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Transitioning to the use of LPG for Cooking and its Impact on Local and National Level Energy Security: A Case Study of Tanzania

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Global Development Studies

**TRANSITIONING TO THE USE OF LPG
FOR COOKING AND ITS IMPACT ON
LOCAL AND NATIONAL LEVEL
ENERGY SECURITY:**

A CASE STUDY OF TANZANIA

By

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May 2023

Declaration

I, Oluwatosin, Victoria Olowolayemo, author of the thesis titled “Transitioning to the use of LPG for cooking and its impact on local and national level energy security: A case study of Tanzania”.

I hereby declare that this submission is my work toward the Master of Science (MSc.) Degree in Global Development Studies. To the best of my knowledge, except where due acknowledgment has been fully made, it contains no material previously published by another person or material which has been accepted for the award of any degree by any other University.

.....
15th May 2023

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Abstract

The global energy crisis disruption to the balance of demand and supply in the energy market has attracted global attention to energy security, particularly in the global south where access to "clean and affordable energy" is a significant concern, and the region's vulnerability in the energy market.

Considering the energy crisis, vulnerability as a country in the global south, the promotion of the use of LPG for cooking despite the lack of domestic source for it further calls for attention. The government has highlighted the health risks associated with emissions from inefficient combustion, and environmental concerns, and has developed policies to guide this transition. This raises important questions about whether global institutions and the Tanzanian government are adequately considering the trade-offs between promoting clean cooking, ensuring energy security, and national security in their policies and strategies.

This qualitative study assesses energy policies and their contribution towards achieving energy security, and whether national security and economic issues are considered in their formulation. Three main findings in this study are; First, there was no mention of energy security in the National Energy Policy, the major document guiding the energy sector in Tanzania. Secondly, the transition to the use of LPG places a high financial cost on Tanzania, thereby making the economy vulnerable to energy market fluctuations which could have an overall impact on the national economy. Lastly, the understanding of energy security among stakeholders is shaped by sectoral interest, and this was displayed in the policy document relevant to each institution.

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List of Abbreviations and Acronyms

EU	European Union
ETI	Energy Transition Index
EWURA	Energy and Water Utilities Regulatory Authority
IEA	International Energy Agency
FYDP	Five Year Development Plan
ITA	International Trade Agency
LPG	Liquefied Petroleum Gas
ME	Ministry of Energy
NEP	National Energy Policy
OECD	Organization for Economic Cooperation and Development
OPEC	Organization of the Petroleum Exporting Countries
REA	Rural Energy Agency
REF	Renewable Energy Fund
SSA	Sub Saharan Africa
TFS	Tanzania Forest Services
TFCG	Tanzania Forest Conservation Group
TANESCO	Tanzania Electric Supply Company
TPDC	Tanzania Petroleum Development Corporation
UK	United Kingdom
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
VAT	Value-Added Tax
WTO	World Trade Organization

1.0 Introduction

The global energy scene is currently characterized by an energy crisis, initially influenced by the pandemic, and further heightened by the Russian invasion of Ukraine in February 2022, resulting in an imbalance between energy demand and supply (IEA, 2023). This crisis has affected various sectors, including residential energy consumption and cooking energy dynamics, and had a distinct impact on the residential sector, particularly in the global south, where access to "clean and affordable energy" is a significant concern (WHO, 2022). As energy prices increased due to the imbalance between demand and supply, concerns about energy security in the global south have been raised by International Energy Agency (2022), particularly because of the vulnerability of these regions in the energy markets. For example, in some countries like Nigeria, the price of LPG increased by more than 60% over the year to April 2022 (African Energy Outlook, 2022)

Given that the residential sector is the largest consumer of biomass energy used for cooking (HBS, 2019), the imbalance of demand and supply of "clean energy" could impact households' accessibility to affordable and reliable energy resources, which could further impact economic stability, social development, and overall energy security in these regions.

Furthermore, as emphasized by IEA, ensuring a proper energy transition management, diversification of energy sources, and investment in sustainable and resilient energy infrastructure is essential because a hasty or unplanned shift from traditional biomass fuels to alternative sources without ensuring their affordability, accessibility, and reliability can create energy insecurity, especially for vulnerable populations of the Global South (IEA, 2022).

The urgency to transition towards renewable energy sources stems from concerns about excessive anthropogenic global warming, which refers to a significant increase in the average tropospheric temperature exceeding 2°C. The accelerating pace of planetary warming has intensified the need for action to mitigate climate change impacts (UN, 2021). According to the analysis conducted by the Intergovernmental Panel on Climate Change (IPCC) in 2022, if the world continues at the current rate, it will exceed the global carbon budget intended to limit the temperature from increasing beyond 1.5°C by 2050.

However, despite contributing only 4% of the world's carbon dioxide emissions in 2019, the Global South is disproportionately affected by the consequences of climate change (IEA, 2021b; Statista, 2021). This disparity highlights the vulnerability of these regions to the adverse impacts of not just energy security but also global warming, including extreme weather events, sea-level rise, and disruptions to ecosystems and agricultural systems.

With the state of vulnerability of these regions to climate change risk and energy crisis, energy security has emerged as a paramount concern in this region, prompting numerous studies to explore the multifaceted nature of energy security and recognizing that energy is a fundamental driver of socioeconomic development essential for the functioning and survival of societies (Dannreuther, 2017). The International Energy Agency (IEA) defines *energy security* as the consistent availability of energy sources at affordable prices (IEA, 2019). However, the concept of energy security has evolved to encompass a broader spectrum of factors beyond supply security, encapsulated by the "four As" of energy security: availability, affordability, accessibility, and acceptability (Sovacool, 2011).

Professor David Victor aptly states that it is like a Rorschach inkblot test, open to interpretation (Sovacool, 2011). However, Khatod et al. (2022) suggest that energy security at the national level depends on the availability of energy at all times. They further recommend that developing countries achieve energy security through diversification of energy sources, the development of energy-efficient technologies, and investment in renewable energy.

These definitions point out that achieving energy security is critical for a functioning society and national development. Therefore, policymakers need to prioritize their energy policies tailored to their specific circumstances. The transition from fossil fuels to cleaner energy sources, such as natural gas or LPG, could also potentially jeopardize the energy security of certain countries, particularly those without the domestic resources leading to a situation of energy dependence on other nations or necessitating engaging in mutual beneficial business arrangements. Consequently, conducting energy security analyses becomes a powerful tool for policymakers to develop policies that prompt necessary actions within their respective communities (Gill-Wiehl et al., 2022; Azzuni et al., 2020).

With this in mind, the careful management of energy transitions becomes paramount. While there is a growing global push towards renewable energy sources, policymakers must consider the unique circumstances and challenges their own countries face. The shift from biomass fuels should be undertaken strategically, recognizing the potential risks and impacts on energy security and national security. This necessitates thoroughly analyzing available resources, domestic capabilities, and potential partnerships to ensure a smooth and sustainable energy transition.

Recognizing the environmental impact of biomass as the primary cooking energy source in many countries, the international community and individual nations have taken steps to achieve energy security while prioritizing environmental sustainability. In this pursuit, the

SE4ALL objectives were established as a global initiative to positively transform energy systems worldwide (Hallding et al., 2009; Bradshaw, 2014; UN, 2022)

Aligned with these objectives, Sustainable Development Goal (SDG) 7 emphasizes the importance of access to affordable, reliable, sustainable, and modern energy, specifically highlighting the significance of clean cooking in achieving this goal. SDG 7.1.2 specifically addresses the need to increase the use of clean cooking fuels to combat Household Air Pollution (HAP), which is responsible for millions of deaths annually. Organizations such as the Energy Sector Management Assistance Program (ESMAP) emphasize the essential role of clean cooking fuel in promoting good health. At the same time, the World Health Organization (WHO) urges low- and middle-income nations to adopt and sustain the use of clean fuels like liquefied petroleum gas (LPG) to improve health outcomes and protect the environment (ESMAP, 2020; WHO, 2021). By acknowledging the significance of clean cooking and its impact on health and the environment, global initiatives and organizations strive to address the energy needs of these communities while ensuring a sustainable future, and the transition to cleaner cooking fuels, such as LPG, presents an opportunity to improve lives, reduce air pollution, and promote environmental stewardship. As nations embrace these objectives and work towards achieving SDG 7, they contribute to the global efforts to realize energy security and sustainable development, striking a balance between the availability of energy resources, affordability, and the preservation of our environment.

The transition towards cleaner cooking solutions, such as liquefied petroleum gas (LPG), is recognized for its significant health, developmental, and environmental benefits (WHO, 2022), and Tanzania, like many countries in the Global South, is exploring the adoption of LPG to address indoor air pollution and improve energy access and as seen in previous studies (Conibear et al., 2022; Pye et al., 2020; Williams et al., 2020; Gould et al., 2018), the focus has been given to the social, health, and environmental aspects of this transition while there has been limited attention to what the potential implications for national security and the economy would be. This raises questions about whether these crucial factors have been adequately considered in Tanzanian energy policies and strategies and if there is a proper energy transition management as emphasized by IEA (IEA, 2022) considering the country's reliance on biomass as a primary cooking energy source and absence of a domestic source for LPG. This further introduces a potential vulnerability to supply disruptions, which could have significant economic and social impacts.

1.1 Problem Statement

Initiatives to instigate an energy transition towards more use of fuels and stoves categorized as "clean" emphasize the negative health impact of emissions from inefficient combustion and insufficient transportation of smoke away from the cook and people near where the cooking takes place. While many countries in the Global South depend heavily on domestic sources of biomass energy, interventions aimed at increasing the use of clean cooking solutions open for the use of fuels such as LPG. These are commonly globally traded commodities and will need to be imported into many countries in the Global South, such as Tanzania. This raises important questions about whether the global institutions and the government of Tanzania, when promoting clean cooking, are adequately considering the trade-offs between promoting clean cooking, ensuring the country's energy security with policies and strategies, and national security.

1.2 Objective of Study

The objective of this study is to

- Assess current strategies and policies contribution towards achieving energy security in Tanzania, and whether there are national and economic consideration in the formulation process.
- Understand the perspectives of different actors, including policymakers, policy implementers, and industry representatives, regarding energy security and the impact of these perspectives on energy security, national security, and the economy.
- Discuss the importance of integrating national security and economic considerations alongside environmental and health concerns in the development of future energy policies and strategies.

1.3 Research Questions

RQ 1: How is energy security understood and reflected among central actors in Tanzania's energy sector?

RQ 2: How are energy security strategies reflected in policy and regulations governing the energy sector in Tanzania?

RQ 3: What perspectives exist among public and private sector actors in Tanzania's energy sector on the implications on national energy security from increasing reliance on LPG?

To address the research questions, a qualitative research method will be employed, using semi-structured interview with key stakeholders, including government officials and representatives from relevant institutions. These interviews will provide insights into the understanding and reflection of energy security among actors in Tanzania's energy sector. Furthermore, a thorough analysis of policy documents, reports, and roadmaps pertaining to energy security will be conducted. This document analysis will contribute to having a understanding of the energy security dynamics within Tanzania's energy sector. By combining in-depth interviews and document analysis, this research approach aims to comprehensively explore the research questions and shed light on the complexities of energy security in Tanzania.

1.4 Structure of the thesis

This thesis is structured into 7 chapters. The first chapter gives a brief introduction, defines the problem, and states the research questions that form the basis of this study. The second chapter gives a background description of energy use in the global south and in Tanzania while highlighting energy policies and institutions responsible for biomass and LPG development. In Chapter 3, the key concepts in energy security and the global index for assessing energy security are described. Chapters 4 and 5 present the methods and findings of the study respectively whereas Chapter 6 discusses the results. In the last chapter, conclusions are drawn from the results.

2.0 Background

2.1 Energy use in the Global South

Biomass, which involves burning solid fuels like wood, agricultural waste, or charcoal, served as the world's primary energy source until the mid-19th century. It was then replaced by coal, followed by the emergence of oil and gas and the rise of hydropower at the start of the 20th century. Energy generation, primarily through the burning of fossil fuels, accounts for about 75 percent of global greenhouse gas emissions. Furthermore, burning fossil fuels and biomass contributes to complications in human health, resulting in at least five million deaths annually through air pollution (UN, 2022). As a result, transitioning towards an energy balance dominated by nuclear and renewable technologies to combat climate change has become essential (Ritchie et al., 2022).

Transitioning from fossil fuels to renewable energy sources has become the most important topic in the energy sector. This transition was launched during the 2015 Paris Agreement, and many nations, including the European Union, set out their vision for a climate-neutral EU in November 2018 through the European Green Deal, looking at all the key sectors and exploring pathways for the transition (EU Commission, 2023).

However, developing countries have been slow to transition due to differences in wealth, income levels, resource energy mixes, political structures, and human capital accumulation. To aid development and set a path towards transitioning to cleaner energy sources, the SE4ALL objectives were conceived as a global objective applying to both developed and developing countries. Despite this, energy access remains a pressing concern in many low- and middle-income countries, while high-income countries have largely achieved universal energy access (World Bank, 2021).

In sub-Saharan Africa, traditional biomass still accounts for almost half of the primary energy mix, despite the region's access to clean cooking and electricity being limited to only 48% of the population (IEA, 2022; IRENA, 2022b). Fossil fuels, particularly coal, and oil (mostly in South Africa), make up a significant portion of the remaining energy sources, with natural gas increasing proportion. Renewable energy sources, excluding traditional biomass, account for almost one-fifth of the primary energy mix in the region. Solar, wind and geothermal energy make up about 1%, while hydropower comprises 1.7% of the primary energy sources (IEA, 2021b). For many people in sub-Saharan Africa, access to affordable electricity is a

major obstacle, particularly given the impact of the COVID-19 pandemic on household finances and the current energy crisis, which has increased costs.

2.2 United Republic of Tanzania

Tanzania, the largest country in East Africa, covers an area of about 940,000 square kilometers, of which 880,000 square kilometers are land. It is situated south of the equator and shares borders with eight neighboring countries, including Kenya, Uganda, Rwanda, Burundi, Zambia, Malawi, and Mozambique. The country boasts numerous lakes and rivers, with large inland water bodies. Lake Tanganyika, which is the longest and second-deepest freshwater lake in the world, extends along the western border of Tanzania. Lake Victoria, the second-largest lake in the world, empties into the Nile River. Tanzania's biggest river, the Rufiji, drains into the Indian Ocean south of Dar es Salaam (CIA, Factbook).

As of 2021, Tanzania has an estimated population of 63.59 million people, with approximately 37% considered urban residents, according to the World Bank. The country has achieved relatively strong economic growth and declining poverty rates, with an estimated GDP of \$67.8 billion and a population growth rate of 2.8%. The most recent estimate of Tanzania's GDP per capita was \$1,136 in 2021, which is 8% below the global average (IBRD, 2021; World Bank, 2021).

Tanzania plans to have developed into a lower middle-income, newly industrializing nation by 2025, with a thriving, internationally competitive economy, and a high standard of living in a safe and secure environment. Tanzania National Development Goal 2025, the nation's long-term development strategy, incorporates this vision and lists improved access to modern energy as one of the necessary elements for socioeconomic change. Tanzania now scores close to or behind other Sub-Saharan African developing nations and low- and middle-income countries on several important energy measures (World Bank, 2021). Tanzania has lower per capita power usage and a higher percentage of the population having access to electricity than the other three regional/economic categories, with 78% of the total population having access (NBS, 2020)

2.3 The energy sector in Tanzania

Tanzania has a diverse range of energy sources, including hydropower, natural gas, coal, biomass, uranium, solar, and wind. However, just natural gas and hydropower have been

commercially explored, while the rest remain largely unexplored. As of 2021, Tanzania has an installed electricity capacity of 1,605.86 MW, with total annual power production at the same level. However, it is projected that the country's peak electricity demand will almost quadruple to 4,000 MW by 2025 (ITA,2022).

2.3.1 Biomass

Biomass, primarily firewood and charcoal, is the main energy source for cooking in Tanzania. According to the household budget survey, the main source of energy for cooking in Tanzania Mainland is firewood (60.9%) followed by charcoal (28.8%)(HBS,2019.) Biomass accounts for about 85% of Tanzania's national energy consumption, with the residential sector being the largest consumer, particularly for household cooking (NBS 2020). Although Tanzania has an abundance of modern energy resources, such as natural gas and hydropower, much of the population relies on traditional biomass for their energy needs. A significant portion of the biomass is obtained through conventional and often unsustainable methods, such as logging in forests, due to tax regulation and lack of awareness (FAO,2019). The informal sector of this industry, particularly the supply and preparation of charcoal, also employs about a million people, making it a significant employer in the country.

2.3.2 Natural gas

Tanzania's natural gas reserves are estimated to be 45 billion m³, which is estimated to meet the current domestic demand and position the country as a major natural gas center in Africa (ITA, 2021). The reserves are in Songo in the Lindi region, Mnazi Bay in the Mtwara region, and Mkuranga in the Coast region. Songo Songo and Mnazi Bay are estimated to have reserves of 30 and 15 billion m³, respectively (ITA, 2021). A 232 km gas pipeline between Songo Songo Island and Dar es Salaam has been constructed, making it possible to provide natural gas for electricity production and other industrial thermal operations. Nine thermal power plants in Tanzania use natural gas to generate electricity, including Ubungo I and II, Tegeta, Songas, Mtwara, Somanga, Kinyerezi I and II, and Dangote (ITA,2021).

2.3.3 Hydropower

In 2018, analysis of electricity generated from national grid showed that 2,234.43 GWh was generated through hydropower (NBS, 2018). Rivers are the primary water source for

hydropower in Tanzania, and several significant hydroelectric projects are planned, including Ruhudji (360 MW), Rumakali (22 MW), and Stiegler's Gorge (2,100 MW) being under construction, and will create a surplus electricity. Despite the potential for small hydropower (less than 10 MW) estimated at 315 MW, only 8 MW have been utilized by TANESCO and private developers to date. The Rumakali (222 MW) and Rhuhudji (358 MW) projects in the Njombe region could potentially increase Tanzania's hydropower capacity from 562 MW to 1,142 MW. The Julius Nyerere Hydroelectric dam, which will provide a peak of 2,115 MW to Tanzania's national power grid, is currently under construction and is 63% complete as of June 2022(ITA, 2022).

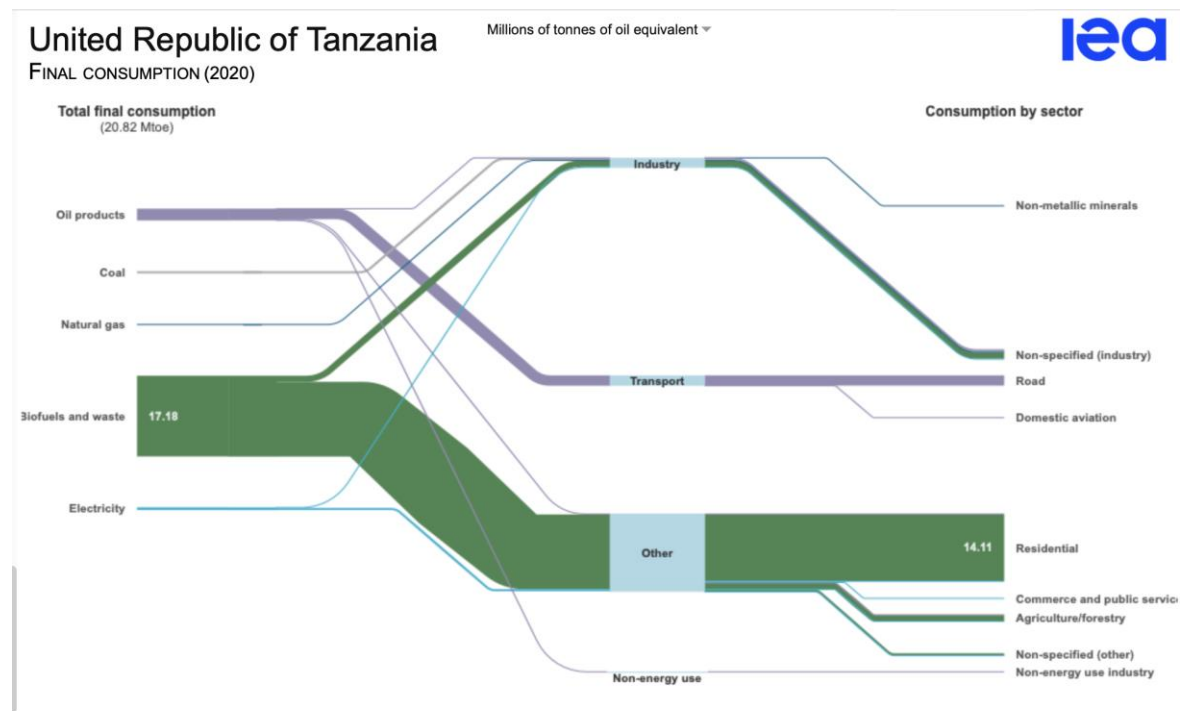
2.3.4 Solar

Tanzania is blessed with abundant solar energy, receiving 2,800–3,500 hours of sunshine annually and 4–7 kWh per m² per day of worldwide horizontal radiation. The central region of the country is especially rich in solar resources, which are being explored for both off-grid and grid-connected solutions (AFDB, 2020). Nonetheless, investments in solar energy are still relatively small in Tanzania. The country's President, Samia Suluhu Hassan, announced the goal of producing 6,000 MW of renewable energy by 2025 (The Citizen, 2022).

2.3.5 Liquified Petroleum Gas (LPG)

In Tanzania, the market for LPG market is currently dominated by five major suppliers: BP Gas, Oryx Gas, Taifa Gas, and Pan African, which is currently testing natural gas bottling and distribution. The LPG industry is expanding in urban areas, such as Dar es Salaam City, where many middle-class families reside and LPG shops are abundant, with some located less than a kilometer from one another. However, despite the expansion of the LPG industry, charcoal and firewood continue to be the primary cooking fuels in almost 90% of all households in Tanzania (NBS, 2020) which is largely contributed to the price hikes of LPG. According to recent statistics from EWURA, there have been significant price hikes in the LPG market, which has led to an increase in the cost of cooking for many households (EWURA, 2023). The price of LPG has risen in recent months, with a 3.1% increase in May 2023 compared to the price in April 2023 (EWURA, 2023).

Figure 1: Sankey Diagram



Source: IEA

2.4 Energy related policies in Tanzania

To promote sustainable energy development and reduce reliance on traditional biomass fuels, the Government of Tanzania (GoT) has implemented various energy policies and strategies. These aim to increase access to modern energy services while minimizing emissions. The energy sector in Tanzania is governed by a policy framework that includes various policies, strategies, and laws aimed at promoting sustainable energy development, improving energy access, and ensuring efficient and reliable energy supply. The policies are developed by the government through the Ministry of Energy and Minerals and are implemented by various stakeholders in the energy sector. The key policies and strategies in place include the National Energy Policy (2015), which provides a roadmap for sustainable energy development and outlines the government's objectives and strategies for energy sector development. Other strategies and plans include Development Vision 2025, EWURA Act 2013, the National Natural Gas Policy of Tanzania (2013), the Energy Subsidy Policy (2013), the Natural Gas Utilization Master Plan (2016). These policies and strategies represent a

concerted effort by the GoT to promote sustainable energy development, increase access to modern energy services, and reduce the reliance on traditional biomass fuels.

One of the proposed solutions is the increased use of Liquefied Petroleum Gas (LPG) for cooking. LPG is considered the cleanest and most effective gasoline on the market compared to traditional fuels like wood, coal, coconut husk, maize husk, and charcoal. It is also portable, convenient, and provides significant health, safety, and environmental benefits (Bruce et al., 2017).

The energy sector in Tanzania is governed by the National Energy Policy, which was first introduced in 2003 and replaced with a revised version in 2015. The policy aims to promote effective energy production, procurement, transmission, and distribution in an environmentally responsible manner (EWURA, 2022). It also emphasizes the need to increase access to modern energy services and reduce reliance on traditional biomass fuels. The policy includes specific objectives and policy statements to facilitate the transition from wood fuel to modern energy and encourage the adoption of suitable cooking appliances to promote alternatives to wood fuel. The specific objective and the policy statements that go along with it include (i) enhancing the switch from wood fuel to modern energy and (ii) facilitating the adoption of suitable cooking appliances to encourage alternatives to wood fuel. Through the National Energy Policy (URT, 2015a), LPG was exempt from import taxes and VAT between 2008 and 2009. (URT-MEM, 2015). Taxes, royalties, tariffs, and levies apply to all other types of cooking fuel. The least expensive fuel is Charcoal, with LPG coming in second (Doggart et al., 2020). Stoves and other LPG-compatible equipment still need to be exempt from paying VAT.

The Energy and Water Utilities Regulatory Authority (EWURA) Act 2013 includes provisions for regulating the clean cooking sector in Tanzania. Under the EWURA Act, the Authority is responsible for regulating the production, distribution, and use of energy, including clean cooking technologies. The act also gives EWURA the authority to develop and enforce standards for the quality of clean cooking technologies and fuels. In addition to regulating the sector, EWURA has taken various initiatives to promote clean cooking in Tanzania. For instance, the Authority has established the Clean Cooking Program, which aims to promote the adoption of clean cooking technologies and fuels in Tanzania.

The Power System Master Plan 2016 (PSMP), which was updated to PSMP 2020, was initiated to give everyone in Tanzania access to power to promote socioeconomic growth. The Plan tackles sustainability and the environmental impact of power generation in addition to its goal of ensuring energy security and affordability. The Plan's stated overall goal is to re-

access the short-term (2020-2024), medium-term (2025-2034), and long-term (2035-2044) transmission plans and power generation to enable access to modern energy. This Plan also contributes to enhancing energy security in the country (PSMP, 2020)

To summarize, while there are existing energy policies in Tanzania that aim to promote sustainable energy development and increase access to modern energy services, there has been minimal focus on clean cooking specifically. However, the government has recently taken steps to address this issue by authorizing the formation of a National Taskforce to develop a comprehensive clean cooking roadmap and setting a target of 70% of Tanzanians using clean cooking methods by 2032. Additionally, a Clean Cook Fund will be established to support initiatives and innovations for the transition to clean cooking. The new climate package introduced also includes a strategy to ensure that institutions serving more than 300 people adopt clean cooking fuels and technologies, with the aim of widening access and use of clean energy by 80-90% in 2035. The national task force will likely suggest implementing this throughout the budget planning period. There was also the introduction of a new sweeping climate package that aims to widen access and use of clean energy by 80-90% in 2035. The new codified Plan included a strategy to ensure institutions providing services to more than 300 people adopt clean cooking fuels and technologies (IEEFA, 2020).

2.5 Government institutions for governance of the energy sector in Tanzania

As in many countries, the GoT is the major actor in the energy sector and is at the forefront of strategies and policies to promote energy development in Tanzania. However, the government formulates strategies and policies through several institutions within the country. This includes the Ministry of Energy and Minerals (MEM), which oversees the overall energy sector in Tanzania, The Energy and Water Utilities Regulatory Authority (EWURA) responsible for regulating the energy and water sectors, The Rural Energy Agency (REA), The Tanzania Electric Supply Company Limited (TANESCO, The Tanzania Petroleum Development Corporation (TPDC) etc. Additionally, there are various private sector companies that play a critical role in the energy sector, including those involved in the production, distribution and sale of LPG, solar energy, and other renewable energy technologies.

2.5.1 The Ministry of Energy

The Ministry of Energy is responsible for formulating and implementing energy policies, strategies, and programs in Tanzania, including the NEP.

The Ministry of Energy in Tanzania plays a crucial role in ensuring energy security in the country. Some of the key roles and responsibilities of the Ministry of Energy include the following:

Formulating energy policies, strategies, and plans: The Ministry of Energy is responsible for formulating policies and strategies that promote the efficient and sustainable use of energy resources in Tanzania. This includes the development of the National Energy Policy and other energy-related policies.

Regulation and oversight: The Ministry of Energy is responsible for regulating the energy sector in Tanzania to ensure that energy resources are used efficiently and sustainably. This includes overseeing the operations of energy companies, promoting competition in the sector, and ensuring compliance with energy regulations.

Promotion of renewable energy: The Ministry of Energy is responsible for promoting the use of renewable energy sources such as solar, wind, and hydroelectric power. This includes developing programs to encourage investment in renewable energy and providing incentives for using renewable energy technologies.

Energy infrastructure development: The Ministry of Energy is responsible for developing and maintaining energy infrastructure such as power plants, transmission and distribution networks, and storage facilities. This includes promoting investment in energy infrastructure projects and ensuring the reliable supply of energy resources.

Overall, the Ministry of Energy plays a critical role in promoting energy security in Tanzania by ensuring the efficient and sustainable use of energy resources, using renewable energy, regulating the energy sector, and developing energy infrastructure (Nishati, 2023).

2.5.2 Rural Energy Agency (REA)

Rural Energy Agency (REA), an independent agency under the Ministry of Energy, began operations in 2007. The main mandate of REA is to promote and facilitate access to modern energy services in rural areas of Tanzania in line with Sustainable Development Goal number 7 and the Government SE4All action Agenda funded through the REA fund. The agency also encourages efficient energy production and facilitates the identification and development of improved energy projects and activities in rural areas to support economic and social development. Some of the key roles and responsibilities of REA include:

Rural electrification: REA is responsible for promoting and facilitating the electrification of rural areas in Tanzania. This includes developing and implementing electrification programs, promoting renewable energy sources, and providing technical assistance to rural communities.

Energy planning and coordination: REA works in collaboration with other government institutions, development partners, and stakeholders to develop energy plans and coordinate energy-related activities in rural areas.

Investment promotion: REA promotes private sector investment in rural electrification projects by providing technical assistance, facilitating access to financing, and promoting public-private partnerships.

Capacity building and awareness-raising: REA provides training and capacity-building programs to rural communities, energy service providers, and other stakeholders to promote the efficient and sustainable use of energy resources.

Overall, the Rural Energy Agency is critical in promoting energy security in rural areas of Tanzania by facilitating access to modern energy services, using renewable energy sources, and promoting private sector investment in rural electrification projects(REA, 2023).

2.5.3 The Energy and Water Utilities Regulatory Authority (EWURA)

The Energy and Water Utilities Regulatory Authority (EWURA) is an independent government institution established under the Energy and Water Utilities Regulatory Authority Act No. 11 of 2001 in Tanzania. The main mandate of EWURA is to regulate Tanzania's energy and water sectors to ensure the provision of reliable, affordable, and high-quality services to consumers.

Regarding energy security, EWURA plays a crucial role in ensuring that the energy sector in Tanzania is well-regulated and operates fairly and transparently. Some of the key roles and responsibilities of EWURA in the energy sector include the following:

Licensing and regulation: EWURA is responsible for licensing and regulating the generation, transmission, distribution, and sale of electricity and petroleum products in Tanzania.

Tariff setting: EWURA sets tariffs for energy and water services to ensure they are affordable and cost-reflective.

Consumer protection: EWURA protects the interests of energy consumers by enforcing standards for quality of service, safety, and reliability.

Monitoring and evaluation: EWURA monitors and evaluates the performance of energy and water service providers to ensure that they comply with regulations and provide high-quality services to consumers.

Overall, EWURA is critical in promoting energy security in Tanzania by ensuring that the energy sector is well-regulated, efficient, and transparent and that consumers have access to reliable, affordable, and high-quality energy services (EWURA, 2022).

2.5.4 Petroleum Bulk Procurement Agency (PBPA)

The Executive Agencies Act authorized the creation of the PBPA, a government organization with the responsibility of overseeing the importation of petroleum products into the nation. The primary goal of the agency is to efficiently acquire petroleum products using a bulk procurement system (BPS).

The PBPA's vision is to be a successful and leading institution in the regional and national supply of dependable, high-quality petroleum products. The agency's goal is to assure supply stability and security, deliver high-quality petroleum products at competitive prices, support long-term socioeconomic and national development, and administer the bulk procurement system.

Preparing plans and budgets to cover its operations, concluding and managing contracts with suppliers, forecasting and determining demand and supply of petroleum products, gathering procurement requirements from oil marketing companies (OMCs), conducting international competitive bidding for the purchase of bulk petroleum products, reporting to the Ministry on an as-needed or monthly basis, and more are some of the key roles and functions of PBPA.

Additionally, the PBPA oversees the prompt receipt of petroleum products by OMCs from delivery vessels, keeps track of shipments and performance, oversees invoicing and payment collection for individual shares of petroleum products imported by an OMC, appoints an inspector to ensure the delivery of acceptable quality and quantity of petroleum products, issues directives, and performs any other task that aims to increase the efficiency of the procurement of petroleum products (PBPA, 2020).

2.5.5 Tanzania Petroleum Development Corporation

Tanzania Petroleum Development Corporation (TPDC) is the state-owned entity through which the MoE carries out its petroleum exploration and development plans. The responsibility of the institution includes employing subsidiary firms to carry out specific

operations in the petroleum value chain; managing the government's participating business interests in the petroleum industry; managing the sale of the nation's portion of in-kind petroleum received; searching for and recommending fresh upstream, midstream, and downstream business opportunities both locally and globally; participation in oil service and supply chain franchises and other licenses(TPDC, 2022).

2.5.6 The Ministry of Natural Resources and Tourism

The Ministry of Natural Resources and Tourism in Tanzania is responsible for overseeing various aspects related to the country's natural resources and tourism sector. In terms of managing forests and charcoal, the ministry plays a significant role in ensuring sustainable practices and addressing related challenges. The ministry's roles and responsibilities in this includes;

(i) Forest Management: The ministry is responsible for formulating and implementing policies, laws, and regulations related to forest management. This includes the conservation, protection, and sustainable use of forests within Tanzania. They work towards promoting responsible forest practices and mitigating deforestation and forest degradation.

(ii) Charcoal Regulation: The ministry also plays a crucial role in regulating the production, trade, and use of charcoal in Tanzania. It develops policies that guide charcoal production, and the monitoring and controlling the charcoal value chain, from production to distribution and consumption.

(iii) Conservation and Biodiversity: Another responsibility of the ministry is the conservation of Tanzania's rich biodiversity found within forests. This involves implementing strategies for protected area management, wildlife conservation, and addressing issues such as illegal logging and wildlife trafficking. They collaborate with various stakeholders to promote sustainable forest management practices that preserve biodiversity.

(iv) Community Engagement: The ministry recognizes the importance of involving local communities in forest and charcoal management. It facilitates community-based forest management initiatives, empowering local communities to participate in decision-making processes and benefit from sustainable forest resources.

(v) International Cooperation: The ministry actively engages in international cooperation and partnerships related to forest management and conservation. It participates in global initiatives, conventions, and agreements to address issues of deforestation, climate change,

and sustainable development. This includes collaborating with international organizations, donor agencies, and neighboring countries to share experiences, knowledge, and resources. Overall, the Ministry of Natural Resources and Tourism in Tanzania plays a crucial role in managing forests and addressing the challenges associated with charcoal production. They are responsible for formulating policies, regulating practices, promoting sustainable forest management, and conservation (MNRT,2023).

One of the institutions that assist in carrying out the mandate of the MNRT is Tanzania Forest Services (TFS) and Tanzania Forest Conservation Group.

2.5.7 Tanzania Forest Service

The Tanzania Forest Services Agency (TFS) is a semi-autonomous government Executive Agency established under the Executive Agency Act, the Forest Act. Its purpose is to develop and manage forest resources sustainably in collaboration with stakeholders to meet socio-economic and environmental needs. The specific roles and responsibilities of TFS includes (i) Establishment and management of national natural forest and bee reserves. (ii) Establishment and management of national forest plantations and apiaries. (iii) Management of forest and bee resources in general land. (iv) Enforcement of forest legislation and extension services within TFS jurisdiction. (vi) Monitoring and evaluation of TFS activities. (vii) Collection of forestry revenue (TFS,2023).

2.5.8 Ministry of Finance

The Ministry of Finance of Tanzania plays a vital role in the energy sector by managing public finances, allocating resources, formulating fiscal policies, and facilitating investments. Its contributions are instrumental in providing the financial framework necessary for the sustainable development of the energy sector and supporting initiatives that promote renewable energy, energy efficiency, and overall energy security. By coordinating financial matters and promoting prudent fiscal management, the ministry helps create an enabling environment for the energy sector's growth and contributes to Tanzania's socio-economic development goals.

The Ministry of Finance has the following key responsibilities: (i) Budget Allocation to various government agencies and sectors, including the energy sector. It assesses the funding needs of energy projects, sets budgetary priorities, and ensures the availability of financial resources for energy infrastructure development, research initiatives, and capacity building

programs. (ii) The ministry formulates policies like FYDP that have an impact on the energy sector. (iii) The ministry also participates in the planning and evaluation of public investment projects, including those in the energy sector. It assesses project proposals, evaluates their financial viability, and ensures that investment decisions align with national development priorities. This involvement helps to ensure efficient use of financial resources and promote sustainable energy projects. (iv) The ministry is also responsible for managing public debt and ensuring its sustainability. This involves assessing the financial implications of energy sector loans, negotiating favorable terms, and monitoring debt repayment to prevent any adverse impact on the economy or the energy sector's development. (v.) The ministry coordinates with other government agencies, including the Ministry of Energy, to ensure that energy sector policies align with broader economic goals. It promotes coordination among different stakeholders to achieve a balanced and sustainable approach to energy development in line with national development plans.

2.6 Private and Non-governmental Institutions

Tanzania's vibrant private sector is actively engaged in developing renewable energy and is supported by the government, establishing and maintaining an enabling business climate. Independent Power Producers (IPPs) and Small Power Producers (SPPs) have become important parts of the renewable energy supply. This includes private investors who own power plants of more than 10MW and operators of small renewable-based projects who sell power directly to consumers. Such as Songas, IPTL, Aggreko, Symbion etc.

Various non-governmental organizations also promote access to equitable and reliable energy in Tanzania. For example, the Tanzania Forest Conservation Group (TFCG).

2.6.1 The Tanzania Forest Conservation Group (TFCG)

The Tanzania Forest Conservation Group (TFCG) is a non-governmental organization dedicated to protecting Tanzania's high biodiversity forests for the benefit of the nation, the world, and future generations. TFCG operates based on the understanding that well-managed forests are essential for both people and biodiversity.

Some of the roles of TFCG includes;

Forest Conservation and community empowerment: TFCG actively works towards the conservation and protection of Tanzania's forests. This involves advocating for sustainable forest management practices, promoting forest conservation policies, and raising awareness

about the importance of forests for biodiversity and ecosystem services and empowering communities by providing them with knowledge about their rights and responsibilities related to forest resources. TFCG supports communities in taking action to participate in decision-making processes and implement sustainable forest management practices.

Capacity Building: TFCG focuses on building the capacity of local communities, civil society organizations, and other stakeholders involved in forest conservation. This includes providing training, workshops, and educational materials to enhance their understanding of forest conservation principles, sustainable livelihoods, and natural resource management.

Research and Monitoring: TFCG conducts research and monitoring activities to gather data on forest biodiversity, ecosystem health, and threats to forests. This information helps in understanding the status of forests, identifying priority areas for conservation, and formulating evidence-based strategies for forest management and conservation.

Collaboration and Partnerships: TFCG actively collaborates with other organizations, both within Tanzania and internationally, to maximize the impact of its work. It forms partnerships with government agencies, local communities, research institutions, and other conservation organizations to promote collective action for forest conservation and management.

Through its work, TFCG strives to create a balance between conservation goals and the socio-economic needs of local communities. By empowering communities, conducting research, advocating for policies, and collaborating with stakeholders, TFCG works towards ensuring the long-term protection and sustainable management of Tanzania's forests.

3.0 Conceptual Framework

There has been a growing recognition of the importance of sustainable energy pathways globally, including in Tanzania (Bishoge et al. 2018). Many countries are working to transition to renewable and cleaner energy sources in order to reduce greenhouse gas emissions and combat climate change, while also increasing energy access and security. In recent years, there has been a growing recognition of the importance of prioritizing renewable and cleaner energy sources in developing sustainable energy pathways. This shift towards clean energy was initially driven by concerns over the health impact (ESMAP, 2020; , WHO, 2021) of using biomass for cooking and has been further accompanied by concerns over climate change (IEA 2022).

While all of this maybe valid and essential, Energy security is a crucial aspect that has been largely absent from the energy development agendas of many countries in the Global South, where policies often focus on addressing the health impacts of traditional energy sources and mitigating climate change and deforestation. However, ensuring energy security is crucial for achieving sustainable energy pathways that prioritize renewable and cleaner energy sources while advancing economic development. While renewable energy sources offer many benefits in terms of environmental sustainability, health, and development, they may present challenges in terms of energy dependence, supply, and affordability. Therefore, it is essential to bring national energy security to the forefront of energy policies and strategies, rather than only focusing on marginalized groups such as rural communities, women, and the poor. Understanding the dimensions of energy security and developing indicators to measure its state is crucial for achieving sustainable energy development in the Global South.

This framework begins by defining key terms and concepts related to energy security, such as energy independence, supply, affordability and diversification. It then explores how they are interrelated. The chapter also seeks to explore the concept of energy security, understand its significance to economic growth and development and understand indicators that can be used for determining the state of energy security and what contributes to it.

3.1 Conceptualizing Energy Security

The concept of energy security has evolved over time. Initially, the term "energy security" was used in the mid-20th century to refer to concerns about the reliability of oil supplies and the potential for supply disruptions during times of conflict. The OPEC oil embargo of 1973

underscored the vulnerability of oil-importing countries and sparked efforts to address energy security concerns. In the 1970s and 1980s, energy security focused mainly on ensuring a stable and reliable supply of oil and gas, the dominant energy sources at the time. This involved securing access to reserves and diversifying sources of supply.

However, the emergence of new energy sources, such as nuclear power and renewables, and changes in the global energy landscape led to a broader understanding of energy security. In the 1990s and early 2000s, energy security became more closely linked to environmental sustainability issues as concerns about climate change grew. This led to a greater emphasis on developing renewable energy sources and energy efficiency measures to reduce dependence on fossil fuels and mitigate environmental impacts.

In recent years, energy security has become more complex and multifaceted, reflecting the increasingly interconnected and interdependent global energy system. It now encompasses issues related to energy affordability, environmental sustainability, and energy access, in addition to the availability and reliability of energy supplies. Factors such as access to energy resources, infrastructure development, technological innovation, and policy frameworks have all influenced the concept of energy security.

According to Benjamin K. Sovacool, energy security is a multifaceted concept that involves ensuring the availability, affordability, reliability, and sustainability of energy sources, as well as protecting against physical, economic, and geopolitical threats to energy systems. Achieving energy security requires a comprehensive approach that incorporates various strategies, such as diversification of energy sources, investment in renewable energy technologies, and adopting energy efficiency measures. Sovacool emphasizes that energy security is not just about having access to energy resources but also about ensuring that energy systems are resilient, adaptable, and sustainable over the long term. He defines energy security as "the condition in which a nation, organization, or individual can continue to depend on a sufficient, affordable, and reliable energy supply while minimizing vulnerability to unexpected or harmful disruptions."(Sovacool 2011)

However, according to Aleh Cherp and Jessica Jewell, the traditional definition of energy security as the availability, accessibility, affordability, and acceptability of energy resources is constrained and insufficient. In their book "Concept of Energy Security: Beyond the Four As," they propose that energy security should be viewed as a multifaceted notion with political, economic, social, and environmental components. They emphasize the need to take into account the various and frequently conflicting interests and values that influence debates about energy security, including the interests of energy producers, consumers, and

environmentalists, as these could impact energy production and consumption as well as the political and institutional contexts in which energy decisions are made (Cherp 2011).

In order to emphasize that energy security is not solely a national issue but also encompasses geopolitical and global dimensions, particularly in the context of climate change, J. Witte and Goldthau (2010) argued in their book, "The Role of Rules and Institutions in Global Energy," that energy security has become a critical issue in international relations, characterized by concerns over resource availability, geopolitical tensions, and the environmental impact of energy consumption. The authors assert that consumer worries about the security of the energy supply are pressuring policymakers to take action, driving the geopolitics of energy. They highlight the significance of various actors, such as governments, businesses, and civil society, in improving energy security and halting climate change, and they maintain that these objectives are achievable through international cooperation.

Beirut et al. (2018) also stress the importance of understanding stakeholder perspectives in ensuring the successful adoption of clean technologies. They argue that incorporating stakeholder perspectives can help identify potential barriers and opportunities, enhance the effectiveness and sustainability of policies, and ensure the successful adoption of new technologies. In particular, the authors examine the geopolitical and geoeconomic implications of energy security in Africa, where access to energy resources has historically been a source of instability and conflict. They contend that addressing these issues requires a more nuanced understanding of the complex and dynamic interactions between politics, society, and energy, as well as an emphasis on inclusive and sustainable growth that benefits all parties.

Jonathan D. Solomon and Christopher A. Hartwell (2014) also advocated for the consideration of geopolitical factors in energy security. They argued that energy security is not solely an economic or environmental issue, but also a geopolitical issue with wide-ranging implications for international relations, security, and power dynamics. The authors highlighted that energy security concerns are often interconnected with national security, energy independence, and strategic interests and can have significant implications for global stability. Therefore, cooperation and collaboration among these actors are essential to addressing energy security challenges and mitigating geopolitical risks, especially given the evolving nature of energy security. Moreover, energy security policies and strategies must be adaptable and flexible, taking into account the potential impacts of these factors on energy systems and international relations. Klare (2017) further emphasized that energy security concerns can have significant implications for national security, including vulnerabilities in

energy supply chains, geopolitical tensions and conflicts, and potential disruptions to critical infrastructure and national economies. Therefore, promoting energy diversity and resilience is crucial to mitigating energy security risks and strengthening national security, while also harnessing the potential of technological innovation to enable sustainable and secure energy systems.

In their 2014 study, Tania Urmee, Kashem M. Muttaqi, and Phil A. L. Khan provided insights into the complex relationship between climate change and energy security. The authors highlighted that although the use of fossil fuels has been recognized as one of the key drivers of energy security and a major contributor to greenhouse gas emissions, which in turn contributes to climate change, transitioning to renewable energy sources can be challenging. The authors emphasized that renewable energy sources are often intermittent, and thus require energy storage technologies. Additionally, the authors noted that transitioning to renewable energy sources can have social and economic implications, particularly for vulnerable communities that may be disproportionately affected. Therefore, it is crucial to consider the potential impacts of energy transitions on different sectors of society, particularly those who are more vulnerable, to ensure a just transition towards sustainable energy pathways.

3.2 Key concepts in Energy security

While energy security has increasingly become an important aspect of every country, there are key strategies to it, and it is important to discuss them. Energy independence, energy supply, energy efficiency and energy diversification are key to the national economy and national energy security.

Energy independence is a key aspect of energy security as it allows a country to reduce its reliance on foreign energy sources and increase its self-sufficiency in energy supply. President Richard Nixon described it as a scenario in which domestic production of energy is sufficient to "meet our own energy needs without depending on any foreign sources" in his November 1973 announcement of the plan (Adele C. et al. 2012).

The concept of energy independence is often associated with energy self-sufficiency, where a country generates all of its energy needs from domestic sources. However, achieving complete energy independence may only sometimes be feasible, particularly for energy-importing nations that lack the necessary natural resources to meet their energy demands. The policy of International Energy Agency (IEA) requiring countries of the OECD to have 90

days worth of petroleum products in stock at any time is an example of a measure aimed at enhancing energy independence (IEA, 2021). By maintaining a strategic petroleum reserve, member countries can ensure that they have access to essential energy resources in the event of a disruption in supply, such as an oil embargo or geopolitical conflict. Achieving energy independence is often considered a desirable goal for countries, as it can provide greater energy security, reduce the risk of supply disruptions, and potentially reduce the influence of external actors on a country's energy policy.

Energy supply is another critical aspect of energy security. A country must have access to reliable and affordable energy supplies to meet its energy needs. However, energy supply can be affected by various factors such as geopolitical tensions, natural disasters, and supply disruptions, which can threaten a country's energy security. For example, the 2011 Fukushima nuclear disaster in Japan resulted in the shutdown of many of its nuclear power plants, leading to a significant reduction in its energy supply. To mitigate this, Japan increased its imports of liquefied natural gas (LNG) to meet its energy needs, diversifying its energy supply and enhancing its energy security. This highlights the importance of energy diversification to enhance energy security.

Energy diversification is increasing the share of different energy sources in a country's energy mix to reduce reliance on any particular energy source or supplier. Energy diversification can enhance energy security by reducing a country's vulnerability to supply disruptions or price volatility of a particular energy source. For example, the European Union (EU) has significantly diversified its energy sources to enhance its energy security. The EU has reduced its reliance on Russian gas imports by increasing its LNG imports and increasing the share of renewable energy sources such as wind and solar power in its energy mix. This has helped the EU reduce its dependence on any particular energy source or supplier and enhance its energy security.

For example, China has invested heavily in its domestic renewable energy sector to enhance its energy security and reduce its dependence on imported oil and gas. This has helped China to reduce its carbon emissions and improve its air quality, thereby enhancing the country's economic growth and social welfare.

Energy efficiency refers to the practice of using less energy to perform the same task or function. It involves designing, constructing, and operating energy-using devices and systems that are optimized for minimum energy consumption while still meeting the required level of performance. The International Energy Agency (IEA) defines energy efficiency as "the ratio of useful energy output to the energy input required to produce it." (IEA,2017). According to

the International Energy Agency (IEA), energy efficiency is "the first fuel" and has the potential to contribute significantly to global energy security by reducing the need for new energy infrastructure and promoting energy independence (IEA,2020). According to the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE), energy efficiency can help to reduce the vulnerability of the energy system to disruptions, such as natural disasters and cyberattacks, and can help to ensure a reliable and resilient energy supply (U.S. Department of Energy 2022).

Energy efficiency is a crucial strategy for reducing greenhouse gas emissions, improving energy security, and lowering energy costs. It also has many other benefits, such as improving indoor air quality, reducing noise pollution, and increasing comfort and productivity.

In conclusion, energy security is critical to national security and economic development. Achieving energy security requires a combination of energy independence, energy supply, and energy diversification. By reducing reliance on any particular energy source or supplier, countries can enhance their energy security and reduce their vulnerability to supply disruptions and price volatility. This, in turn, can help to promote economic growth and national security.

3.3 Measuring Energy Security

Measuring energy security is a complex task that requires considering various aspects of energy supply, demand, independence, diversification, and infrastructure. There is no single way to measure energy security, and different countries may prioritize different factors depending on their unique circumstances. However, several frameworks have been proposed to help policymakers comprehensively assess energy security.

The Energy Trilemma Index (ETI) is a widely used framework for measuring energy security. It was developed by the World Energy Council (WEC) to capture the three dimensions of energy security: energy security, energy access, and environmental sustainability. The framework assesses each dimension based on a set of quantitative and qualitative indicators and then combines them into an overall score for each country. The energy security dimension in the ETI assesses the reliability and affordability of energy supplies, the diversity of energy sources and routes, and the extent of energy infrastructure. The energy equity dimension measures the accessibility and affordability of energy services to households and businesses, as well as the availability of modern energy sources such as

electricity and clean cooking fuels. The development of energy supplies from renewable and other low-carbon sources, as well as the attainment of supply and demand side energy efficiencies, are all included in the environmental sustainability dimension (WEC, 2015).

Another indicator is energy diversification, which measures the degree to which a country relies on a single energy source or a small number of sources. A more diversified energy mix can provide greater energy security by reducing the impact of supply disruptions or price fluctuations in any one energy source (Ferreira & Marques, 2015).

The Global Energy Security Index (GESI), developed by the EIU in collaboration with the Switzerland-based energy company ABB identifies that energy security can be assessed based on four dimensions: energy supply, energy diversity, environmental sustainability, and geopolitical risks. Energy supply is the country's ability to ensure reliable access to energy supplies. This dimension considers factors such as a country's dependence on imported energy, the stability of its infrastructure, and its ability to respond to disruptions in energy supply. Energy diversity is the country's ability to diversify its energy mix and reduce its dependence on any one source of energy. This dimension considers factors such as a country's reliance on fossil fuels versus renewable energy sources and its level of investment in energy efficiency and conservation measures. Environmental sustainability is the country's ability to balance energy security needs with environmental concerns. This dimension considers factors such as a country's level of greenhouse gas emissions, its investment in renewable energy sources, and its commitment to reducing its carbon footprint. And, finally, the geopolitical risks dimension of the GESI is the country's exposure to potential geopolitical risks that could affect its energy security. This dimension considers factors such as a country's level of dependence on energy imports from politically unstable regions and its level of exposure to potential energy supply disruptions due to conflicts or other political events.

The Energy Access Situation survey report developed by the Tanzanian government and the World Bank to measure the progress of energy access in Tanzania, has based it on four dimensions: affordability, reliability, quality, and safety. The affordability dimension identifies the energy cost and its availability to households, businesses, and industries. The reliability dimension measures the consistency of the energy supply and the frequency of power outages. The quality dimension assesses the efficiency and effectiveness of energy supply systems, including transmission and distribution. Finally, the safety dimension assesses the risks associated with energy use, including health risks and accidents. In light of this, the report tracked the progress in achieving universal energy access in Tanzania and to

identify areas where investments and interventions are needed. The index has been used in various energy access projects and initiatives in Tanzania, including the Rural Electrification Expansion Programme (REEP).

In light of the previous, measuring energy security is a complex task, and there is no one-size-fits-all approach. Therefore, according to Kruyt et al., (2009) several frameworks and indexes exist to help in the task, but their application should be tailored to the specific context in which they are being used. Adopting a set of indicators must involve a clear conceptualization of energy security, outlining vital energy systems, identifying possible vulnerabilities, and reviewing and selecting indicators that best reflect the unique energy context being analyzed. By adopting a structured approach to measuring energy security, policymakers can make informed decisions to improve energy access, affordability, reliability, and sustainability, thus ensuring energy security for their countries and region.

4.0 Research Design and Methodology

This chapter seeks to provide an exposition of the research methodology relevant to meeting the prime objective of the study, which is to explore how energy security is expressed in the policy and among actors in the energy sector. Specifically, the chapter discusses the data collection methods, sampling techniques, study design, and research ethics. The selected policies used in this research were based on several considerations and objectives. Firstly, they were designed to address specific challenges and opportunities in the energy sector of Tanzania. These challenges include addressing energy access, promoting renewable energy sources, improving energy efficiency, and attracting private sector investments. The policies have been developed through a collaborative and participatory approach, involving input from government agencies, industry experts, civil society organizations, and other relevant stakeholders considering global energy trends, technological advancements, and international agreements such as the Sustainable Development Goals or the Paris Agreement on climate change.

4.1 Research design

Research design guides the gathering and analysis of data by combining scientific strategy and methods with creative thinking (Gray et al., 2007). Therefore, a research design is a framework for generating data selected to address the research question(s) in which the investigator is interested (Bryman, 2016). This study's research design is qualitative, with policy documents and semi-structured interviews being used as primary documents. This approach allowed a deeper understanding and varied perspective of the LPG transition situation in Tanzania. Qualitative research was adopted for the study purpose because the perspective of actors in the energy sector is relevant to examine their understanding of energy security and how this might have had possible influence on energy policies or strategies. According to Sutton and Austin (2015), qualitative methodology is relevant to the study of human behaviors in a geographical space or social setting. As also indicated by Bryman (2016), qualitative research allows proximity and maximizes the subjects' involvement, which helps to understand the situation/research from their eyes genuinely.

The Methodology of this article discusses how the perception and understanding of energy security influence actors' formulation and implementation of policies and strategies that involve energy transitioning to LPG.

4.2 Sampling Technique

The data for this thesis was collected through qualitative research. To comprehend people's social realities, qualitative research emphasizes how people interpret and make meaning of their experiences (Mohajan, 2018). Purposive sampling was used to select relevant government ministries and agencies representatives, individuals, and civil organizations in the energy sector specifically tasked with overseeing the transition to natural gas (LPG) and using LPG for cooking and managing the national forest reserve. Purposive sampling is a non-probability form where the participants are selected according to their relevance in answering the research questions (Bryman, 2016) and according to Patton (1990), purposive sampling allows me to choose the population's most informative.

Through purposive sampling, individuals selected for the interview were government officials from EWURA, REA, Oryx, and non-governmental organizations like. An individual who was also one of the major stakeholders in the drafting of the National Energy Policy was also interviewed. However, it is important to note that the information gotten from them doesn't necessarily represent the institution they work. These are largely personal opinions.

Due to limitations in access, time, and resources, the sample size for informants was ultimately determined by these practical constraints, despite the desire to continue until reaching saturation point as outlined in Kvale & Brinkmann (2009). But as mentioned by (Johannesen et al., 2010) It is not uncommon for smaller research projects to have a sample size of around 10-15 informants

4.3 Data Collection

The research approach used a combination of unstructured and semi-structured interviews. Unstructured interviews were conducted at the early stages to obtain feedback on relevant aspects of the research topic, while semi-structured interviews were conducted later, using an interview guide focused on the research questions. A flexible approach was utilized throughout the interviews to gain further insights into the interviewees' perspectives. The use of an interview guide, as defined by Patton (2002), helped to ensure that the same basic topics were covered with each interviewee.

Ethical research practices require obtaining informed consent from interviewees, allowing them to understand what they are consenting to and make an informed decision about their participation (Bryman, 2016). To achieve this, an information letter was sent to the interviewees before the interview, providing an introduction to the research objectives and a paragraph to obtain informed consent. While Eisner (2017) argues that obtaining fully informed consent may not be possible in semi-structured interviews, as the interviewer cannot predict the direction the interview may take, researchers should still make a genuine effort to obtain informed consent as it is crucial to ethical research practices.

My sources of written information also include both primary and secondary sources, official documents from official government webpages, and official documents shared by individuals. The documents analyzed in the study capture both the energy and environmental policies and the professional and bureaucratic perspectives. Additionally, through the interviews, various stakeholders were allowed to express their views and opinions. As a result, this work offers valuable insights into the policies and highlights the interests of the actors involved. While it is important to note that these documents may not reveal the more nuanced conflicts and could potentially obscure some of the underlying power struggles that took place during the policy formulation process, the interview with some of the centrally involved actors has shaped my understanding of the category of stakeholders that were most actively involved in the process of policy-making.

The semi-structured interviews were designed to cover the same main questions to facilitate comparisons across different interviewees. However, it was also important for me to create an informal and relaxed atmosphere encouraging interviewees to speak freely about the topic. This approach effectively built trust and openness between me and the interviewees and allowed me to delve into more contentious issues more comfortably. Additionally, the semi-structured format ensured that the core topics were addressed and that each interview touched upon a set of common questions that enabled me to compare responses across interviews.

During the early stage of the research, I utilized recordings and transcriptions to document the interviews. However, as the research progressed and time constraints became more pressing, I shifted to taking notes and recording important quotes from the conversation instead. This decision was based on prioritizing efficiency and time management, as the interviews occurred late in the research process. While relying solely on notes may have compromised the reliability of the data and introduced the potential for omission or distortion, I took care to ensure that my notes accurately captured the relevant points. Ultimately, this approach was effective for my research.

To collect primary data for this research, a semi-structured interview schedule was used with open-ended questions that allowed for additional inquiries and clear expression of the topic of focus. Policy documents related to energy development, such as the National Energy Policy 2003, Biomass Energy Strategy (BEST) 2014, Power System Master Plan 2016, Rural Energy Master Plan (REMP), and other relevant strategy documents, were also analyzed to answer the research questions. The effectiveness of these strategies and their impacts on the energy sector were also evaluated. In addition, to understand the rationales behind the policies and strategies, interviews were conducted to encourage conversations and allow participants to give their perspectives and inputs into the transitioning drive.

After the review process, I conducted a systematic content analysis of the qualitative data by operationalizing the elements in the conceptual framework, which involved identifying and categorizing recurring themes and patterns in the data, like energy efficiency, accessibility, and affordability. To ensure consistency and accuracy, I used a coding scheme based on the research questions and aims. The coding scheme allowed me to identify and categorize the data under the themes, which were then analyzed to develop a comprehensive understanding of the research topic.

Overall, content analysis proved to be an effective method for analyzing the qualitative data, as it allowed me to systematically identify and categorize the data and ultimately extract meaningful findings that aligned with the research questions and aims.

According to Holsti, content analysis involves identifying specific message characteristics to make objective and systematic inferences (Holsti, 1969). To begin the analysis, a coding scheme was developed, as recommended by Patton (2002). The recorded interviews were listened to again, and emerging topics and themes were identified as categories for coding. Before conducting the formal coding, each transcript was reviewed several times to ensure that all important pieces of data were noticed. The codebook categories were developed from the interview questions, transcripts, and a few additional categories for data that needed to fit into established categories. The categories were strengthened by evaluating their consistency and fit within the larger picture. It was also important to ensure that the categories were clear and sufficient to cover all the data. This process of coding and categorizing the data was instrumental in uncovering insights and patterns in the data, aligning with the research questions and aims (Patton, 2002).

For the policy analysis, I specifically searched for mentions of the term "energy security" and examined how it was defined and used in context. Additionally, I looked at three main themes: energy independence, energy supply, efficiency, and sustainable development.

4.4 Limitations and Ethical considerations

In this study, there were both strengths and limitations. As a novice researcher, it was a significant undertaking, but it was approached to create a valuable learning experience for both the researcher and participants.

One limitation was the language barrier, as some relevant policies and strategies were in Swahili, requiring translation tools and assistance to understand the documents. This informed the need to use translation tools to understand the documents. Additionally, the lack of in-person engagement due to the challenge of getting the interview participants at the same time and the early stage of the research also contributed to limited opportunity to establish relationships with key informants and organizations, which could have yielded more valuable insights and information.

Another limitation experienced during this research is the inability to get key informants, especially in the Ministry of Finance. The nature of the research requires some financial documents to be analyzed to get figures on actual government costs in terms of the balance of payments, subsidies, and revenues regarding energy sectors, as the case may be. This was either due to privacy and code of conduct or restricted access to these documents.

This study had ethical considerations that were duly observed. As a social science researcher, it is crucial to respect people's rights, privacy, and welfare (Angelsen, 2011; Berg & Lune, 2017). The four primary areas of ethics were taken into account during the study, which included avoiding harm to participants, ensuring informed consent, protecting privacy, and avoiding dishonesty (Bryman, 2016). Throughout the research, steps were taken to protect participants from physical or psychological harm, including maintaining their anonymity and confidentiality of personal information.

As a researcher, I strictly adhered to the ethical guidelines set by the Norwegian Centre for Research Data (NSD), a mandate for all research affiliated with NMBU. Before data collection, I shared a detailed study outline with the NSD for approval. In line with the NSD guidelines, I ensured all participants were fully informed about the study's nature and purpose. I emphasized to the participants that their involvement was voluntary and that they could withdraw from the study at any point. I also assured the participants that their personal

information would remain confidential to protect their anonymity. It was essential for me to conduct the study ethically, not only to adhere to the institutional mandates but also to ensure that the participant's rights and welfare were protected.

4.4 Trustworthiness; credibility, transferability, dependability, and confirmability

Credibility is a crucial aspect of any research, as it determines the validity of the researcher's interpretation of the data collected from the participants. Triangulation is a method that can ensure credibility in research (Bryman, 2016; Nowell et al., 2017), which was utilized in this study by incorporating data from two sources, interviews, and policy papers. However, a limitation of this study that could affect credibility is the subjective perspective of participants depending on the ministry and organization, which could have influenced the discussions and subsequent reviews of the policies and strategies guiding the energy sector.

Transferability, the ability to replicate a study, is another important aspect of research (Bryman, 2016; Nowell et al., 2017). This study may not be replicated in another country due to the variability of factors considered in drafting the policies and the energy situation within the country. However, certain recommendations may be applied to other African countries with similar energy and economic situation.

Adopting an 'auditing' approach, Dependability entails maintaining concise records of the research process throughout its stages (Bryman, 2016). To ensure Dependability, the researcher in this study-maintained records of each step, including a reflexive journal, the initial research proposal, workshop development, all data collected, and transcripts thereof, which can be accessed by other researchers if desired.

Confirmability is a crucial aspect of research, and it is achieved when credibility, transferability, and Dependability are attained (Nowell et al., 2017). It involves the researcher's objectivity and ability to recognize and minimize their biases (Bryman, 2016; Fusch et al., 2017). As a researcher, I am aware of my positionality, as described in the loci of enunciation preceding the introduction, and the potential for bias that comes with it. Therefore, I consciously tried to remain impartial throughout the research process and analysis. To achieve confirmability, it is essential to ground research on a constructivist ontological position and recognizes that reality is socially constructed (Bryman, 2016). In discussions with participants, I made it clear that there were no right or wrong answers and that their opinions were valued, regardless of whether they aligned with mine. These ethical

considerations are essential in any study. Although complete confirmation is impossible, my efforts to minimize bias contributed to the confirmability of this research.

5.0 Analysis

This chapter presents the study's findings on policy and stakeholders' focus on energy security. It includes an analysis of policy documents and interviews conducted with various stakeholders. The analysis sheds light on the current understanding of energy security in Tanzania, policy formulation, and implementation.

5.1 Analysis of policy documents

This study evaluated policies and master plan from the Ministry of Energy and other energy-related institutions. Given the limited literature available on policy assessment regarding transitioning to LPG for household use in Tanzania, a content analysis approach was utilized to determine how closely the Tanzanian government's national energy policy and strategy adhere to energy security's three main pillars of affordability, accessibility, and efficiency. The study also assessed whether the policies emphasized implementation strategies.

5.1.1 The National Energy Policy 2015 (NEP, 2015)

The NEP 2015 is the major document that guides the energy sector in Tanzania and is, therefore, relevant to this research. Along with encouraging energy efficiency and conservation, the policy considers the worldwide initiative to provide sustainable energy for everyone. Tanzania's 2015 National Energy Policy was designed to guide sustainable development and utilization of energy resources to ensure optimal benefits to Tanzanians and contribute towards the transformation of the national economy. The policy promotes the utilization of renewable energy sources, including hydro, natural gas, and coal, towards increasing the country's energy generation capacity and improving the efficiency of the energy sector.

Tanzania's 2015 National Energy Policy recognized that energy is a prerequisite for the proper functioning of nearly all economy subsectors; it therefore aimed to address the country's energy needs comprehensively and strategically at the household and national levels. In the NEP, significant energy challenges, including a shortage of reliable and affordable energy sources, inadequate energy infrastructure, and high dependence on fossil fuels within the country, were identified, and several initiatives were aimed at addressing these challenges, which included;

-Transitioning from biomass and exploring the possibilities of other forms of energy such as compressed natural gas, liquefied petroleum gas (LPG), and renewable energy sources and facilitating the adoption of appropriate cooking appliances to promote alternatives to wood fuel. In essence, aiming to diversify the country's energy mix to reduce reliance on a single energy source.

- Expansion of Energy Infrastructure: The Policy recognizes the need for significant investment in energy infrastructure to improve access to energy and increase the country's energy generation capacity, which includes the expansion of transmission and distribution networks and the development of new energy projects.

- Promotion of Energy Efficiency: The Policy emphasizes promoting energy efficiency measures to reduce energy demand and improve the overall sustainability of the energy sector. This included adopting energy-efficient technologies and practices in industries, buildings, and transportation.

However, while the policy identifies all of this, there was no discussion on a clear implementation plan for the strategies stated. For example, while the Policy promotes the use of renewable energy, it does not specify what percentage of the country's energy mix should come from renewable sources by a certain date.

The policy also promotes the use of renewable energy and identifies various renewable energy sources that could be explored through public-private partnerships in the energy sector by attracting foreign investment. However, there was more focus on the electricity and petroleum sector.

There was a minimal emphasis on energy efficiency concerning cooking, a critical component of energy security. Although energy efficiency was identified as an issue that needed to be addressed in the residential sector, however, the focus was on cooling, heating, and lighting directly related to the building orientation, design, and materials; appliances; the occupants' needs and behaviors; and the surrounding micro-climate. The energy efficiency measures were not addressed towards cooking fuel choice, the cooking technologies, or even the cooking environment in terms of ventilation.

Also, while there was a mention of the "utilization of energy resources to ensure optimal benefits to Tanzanians and contribute towards the transformation of the national economy" (NEP, 2015), Data from the World Bank has revealed that there has been more focus on implementing the policy strategies in the urban areas, with a 72% and 22% of the rural population having access to electricity (World Bank Data, 2020).

Regarding the security of supply, the Tanzania National Energy Policy (NEP) stated specific objectives to improve the security of supply and cross-border trading. However, it is the NEP primarily focused on ensuring the security of supply within the national borders, i.e., sectors within the country. One notable gap in the policy is the lack of consideration for the country's reliance on other nations for its fuel supply. This oversight raises concerns about the resilience and sustainability of Tanzania's energy sector, particularly in the event of disruptions or fluctuations in fuel availability or pricing from international markets.

Despite addressing certain concepts related to energy security, the NEP in Tanzania notably lacked an explicit mention of energy security in the policy framework. Furthermore, the policy did not encompass a comprehensive strategy aimed at achieving energy security at both the national and household levels. Furthermore, the financial status of citizens (affordability) and the impact of transitioning were not mentioned. Additionally, the highly scattered landscape, particularly in rural areas, was not considered, despite its potential contribution to ensuring energy security. These critical factors were omitted in the NEP.

5.1.2 The Five Year Development Plans (FYDPs)

The Five Year Development Plans (FYDPs) I, II, and III play a crucial role in Tanzania's planning process, aiming to achieve sustainable development across various sectors, including energy. FYDP III represents the final implementation phase of the 15-year Long Term Perspective Plan, which aligns with the National Development Vision 2025 to transform Tanzania into a middle-income economy driven by industrialization and human development.

The FYDPs outline several interventions, which include: (i) strengthening availability, reliability, and increasing generation capacity, transmission, and distribution of networks, (ii) Promoting renewable energy technologies, and (iii) strengthening sustainable use and management of oil and natural gas. (iv) Construct and strengthen natural gas supply infrastructures for domestic, industrial, and transport use. The FYDP III also recognizes the importance of renewable energy sources for cooking to mitigate climate change.

Moreover, the plan focuses on expediting activities in the petroleum and gas sectors across the entire value chain, improving the investment climate in the energy sector, and addressing global climate change concerns. It acknowledges that the energy sector is vital as an enabler for manufacturing, transportation, trade, and other socio-economic activities, highlighting the importance of an energy-secure system that contributes to the national economy.

While the FYDP III encompasses various economic aspects, it aligns with the concept and scope of energy security. Diversification of the energy mix is a key strategy within the plan, aiming to reduce dependence on a single energy source. This involves promoting the development and utilization of renewable energy sources alongside traditional sources like hydroelectric power. By diversifying energy sources, Tanzania aims to enhance energy security by mitigating risks associated with over-reliance on a single fuel or technology.

Additionally, in the bid to build an industrialized economy that can compete regionally and globally while also prioritizing human development, the plan aims to address infrastructure challenges, particularly in terms of electricity access, with a focus on availability, accessibility, and reliability. This suggests that improving the infrastructure for electricity transmission and distribution networks is crucial for ensuring a reliable energy supply which could further impact economic development, social well-being, and overall energy security. Furthermore, in terms of security of supply, the recognition of the importance of natural gas supply infrastructure and the promotion of sustainable use and management of oil and natural gas suggests there is an attention to the need to develop robust supply infrastructures to ensure a stable and secure energy supply, thereby reducing vulnerabilities associated with relying on external sources.

While energy security is not explicitly stated in the FYDP III, the plan acknowledges the relevance of the energy sector as an enabling sector that supports manufacturing, transportation, trading, and other social and economic activities. This suggests the importance of having an energy-secured system as it contributes to the national economy.

It is noteworthy to mention that the FYDP not only outlines the strategies and interventions for achieving sustainable development in the energy sector but also provides a comprehensive implementation framework. This framework consists of three key components: (i) the Financing Strategy, (ii) the Action Plan and the Monitoring, and (iii) the Evaluation Strategy.

Together, these implementation strategies provide a comprehensive framework for executing the FYDP III. They ensure a systematic approach to securing funding, implementing activities, and monitoring progress, thereby increasing the likelihood of achieving the energy-related objectives outlined in the plan.

5.1.3 Energy and Water Utilities Regulatory Authority (EWURA) Act of Tanzania

The Energy and Water Utilities Regulatory Authority (EWURA) Act of Tanzania is responsible for technical and economic regulation of Tanzania's electricity, petroleum, natural gas, and water sectors.

While the NEP highlighted the need for energy investments, the EWURA Act provided a regulatory framework for incentives for private sector investment in the energy sector. This can limit the sector's growth and the availability of energy resources, negatively impacting energy security. Private sector investment is essential for developing and expanding the energy sector in Tanzania, as it can provide the necessary capital, expertise, and innovation to support the sector's growth. However, investors need the right incentives to invest in the energy sector, such as favorable regulatory frameworks, access to financing, and stable and predictable policies. While the EWURA Act sets out regulations and standards for energy and water utilities to ensure that they operate efficiently, provide reliable services to customers, and comply with environmental and safety standards, the Act did address the implementation of these strategies in terms of training personnel and provisioning adequate resources to make them effective resources to monitor compliance with regulations, inspecting facilities regularly, or conducting investigations and enforcement actions against violators.

The EWURA Act also has provisions aimed at promoting energy security. However, the Act does not provide sufficient coordination between the energy sector and other sectors, such as transportation and agriculture, which are major energy consumers and can contribute to energy inefficiencies and waste of energy resources. For example, transportation is a major energy consumer in Tanzania, and the transport sector heavily relies on fossil fuels, which are finite resources. However, the EWURA Act does not have provisions for coordinating with the transport sector to promote energy efficiency and alternative and sustainable energy sources. This could also lead to a situation where there is excessive use of fossil fuels in the transport sector, which can negatively impact energy security.

Similarly, the agriculture sector is also a major consumer of energy in Tanzania, particularly for irrigation and processing of crops. However, the EWURA Act does not have provisions for coordinating with the agriculture sector to promote energy efficiency and renewable energy sources, such as solar or biomass. This can lead to a situation where there is an inefficient use of energy in the agriculture sector, which can also negatively impact energy security.

5.1.4 The National Natural Gas Policy of Tanzania (2013)

Tanzania's National Natural Gas policy was formulated in 2013 to guide the sustainable development and management of the country's natural gas resources. One of the aims of the Natural Gas Policy in Tanzania is to promote the development of the natural gas industry, including the production and distribution of LPG. By promoting the development of the natural gas industry, the Policy aims to increase the availability of LPG in the country, thereby reducing the need for importation. This has the potential to enhance energy security in Tanzania by reducing the country's reliance on imported fuel. In addition, the Policy encourages using LPG as a cleaner and more efficient energy source, particularly in households and small businesses. This aligns with the country's efforts to increase access to modern and clean energy sources as part of its commitment to sustainable development. By promoting the use of LPG, the Policy aims to reduce reliance on traditional fuels such as charcoal and firewood, which are associated with health and environmental hazards.

However, while the Policy recognizes the importance of natural gas as a significant energy source for Tanzania's economic development and the possibility of it contributing to an increase in access to modern and clean energy sources., the Policy failed to address the potential of other local energy sources such as solar, wind, and geothermal energy. The Policy focuses primarily on developing natural gas infrastructure and distribution networks, which may only be relevant for off-grid populations connected to the national grid. This can limit the impact of the Policy on energy access for these populations.

The Natural Gas Policy in Tanzania emphasizes energy efficiency as a means of promoting sustainable development and reducing energy waste. The Policy recognizes that energy efficiency is an important element of the country's energy strategy and identifies several measures to promote energy efficiency in different sectors.

At the same time, the Policy recognized the importance of LPG as a complementary energy source to natural gas, particularly in areas that do not have access to natural gas pipelines. The Policy has identified LPG as a key fuel for household cooking and heating, as well as for industrial uses such as power generation, transportation, and manufacturing, and therefore highlighted several initiatives to promote the security of supply of LPG to expand the availability and use of this fuel which includes Establishing LPG storage facilities and distribution networks, Promoting LPG as a cooking fuel through campaigns targeted at household and businesses, and Implementing policies and regulations to ensure the safety and quality of LPG products.

5.1.5 The Tanzania Energy Subsidy Policy of 2013

The Tanzania Energy Subsidy Policy of 2013 was formulated and aimed to reduce the cost of energy for the population by subsidizing petroleum products such as gasoline and diesel, as well as electricity. While this Policy may have provided some benefits, it also had several flaws that could hinder energy security in Tanzania.

The government of Tanzania introduced subsidies to ease affordability for the poor masses; however, it was impossible to target this subsidy only to the poor, so the rich also benefitted from it. Although it can be contested that the rich should also be considered in the issues of energy security, it defeats the idea of affordability for the poor for which the Policy was originally targeted, and this means that the government of Tanzania is essentially spending money on subsidizing energy for those who could afford to pay for it at market prices.

The subsidies represent a significant drain on the national budget. They may not be sustainable in the long run, suggesting that the government would have to continue subsidizing energy to keep prices low. This would divert funds away from other important areas, such as education, health, and infrastructure. The energy subsidy policy also encouraged wasteful energy consumption. While subsidizing enhanced affordability, relatively low energy prices could lead to wasteful consumption, increasing carbon emissions and environmental degradation.

The Energy Subsidy Policy did not address incentives for private investment in the energy sector. The National Energy Policy discussed the involvement of private investments, and to encourage this, it would have been ideal for the Subsidy policy to make provisions for private investments; since energy prices were artificially low, there was little incentive for private companies to invest in energy infrastructure or explore alternative energy sources. This could harm the long-term development of the energy sector and the country's overall economic growth.

5.1.6 Tanzania Rural Energy Master Plan (TREMP)

The Tanzania Rural Energy Master Plan, although not an official document, is a comprehensive plan that outlines the strategies for providing energy access to rural communities in Tanzania. However, because of the gap in addressing access to improved and clean cooking, Volume 3 of the Tanzania Rural Energy Master Plan (TREMP) was developed in 2022 by Multiconsult Norge AS, with IED of France, the Norwegian University of Life

Science, and Norplan Tanzania Ltd as sub-consultants (CEAP, 2022). CEAP was created to specifically guide efforts to improve access to improved and clean cooking options in rural Tanzania Mainland towards 2030. While CEAP is not an official document, the plan contributes to governance processes of the energy sector and is aligned with the government's National Energy Policy of 2015.

Some of the core solutions described in the document include (i) reducing the overall dependence on biomass as a primary cooking fuel in Tanzania to below 50%. (ii) adoption of improved cookstoves, (iii) promoting the adoption of LPG as a cooking fuel, and (iv) improving rural energy access.

The CEAP aims to contribute to Tanzania's energy goals and aligns with broader national objectives such as poverty reduction, health improvement, gender equality, forest conservation, and climate change mitigation. By integrating economic, social, and environmental factors, the CEAP recognizes the interconnectedness of Sustainable Development Goals (SDGs) 7 (Affordable and Clean Energy), 3 (Good Health and Well-being), 5 (Gender Equality), 13 (Climate Action), and 15 (Life on Land). This comprehensive approach acknowledges the complex nature of development challenges and underscores the need to address multiple dimensions simultaneously.

While the NEP tends towards a fuel switch from biomass and calls for exploring possibilities for fuel switch to other fuel choices, the CEAP identifies biomass as a mainstay in the country's energy supply and proposes an acknowledgment in policies and across sectors. The CEAP also addresses the gap in the TREMP concerning the affordability and accessibility of fuel and modern cooking technologies in rural areas and the need for substantial and sustained investment for ICS, LPG facilities, and distribution capacity to enable expansion into the new areas.

The CEAP recognizes that energy security can pose a significant barrier to market development (CEAP 2022). It was revealed that during the inception phase of the study, the findings from demand analysis, projections, and targets were further analyzed through economic and financial assessments of the prioritized energy options. This analysis revealed the presence of significant barriers to market development for various energy options, including aspects related to energy security, as well as the environmental, social, and cultural values or costs associated with each option.

5.1.7 Biomass Energy Strategy (BEST) 2015

Although the Biomass Energy Strategy in Tanzania is not an official document, it provides an entry point for understanding the governance of the country's energy sector. The strategy provides a roadmap for promoting the sustainable use of biomass energy resources and transitioning to a more sustainable and efficient energy system. It also aligns with the government's National Energy Policy of 2015 and the Rural Energy Master Plan (REMP), which aims to provide access to reliable, affordable, and sustainable energy for all Tanzanians, including those in rural areas. By promoting the sustainable use of biomass energy resources, the strategy seeks to improve energy security in Tanzania and reduce the country's reliance on traditional biomass fuels. (i) Diversifying the energy mix, (ii) Improving energy efficiency, (iii) Enhancing the availability and accessibility of biomass energy resources, and (iv) Strengthening the Policy and regulatory framework.

However, while the BEST highlights viable alternatives to biomass energy and the diversification of Tanzania's energy mix, there needed to be more focus on biomass energy and more attention to other energy sources.

The BEST addresses the demand and supply side of biomass energy and identifies that the demand for biomass has resulted in the increasing unsustainability of biomass energy. However, no clear recommendations were outlined to improve the efficiency of biomass energy production. The strategy further recommended the need for coordination, management, and government agencies to make biomass energy a key element in their agencies' policies and activities, particularly: The National Energy Policy (NEP) § The Tanzania Forest Service (TFS) Framework Document and the Five Year Development Plan (BEST, 2014)

The BEST points attention to the need to ensure energy efficiency not only within the residential sector but also in the agricultural sector, as this sector also plays a major role in the Tanzania forest and contributes to biomass (fuel wood used for drying tobacco) (BEST 2014).

While the strategy recognizes the importance of a supportive policy and regulatory framework for the sustainable use of biomass energy resources, it identifies that there has been limited attention to biomass energy in the energy policies in Tanzania.

Also, BEST suggests the promotion of improved charcoal cook stoves (ICS) as a quick and cost-effective means of reducing the demand for charcoal. The BEST proposes funding and launching a significant, commercially focused, mainstream improved cook stove business,

focusing on urban households and commercial and institutional clients. The aim is to reduce the demand for urban charcoal by 50% by 2030 (ESMAP, 2020).

However, while BEST provides specific strategies to strengthen its framework within the borders of the issues raised, the concept of energy security was not mentioned nor included in the framework.

5.2 Interview with key stakeholders

All participants in the study reported being aware of energy security and clean fuels and what it means. The study's findings revealed that all the participants are aware of the drive for transition to using clean fuels for cooking; however, the energy security perspective may have yet to be well considered.

At the stakeholders level, stakeholders' analysis was carried out to gather information about their understanding of energy security and their opinion of Tanzania's state of energy security as it relates to clean cooking; the research also sought to understand their interests and to gauge the influence and resources they have over decisions and the implementation of using LPG for cooking. The interviews were transcribed, and content analysis followed suit for the qualitative analysis. The results of the six interviewees' responses to the interviews were contrasted with one another.

Analysis of the qualitative data revealed several key themes related to energy security. Stakeholders discussed the challenges of energy access, particularly in rural areas, where the lack of infrastructure and high costs posed significant barriers to adopting modern energy sources. The importance of energy diversification and affordability emerged as a key theme, with stakeholders emphasizing the need for household income to be reviewed and the need for government to focus on making the charcoal industry more sustainable and productive. The issue of energy supply at the national level was also raised, with stakeholders discussing the need for a diverse and reliable energy mix, including renewable energy and natural gas, to ensure security and protect against supply disruptions.

The theme of environmental sustainability was also prominent, with stakeholders highlighting the importance of promoting sustainability.

Concerns for the national economy were also raised, as participants acknowledged the financial implications of transitioning to the use of LPG, not just for households, which remain a significant barrier for many low-income households in Tanzania but for the country itself. Aside from the subsidies granted to LPG, participants identify other expenses incurred

by the government to facilitate the adoption of LPG as the first option for cooking fuel, like the ongoing construction of LPG refilling plants in upcountry regions, including Lindi and Mtwara.

Stakeholders also recognized the importance of government subsidies and financial support to promote the adoption of LPG and reduce the negative environmental and health impacts of traditional biomass energy sources.

Finally, the theme of energy governance emerged, with stakeholders stressing the need for transparent and accountable decision-making processes that involve stakeholder participation and ensure fairness and equity. Overall, the thematic analysis demonstrated participants' diverse perspectives and experiences regarding energy security and highlighted the critical importance of addressing the various dimensions of energy security to achieve sustainable and inclusive energy development in Tanzania. This is obvious in their contributions and interest in LPG. While most of the participants within this ministry of energy were in support of transitioning to LPG and saw it as the most feasible way to go, the participants within the forestry and tourism sectors were more inclined towards maintaining biomass as a major cooking energy source and making it more sustainable and adopting improved cooking technologies.

In terms of affordability, maintaining the cost of LPG at a reasonable cost and then the government's ability to meet energy demand are the two pillars of affordability. Price stability was one of the key discussions about LPG as a cooking fuel. Participants worried about unanticipated pressure on consumers' disposable income from price volatility. To further assess the households' affordability, some stakeholders discussed the share of Household Income spent on energy to gauge the consumers' affordability. According to research carried out by Lusambo LP (2016), the average household in Tanzania spends 28-34% of its income on cooking fuels. A participant from TFCG mentioned that:

“although the government reduced tax on LPG and have made effort to increase the number of LPG retailers in the country to improve the affordability of LPG, these efforts have still not contributed to LPG being cheap”.

Some participants cited the initiative by the government where the upfront cost of purchasing an LPG cookstove and cylinder is being undertaken. However, households need to refill once it runs out because the cost is prohibitively high for many households. According to a participant from TFS rating on LPG acceptance:

“for LPG to become a dominant cooking fuel, The household income needs to be reviewed so that the purchasing power of the people would match the market price and the fluctuations in the energy market”.

Regarding the security of supply, the stakeholders proposed a different perspective on the supply of LPG. There was common knowledge of the country's total reliance on LPG supply from other countries. Some participants raised concerns about the security of the energy supply and perceived it as a threat to the national economy. In the words of one of the interviewees from Oryx gas;

“what happens if there is a crisis that involves one of the major suppliers of LPG to Tanzania, does that mean an automatic ticket to economic crisis.”

At the same time, one of the participant, an individual involved in the NEP formulation argued that;

“No country is an island and so it is okay for countries to depend on themselves and importing LPG is a form of preserving a positive commercial tie with other countries.”

In line with the BEST, interviewees in the forest management and natural resources sector raised concerns about the security of supply for LPG at the national level. In the words of a participant from TFS;

“Charcoal is being neglected despite the industry’s contribution to the GDP of the country. Asides the trillions of shillings that traded in the charcoal industry, Tanzania has a domestic source for it, so i expect that it should receive more attention in terms of energy supply compared to an energy fuel that the country has no grip over.”

In terms of energy diversification, concerns were raised by all the interviewees on energy policies that were targeted toward driving a swift shift to LPG. The general view was the need to emphasize diversifying the energy mix to ensure sufficient availability, developing domestic resources like charcoal, and making it sustainable rather than a total disregard for the industry.

Regarding acceptability, there was a consensus on LPG being convenient and reliable. However, they also identified that the issue of acceptability varies depending on several factors, such as income level, access to energy, individual preferences, and cultural practices. In the words of one of the participants from TFCG;

“just as access to electricity for all Tanzanian households and the promotion of it as an alternative cooking energy source have been invested over the years, many households in Tanzania still do not rely on it as their primary cooking energy source, so the question is why are they not still using it. The fact that people have access to LPG does not mean they will embrace it as a primary cooking energy fuel. That is the reality”.

Many participants further concurred that LPG might be acceptable in urban areas because of its time-saving benefits, as it requires less time and effort for cooking and cleaning than traditional fuels. However, most households in rural areas who use the LPG still combine it with charcoal, i.e., the fuel-stacking model, and this may continue because of the financial cost. In the words of one of the interviewees from EWURA;

“The financial capacity of adopting new technologies is a question. For a local farmer, spending few dollars on buying new stoves is a lot.”

The interviewee from EWURA further explained.

“Although LPG is cheaper than charcoal, the investment cost puts away people but the availability of charcoal in small quantities gives it an advantage over LPG. it is sold in retail quantities depending on the needs of the buyer.”

The socio-cultural influence was also identified as one of the major barriers to the acceptability of LPG as the first option for cooking fuel in many households. It was reiterated that while LPG is being proposed as a clean and more efficient cooking fuel, cultural preferences like the yearning for taste and aroma of food cooked with charcoal still contribute to its acceptance.

In the words of one of the interviewees from TFS;

“There are some foods people prefer to use charcoal to make food like Nyama choma and also it is tastier when charcoal is used to cook rice”

Regarding policy documents, there was a consensus on gaps in the policies within the energy security framework. For example, the National Energy Policy 2015, identified by the interviewees as a major policy that guides the energy sector in Tanzania, was noted to be focused on electricity, and less attention was paid to other energy sources. One of the interviewees, an individual who was involved in the policy-making process mentioned in his words

“the focus when drafting the NEP was electricity and that is why many of the strategies aligns more with that sector and may be impracticable for LPG especially for cooking”

The interviewees also raised concerns about the absence of an official policy document focused on clean cooking despite the drive and LPG awareness being done by the government. In the words of one of interviewee from REA;

“While there are different strategies, plans and roadmaps to achieving clean cooking, there is no comprehensive official document that guides the country to achieving this. What is available are policy papers and strategies from different organizations that may need more guidelines for implementation across the country”.

So, in the words of the interviewee from Oryx gas;

“if the government is really focused on achieving this, the NEP should be reviewed to include LPG importance and have a clear and official document focused on this directive to guide the ministries and institutions, as this is the responsibility of the government”.

The interviewee from REA further mentioned;

“ we currently have a situation where the ministries roles and key responsibilities contradicts one another: for example, REA has a key responsibility of promoting clean cooking fuels and technologies, and the Ministry of Natural Resources and Tourism has a responsibility for generating revenue from the charcoal industry which is widely used for cooking”

to further buttress this, In the words of another interviewee from TFS;

“ there is a misdialogue between the Ministry of Energy and the Ministry of Natural resources and Tourism”

In conclusion, there was also a consensus among the interviewees about the subject of energy security being considered in the country’s energy policies, In the words of one of the interviewees from REA:

“there is no mention of energy security in the NEP or any other official energy policies, although there are key concepts like energy access and affordability mentioned, there is no energy security... the government has just started paying attention to this”.

6.0 Discussion

The previous chapter presented the findings of this study. This chapter discusses the actor's understanding of energy security, their perspectives on transitioning to different energy sources, and the implications of these findings for policies and stakeholders in Tanzania's energy sector. Finally, this chapter will consider biomass as a potential pathway to improving energy security in Tanzania. Overall, this chapter aims to provide insights into the complex challenges and opportunities facing Tanzania's energy sector and to inform the focus for future policies and strategies.

6.1 Stakeholders Understanding of Energy Security

The major concept used in this paper is energy security. There was general knowledge and consensus that energy security means access to affordable, reliable, and environmentally sustainable energy sources. However, while there is a general understanding of energy security in this sense, different actors prioritized various aspects of energy security.

For policymakers and government officials, energy security is largely understood as ensuring a stable supply and environmentally sustainable energy sources to meet the nation's demands, and this aspect is prioritized. However, a common phenomenon was the sync in the understanding of energy security among policymakers and government officials in the Ministry of Energy compared to those in the forest sector. For instance, officials from the Ministry of Energy and energy-related institutions had a more technical understanding of energy security. While officials from other sectors, like forest management, viewed it more broadly regarding affordability and availability.

For energy companies and their employees, energy security was largely understood from a business perspective, focused on assurance of the reliability of the energy supply, as well as energy investments and risk reduction associated with an investment in the energy sector. This understanding, grounded in the requirement for reliable and successful operations, frequently took into account factors like maintaining a diverse energy portfolio, investing in renewable energy sources, and reducing reliance on insecure or politically unstable energy sources. In essence, energy security to them getting to a state where they could continue to operate effectively and efficiently even though there might be disruptions to energy supply, demand, pricing, and regulations.

Government officials and policymakers are primarily concerned with ensuring access to and supply of energy, as the energy sector plays a crucial role in economic development.

However, there appears to be a greater emphasis on environmentally sustainable energy driven by global agendas. For instance, there is a push for adopting LPG as a cleaner and more efficient cooking fuel to reduce deforestation and air pollution without giving equal consideration to the country's national economy or security.

Interviewees from non-governmental organizations like TFCG understood energy security from the energy access and affordability perspective with particular focus to the vulnerable people in the population like women and children i.e providing access to sustainable energy resources

Overall, different actors in Tanzania have varying perspectives on energy security depending on their interests and priorities. However, ensuring access to reliable and affordable energy was a common perspective for all the participants and actors interviewed. This diversity of understanding is not unique to Tanzania. Scholars have noted that energy security is a contested concept that means different things to different people and contexts (Bazilian et al., 2011; Sovacool, 2013; Tor et al., 2018). In the case of Tanzania, the different understandings of energy security are further shaped by a range of factors, including consideration for the political, economic, and the country's unique energy landscape. Being a country with a large source of biomass energy, the development of these resources is complex and fraught with challenges, including political and economic uncertainties, social and environmental concerns, and technical and infrastructural constraints (Baiyegunhi et al., 2020). Given these challenges, different actors in Tanzania have different priorities and interests regarding energy security.

According to Kohler et al. (2017), Actors play pivotal roles in sustainability transitions, which have been considered 'multi-actor processes' whereby a variety of actors and social groups, whether deliberately or not, apply their resources, capabilities, beliefs, strategies, interests, and agencies in the formulation and implementation of their responsibilities. From the findings of this research, the understanding of energy security by the stakeholders has impacted the strategies put in place and the implementation plan. This is evident in the discourse of energy policies and strategies, which are more environmentally focused because this process involves more government officials. For example, the National Energy Policy, the most recognized energy policy in Tanzania, is streamlined along that focus; it was more focused on increasing the renewable energy mix. The recently developed National Clean Cooking Roadmap towards the 2033 draft is another example; while the objective stated that the national economy is the focus, the strategies were still centered around preserving the environment and improving health and social welfare.

The different perspective of energy security understanding from various stakeholders is a valuable contribution to Aleh Cherp and Jessica Jewell's perspective on energy security (Cherp & Jewell, 2011). Their understanding of political, economic, social, and environmental components recognizes that energy security is not just a technical issue limited to the four As but also an economic and political issue. This suggests that in energy policy, it is crucial to consider not only social and technical aspects but also economic and security ones. It also became clear that stakeholders' understanding of energy security is crucial in ensuring the successful adoption of clean technologies, identifying potential barriers and opportunities, enhancing the effectiveness and sustainability of policies, and promoting inclusive and sustainable growth because their opinion can force the basis of their input in decision-making processes.

6.2 Stakeholders' perspectives and Policy Implications on Energy Security

Tanzania's energy policies have significant implications for its energy security, impacting its ability to meet its energy needs, maintain stable energy supplies, and reduce its reliance on imported energy sources. As discussed earlier, energy security is a key element for any country; also, the perspective of key actors and stakeholders can influence policymaking, strategies, and even implementation.

The government's focus on promoting Liquefied Petroleum Gas (LPG) as a clean cooking solution will create a dependence on imported fossil fuels, undermining the country's energy security. While LPG is promoted to be a cleaner and more efficient cooking fuel than traditional biomass fuels, its high cost and reliance on imports make it vulnerable to supply chain disruptions and price fluctuations. The plans and strategies used to push transition have raised concerns among some interviewees. Concerns about how government's subsidy program for LPG are being majorly targeted at only residents of rural areas, thereby being a disadvantageous initiative to residents of urban areas. Further discussion how this is mostly benefitted by mostly the middle-income households because they can afford the upfront cost of purchasing the LPG stoves and cylinders compared to the poorest households who still rely on traditional biomass fuels for cooking. One possible implication of this situation is that the poorest households in rural areas may continue to have a problem of affordability of LPG as a cooking fuel.

Another implication mentioned was how clean cooking policies could discourage "alternative biomass-improved cookstoves". These technologies have the advantage of being produced locally and offering sustainable and affordable energy solutions for rural communities. However, the government's focus on promoting LPG as a cleaner cooking fuel may result in limited funding and attention to these alternative technologies. This can hinder energy diversification efforts and limit the potential benefits that biomass-improved cookstoves can bring regarding local production, affordability, and environmental sustainability.

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6.3 Stakeholder Perspective on the reliance on LPG

While there was different perspective among actors and stakeholders in their understanding of energy security, in the same regard, there are different perspectives among actors regarding the reliance on LPG. Perspectives on the reliance on LPG ranged from concerns on affordability, safety, environmental, and even financial concerns. Many actors, including governments, energy companies, and consumers, support using LPG as a clean and efficient energy source. However, LPG was argued as a better alternative to traditional solid fuels such as charcoal and firewood, which are associated with health hazards, deforestation, and environmental degradation.

For some of the actors, there were concerns about affordability. Despite its benefits, LPG is perceived as an expensive energy source, particularly for low-income households. Some actors, including the private sector, expressed concerns that the high cost of LPG could exclude low-income households from accessing clean energy and their proposed opinions of affordability by the government or the continued use of improved cook stoves which are

relatively affordable at about 3 Euro for the ceramic standalone and 5 Euro for the metal stoves.

There were also safety and environmental concerns. There is a common understanding among these category actors about LPG being a highly flammable substance that requires careful handling and storage to avoid accidents. Concerns were raised about the safety of LPG use, particularly in households with poor infrastructure and limited access to safety equipment. While LPG is considered cleaner than solid fuels, there were concerns about it still contributing to greenhouse gas emissions when burned. Some actors instead expressed concern about the environmental impact of LPG use, particularly if it leads to increased demand for fossil fuels and the associated environmental consequences.

While various actors raised concerns about the reliance of Tanzanian households and businesses on the reliance of LPG, what is most notable is that the financial impact was not a concern for the stakeholders. Considering the amount spent on the importation of LPG and subsidies to Tanzanians by the government, the financial implication of the reliance on LPG by Tanzanians must be considered. According to one of the participants of the interview working in the energy companies, “Tanzania imports about 3000 metric tonnes of LPG every day and with current global petrol prices”.

Although the Policy recognizes the importance of raising awareness as a strategy for improving energy security, the prescribed action statements need to address the issue of raising awareness and capacity building (URT, 2015). Furthermore, the action statements should have addressed the impact of the LPG transition on citizens; for example, one might wonder how the prescribed action statements will address issues such as LPG importation, increased reliance on other countries, and threats to energy security. Also,

Another implication was highlighted regarding the financial implication, technical expertise, and institutional capacity. The cost of LPG tax exemptions for lost government revenue is high; in 2017 and 2018, 120,961 Metric Tonnes of LPG were imported. (EWURA, 2018; Chifungu & Student, 2022). It would have generated TZS 93 billion, or US\$ 40.7 million, or 0.74% of GDP if LPG taxes were paid at a comparable rate to kerosene taxes, i.e., TZS 768,750/tonne (based on TZS 615/liter converted at a rate of 1 l = 0.8 kg of kerosene, with 1 kg of kerosene being roughly equivalent to 1 kg of LPG in energy content) (Chifungu & Student, 2022). Although subsidies for LPG adoption benefit households, it highlights a major loss in the financial purse of the government of Tanzania (Maes & Verbist, 2012).

6.4 Biomass: vital for Energy security in Tanzania

Biomass, including wood, agricultural residues, and animal waste, produces energy through heat, electricity, and biofuels. Biomass is widely available in Tanzania, and biomass as a source of energy is also readily available, accessible, and affordable for the masses. It can be a pathway to improving energy security in Tanzania if produced and managed sustainably, thereby making Tanzania sufficient without reliance on external energy markets.

There is a widely accepted hypothesis that charcoal acts as a "transition" fuel, meaning that as households and nations experience economic growth, people's energy preferences move up a contemporary energy ladder from "inferior" biomass fuels like charcoal to LPG, kerosene, and electricity. However, low-income households do not primarily consume charcoal; rather, it is consumed across a wide range of income categories with little variation in per capita consumption (Mwapamba, 2007). There have also been reports and literature about charcoal being a major contributor to household pollution. However, according to Mwapamba(2007), charcoal data is often grossly misrepresented with other woodfuels there, resulting in a need for more reliable, consistent, and comparable data on the charcoal sector in Tanzania.

While transitioning to LPG is currently under development, biomass should not be completely disregarded as a source of energy, as completely disregarding biomass could negatively impact Tanzania's energy security, and a complete transition to LPG would increase Tanzania's energy import dependency. Tanzania relies heavily on imported energy, with 100% of the LPG supply obtained from the middle east and Asia. This points toward economic vulnerability in case of a supply shortage or price disruptions, thereby threatening its national security (Kapama & Kinyondo, 2020). For example, in a country like Tanzania, a disruption in the supply source or distribution network could result in a catastrophic situation whereby households that relies solely on LPG find themselves in a situation of energy shortages. In Deutch (2010), an increase in imported energy prices resulting from outages in energy flow can pose economic challenges for a country, particularly if such a country is unable to decrease its energy consumption levels rapidly. This situation, coupled with ongoing energy dependency, can lead to a significant deficit in the current account balance of trade and consequently weaken its competitiveness in international markets. In addition to economic implications, there are other consequences to consider. Aslantürk and Kırprızlı (2020) mentioned that increased import dependence could result in inflation, job losses, consumer insecurity, unemployment, deteriorating foreign trade balances, and worsened balance of payments (Costantini et al., 2007).

Biomass is a domestic resource in Tanzania, and sustainable exploration of this cooking fuel would reduce Tanzania's dependence on imported fuels. With Tanzania being the continent's fifth-largest producer of charcoal (FAO, 2020), biomass can be produced sustainably through agroforestry, which involves planting trees and crops together to create a balanced and diversified ecosystem that can provide both food and fuel (Wilson & Lovell, 2016). Although there have been reports that the use of charcoal has largely contributed to deforestation in Tanzania, this is weakly validated (Mwapamba, 2007). In Doggart et al., 2020, agriculture was identified as the main driver of deforestation using satellite data and national data on land use change. The research attributes 81% of deforestation to agriculture, with most of this driven by small-scale cultivation (Doggart et al., 2020).

The transition to using LPG for cooking in Tanzania reveals a complex interplay of socio-economic, cultural, and environmental factors among the Tanzanians. While LPG has been promoted as a cleaner and more efficient cooking fuel, the transition from biomass fuels (charcoal and firewood) at the household level still encounters challenges in assuming the first option of cooking fuel due to cultural preferences for cooking with charcoal. As Roger's theory (2003) put it, it is easier to embrace a technology when it is aligned with potential users' beliefs, experiences, and requirements. Although, a study (Kithinji et al., 2018) identified the cost of LPG cylinders and stoves as a significant barrier to adoption, particularly among low-income households. Moreover, cultural preferences for the taste and aroma of food cooked with charcoal still contribute to resistance towards the transition to LPG.

Also, there was perception of charcoal and firewood being the least expensive and the retailing power (i.e., consumers being able to buy in small based on their needs) giving it a pricing advantage over LPG. Charcoal was mentioned to be purchasable *at* the lowest unit price of about TZS 1,000, compared e smallest unit price of LPG is around TZS 11,500”.

However, so far, LPG's acceptance has been promoted by its exemption from VAT, excise charges, and higher tariffs. While all these are in place, this raises the question of "Why is LPG still not the primary cooking option in Tanzanian households?" "Why do many households, even in urban areas, alternate between LPG, electricity, and charcoal, which is the haven?" 90% of Tanzania has access to electricity, but only 3% primarily cook with electricity (NBS, REA, 2020).

Biomass fuels also provide a source of income for many rural households who rely on charcoal production for their livelihoods and contribute to the country's GDP. According to World Bank (2020), the charcoal sector in Tanzania generates an annual value of an estimated US\$650 million. Based on a price of about US\$ 0.34 per kilogram and a transaction volume of 2 million tonnes, the charcoal trade contributes about 1.75% to the national GDP. Therefore, what Tanzania should think of is coming up with a more sustainable approach to producing charcoal in Tanzania and diversifying the energy mix, which includes both LPG and biomass fuels, as well as alternative energy sources such as biogas, solar, and wind power. This approach would provide greater energy access for the local population and contribute to more sustainable and equitable economic development. Also, despite stereotyping the charcoal industry as an informal industry, the charcoal supply chain is highly efficient at meeting demand. Charcoal shortages in urban areas are extremely rare in cases where there are Government interventions such as production and transportation bans or crackdowns are the main cause of charcoal shortages in urban areas (Minten et al., 2013; Plas van der, 2008; ESD, 2007; World Bank, 2009; Mwapamba et al., 2013).

The charcoal industry not only plays a significant role in revenue generation, but it also plays a significant role in the livelihoods of millions of people in both rural and urban areas worldwide. In Sub-Saharan Africa (SSA), the wood-based biomass sector, including charcoal, provides regular income to millions of people. In Tanzania, the charcoal sector for Dar-es-Salaam alone is estimated to provide labor and cash income to several hundred thousand people (World Bank 2009). Rough estimates indicate that the charcoal industry in Sub-Saharan Africa provides income and livelihood to seven million people, which could increase to around 12 million people by 2030, according to the International Energy Agency (IEA, 2009).

A transition to LPG in Tanzania could result in a continued reliance on imported LPG, which would have significant implications for the national budget. In 2022, Tanzania imported 250,200 tonnes of LPG, spending an estimated USD 35 million on LPG importation (EWURA, 2023, Global Petrol price2022). Comparing this to the national budget of the 2022 /2023 fiscal year, estimated to be about \$ 18 billion, this represents about 20%. This implies that the high cost of importing LPG could strain the country's foreign currency reserves, particularly with the ongoing conflict between Russia and Ukraine, which continues to limit the availability of LPG on the global market.

Furthermore, fluctuations in the global financial system could exacerbate this problem, as changes in currency values could affect the cost of importing LPG and create a balance of payment problems for the country. This could negatively affect the country's overall economic stability, as resources that could have been used for developing other infrastructure and addressing other economic priorities may need to be diverted to cover the cost of LPG imports.

Therefore, Tanzania needs to explore various options for meeting its energy needs, including charcoal and domestic natural gas sources. Domestic natural gas could also provide a more cost-effective and sustainable energy source for the country in the long run while promoting energy security and reducing reliance on imported fuels.

Investing in domestic natural gas infrastructure and production could also create new job opportunities and support economic growth in Tanzania. Therefore, it is crucial for the country to carefully consider the economic and environmental impacts of each energy option and adopt a diversified and sustainable energy strategy that can meet the country's energy needs while supporting its overall economic and social development goals.

7.0 Conclusion

Based on the findings in this study, there is a common understanding of energy security among the interviewees, which is largely understood as access to affordable, reliable, and environmentally sustainable energy. However, the government is giving the environmental aspect attention. The findings also establish that, while sectoral interests might influence stakeholders' understanding of energy security, there is a consensus on limited national security considerations, as evident in the policy documents.

Furthermore, the study highlights that the energy policies in Tanzania prioritize environmental and health concerns, discouraging the utilization of biomass fuels with less emphasis on exploring avenues to ensure their sustainability. This approach must acknowledge their economic value and potential contribution to national security. Subsequently, there is a need to reevaluate current energy policies, considering the economic and national security implications of energy choices alongside environmental and health considerations. Future policies should strive to incorporate these additional dimensions.

This study also highlights that sectoral interests significantly influence stakeholders' understanding of energy security. Interviews with various stakeholders showed that persons in the same institutions had a similar understanding of energy security. For instance, individuals working for the Ministry of Energy view energy security primarily from the supply perspective. On the other hand, stakeholders working with Forest management prioritize affordability and availability, as reflected in their policies. It is important to consider these sectoral interests when developing and implementing energy policies to ensure that they meet the needs and goals of all stakeholders involved.

Also, with the increasing attention to LPG as a clean cooking fuel, energy imports to the country will increase. This study suggests that more consideration needs to be made regarding the potential implications for the national energy economy.

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Appendix

#	Policy /Strategies	Institution	Responsibilities
	National Energy Policy	Ministry of Energy	Development and implementation of policies related to energy, including renewable energy, oil, and gas.
	Five Year Development Plan (FYDPs)	Planning Commission, Ministry of Finance and Planning	Development and implementation of Tanzania's long-term economic and social development plans, including plans related to energy and other sectors.
	Energy and Water Utilities Regulatory Authority Act	Energy and Water Utilities Regulatory Authority (EWURA)	Regulation of the electricity, gas, and water sectors in Tanzania, including licensing, tariff setting, and quality control.
	National Natural Gas Policy of Tanzania	Ministry of Energy	Development and implementation of policies related to the exploration, production, and distribution of natural gas in Tanzania
	Tanzanian Energy	Ministry of	Development and implementation of

	Subsidy Policy	Energy	policies related to energy subsidies and pricing, including the management of the Energy and Petroleum Regulatory Authority (EPRA).
	Tanzania Rural Energy Master Plan	Ministry of Energy	Development and implementation of policies related to rural electrification and the promotion of renewable energy in rural areas.
	Biomass Energy Strategy	Ministry of Energy	Development and implementation of policies related to the use of biomass as a source of energy, including the promotion of sustainable biomass production and use.

Interview Questions

1. What do you understand by energy security? What do you think of state of energy security in Tanzania?
2. What is your opinions about the use of LPG for cooking and how it contributes to energy security
3. To what extent do you think the stakeholders understanding of energy security impacted the energy policies/ strategies?
4. To what extent do you think the national economy and national security is considered in the transitioning drive.
5. What could be the possible implications of transitioning on the national budget.
6. Do you think this is being considered?
7. To what extent do you think the transition to the use of LPG for cooking would impact energy security in Tanzania.
8. What is your opinion about the use of biomass for cooking?
9. Do you think the government is biases towards it?
10. Will the current energy crisis affect or accelerate the transition to the use of LPG in Tanzania?
11. What is your opinion on how energy security can be achieved in Tanzania?
12. What strategies do you think could secure long term supply of energy