth and development over the past three decades, which has led to higher emissions. This period corresponds with increased urbanization, industrialization, and rising energy demand across East Africa. However, since 2005, differences in the trajectory of emissions between countries is evident.

Kenya actually shows a substantial decrease in emissions (by 42%) from 2005 to 2022. Uganda shows a decrease in emissions by 9% during the same period, suggesting moderate progress in managing emissions, although the reduction is not as significant as Kenya's. Tanzania, in contrast, shows a sharp increase of 134% in emissions from 2005 to 2022. This indicates that the country has not yet managed to curb its emissions growth. It may also indicate a slower adoption of renewable energy sources or less effective policies in reducing emissions. Overall, while all three countries have experienced substantial emissions growth since 1990, their recent trajectories differ, with Kenya showing the most promising trend towards reducing emissions and Tanzania facing the most significant challenges in achieving emission reductions.

Table 5.1: Power sector emissions evolution

Country	2022 vs 1990	2022 vs 2005
Kenya	+300 %	-42 %

Uganda	+300 %	-9 %
Tanzania	+300 %	+134 %

EDGAR (Emissions Database for Global Atmospheric Research) Community GHG Database

5.4 Overall Qualitative Assessment of Planning Credibility

In this section, I provide an overall qualitative assessment climate and energy planning credibility in each of my case-study countries.

Starting with Electric Utility Independence, Kenya and Uganda both scored 1, indicating that these countries have relatively independent utilities. The distinction lies in the fact that Uganda employs a fully privatized model for its electricity sector, while Kenya has a partially privatized model. This might suggest a higher degree of autonomy and potentially more reliable power sector planning while Tanzania Scored 0, implying less independence in its utilities, which could affect the credibility and effectiveness of its power sector planning. In terms of Power Sector Flexibility and Adaptive Planning, Kenya scored 1, demonstrating that its power sector planning is both adaptable and responsive to changes and unforeseen challenges, as evidenced by updated projections in its plans. Conversely, Tanzania and Uganda exhibit stagnant projections, indicating limited flexibility in their power sector planning. This lack of adaptability may impede their ability to effectively respond to new developments or challenges. For Data Availability, Kenya and Uganda both scored 1, reflecting good availability of data necessary for effective power sector planning whereas Tanzania scored 0, suggesting issues with data availability, which could impede planning and decision-making processes.

When evaluating NDC credibility, Kenya and Uganda stand out with regard to Power Sector Inclusivity. That is, the NDCs include the power sector in energy projection commitments, which enhances the comprehensiveness and relevance of their respective NDCs. In contrast, Tanzania has not similarly included the power sector, potentially limiting the scope and effectiveness of the country's commitments. In terms of NDC Flexibility/Adaptive Planning, Tanzania's credibility is further compromised by a drastic

shift in its reduction goals—from 10% to 30%—which raises concerns about the feasibility and stability of its targets. Additionally, Tanzania’s reliance solely on conditional commitments undermines its overall credibility. In contrast, both Kenya and Uganda have both conditional and unconditional targets, along with consistent levels of reduction.

Turn to assessment of Past NDC Performance, unlike Kenya and Uganda, Tanzania's power sector emissions have increased. It has seen rapid development without the corresponding adoption of cleaner technologies and practices. Kenya’s targets are considered more feasible relative to its past performance, given its recent success in reducing emissions and managing capacity effectively. Uganda’s targets, while achievable, might require enhanced strategies and more aggressive measures to align with its historical performance trends.

The summary Table 5.2 highlights significant variations in power sector and NDC credibility among Kenya, Uganda, and Tanzania. Kenya excels with high scores across most indicators, demonstrating strong utilities independence, inclusivity, and adaptability in both its power sector and NDC. This is complemented by robust data availability, making Kenya's plans and commitments highly credible. Uganda shows strengths in inclusivity, adaptability, and past performance but just falls short in flexibility for its power sector. The notable improvement in its NDC's inclusivity reflects recent positive changes. In contrast, Tanzania struggles with low scores in nearly all indicators, including utilities independence, data availability, and commitment inclusivity, suggesting significant challenges in both power sector management and NDC effectiveness.

Table 5.2: Overall Energy and Climate Planning Credibility Assessment

	Component	Indicator	Kenya	Uganda	Tanzania
Qualitative	Power sector credibility	Utilities independence	1	1	0
		Flexibility /Adaptative planning	1	0	0

		Data availability	1	1	0
	NDC credibility	Inclusivity	1	1	0
		Adaptability / flexibility	1	1	0
		Past performance	1	1	0
Total			6	5	0

5.5 Conclusion

After conducting a review of planning documents across our study countries, I found that Kenya is the most proactive in formulating policies and adapting its power sector documents to meet its GHG reduction objectives. Kenya's comprehensive approach includes detailed strategies and consistent updates, ensuring high credibility in its climate and energy planning. Uganda also has an equal score to Kenya. Uganda's performance in the past, inclusion, and adaptability are all strong points, but its power sector lacks flexibility. Its NDC's noteworthy progress in inclusion reflects recent improvements. Tanzania with low credibility faces significant challenges that undermine its planning credibility, such as a lack of data, conditional commitments to international initiatives, and stagnant projections in updated planning documents.

CHAPITRE 6 RESULTS: Independent modeling results

6.1 Introduction

In this chapter, I present results from an independent modeling exercise I conducted to forecast future electricity demand and GHG emissions in my three case studies: Kenya, Uganda, and Tanzania. I first present projected electricity demand for each country under various climate and energy planning scenarios. Following the projection of electricity demand, I shift the focus to estimating GHG emissions associated with each scenario. Leveraging projected electricity demand and using the LEAP model, I quantify the expected emissions trajectory for each country over the forecast period of 10 years. Results elucidate the interplay between electricity demand, GHG emissions, and climate objectives in Kenya, Uganda, and Tanzania. I conclude that there is a substantial discrepancy in the emissions forecasts for each of the three countries, which can be seen in official government records as well as in independent modelling evaluations.

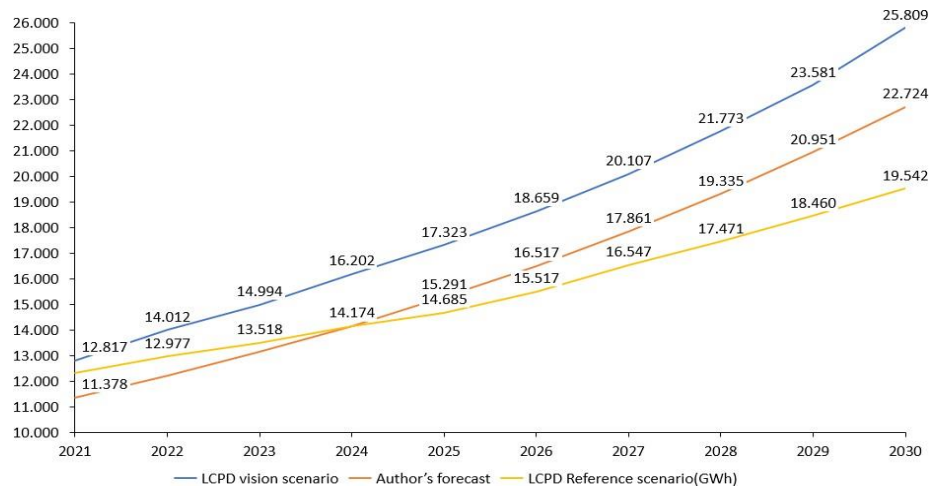
Independent modeling is crucial for verifying the credibility of climate and energy planning as it provides a more objective perspective, relatively free from conflicts of interest or vested agendas that may arise from internal planning processes. This ensures transparency in assessing the effectiveness of proposed strategies and policies.

6.2 Kenya modeling results

6.2.1 Forecasting Future Electricity Demand

Total electricity demand in the base year, 2021 was 11,378 GWh, and this is expected to grow to 22,724 GWh by the year 2030. Electricity demand forecasts estimated using the LEAP model are comparable to the forecasts in the LCPDP 2021, where electricity demand is estimated to be 25,809 GWh in the official projections of LCPDP in the vision scenario and 19,542 GWh in the reference scenario (ERC, 2021).

Figure 6.1: Electricity demand forecast for Kenya



6.2.2 Analysis of GHG emissions for each scenario

For Kenya, I developed 3 scenarios: business-as-usual (BAU), Coal and Green scenarios for electricity generation. The BAU is based on the current energy generating policies in the country. It assumes that future electricity generation will follow the trends suggested by these policies and that no new policies will be adopted. The LCPDP 2021-2030 serves as a framework for the creation of this scenario. The Coal scenario represents the projections outlined in the 2017 version of the LCPDP, where a capacity of 981 MW from coal sources was anticipated. This scenario serves as a pivotal reference point for understanding the trajectory of coal-based electricity generation within the energy landscape. The Green scenario anticipates the production of electricity from renewable sources while minimizing the production of electricity from non-renewable sources. More specifically, it assumes that diesel power generation is phased out and replaced with geothermal, wind, solar and hydro starting from 2022.

I first present results from projected installed electricity generating capacity, in MW (Figure 6.2). The BAU and Green scenarios are similar in terms of installed capacity, both projecting a total of 4,197 MW by 2030. The difference lies in the replacement of diesel capacity with additional capacity from wind, solar, hydro, and geothermal sources, each contributing equally. In contrast, the Coal scenario anticipates greater capacity compared to the other two scenarios, totaling 6,653.9 MW by 2030. This variance stems from its

adherence to the 2017 version of the LCPDP, whereas the 2021 version forecasts lower capacity levels, as dictated by the government's revised projections.

I also forecasted electricity generation under the three scenarios, in GWh (Figure 6.3). Electricity generation in base year 2021 is 11,378 GWh, and electricity generation is predicted to grow to 22,724 GWh in the year 2030, representing a 100% increase. Comparison of the BAU with the Green scenario indicates a reduction of generation of electricity from non-renewable resources by 10% (14.7% in BAU scenario in 2030 vs 4.7% in green scenario).

Finally, Figure 6.4 depict the greenhouse gas (GHG) emissions related to three various scenarios. It is estimated that the GHGs emissions from electricity generation in 2022 year stands at 0.65 MtCO₂eq. However, by the year 2030, GHG emissions from electricity generation is estimated to be 0.81 MtCO₂eq and 0.21 MtCO₂eq for the BAU and Green scenario respectively. A comparison between BAU and the green scenario shows that GHGs emissions from electricity generation will be reduced by 73%. Exploitation of liquified natural gas (LNG) turbines for electricity generation is anticipated to begin in the year 2028, explaining the gradual increase in GHGs emissions in both scenarios. As for the coal scenario, the GHG levels will reach 1.4 MtCO₂eq. This increase in GHG levels is primarily attributed to the additional capacity generated from coal sources.

Figure 6.2: Electricity Generation Capacity Scenarios in Kenya, in MW

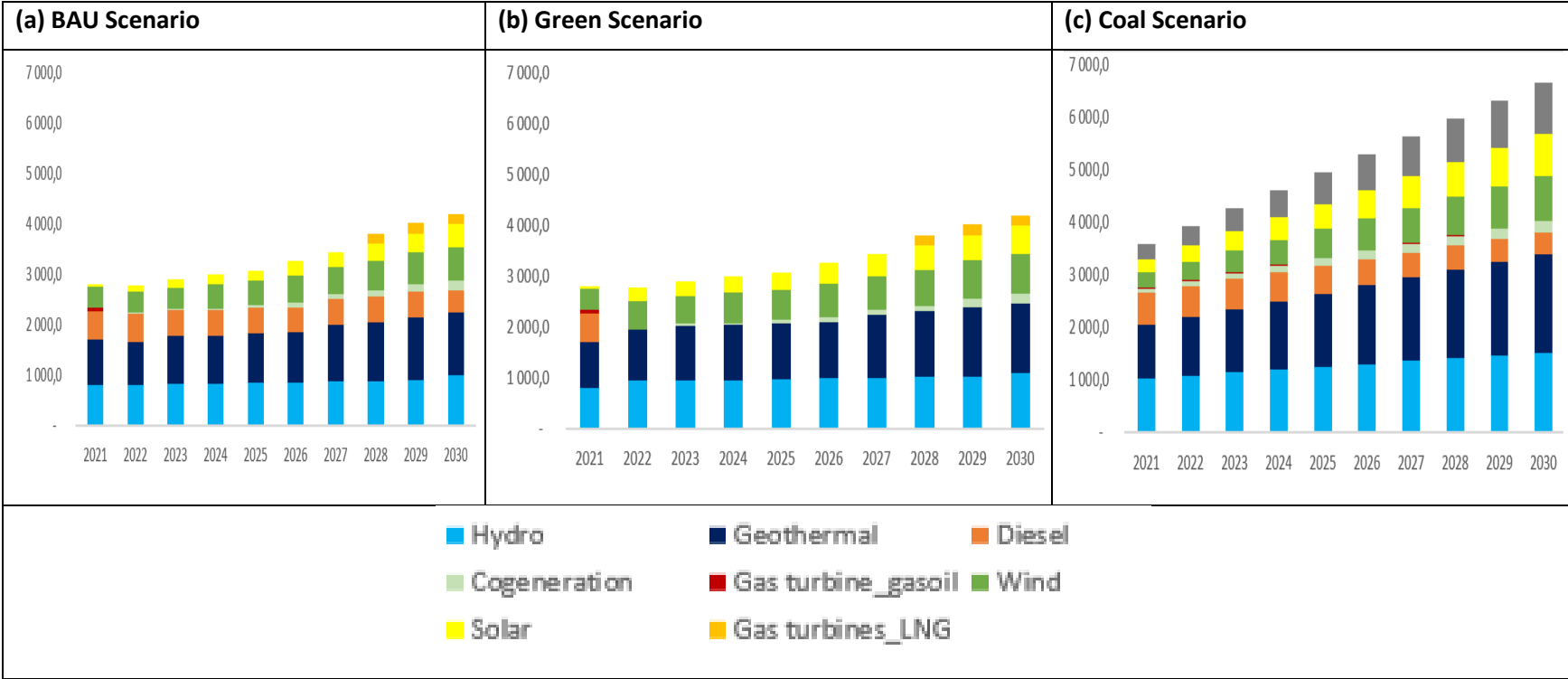


Figure 6.3: Electricity Generation Scenarios in Kenya, in GWh

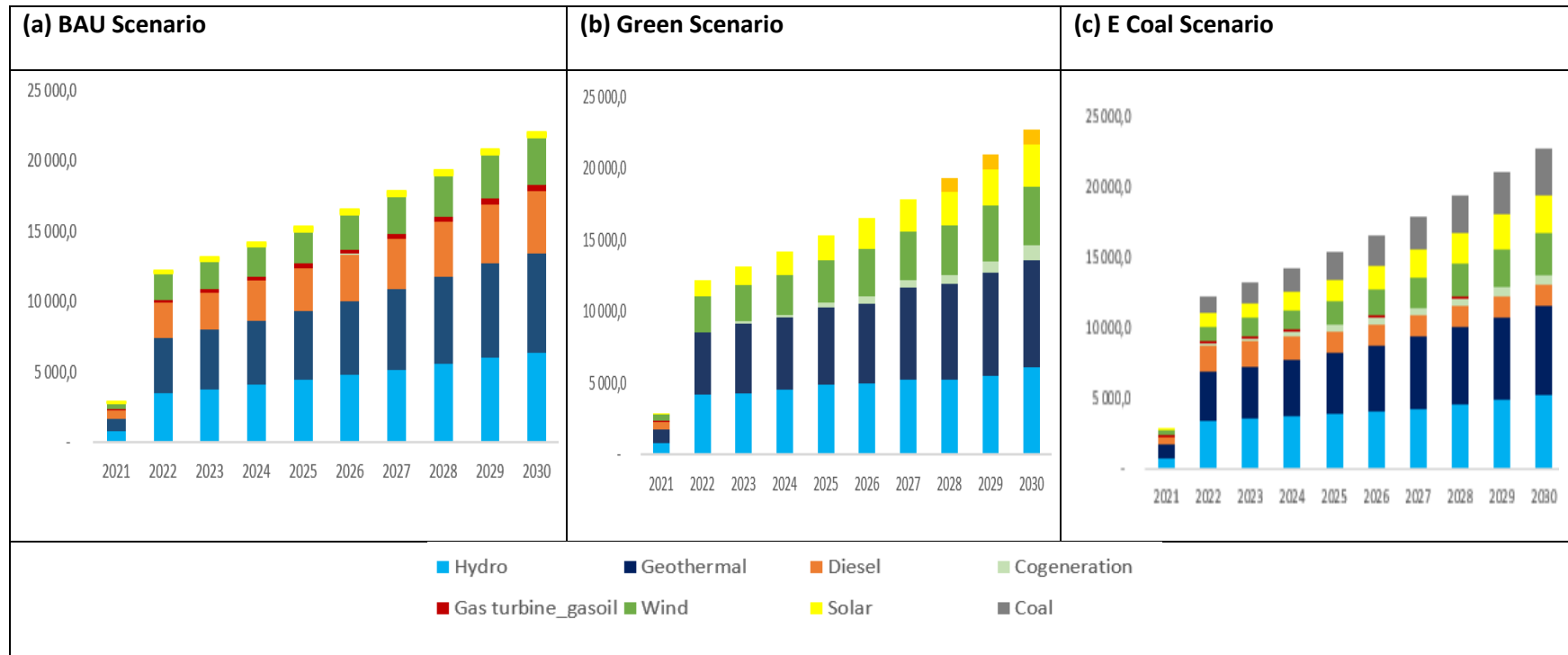


Figure 6.4: Power Sector GHG Emission Scenarios in Kenya, in ktCO₂e

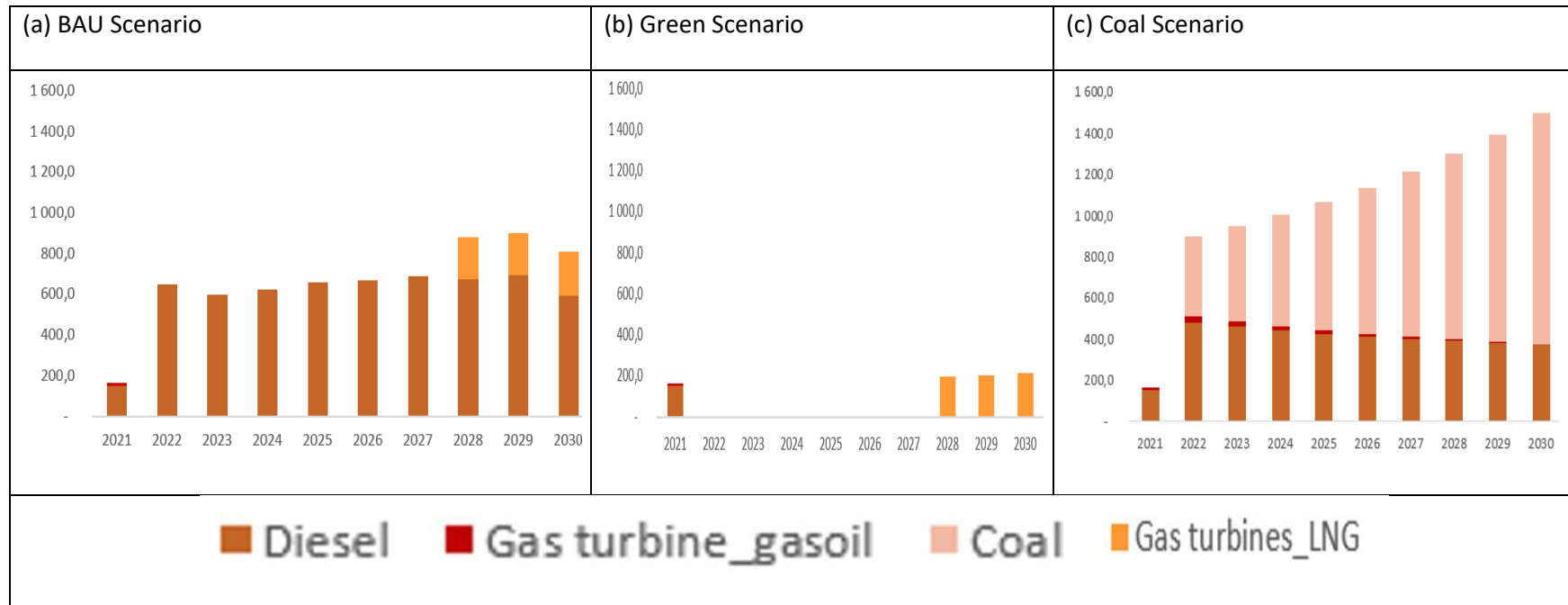


Table 6.1 compares our BAU scenario results with LCPDP (2021 version) with the reference and vision scenario of the 2018 version of LCPDP. While comparing the amount of fossil fuel used and the emissions of our results with the LCPDP vision scenario, I found that the amounts are disproportional. This can be explained by the fact that the 2018 scenario relies mainly on the 981 MW of coal capacity projected whereas this projected was abandoned in the 2021 version. Comparing the amount of CO₂ emitted per fuel, it's clear that coal is more pollutant than diesel or natural gas.

Table 6.1: Comparison of 2030 projections -Kenya

	BAU LEAP 2021	Reference LCPDP 2018	Vision LCPDP 2018
Demand (GWh)	22 723,90	25 195,00	34 847,00
Fossil fuel used (GWh)	3346	363	5281
2030 Emissions (MtCO ₂ e)	0,81	0,31	4,11

6.3 Uganda modeling results

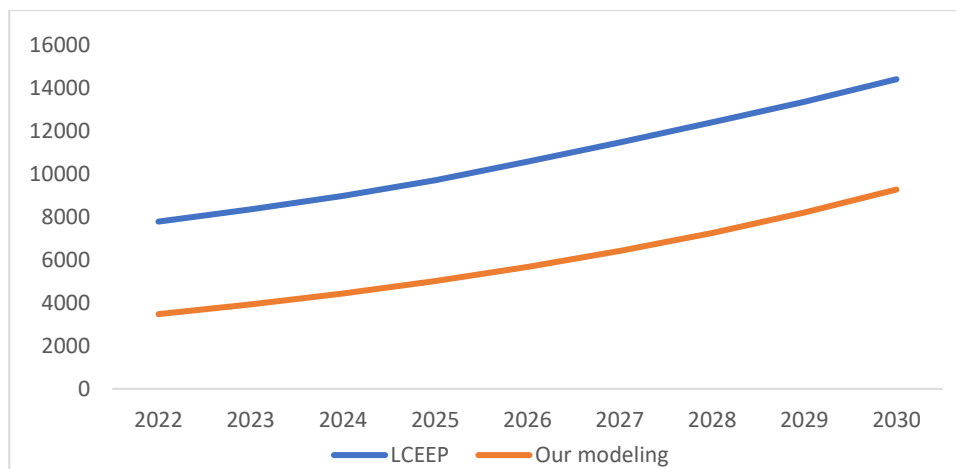
6.3.1 Forecasting Future Electricity Demand

Based on the findings outlined in Uganda's LEECP 2020, it is evident that the average demand growth in the Base Case Scenario (Business as Usual) is projected to be robust, reaching 7.8% annually. Over the period from 2020 to 2030, the total demand is anticipated to surge significantly, escalating from an initial capacity of 767 MW to a projected 1,644 MW. This corresponds to a corresponding increase from 6,718 MWh to 14,401 MWh in power generation. This anticipates a remarkable increase of 114% over the coming decade.

My modeling forecasts a significant increase in electricity consumption, projected to rise from 3,474 MWh in 2022 to 9,269 MWh by 2030. These projections are based on the causal relationship between electricity demand and various socioeconomic factors. However, upon comparing our results with the official projections, a notable discrepancy of 5,000 MWh emerges (Figure 6.5). This suggests that my forecasts diverge significantly from the Uganda government's expectations. One possible explanation for this disparity is the optimistic objectives set forth by the government. The government anticipates higher economic growth rates than those accounted for in our modeling. Additionally, the government has

ambitious targets for achieving total electricity access in Uganda by 2040, which could contribute to the higher projections.

Figure 6.5: Official and Modeled Electricity Demand Forecasts in Uganda (MWh)

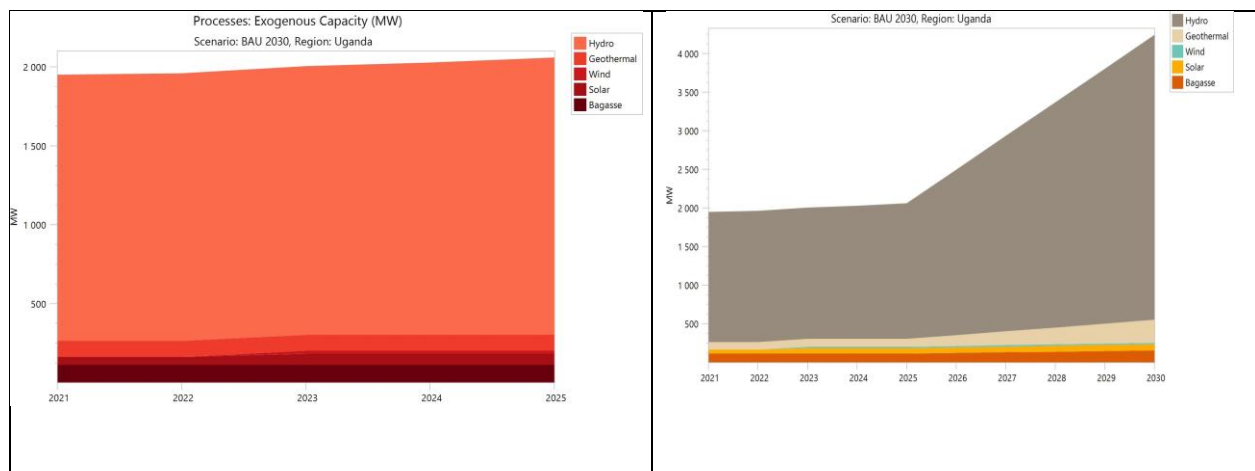


6.3.2 Analysis of Greenhouse Gases Emissions from different scenarios

The BAU scenario is currently projected up to the year 2025. Notably, the Uganda government’s plan does not extend its supply forecast to 2030. Instead, it highlights projects currently under feasibility study with a focus on the period until 2030. However, what stands out is the absence of specific expected dates for the implementation of each power plant project, leaving a certain level of uncertainty regarding the timeline for their completion. The BAU25 scenario refers to that calibrated to projects forecast in the LCEEP while the BAU30 refers to my interpolation of the installed capacity extended until 2030.

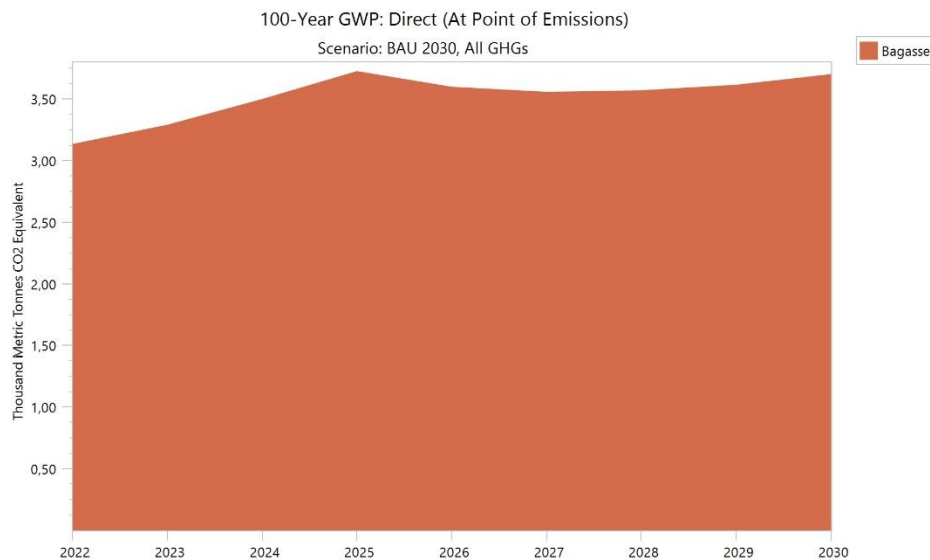
Figure 6.6: Contrasting Electricity Generation Capacity Scenarios in Uganda, MW

(a) BAU25 Scenario	(b) BAU30 Scenario
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Results indicate a stabilization in emissions from 2025 to 2030 despite a significant increase in electricity generation during this period. This seeming contradiction can be explained by the incorporation of environmentally friendly energy sources—including hydro, solar, and geothermal power—into the additional installed capacity. Notably, Uganda stands as a notable global leader in renewable energy adoption, securing the 9th position on the international stage with an impressive 99% share of renewables in its electricity generation. It is noteworthy that the only discernible GHG emitter in this scenario is a modest 8.5 MW of biomass resulting in 3.7 ktCO₂eq. This trend underscores a trajectory towards a more environmentally responsible energy system. By prioritizing the adoption of renewables and leveraging its abundant natural resources, Uganda has not only diversified its energy mix but also positioned itself as a role model for other nations striving to transition towards a low-carbon future.

Figure 6.7: Business-as-usual emissions in Uganda



6.4 Tanzania modeling results

6.4.1 Forecasting Future Electricity Demand

The challenge of running the model in Tanzania stemmed primarily from a critical shortage of available data, which severely constrained my ability to generate reliable outcomes. Without access to comprehensive and high-quality data, modeling results lacked robustness and precision. Significantly, key variables such as historical electricity consumption patterns and mainly electricity price data were either unavailable or inadequately documented, leaving critical gaps in our understanding of the system dynamics.

6.4.2 Analysis of Greenhouse Gases Emissions from different scenarios

Figure 6.8 presents electricity generation capacity under two scenarios in Tanzania. First, the BAU scenario is grounded in existing energy generation policies, as it reflects the anticipated government strategy. It assumes that future electricity generation will align with the trends outlined in these policies and does not anticipate the adoption of any new policies. The Power System Master Plan (PSMP) provides the

foundational framework for shaping the BAU scenario. Second, in contrast, the Green scenario presents an alternative approach where I replace gas turbines, which are the most pollutant fuel source in the BAU scenario, with renewable energy. This substitution aims to significantly reduce emissions and promote environmentally sustainable energy generation.

Figure 6.9 consider electricity generation in Tanzania under BAU and Green scenarios. Electricity generation in base year 2021 is 9,098 GWh, and electricity generation is predicted to grow to 28,663 GWh in the year 2030, representing 210% increase.

Finally, the estimated GHG emissions from electricity generation in the year 2022 are recorded at 0.6 million MtCO₂eq (Figure 6.10). However, projections for the BAU scenario anticipate a significant increase, with GHG emissions from electricity generation expected to soar to 2.65 MtCO₂eq by the year 2030. By implementing the strategy of replacing gas turbines with greener alternatives, Tanzania could achieve a substantial 82% reduction in emissions. This reduction would result in GHG emissions dropping from 2.65 MtCO₂eq to 0.46 MtCO₂eq—marking a significant stride towards mitigating environmental impact and fostering sustainability in energy production.

Figure 6.8: Electricity Generation Capacity Scenarios in Tanzania, in MW

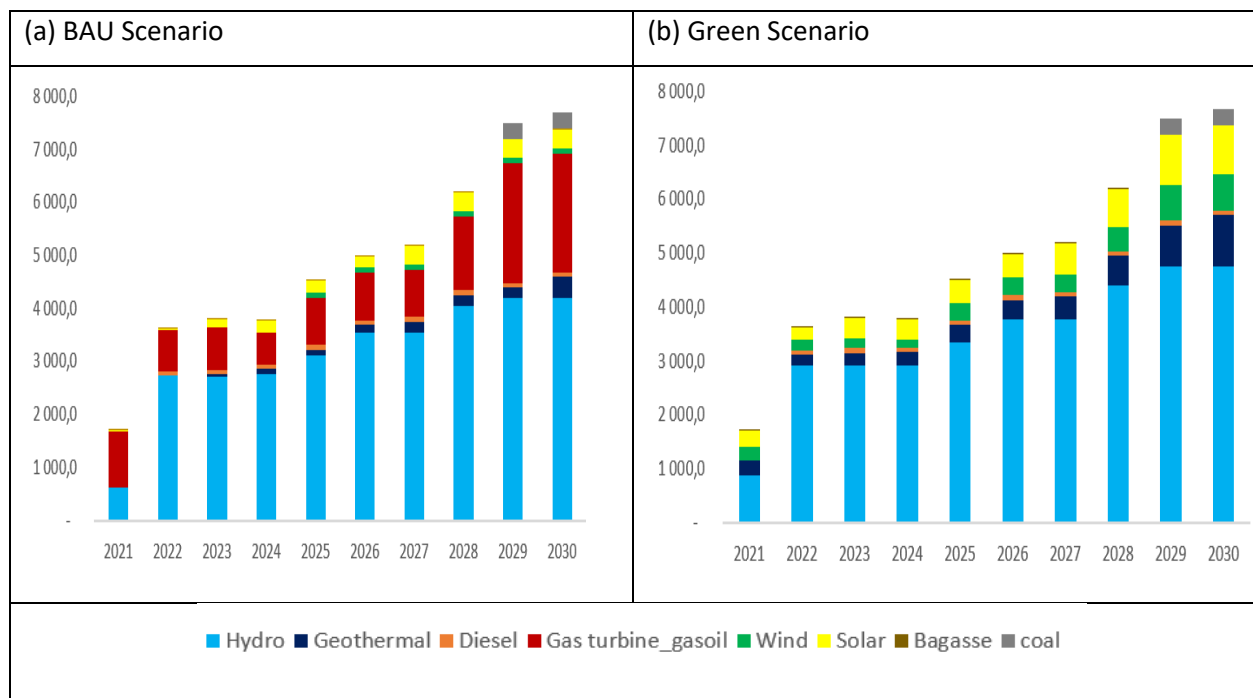


Figure 6.9: Electricity Generation Scenarios in Tanzania, in GWh

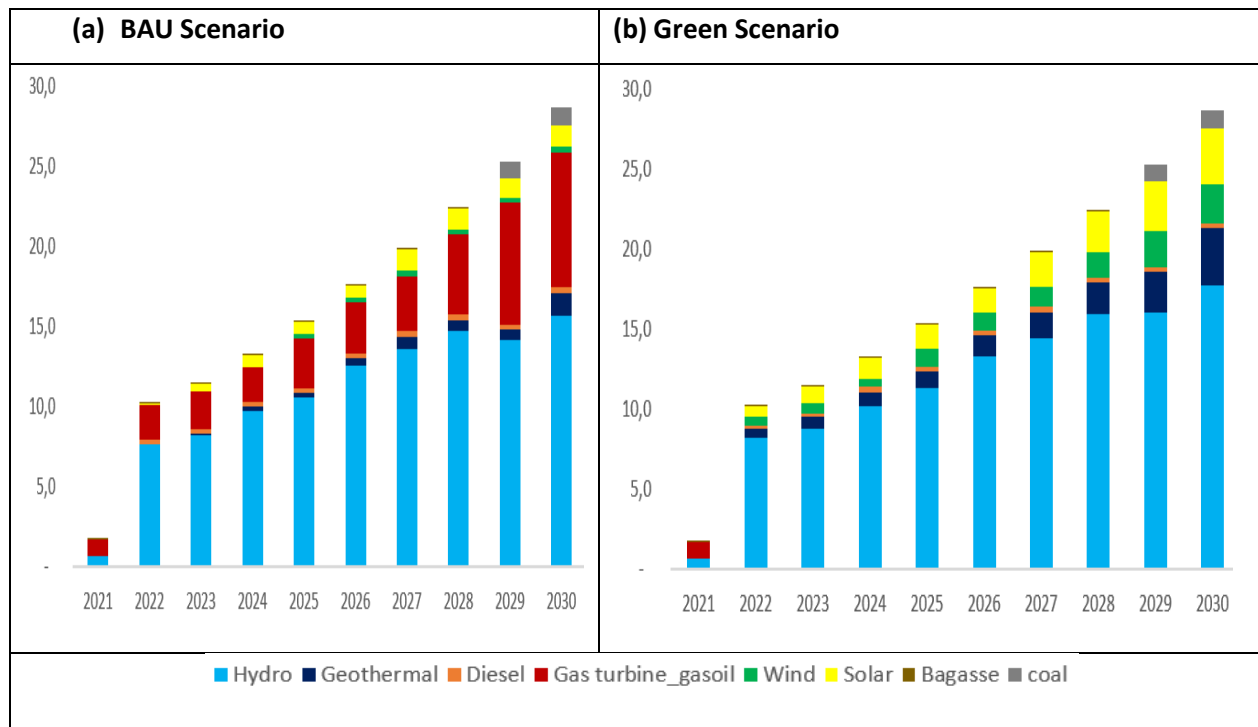
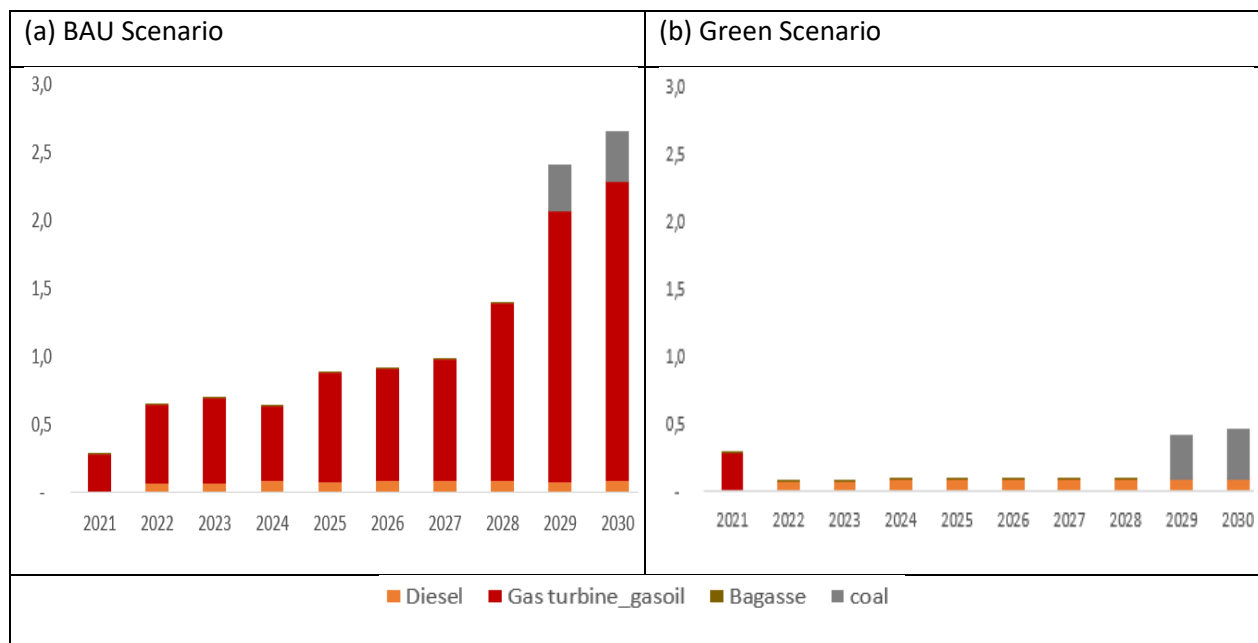


Figure 6.10: Contrasting Electricity Generation Emissions Scenarios in Tanzania



6.5 Assessment: Alignment with Independent Modeling

In all three countries, there exists a significant misalignment of emissions projections evident not only between various official government documents but also between these governmental projections and independent modeling analyses. See a summary of these differences in Table 6.2 (Kenya), 6.3 (Uganda) and 6.4 (Tanzania).

For instance, Kenya's NDC commitment in the electricity sector is not congruent with its emission projections in official plans. The significant variance between the projected 4.1 MtCO₂e and the committed 19.4 MtCO₂e in the NDC underscores this misalignment. Moreover, the 2021 power sector emissions projections are anticipated to be considerably lower, particularly due to the cancellation of the coal plant project. The misalignment between the Baseline Update Report, submitted to the UNFCCC, and the Least Cost Power Development Plan (LCPDP) is significant. If the electricity sector were to follow the trajectory outlined in the LCPDP, it has the potential to account for the majority of the required emission reductions to meet the national NDC target of 100 MtCO₂e by 2030.

Similarly, in Uganda, the long-term vision of providing an installed capacity of 42,000 MW and achieving 100% electricity access by 2040 is at odds with the medium-term forecasts outlined in the least-cost electricity expansion plan for 2020-2030. This misalignment underscores the critical need for cohesive and harmonized planning approaches to ensure effective and sustainable energy sector development aligned with climate change mitigation goals.

In the case of Tanzania, conducting a comprehensive comparison was challenging due to the scarcity of data and scholarly work in the field, which hindered our ability to effectively undertake the exercise. Despite these constraints, the projections I managed to obtain revealed significant disparities, particularly in the variable of greenhouse gas (GHG) emissions. This disparity underscores the complexity and uncertainty surrounding Tanzania's climate and energy planning landscape.

Table 6.2: Alignment with independent modeling - Kenya

Kenya	Electricity planning documents	Climate planning documents	Independent modeling	Academic literature
Electricity demand (GWh)	19,542	-	22,724	32000 (Maina et al., 2022) 17500 (Kehbila et al., 2021)
Power sector GHG emissions for BAU scenario (MtCO ₂ eq)	0.31 (2017-2037 LCPDP)	41.90 (NCCAP 2018) 19.40 (Baseline report 2017)	0.81	2.00 (Carvallo et al., 2017) 5.00 (Wambui et al., 2022)

Table 6.3: Alignment with independent modeling - Uganda

Uganda	Electricity planning documents	Climate planning documents	Independent modeling	Academic literature
2030 Electricity demand (GWh)	14,016 (Demand in LCEEP in MW converted to GWh) 156,320 (Vision 2040)		9,269 GWh	20,901 (Kasule & Ayan, 2021)
Power sector GHG emissions for BAU scenario (MtCO ₂ eq)		10.1 MtCO ₂ e (all energy) (NDC)	0.0037 MtCO ₂ e	~ 0 (2030) /0.4 (2040) (Sridharan et al., 2020)

Table 6.4: Alignment with independent modeling - Tanzania

Tanzania	Electricity planning documents	Climate planning documents	Independent modeling	Academic literature
Electricity demand (GWh)	28,663 GWh	-	-	33,333 GWh(Rocco et al., 2021)
GHG emissions for BAU scenario (MtCO ₂ eq)		43.9 MtCO ₂ e (all energy) (NDC)	2.7 MtCO ₂ eq	15 MtCO ₂ eq

6.6 Conclusion

In all three countries, there is a notable misalignment of projections offered in governmental energy and climate planning documents and independent modeling analyses.

In Kenya, this misalignment can be partially attributed to frequent updates and revisions in the projections, reflecting ongoing efforts to adapt and refine their climate and energy planning strategies as seen in the comparison between the different versions of LCPDP. These updates, while aiming to enhance accuracy and responsiveness, sometimes result in discrepancies when compared to independent analyses.

On the other hand, Uganda and Tanzania exhibit no such modifications, leading to a more static and less responsive planning framework. This lack of updates and revisions contributes to the persistent misalignment of projections, as the governmental documents fail to reflect the evolving data and trends captured by independent models. Consequently, the credibility of climate and energy planning in Uganda and Tanzania is further compromised by this stagnation, highlighting the need for more dynamic and responsive planning processes.

CHAPITRE 7 : DISCUSSION

In my study, I have investigated the relationship between state capacity and energy and climate planning credibility, focusing on a comparative analysis of Tanzania, Uganda, and Kenya. I hypothesized that greater state capacity would correlate with higher levels of energy and climate planning credibility. Kenya is widely recognized for having a higher state capacity than both Uganda and Tanzania, characterized by more robust governance structures, better resource management, and stronger institutional frameworks. It was anticipated that this greater state capacity would result in higher energy and climate planning credibility, meaning that Kenya should demonstrate the most consistent and credible energy and climate planning among the three countries. However, the findings revealed a different picture. Despite Kenya's higher state capacity, both Kenya and Uganda exhibited similar levels of planning credibility in their energy and climate strategies.

7.1 Differences of planning credibility in Kenya, Uganda and Tanzania 's context

To begin, I contrasted Kenya with Tanzania and Uganda, two countries with relatively lower levels of state capacity. Relative to Kenya, both Tanzania and Uganda face lower GDP per capita, low government effectiveness, limited electricity access, and weak tax extraction capabilities. In the East Africa region, Kenya clearly appears to have higher state capacity

First, in conducting the qualitative assessment across the three countries—Kenya, Uganda, and Tanzania—I examined their power sector planning documents alongside their NDCs, key climate planning documents submitted to the UNFCCC. The analysis revealed that Kenya and Uganda exhibit a similar level of planning credibility. Both countries have demonstrated a reasonable commitment to climate and energy planning, particularly within the power sector. This commitment is illustrated by a strong emphasis on producing detailed and flexible electricity projections as well as inclusive and adaptable NDCs. However, the findings for Tanzania were markedly different. Upon reviewing Tanzania's power sector planning documents and its NDC, it became evident that there is a significant gap in credibility. Tanzania's plans appeared inconsistent and lacked the necessary detail and alignment to demonstrate a realistic pathway toward achieving its stated energy and climate objectives.

In contrast to Kenya and Uganda, which have unbundled their electricity supply industries by separating generation from transmission and distribution, Tanzania's electricity sector may face challenges due to

TANESCO's dual role. As a vertically integrated state-owned enterprise, TANESCO is responsible for generating, transmitting, and distributing electricity, while also acting as the primary procurer of new generation capacity. This dual role places TANESCO in direct competition with Independent Power Producers (IPPs), leading to biased decision-making processes, market distortion, and challenges for foreign and private investments.

When looking into the power sector planning documents, Kenya, Uganda, and Tanzania exhibit distinct approaches in their planning. Kenya is notably proactive, aligning its projects and forecasts with its Vision 2030 and prioritizing environmental sustainability and cost-effectiveness, as evidenced by its abandonment of coal projects which was driven by a combination of environmental, legal, economic, and social factors. Uganda, on the other hand, has limited its long-term forecasting to 2025 and focuses on feasibility studies for 2030, indicating a need for more forward-looking strategies. Tanzania, while consistent in its forecasting, lacks the dynamism and adaptability seen in Kenya, potentially limiting its responsiveness to new technologies and environmental concerns.

Concerning our third indicator -Data availability- while each of the three countries presents projections for energy emissions, it is notable that only Kenya and Uganda provide detailed forecasts specifically for electricity power emissions. This level of detail reflects their comprehensive approach to planning and transparency in its energy sector. In contrast, Tanzania lacks historical data on electricity prices, which hampers the ability to conduct thorough trend analyses and make informed policy decisions. Furthermore, previous versions of the power plans for Tanzania are not readily accessible, limiting the ability to evaluate progress over time or compare current strategies with past objectives. This lack of data transparency and availability in Tanzania presents significant challenges for their planning credibility.

When it comes to engagement with the UN climate change regime, Uganda has demonstrated notable proactivity by frequently submitting and updating its technical climate policy reports. This consistent engagement reflects Uganda's dedication to addressing climate change and aligning with global environmental standards. Tanzania, on the other hand, has taken a more conditional approach. It submitted a NDC commitment that is contingent on receiving external support. This means Tanzania's ability to reduce its emissions relies heavily on international assistance, raising concerns about its capacity to achieve these goals independently. Additionally, Tanzania has increased its conditional commitment significantly, from a 10% reduction to a 30% reduction. However, this ambitious target raises questions

about its feasibility, especially given the lack of concrete projects or strategies to support such a substantial increase in emissions reduction. In contrast, both Kenya and Uganda have made commitments that include both conditional and unconditional elements. This dual approach indicates a more robust and flexible strategy for tackling climate change. Furthermore, Kenya and Uganda have each reduced their emissions targets in their updated NDCs, showcasing a more realistic reassessment and commitment to achievable goals. This recalibration suggests a deeper understanding of their capacities and a more strategic approach to implementing effective climate actions. Overall, while Uganda and Kenya display a balanced and proactive stance, Tanzania's increased conditional commitment without solid backing projects may pose challenges to its implementation, highlighting the importance of realistic planning and reliable support mechanisms in international climate politics.

The alignment with independent modeling efforts is significantly hindered by the lack of available data in Tanzania, making it difficult to accurately compare official projections with independent models. The absence of historical data and future projections for key parameters poses a substantial barrier to thorough analysis and validation of official energy plans. In stark contrast, Kenya and Uganda stand out for their transparency and detailed documentation, providing specific forecasts and commitments for the electricity sector. This comprehensive approach is bolstered by a robust body of independent academic research, which is more prevalent in Kenya than in Uganda and Tanzania. Many scholars have engaged in modeling and analysis of Kenya's energy sector, contributing to a richer and more reliable pool of knowledge. On the other hand, Tanzania tends to conduct high-level assessments of its energy sector without delving into the specifics of electricity. The lack of detailed planning and research in Tanzania results in less reliable and less verifiable projections, ultimately leading to weaker strategic planning and potential misalignments with actual future energy needs.

Overall, after conducting a thorough analysis of the indicators pertaining to both our dependent and independent variables, a distinct pattern emerged: Kenya exhibits higher levels of state capacity compared to Uganda and Tanzania. This finding suggests that Kenya possesses a stronger institutional framework and administrative capability to plan effectively. However, when assessing the credibility of energy and climate planning across the three countries—Kenya, Uganda, and Tanzania—it becomes evident that Kenya and Uganda demonstrate a medium level of planning credibility, while Tanzania lags behind with the lowest level of credibility.

Table 7.1: Impact of state capacity on climate and energy planning credibility

		State capacity	
		High	Low
Climate and energy planning credibility	High		
	Medium	Kenya	Uganda
	Low		Tanzania

7.2 A less than perfect relationship between state capacity and energy and climate planning credibility

The disparity between my three case studies underscores the critical role of state capacity in shaping the effectiveness and trustworthiness of energy and climate planning efforts, though this is not a systematic correlation. While of only a limited number of cases, my results suggest a lack of relationship between state capacity and planning credibility. While higher state capacity is generally associated with more robust and reliable energy and climate planning, there are notable exceptions to this trend as exemplified in the situation of Uganda. Despite lower state capacity than Kenya, Uganda's climate and energy planning credibility was found to be similar. This suggests that other factors are at play in determining the success of such initiatives. This example highlights the complexity of the relationship between state capacity and the effectiveness of planning efforts. It suggests that while state capacity is an important factor, it is not the sole determinant of success.

Thus, there is a relationship between state capacity and energy and climate planning credibility, but it is less than perfect, suggesting other factors intervene to shape outcomes. While our analysis highlights the significant influence of state capacity on the credibility of energy and climate planning, it also underscores the complexity of the relationship. According to (Piano, 2019), the mere presence of state capacity doesn't provide a definitive insight into how that capacity will be utilized. The notion of state capacity refers to "the ability of a state to collect taxes, enforce law and order, and provide public goods" (Johnson and Koyama 2017, p. 2). In that sense, capacity is a technological notion, rather than an economic one. Which is to say that observing an increase in state capacity does not necessarily tell us how that capacity will be

employed, but merely that a ruler with relatively high capacity is better able to “collect taxes, enforce law and order, and provide public goods.”

These results build on existing evidence of the importance of state capacity. Winanti & Mas’Udi (2022) argue that state capacity plays a vital role in the success of energy transition policies in emerging economies, and it helps by enabling effective resource management and governance for sustainable transitions. Lack of capacity is a recognized challenge for energy and climate policy implementation. Strengthened multilevel governance, institutional capacity, policy instruments are among the enabling conditions that are often called on to enhance the feasibility of mitigation and adaptation options (IPCC, 2018). This is seen particularly in the context of developing countries where disproportionate national capacity stands out as a primary reason for their reluctance to undertake mitigation commitments (Dubash & Morgan, 2013; Mathur & Shrivastava, 2015; Okubo & Michaelowa, 2010).

Indeed, state capacity serves as a foundational element shaping the effectiveness and trustworthiness of planning efforts. However, it is not the sole determinant of outcomes. Various other factors intervene to shape energy and climate planning credibility, operating within and beyond the realm of state capacity. Further research has led us to identify additional variables ranging from political benefits such leadership can produce for political actors (Deshazo & Freeman, 2007), to perceived economic benefits, to voter preferences (Engel, 2006). Governments may be motivated to take on leadership roles both domestically and internationally, engaging in 'paradiplomacy' initiatives, even in the absence of full capacity (Happaerts et al., 2010). This is exemplified in the case of Kenya, which has set ambitious goals in various areas including climate action. Conversely, there are instances where countries prioritize other development objectives over climate initiatives, as seen in Tanzania. Since 2015, Tanzania has placed a strong emphasis on rapid industrialization and infrastructure development, relegating climate change policy to a lower priority on the political agenda (Nachmany, 2018). Also the potential for climate action can also be shaped by a range of intangible political elements, such as ideology, political influence, and regional identity (Rhodes, 2007; McEwen and Bomberg, 2014) or non-political elements such as technological innovation, transfer and mobilization of finance, as well as changes in human behavior and lifestyles (IPCC, 2018)

It is beyond the scope of the present study to identify factors other than state capacity in order to explain results. It should be recalled that I have focused on administrative capacity--only one dimension of state capacity. Consequently, while my study delves into administrative capacity specifically, it is essential to

recognize the interconnectedness of these components and their collective influence on governance and planning credibility. Future research could explore the interactions between different forms of capacity to provide a more comprehensive understanding of state capacity and its implications for public administration and policy implementation.

7.3 Policy implications

To enhance the credibility of energy and climate planning in Uganda, Tanzania, and Kenya, several practical steps can be taken. First, improving data collection and analysis is essential. Reliable and accurate data underpins informed decision-making and allows for more accurate forecasting of energy consumption and emissions. Strengthening data collection systems across the region will ensure better alignment of energy and climate plans with realistic projections. This requires investment in data infrastructure that can monitor electricity consumption, greenhouse gas emissions, and energy infrastructure development, ultimately improving the reliability of the plans.

In addition to data improvements, there is a critical need to enhance institutional capacity. Energy and climate institutions in the region should be equipped with the necessary skills to improve energy modeling, climate forecasting, and policy implementation. By building technical capacity within these institutions, governments will be better positioned to create robust and credible plans that contribute to long-term sustainability and resilience.

Regional collaboration is another key area for improvement. East African countries face common challenges in energy and climate planning, and by working together, they can share knowledge, resources, and best practices. Collaboration can help harmonize policies, improve resource management, and create synergies that strengthen the credibility of national plans. Such cooperation would be particularly beneficial for countries like Tanzania, which face challenges related to data and technical capacity, by enabling them to learn from their neighbors and overcome these barriers.

Furthermore, involving stakeholders and the public is crucial for ensuring the feasibility and inclusiveness of energy and climate policies. Engaging local communities, civil society, and the private sector in the planning process ensures that policies reflect the needs of the population and are more likely to gain broad support. This transparency not only fosters trust but also enhances the accountability of governments in

implementing their climate and energy commitments, making it more likely that plans will be effectively executed.

Political will and accountability are also central to the success of energy and climate planning. Governments need to demonstrate strong political commitment by embedding climate and energy goals into national development frameworks. Setting up monitoring and evaluation mechanisms will help track progress and ensure that governments are held accountable for meeting their climate and energy targets. These actions will make it possible for policies to be not only credible but also actionable, ensuring that they drive real change.

Finally, seeking external support can provide the necessary resources and expertise to address gaps in energy and climate planning. International financial and technical support from climate finance mechanisms and development partners can help fund renewable energy projects, build institutional capacity, and enhance climate adaptation efforts. By leveraging external support, governments can accelerate their efforts to achieve their energy and climate goals while addressing local challenges more effectively.

Incorporating these steps into policy frameworks will help East African countries create more credible and effective energy and climate plans. Through improved data systems, enhanced institutional capacity, regional collaboration, public engagement, strong political commitment, and external support, the region will be better positioned to confront climate change, promote sustainable development, and ensure a resilient energy future.

7.4 Study limitations

While this study on the credibility of climate and energy planning in Uganda, Tanzania, and Kenya offers valuable insights, but several limitations must be acknowledged to contextualize the findings and guide future research. These limitations primarily stem from data quality, methodological constraints, and the geographical focus of the analysis.

One of the key challenges was data availability and quality. The forecasting models relied on datasets that were incomplete, inconsistent, or lacked sufficient granularity. For example, critical information on electricity price, CO₂ emissions from electricity sector, and energy sector emissions often varied in quality

across the three countries. The limitations were particularly pronounced in Tanzania. Unlike Uganda and Kenya, where historical data on electricity consumption was sufficiently detailed to support forecasting models, Tanzania lacked adequate historical records. This absence of reliable data made it impossible to forecast future electricity consumption with confidence, thereby limiting the scope of the analysis for this country. These gaps introduced uncertainties in the projections, limiting their precision and reliability. As a result, the findings should be interpreted as indicative trends rather than definitive predictions.

Methodological constraints also influenced the study's outcomes. The forecasting techniques employed, while appropriate for the scope of the research, rely on assumptions that may not fully reflect the complexities of climate and energy systems. The research employed the Autoregressive Distributed Lag (ARDL) model, which is particularly suited for analyzing non-stationary variables—a common characteristic in energy demand data. While this approach is advantageous for capturing both short-term dynamics and long-term relationships between variables, it requires sufficient and reliable data to produce robust results. The limitations of the available data, especially in Tanzania, restricted the application of ARDL models and reduced the reliability of findings in cases where data quality was poor. Furthermore, while the ARDL methodology accommodates non-stationary data, it assumes stable relationships between variables over time, which may not fully account for dynamic real-world factors such as sudden policy shifts, market disruptions, or technological advancements. These limitations, compounded by the challenges of working with imperfect data, highlight the need for further methodological refinement and more robust datasets to enhance forecasting accuracy.

Another limitation is the geographical focus on Uganda, Tanzania, and Kenya, which, while offering critical insights, may not capture the full diversity of the East African region. Each country has unique socio-economic, institutional, and environmental characteristics that shape its energy and climate planning. For instance, Kenya's comparatively advanced renewable energy sector and electrification rates differ significantly from the challenges faced by Uganda and Tanzania. These differences may limit the generalizability of the findings even within this subset of East Africa. Furthermore, while the study focuses on three countries within the East African Community, its regional applicability to other nations in the bloc, such as Rwanda, Burundi, or South Sudan, is limited. These countries face distinct challenges, including smaller economies, different policy priorities, and varying levels of state capacity. As such, the findings should not be extrapolated across the broader region without accounting for these contextual differences.

CONCLUSION

In my study, I aimed to investigate the relationship between state capacity and energy and climate credibility by conducting a comparative analysis of Tanzania, Uganda, and Kenya. The hypothesis driving this research was that greater state capacity would correlate with higher levels of energy and climate credibility. State capacity, in this context, pertains to the standard of the state's administrative and bureaucratic institutions, strong regulatory frameworks, sufficient infrastructure, and openness and accountability systems. Energy and climate credibility, on the other hand, involves the flexibility, feasibility, and transparency of a country's energy policies and climate commitments.

The selection of Tanzania, Uganda, and Kenya for this comparative analysis was based on their varying levels of state capacity, with Kenya generally recognized for having a higher state capacity compared to Uganda and Tanzania. Kenya has been perceived as having a more robust administrative structure, better resource management capabilities, and stronger institutional frameworks, which were expected to contribute to higher credibility in its energy and climate plans. Uganda, while having a moderate level of state capacity, was expected to demonstrate a corresponding level of credibility. Tanzania, with its relatively lower state capacity, was anticipated to show less credibility in its energy and climate planning.

To assess state capacity, I conducted a quantitative analysis comparing various indicators, including GDP per capita, government effectiveness, tax revenue, and electricity access. This provided a broad overview of the state's administrative capacities. In addition to this quantitative approach, I used a mixed-methodology approach—incorporating both quantitative and qualitative analysis—to assess the credibility of energy and climate planning. For this, I compared the documentation related to power sector planning and the NDCs to evaluate their reliability and coherence. Furthermore, I conducted a modeling exercise to examine the consistency of future electricity demand and GHG emissions within governmental projections and independent sources. This allowed me to assess the reliability and robustness of the government's energy and climate planning efforts.

Contrary to my initial hypothesis, the findings of the study revealed that Kenya and Uganda have similar levels of planning credibility in their energy and climate strategies, despite differences in state capacity. Both countries demonstrated a degree of utility independence inclusive, inclusive, adaptable, and coherent power sector plans and NDCs, indicating a moderate level of credibility. In contrast, Tanzania

exhibited poor planning credibility, with significant discrepancies between its stated targets and the feasibility or realism of achieving them based on independent assessments. This suggests that Tanzania's energy and climate planning may suffer from issues such as inadequate data, unrealistic projections, or a lack of coherent policy planning.

These findings challenge the assumption that higher state capacity necessarily translates into higher energy and climate credibility. While Kenya's higher state capacity might have been expected to result in significantly higher credibility than Uganda and Tanzania, the similar levels of credibility between Kenya and Uganda suggest that factors other than state capacity may play a crucial role. This includes aspects such as political commitment, external support, public engagement, and the technical capacity of relevant institutions.

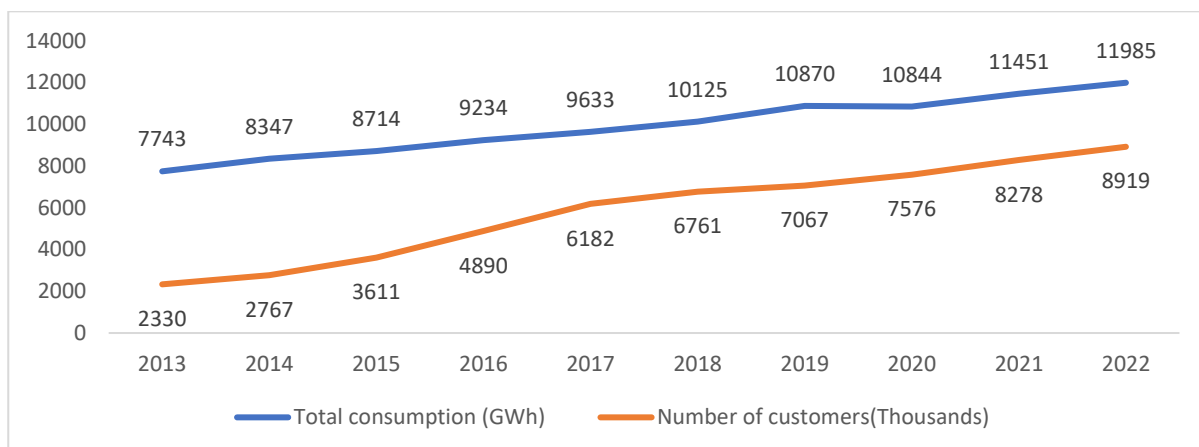
For the case studies examined, state capacity does not appear to be the determining factor in shaping energy and climate credibility. Instead, the study points to the need for a more nuanced understanding of the drivers of credibility in energy and climate planning. While state capacity remains an important factor, its impact may be mediated by other contextual factors that influence policy formulation and implementation effectiveness. This insight opens up new avenues for research to explore the complex interplay of factors that contribute to credible energy and climate planning, beyond the simplistic correlation with state capacity.

ANNEXE A: Project context

A.1: Energy profile of Kenya

Over the past decade, the nation has witnessed a substantial surge in demand for electricity. Peak demand rose from 1,512 MW in the fiscal year 2014/15 to 1,926 MW by 2019/20. Remarkably, even during the widespread disruptions caused by the COVID-19 pandemic, a new peak of 1,976 MW was achieved in December 2020 (LCPDP, 2021). Overall electricity consumption experienced an upward trajectory, increasing from 7.743 GWh in 2013 to 11.985 GWh in 2022, exhibiting a consistent annual growth rate of 4.7%. This resilient growth is graphically represented in Figure A.1, illustrating the upward trajectory of demand from 2013 to 2022 (KNBS, 2023). Furthermore, Kenya has achieved significant strides in increasing the number of customers connected to the electricity grid, rising from 2,330,962 customers in the financial year 2013 to 8,919,440 in the financial year 2022 representing 76.54% of the population. Notably, rural connections constituted a substantial portion, totaling 2,100,734 and accounting for 23% of the total connections. This notable annual average growth rate of 14.36% can be attributed to the successful implementation of accelerated electrification programs across the country under the government’s “2030 Vision” to become an industrialized middle-income country by the year 2030, where energy sector is identified as one of the key drivers (Manyara & Mading, 2012; MOEP, 2015; Longa & Zwaan, 2017). These initiatives have played a pivotal role in extending electricity access to previously underserved rural areas, contributing significantly to the overall electrification progress.

Figure A. 1: Electricity demand statistics in Kenya



Source: Author construction based on KNBS data, 2023

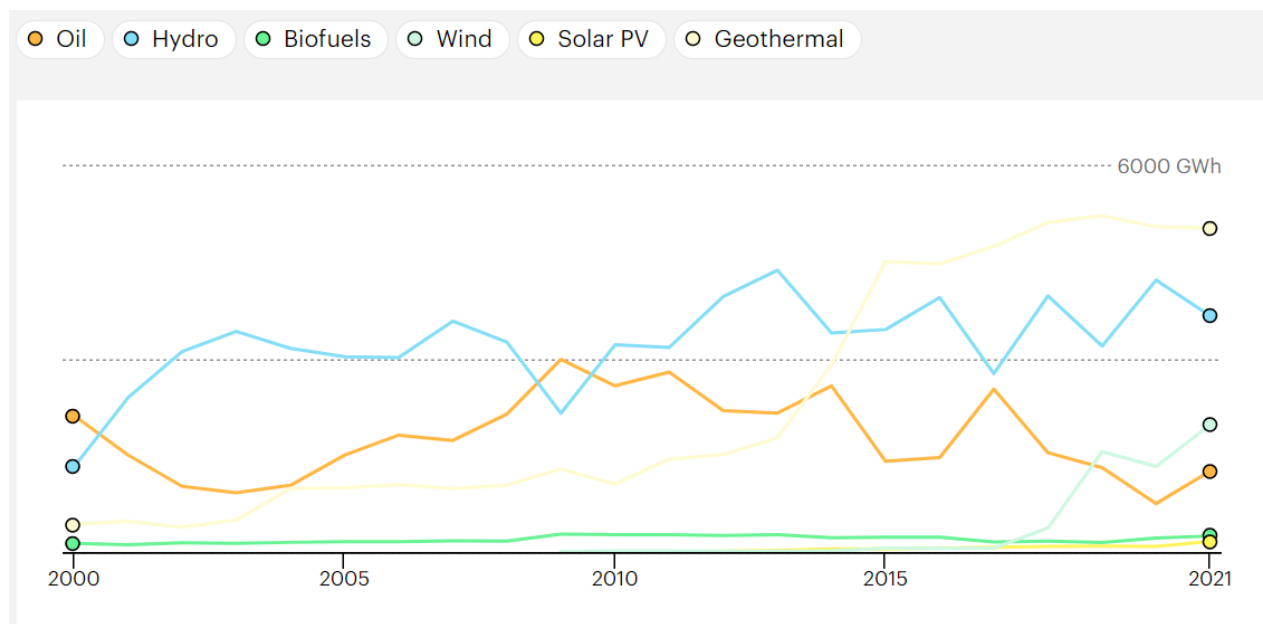
The quantity of electricity generated in Kenya exhibits a consistent upward trend, as illustrated in Figure A.2. In 2022, total electricity generated (including imports) reached 12,985 GWh, marking a substantial 4.39% increase from 2013 (KNBS, 2023). The primary sources contributing to electricity generation in Kenya are geothermal, hydro, and thermal, collectively constituting 98% of total electricity output under normal hydrological conditions (Kiplagat et al. 2011; Taneja 2018; MEF, 2018).

Over the past decade, electricity generation from geothermal power has trended upwards, while the generation from thermal and hydro sources has exhibited fluctuating patterns. Renewable sources constituted 86% of the total electricity generated during 2022, with geothermal and hydro being the major contributors, accounting for 43% and 23%, respectively (KNBS, 2023). However, hydroelectric power generation is vulnerable to climatic conditions, leading to reduced output during dry seasons. Consequently, electricity generation from greenhouse gas-intensive sources like diesel and oil becomes necessary (Kaseke & Hosking, 2013 ; Mwangi, 2014 ; NEMA, 2015 ; Laconde, 2018 ; Mokveld & Eije, 2018 ; Taneja, 2018). In 2017, with low rainfall, hydro generation dropped by 27%, while oil generation increased by 25% (ERC, 2018 ; KNBS, 2023). The most notable surge in capacity comes from wind power, witnessing a remarkable increase from 15 GWh to 2,143 GWh, boasting an annual growth rate of 64.25 percent.

Recognizing the need to increase power generation to meet growing demand, Kenya possesses untapped potential in wind and solar resources, particularly in areas like Marsabit, Turkana, and the Rift Valley edges (Muzee, 2011 ; Ongoma, 2018). Notably, the construction of the largest anticipated wind farm in Africa, capable of generating 300 MW, is underway in Turkana. Additionally, Kenya boasts hydro potential in regions such as Lake Victoria, Rift Valley, Ewaso Nyiro North river, and Tana River basins, as well as geothermal potential primarily sourced from the Rift Valley (Kiplagat, Wang, & Li, 2011 ; ERC, 2018).

Despite recent mineral discoveries like coal, natural gas, and oil, it is anticipated that their exploitation, including electricity generation, will bring significant economic developments along with negative environmental impacts, including greenhouse gas emissions (MENR, 2016). The Lamu coal power project was expected to be the first coal plant in Kenya. The country is also exploring the use of nuclear energy for power generation.

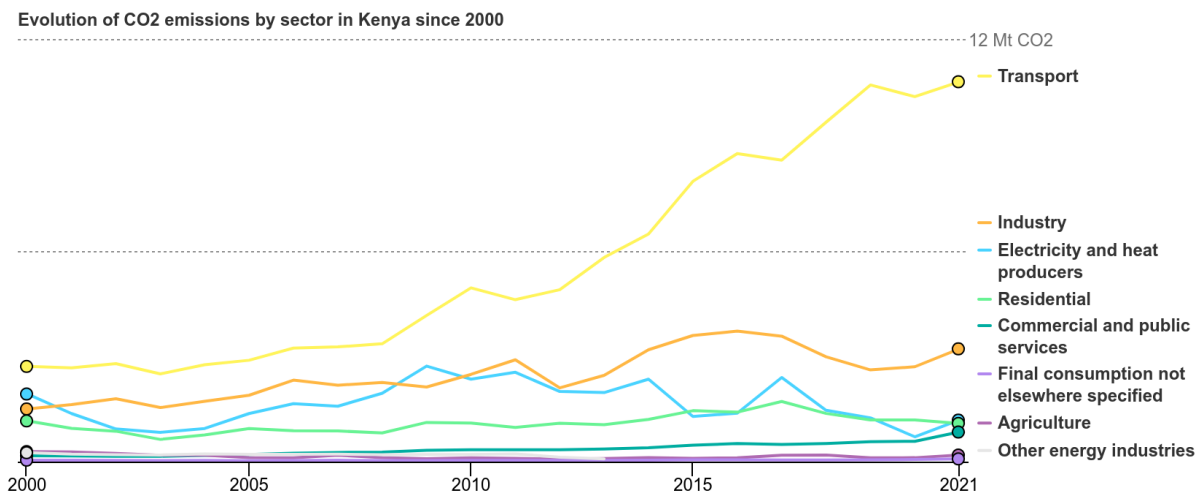
Figure A.2: Electricity generation by source in Kenya



Source: IEA

Kenya bears minimal historical or contemporary responsibility for climate change, as its greenhouse gas (GHG) emissions constitute less than 1% of the total global emissions. Despite this relatively low contribution, the global release of greenhouse gases by human activities has consistently risen each year since the Industrial Revolution, reaching alarming levels. While prioritizing adaptation remains crucial for Kenya, there is a pressing need for concerted efforts to mitigate greenhouse gas (GHG) emissions. Projections indicate an anticipated increase in emissions attributed to population and economic growth, as illustrated in Figure A.3.

Figure A.3: CO2 emissions by sector in Kenya



Source: International Energy Agency. Licence: CC BY 4.0

Source : IEA

While Kenya's electricity generation mix demonstrates a relatively low emissions intensity, it is important to note that certain components, such as medium-speed diesel and natural gas, contribute significantly to greenhouse gas (GHG) emissions. Despite the overall environmentally friendly profile of the country's energy generation, targeted attention and mitigation strategies are essential to address and minimize the emissions associated with these specific sources.

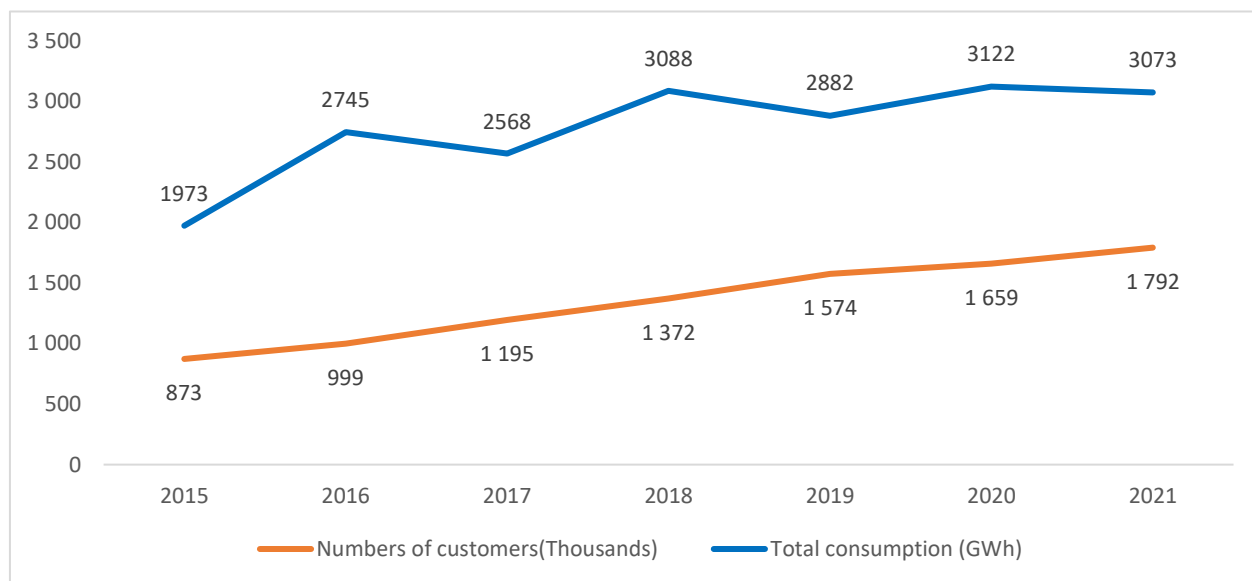
A.2: Energy profile of Uganda

In the context of Uganda, both electricity consumption (measured in Megawatt) and number of customers, have exhibited steady growth since 2015, as depicted in Figure A.4. The total electricity demand exhibited substantial growth, increasing from 1973 MW to 3073 MW, showcasing an annual growth rate of 6.5%. Concurrently, the number of customers experienced a noteworthy annual growth rate of 10.82%, surging from 873 thousand to 1792 thousand over the specified period.

Uganda possesses ample potential for electricity generation, primarily through hydroelectricity harnessed from numerous waterfalls and rapids. Despite this significant potential, the country grapples with recurrent power outages, commonly known as load-shedding, particularly during peak consumption

periods. This electricity scarcity not only has adverse effects on the daily lives of the population but also disrupts activities in commerce, industry, and agriculture sectors (Sekantsi,2016 ; IEA, 2023).

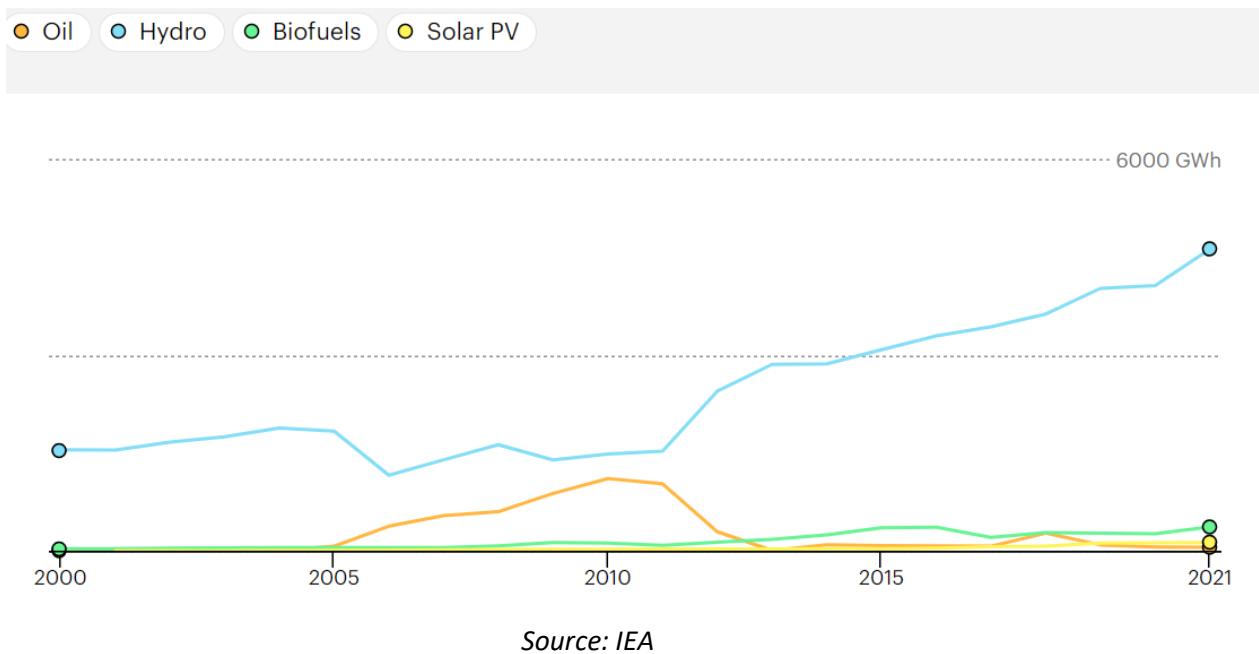
Figure A.4: Historical electricity consumption in Uganda



Source: Author construction based on ERA data, 2022

In Uganda, electricity constitutes merely 2% of the overall final energy consumption, with biomass and fossil fuels making up 88% and 10%, respectively (MEMD,2019). In 2021, Uganda produced 5,211 gigawatt-hours (GWh) of electricity, a significant increase from less than half of this amount in 2007, as illustrated in Figure A.5. The majority of the electricity generated in 2021 originated from hydroelectric power plants (HPPs), accounting for 90%. Co-generation plants, utilizing sugar cane bagasse, contributed the second-largest share at 7%, followed by solar photovoltaic (PV) plants at 2%, and thermal plants operating on fuel oil at 1%. The annual distribution of these shares is notably influenced by the available hydropower capacity, which, in turn, is dependent on factors such as rainfall and water levels, especially from Lake Victoria.

Figure A.5: Electricity generation by source in Uganda

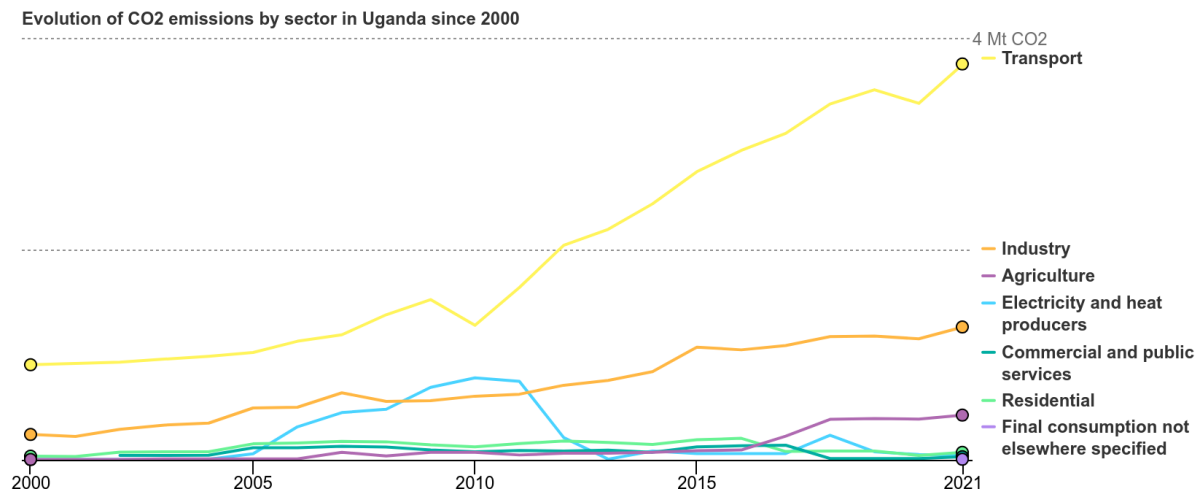


In Uganda, carbon dioxide (CO₂) emissions from hydrocarbon combustion and industrial activities constitute approximately 0.099% of the global carbon stock. While Uganda's contribution to the potentially harmful accumulation of human-made carbon footprints is relatively small, the country remains vulnerable to the impacts of climate change. Uganda's carbon stock is one of the lowest globally, estimated at 1.39 tons of carbon equivalent, significantly below the world average of 7.99 tons of carbon emission equivalent per capita (GOU, 2015).

Uganda's greenhouse gas (GHG) emissions have been steadily increasing, showing a gradual rise from 53,442 gigagrams of carbon dioxide equivalent (Gg CO₂e) in 2005 to 90,230 Gg CO₂e in 2015.

The energy sector holds the position of the third-largest contributor to greenhouse gas (GHG) emissions in Uganda, constituting 10.7% of the country's total emissions. The primary source of emissions lies in the Land Use and Land Use Change and Forestry (LULUCF) sector, accounting for a significant 59.5% (53,670 Gg CO₂e) of the total emissions. It is crucial to note that energy serves as an indirect driver of LULUCF emissions due to Uganda's heavy reliance on biomass energy (charcoal and firewood), a prominent factor contributing to deforestation. As noted by Zutari [37], emissions from fuelwood and charcoal play a major role in CO₂ emissions in Uganda.

Figure A.6: GHG emissions by sector in Uganda



Source: International Energy Agency. Licence: CC BY 4.0

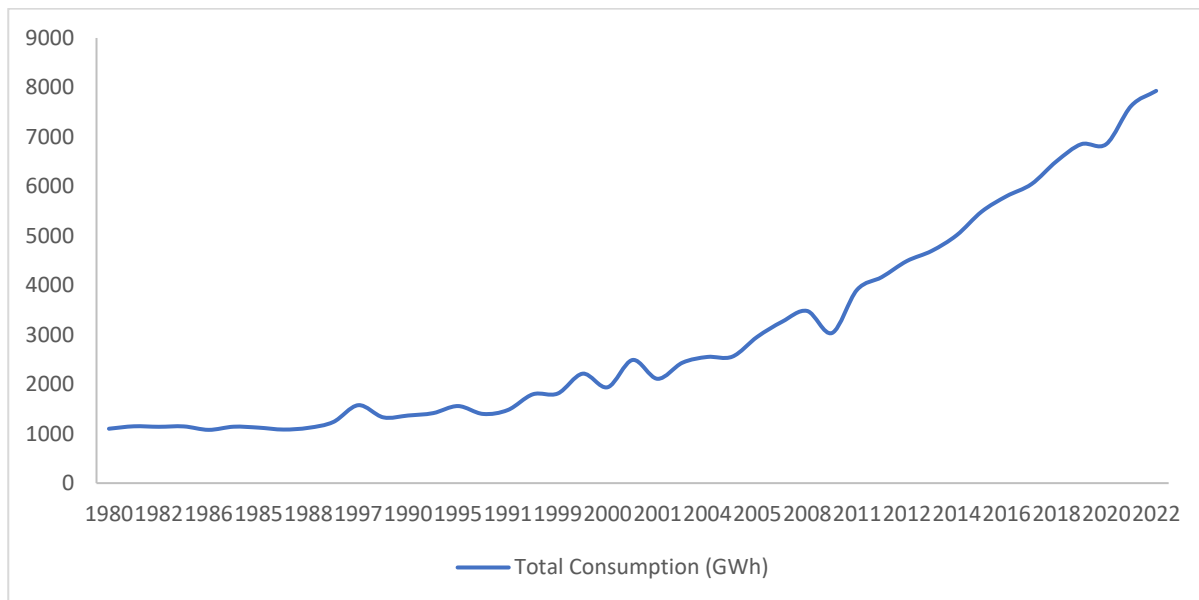
Source :IEA

However, these emissions are categorized under the LULUCF sector as wood removal losses, rather than being accounted for directly under energy emissions. Other substantial sources of GHG emissions include agriculture (26.9%) and waste (2.3%).

A.3: Energy profile of Tanzania

As of June 30, 2020, entities holding licenses for electricity distribution activities served a total of 2,869,151 customers. Among these, 2,864,560 were attributed to TANESCO, and Mwenga Power Services Limited accounted for 4,591 customers. In comparison to the period ending on June 30, 2019, TANESCO experienced a customer increase of 15.31%, while Mwenga saw a growth of 16.05%. This rise in electricity consumers is attributed to the successful implementation of initiatives by the Rural Energy Agency (REA).(EWURA,2020)

Figure A.7: Historical electricity consumption in TANZANIA



Source : AFDB based on TANESCO data

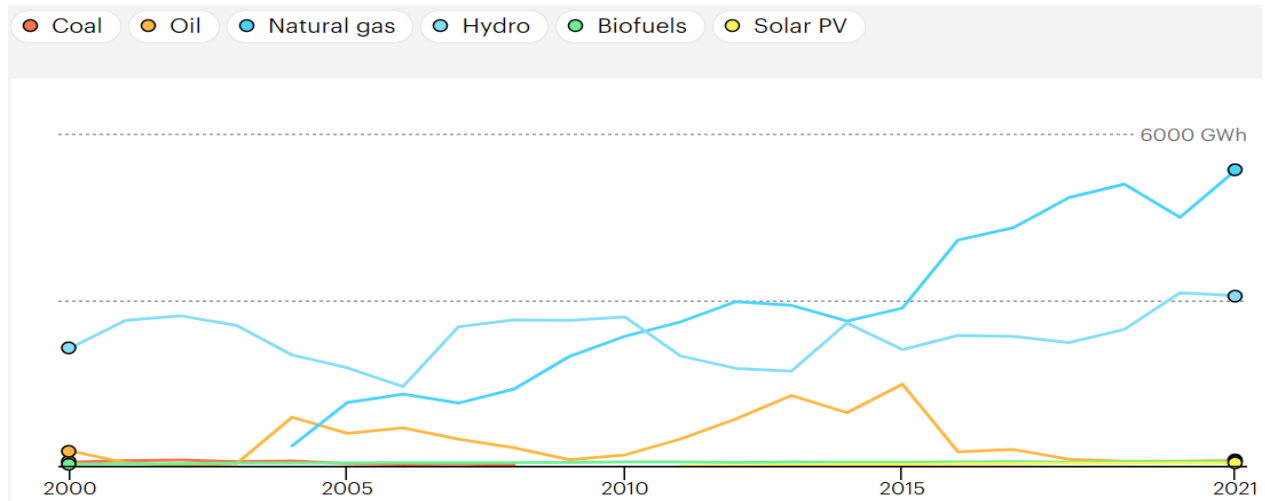
The technological composition of Tanzania's electricity sector primarily includes hydro and thermal power plants, specifically those utilizing gas and heavy fuel oil (HFO) (MOE Tanzania, 2020). Historically, overreliance on a substantial portion of electricity generated from hydropower plants has posed challenges to supply security due to unpredictable weather patterns (Loisulie, 2010). This heavy dependence on hydropower has led to power interruptions and rationing during periods of severe drought, as observed in previous decades (MEM 2013; Loisulie, 2010).

The integration of thermal power plants into electricity generation has successfully addressed security of supply challenges through a transformed generation mix (MEM, 2013) [MEM, Joint Energy Sector Review (JESR) 2012/13—Tanzania, Ministry of Energy and Minerals, Dar es Salaam, Tanzania, 2013.]. However, this transition towards more thermal power plants has led to a significant rise in greenhouse gas emissions and other pollutants from the power sector (IEA, 2014) [IEA, "IEA statistics : CO₂ emissions from fuel combustion highlights," in IEA Statistics, vol. 2014, International Energy Agency (IEA), Paris, France, 2014].

The overall installed capacity in the country amounts to 1,602.32 MW, comprising 1,565.72 MW for the Interconnected Grid System and 36.60 MW for the Isolated Grid System. Within the National Grid System, owned by TANESCO and Independent Power Producers (IPPs), the total capacity is 1,565.72 MW as of the base year 2019. This includes hydro (573.70 MW or 36.64%), natural gas (892.72 MW or 57.02%), liquid fuel

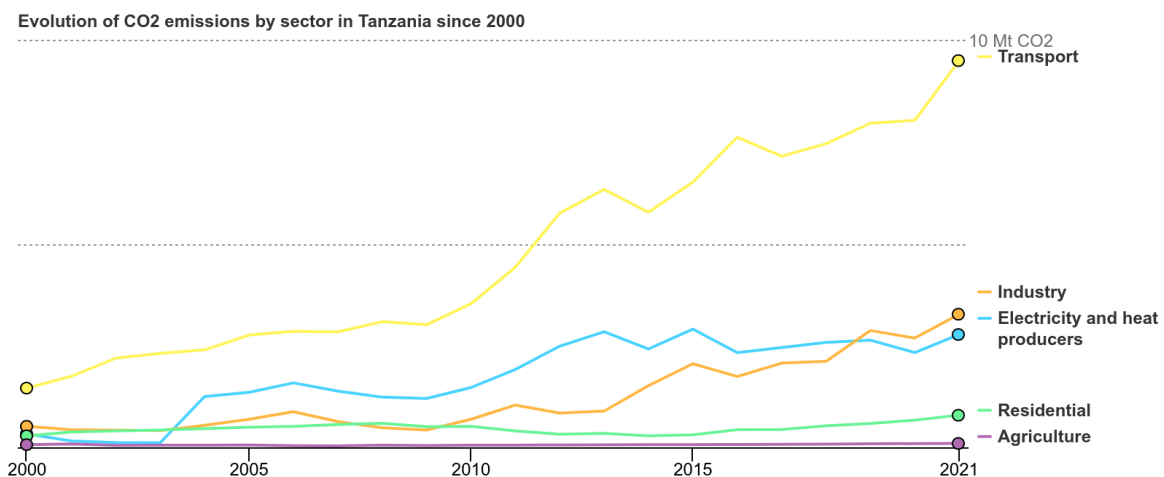
(88.80 MW or 5.67%), and biomass (10.50 MW or 0.67%). The highest recorded Maximum Demand (MD) for the system was 1,120 MW, observed on November 30, 2019(MOE Tanzania,2020).

Figure A.8: Electricity generation by source in Tanzania



Tanzania has negligible emissions levels of GHGs in terms of total and per capita whereby emissions are estimated at 16.468 Mt CO₂. The primary contributor to greenhouse gas (GHG) emissions in Tanzania is the transport. Additionally, other sectors such as Agriculture, Energy, Waste, and Industrial Process and Product Use also play a role in contributing to overall greenhouse gas emissions in Tanzania.

Figure A.9: Emissions by sector in TANZANIA



Source: International Energy Agency. Licence: CC BY 4.0

ANNEXE B

Independent Modeling Results of Power Sector Emissions

B.1 : Kenya

B.1.1: Descriptive statistics

I applied the log transformation to reduce the variability of data and to make it less skewed.

Table B.1: Descriptive Statistics for Kenya

Stats	ITED	GDPpc	GDP	Price	Urb
N	39	39	39	39	39
Mean	8,1936	6,2806	9,6959	1,279	-3,1100
p50	8,1760	6,0434	9,4716	1,550	-3,1151
Sd	0,5155	0,5660	0,8673	1,219	0,0555
Min	7,2935	5,3939	8,6573	-0,927	-3,2058
Max	9,0714	7,4431	11,3826	2,683	-2,9856
Skewness	0,0315	0,6928	0,5679	-0,467	0,6217
Kurtosis	2,0096	2,1249	1,8992	1,808	3,0641

The comparison between median and mean for all the variables indicates that the data is symmetrically distributed. This is because the mean and median are approximately equal. The skewness of total electricity demand as well as price ranges between -0.5 and 0.5, implying that the data is fairly symmetrical, while skewness for GDP, GDP per capita and urbanization ranges between 0.5 and 1 implying that the data are moderately skewed to the right. Kurtosis of all variables, except urbanization, ranges between -3 and 3, implying approximately normal distribution.

B.1.2: Unit Root Test

Before executing the unit root tests, an appropriate lag length was chosen to ensure that the residuals are not serially correlated. The Augmented Dickey Fuller (ADF) test was used to determine whether the series was stable in order to avoid the problem of spurious regression.

Table B.2: ADF unit root test for Kenya

Variable	Lags	Constant but no trend	Constant and trend	Comment
TED	1	0.9416	0.6245	Non Stationary
d.TED	0	0	0	I(1)
Urb	1	0.3563	0.3943	Non Stationary
d.Urb	0	0	0	I(1)
GDPpc	1	0.9753	0.5434	Non Stationary
d.GDPpc	1	0.0004	0.0009	I(1)
PriceAvg	1	0.3978	0.8204	Non Stationary
d.PriceAvg	0	0	0	I(1)

All the variables are integrated of order one, they are stationary after taking the first difference, that is I(1).

B.1.3: Cointegration Test

Since all the variables are I(1), I'm going to run the Johansen cointegration test. The decision rule based on the cointegration test results is to reject the null hypothesis of no cointegration if the computed trace statistic is greater than the critical value. The test result reveals that no cointegration is rejected under none. Thus, the presence of one cointegrating equation among the variables indicates the presence of a long run link between the variables.

Table B.3: Results of Johansen test for cointegration

Maximum rank	Parms	LL	Eigenvalue	Trace statistic	5% critical value
0	36	-189,5431	,	53,2382	47,2100
1	43	-174,0214	0,5778	22,1946*	29,6800
2	48	-168,2113	0,2759	10,5745	15,4100
3	51	-164,6429	0,1798	3,4377	3,7600
4	52	-162,9240	0,0911		

B.1.4: Vector Error correction models.

The results reveal that income elasticity of electricity demand is positive, significant at 1% level of significance and inelastic. In particular, a one percent increase in GDP per capita leads to a 0.74 percent increase in electricity demand. The price of electricity is found to be highly inelastic, significant at 5% level of significance, and positively related to electricity demand. If electricity price increases by one percent, electricity demand would increase by 0.12 percent. Urbanization is elastic, significant at 1% level of significance, and positively related to electricity demand. A one percent increase in the degree of urbanization would lead to a 3.75 percent increase in electricity demand.

B.1.5: Test diagnosis

The model was subjected to autocorrelation test, normality test, and model stability test.

- Auto-correlation test

The null hypothesis states that no autocorrelation is present at lag order. At lag 1 and lag 2,

Table B.4 – Johanson normalization results

Beta	Coef.	Std. Err.	Z	P> z	[95% Conf. Interval]
cel ITED	1	,	,	,	,
GDPpc	-0,7371	0,1296	-5,6900	0,000	-0,9911 -0,4830
Price	-0,1174	0,0525	-2,2300	0,025	-0,2203 -0,0144
Urb	-3,7451	1,0117	-3,7000	0,000	-5,7280 -1,7621
_cons	-15,2972				

The p values are insignificant. Therefore, accept the null hypothesis. Hence it means at lag 12, the VECM model is free of the problem of autocorrelation.

- Normality test

The null hypothesis states that the residuals of variables are normally distributed. Apart from GDPpc, p values of all other variables are significant, indicating the null hypothesis is rejected. Therefore, residuals of these variables are not normally distributed. Therefore, this VECM model carries the problem of normality.

- Stability test

With the eigenvalue stability condition, the VECM model is said to be stable whenever the modulus of each eigenvalue is less than one. So, the results show that our model is stable.

Table B.5: Lagrange multiplier test results

Lag	Chi 2	df	Prob>chi2
1	11,857	16	0,7538
2	8,4434	16	0,9346

Table B.6: Normality test results

Equation	chi2	df	Prob >chi2
D_ITED	123,9	2	0
D_GDPpc	1,458	2	0,4823
D Price	6,624	2	0,03645
D_Urb	510,342	2	0
All	642,324	8	0

Table B.7 – Eigenvalue stability test results

Eigenvalue	Modulus
1	1
1	1
1	1
0,5623	0,5623
0,2043639 + 0,1631722i	0,2615
0,2043639 - 0,1631722i	0,2615
0,2321	0,2321
0,0129	0,0129

B.2: Uganda

B.2.1: Descriptive statistics

I applied the log transformation to reduce the variability of data and to make it less skewed.

Table B.8 – Descriptive Statistics for Uganda

Stats	ITED	GDPpc	GDP	Price	Urb
N	31	31	31	31	31
Mean	7,1608	6,0507	23,2253	5,4546	1,7547
p50	6,9546	5,8487	23,0236	5,7617	1,7457
sd	0,4927	0,6132	0,8747	0,7100	0,0465
Min	6,4118	5,0237	21,7732	3,9921	1,6970
Max	8,0462	6,7996	24,4253	6,3581	1,8916
Skewness	0,5954	-0,0331	0,0414	-0,2866	1,1883
Kurtosis	2,0588	1,4280	1,4859	1,7096	3,9452

The comparison between median and mean for all the variables indicates that the data is symmetrically distributed. This is because the mean and median are approximately equal. The skewness of GDP, GDP per capita as well as price ranges between -0.5 and 0.5, implying that the data is symmetrical, while skewness for total electricity demand and urbanization ranges between 0.5 and 1 implying that the data are moderately skewed to the right. Kurtosis of all variables, except urbanization, ranges between -3 and 3, implying approximately normal distribution.

B.2.2: Unit Root Test

The ADF tests for stationarity show that total electricity demand, GDP pc as well as the price variables are non-stationary at log transformation. They become stationary at first difference. While the urbanization is stationary at first level.

Table B.9 – Stationarity test results

Variable	Lags	Constant but no trend	Constant and trend	Comment
----------	------	-----------------------	--------------------	---------

TED	1	0.9520	0.6334	Non Stationary
d.TED	0	0	0	I(1)
Urb	0	0.0041	0.0411	Stationary I(0)
d.Urb	NA	NA	NA	NA
GDPpc	1	0.5145	0.5400	Non Stationary
d.GDPpc	0	0.0006	0.0038	I(1)
PriceAvg	1	0.6327	0.0239	Non Stationary
d.PriceAvg	0	0.0001	0.0011	I(1)

B.2.3: Cointegration Test

I test for cointegration between the variables using Bounds test and assuming no structural break. According to the table. I cannot reject the null of no cointegration and therefore there is no cointegration. However, this conclusion might be misleading if the long-run reintegrating relationship between the variables has shifted over time due to a structural change. To test for cointegration in the presence of an unknown structural break I use the three tests suggested by (Gregory & Hansen, 1996).

Table B.10 – Gregory and Hansen test results

	Test statistics	Date	Critical value 5%
	Model 1 : Break in the constant		
ADF	-6.61	2014	5.28
Zt	-6.72	2014	5.28
	Model 2 : Break in the constant and trend		
ADF	-6.26	2014	-5.57
Zt	-6.42	2014	-5.57
	Model 2 : Break in the constant and slope		
ADF	-6.92	2010	-6
Zt	-7.04	2010	-6

The ADF and Zt statistics in absolute values are higher than the 5% critical values so I can reject the null hypothesis. therefore, there is cointegration among the variables.

B.2.4: Vector Error correction models

Only price variable is not significant at 5% level. Urbanisation and GDPpc are significant at 5% level. A one percent increase in GDP per capita leads to a 0.88 percent increase in electricity demand. Price of electricity is found to be highly insignificant at 5% level of significance. Urbanization is elastic, significant at 5% level of significance, and positively related to electricity demand. A one percent increase in degree of urbanization would lead to 2.58 percent increase in electricity demand.

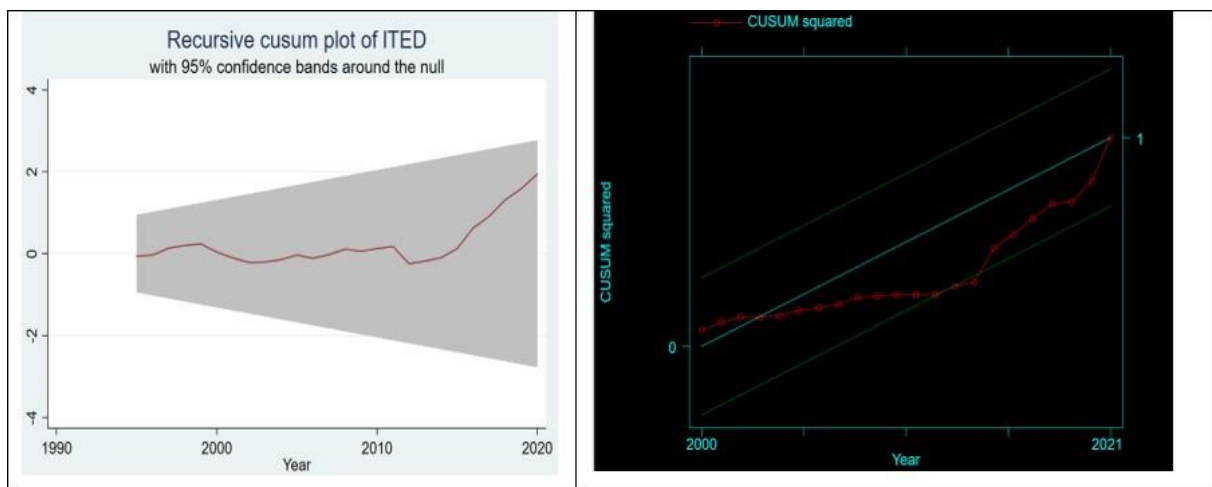
Table B.11 – ARDL results

	Coef	P> t
Urb	2.577897	0.0231
GDP pc	.8816377	0.028
Price	-.0048701	0.976

B.2.5: Test diagnosis

I tested the stability of the model cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMQ) plots are displayed in Figures B.4.

Figure B.2:Plot of recursive CUSUM and CUSUMQ



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