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Multi-criteria Analysis of the Sustainable Energy Transition Pathways in Sub-Saharan Africa: Power Sector Investment Policy Dimensions in Tanzania

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Abstract

Energy is central to socio-economic development. The use of fossil fuels dominates the global energy sector that supports the economy. With increased advocacy to address climate change impacts, the global South struggles to strike a balance between fast-tracking economic growth through investing in fossil fuels, a low-cost and versatile energy source, and the so-called clean but intermittent and hard-to-dispatch sources like solar and wind. Dependence on imported fuels to support economic activities has subjected sub-Saharan Africa to fall prey to global fuel price volatility, affecting local economies. This study explores how countries in Sub-Saharan Africa can navigate this energy trilemma by designing and developing policies that consider the essential sustainability pillars, including the environment, economy, and social aspects. The study found that global dynamics have forced countries to resort to a pathway that guarantees the security of supply; the move towards renewable energy is central to global discussions in a sustainable future. At the same time, countries across the globe are hesitant to completely phase out the use of fossil fuels due to the essential attributes that need to be added to renewable energy. Sub-Saharan Africa prioritises achieving universal access to energy and securing the security of supply with low cost of services. Increasingly, countries find that dealing with energy security requires addressing climate change concerns. The study provides practical recommendations for policy directions, including undertaking strategic reforms, creating task forces, investing in research, building local capacity, and forging strategic partnerships.

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1. Introduction

The global community started dealing with climate change impacts in the early 1990s, with the first attempt to address climate change in 1997, the Kyoto Protocol (Kim et al., 2020). It is claimed that the world has remained with a limited carbon budget (Rogelj et al., 2019) towards achieving the Paris Agreement goal of limiting the global temperature rise by 1.5 degrees Celsius by 2050. Analysis shows the world is off the track to achieving the Paris climate target of limiting temperature rise well below 2 degrees Celsius above pre-industrial levels (Smith et al., 2024); thus, countries must consider the concept of a carbon budget when planning for financial and economic decision-making to help the world attain a net-zero goal (WEF, 2024). The energy transition is critical in addressing anthropogenic climate change emissions (Kühne et al., 2022). Reports claim that energy has contributed to about three-quarters of global greenhouse gas (GHG) emissions (Ritchie, 2020). The use of energy sources that jeopardise global sustainability in terms of climate and resources impend the efforts to achieve the Global Sustainable Development Goal 7 objectives that entail energy accessibility, penetration of renewable energy and the sustainable use of energy (Madurai Elavarasan et al., 2023). It also aligns with the objectives of fostering the use of low-carbon energy in the global primary energy supply to support the 2050 goal of achieving a carbon-neutral society (Pan et al., 2023).

Although the African continent's share of GHG emissions is insignificant, about three per cent (IEA, 2022), it is paramount for these countries to embrace green economic development principles. Africa is a disadvantaged region due to its inherent poor economy, lack of technological capabilities, and weak institutional frameworks to support climate actions (Sokona & Denton, 2001). Energy and climate security are other aspects to consider in the energy transition agenda; the two can no longer be treated as separate priorities; it is paramount to create a policy environment that supports the use of energy sources that are secure to the environment and support economic growth (Biririza, 2024a). Climate change has direct impacts on energy availability and affordability. Energy and climate security can be linked to various attributes that affect the wellbeing of people and the planet (IPCC, 2022). Geopolitics and global pandemics like COVID-19 also affected the global energy and climate security space (AtlanticCouncil, 2022). Amid these energy complexities, countries in Sub-Saharan Africa (SSA) face acute challenges in the energy sector, namely, constrained energy access, low per capita energy consumption, increasing energy prices due to dependence on imported fuels, low technological

capacity, difficulty in accessing financing for investments, along political, and geopolitical challenges (Mukhtar et al., 2023).

The energy transition is not a new subject; in developed nations like the United States of America (USA), it traces back to the second half of the 18th century, pathing through several courses, from dependence on biomass to the discovery of oil and transitioning to renewables; the phenomena and complexities differ in today's energy transition discourse (Smil, 2017), thus, underpinning a need for a critical knowledge of interlinkages of several issues and factors that are essential to upholding a precautionary principle (OECD, 2023). The energy transition pathway needs to look at criteria that support sustainability factors: environment, society and economy. Energy transition in Tanzania will have to address issues inherent to the energy sector, including increasing access to affordable and sustainable energy services for the population and aligning with international climate policies articulated to its nationally determined contributions (Biririza, 2024b).

Energy transition in Africa bears different connotations; it transforms energy poverty into investing in energy supporting economic growth. Globally, 685 million people do not have electricity access, three-quarters of which are in sub-Saharan Africa (IEA et al., 2021). Like many countries in sub-Saharan Africa, Tanzania has yet to achieve universal access to electricity, with about 78.4% access as of July 2020 and less than 50% actual connectivity (REA & NBS, 2020). About 80 per cent of its population depends on biomass fuels for cooking (REA & NBS, 2020). The lack of sustainable energy access affects various dimensions of sustainability. Energy transition in Tanzania would need to look at these factors while positioning itself to participate in the global agenda of addressing climate change through the shift to clean energy options. However, this will need to be a gradual process, including using fossil fuels to justly support the transition to clean energy without jeopardising other essential parameters for socio-economic flourishing (Leke et al., 2022). The continent has to be supported to access technology, develop local capacity and address financing restrictions.

The study aims to understand and analyse how the policy transformation of sub-Saharan African countries like Tanzania can accelerate their participation in the global energy transition agenda, positively impacting their socio-economic growth, and how the policies can be developed to suit the economic transformation while embracing the global sustainability aspects and specifically, looking at how Tanzania can embrace inclusive energy policies to achieve its energy transition and transformation pathways. The second main question examines how a country can engage the

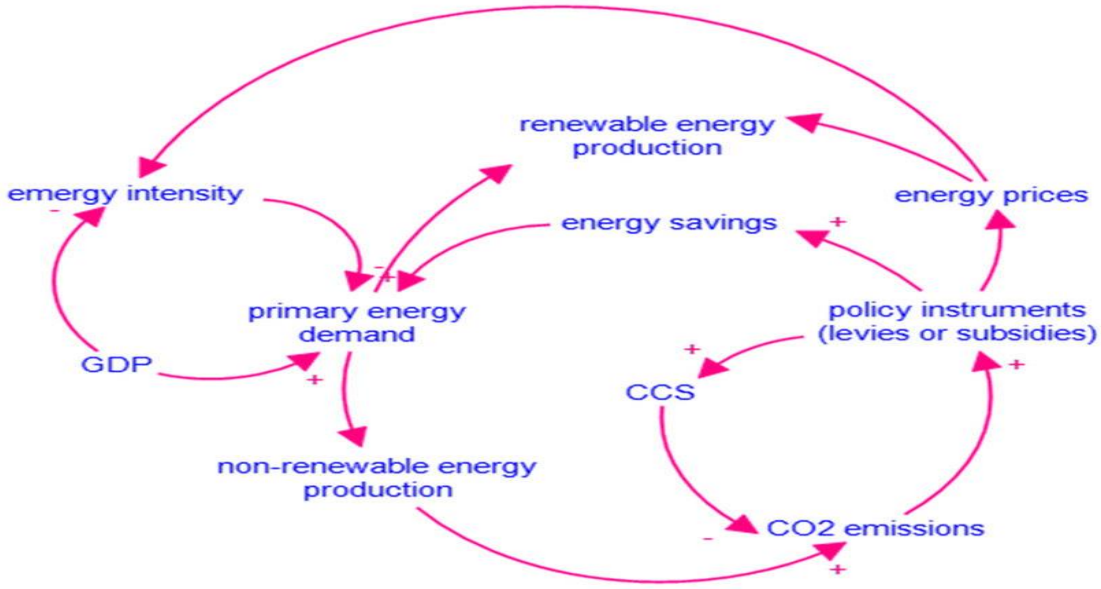
international community to participate effectively in its sustainable energy transformation and transition pathways. It can position itself strategically to tape the potential international financing and foreign direct investments in sustainable power generation.

2. Theory of Change and Causality

The theoretical framework is an essential tool to the research (Lederman & Lederman, 2015); as argued by Erdoğan (2023), it provides the framework for the credibility of the scientific research by organising the thoughts and analysis of information well to make it available to a broad audience (Erdoğan, 2023). This study employs a theory of change and causality of factors to help understand the energy transition pathways. The theory of change (TOC) is a phenomenon that defines the strategy that articulates the processes towards achieving a desired change. It involves some assumptions and inputs to support the goal (Serrat, 2013). It is best used for intervention during the formulation stage to develop an efficient implementation, monitoring, and evaluation framework (Mayne, 2015). It is one of the tools for formulating policy, leading to creating strategies and plans. It indicates the pathways to achieve a goal, identifies the required resources, and lays out the assumptions. The TOC makes it plausible to develop a country-specific policy towards energy transition, looking at local conditions and taking advantage of global opportunities. The TOC is outcomes-based, uses a participatory approach, applies critical thinking to the design and implementation, and evaluates an initiative (Serrat, 2017).

As a multifaced and complex discourse, the energy transition agenda is affected by various parameters such as economic situation, availability of resources, political will, and interconnected issues among the global stakeholders. Climate change dictates the energy transition discourse, a global issue requiring a robust international partnership to accelerate the energy transition. The climate change issue can be translated as more imperial, taking the face of colonialism (Mercer & Simpson, 2023). However, the world should expect the issue to be addressed with something other than individualist mindsets. It is a matter of cause and effect, where one act facilitates the other. Figure 1 provides an example of a highlight of the causality model to the energy transition agenda (Linderhof et al., 2020). The main variables for sustainability in line with the causal relationship is that the energy services are related to the policy decisions in what energy sources to invest in; it also relates to the advantage of one source having both the supply and demand side of energy. The policy decisions ultimately affect the environment, economy, and social aspects. Choosing one source over others needs to look at multiple factors favouring different aspects of sustainable development.

Figure 1: Causal Loop Diagram of System Dynamics Model for Energy Policy



Source: Adapted from Linderhof et al. (2020)

3. Methods and materials

3.1 General Methodology

The research reviews literature with recurring questions about making Africa adopt sustainable investing methods in low-carbon energy sources. The first main question is meant to understand how energy policies can be designed to unlock the potential of available energy resources to meet the necessary energy needs for socio-economic growth while embracing sustainable transformation to a low-carbon future and looking at how Tanzania can embrace inclusive energy policies to achieve its energy transition and transformation pathways. The second main question examines how a country can engage the international community to participate effectively in its sustainable energy transformation and transition pathways.

The research used a multi-criteria approach to understand the issues in connection with the energy transition agenda for sub–Saharan Africa. The study analyses several factors and examines how they link with policy dimensions in the power sector by reviewing the existing policy landscapes and practices and considering devising new ways of thinking about energy projects. Together with literature reviews, data was collected via structured questionnaires and one-on-one interviews with respondents who comprised energy experts, policymakers and end-users. Information was triangulated to arrive at appropriate energy transition pathways considering the

needs and issues around stakeholders. In analysing the country's sustainable energy transition pathways, multiple dimensions were considered in line with sustainability principles. Analysis of the plausible energy transition pathways is determined by both the demand and supply side, as portrayed in Table 1.

Table 1: Supply and Demand Side Factors for Energy Transition Pathway

Supply		Demand	
Factors	**Baseline indicators**	**Factors**	**Baseline indicators**
National Policies	Developing policies that support investments in clean energy technologies and solutions such as renewable energy, energy efficiency and cleaning of fossil fuels. Some of these policies could be the provision of incentives and disincentives, setting up special funding mechanisms, etc.	**Increased population**	Population increases, and urbanisation are the primary causes of increased demand for electricity.
International Policies and Donor Dependence	Ratifying and adopting international policies on climate change will likely influence the investment direction of a country's energy transition. This is primarily due to the country's dependence on external funds for their budget support in the sector.	**Introduction of electric vehicles**	Introducing electric vehicles will demand a more reliable and sufficient electricity supply. Appropriate sources and technologies will have to support this transformational change.
Regulations	Establish regulatory requirements for the energy transition agenda, such as mandating that utilities include renewable energy and clean power generating systems in the network and that end users use electricity efficiently.	**Energy efficiency**	Energy efficiency in households, industries, and institutions will serve a good power margin. However, there is a possibility of backlash causing an increased demand responding to low-cost energy resulting from efficient systems, appliances and equipment.
Technologies	Investments in clean technologies to replace polluting sources. It can include natural gas to shift from dependence on diesel and heavy fuel oil for power generation and use NCG for transportation to replace petroleum fuels.	**Power distribution infrastructures**	Power distribution infrastructures entail strengthening power transmission and distribution infrastructure, reducing technical losses, and investing in supply reliability, which will respond to the increased demand around the infrastructure.
Sources	We need to move away from GHG-intensive sources such as diesel and gasoline. Natural gas could be a strategic fit to replace these sources in a transitional manner.	**Increased economic activities**	Increased economic activities in line with economic growth and population increase will directly affect the need for investment in reliable, affordable and versatile energy systems.
Research and Development	Fostering research and development will help a country to understand global trends and local needs. Scientific research provides a foundation for designing appropriate policies to embrace a sustainable and just energy transition that does not harm people, the economy, and the planet.	**Community movements on climate change**	Increased awareness of the impacts of climate change on the population (especially those directly affecting their livelihoods) will likely influence the policy direction of power systems investments.
Demand and supply factors are analysed in a multi-criteria analysis to inform appropriate policy pathways that entail different factors that affect sustainability, looking at the three dimensions: environment, society, and economy.			

Source: Author's analysis

3.2 Sampling

The study used a mix of sampling methods aligned with the nature of the research and the objectives. The sampling methods include theoretical and convenience techniques (Shaheen et al., 2019). The theoretical context of the study envisaged the data collected during the study, which was undertaken between 2023 and 2024, and the theory deployed focused on the hypothesis underlining the policy chosen for the decision to invest in the power sector in the African continent. Based on this, the author has made a judgment of the potential target audience for data and information collection; a specific target group that includes primarily those in the energy sector, notably experts and policymakers at the ministerial level, were consulted from Tanzania, Kenya, Uganda, Zimbabwe and the USA. The mix of sampling techniques has reduced the risks for bias and generalisation as it has considered diverse sources of information and data collection methods.

3.3 Data Analysis and Hypothesis Testing

The analysis of the findings considered the three sustainability fathers and gauged in Likert scale format: 1-Not important, 2-Less Important, 3-Can be considered, 4-Important, 5-Extremely Important. The findings are presented considering the level of occurrence of a particular factor based on the response received. Additional analysis used chi-square to prove the hypotheses. The research is meant to prove two null hypotheses in line with energy transition pathways for SSA by looking at the policy dimensions:

Null hypothesis 1 (H_{01}) Energy transition in SSA is primarily driven by economic growth rather than the climate change dimensions and

Null hypothesis 2 (H_{02}): Policies in sub-Saharan Africa need to be aligned with a multi-criteria approach to energy investments, defeating sustainability and the purpose of addressing the prevailing needs and issues facing the countries. Only the population interested in the subject matter was selected for the study.

The study uses statistical methods to test the stated hypothesis by comparing a sample's two specific data sets by looking at the hypothesised data against the one observed from the sample (Veazie, 2015). In building the data for the first hypothesis, it is assumed that all the parameters in the two sustainability dimensions carry equal weight and, thus, are equally distributed. These values are used as control values to test the change of the responses from the collected data. The

analysis from the collected data is then compared with the one carrying equal weight. The critical value is determined from standard calculations; it is the value that provides a reference that helps in deciding to reject or retain a null hypothesis. The critical value commonly known as the chi-square statistic ($\chi 2$ Test) is calculated from equation (1) (Singhal & Rana, 2015).

$$\chi 2 = \sum \frac{(O-E)^2}{E} \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where O = Observed frequency and E = expected frequency in each response category.

The chi-square calculation to analyse data and prove the hypothesis is performed using advanced Excel and the Statistical Package for the Social Sciences.

4. Presentation of Findings

4.1 Perspectives on Sustainable Energy Investment

Various categories of respondents were consulted in analysing the multi-criteria for sustainable energy policy dimensions. Respondents were primarily from Tanzania and other countries, including Kenya, Uganda, Zimbabwe and the USA. The presentation of the findings is primarily analytical, with statistical data that support the analysis.

Table 2: Summary of Perspectives on The Sustainable Pathways for Power Sector Investment

Stakeholder Group	Representations	Critical parameters for power sector investments
Power utility	Power utility	Security of supply, low cost of power generation, policies, and regulations.
Political class	Ministers and members of parliament, Ministers, etc.	Security of supply, reliability, and the cost of services.
Industry	Cement, brewing, steel, bottling, etc.	Security of supply, reliability, versatility, policies, and regulations.
Private sector	Project Developers, Sector Associations, etc.	Security of investment, supportive and predictable policies and regulations, markets, etc.
Government institutions	Ministries, regulators, science and technology institutions, sub-sector institutions such as gas and petroleum, etc.	General social services, increased access, and less government financial burden, e.g., incentives, subsidies, dispatchability, etc.
End users	Households, businesses, institutions	Reliability, affordability, versatility
Development partners	United Nations Organisations, Donor Communities, and Financing Institutions	Supporting international climate agenda, sector progression towards a low-carbon economy. Financing institutions (payment guarantees, international climate policies for strategic business positioning
Financing institutions	Commercial banks	Reliability of supply, cost of generation and services, guarantee of return on investments.
Academia	Universities and colleges	Technology proof of concepts, efficiency improvements.

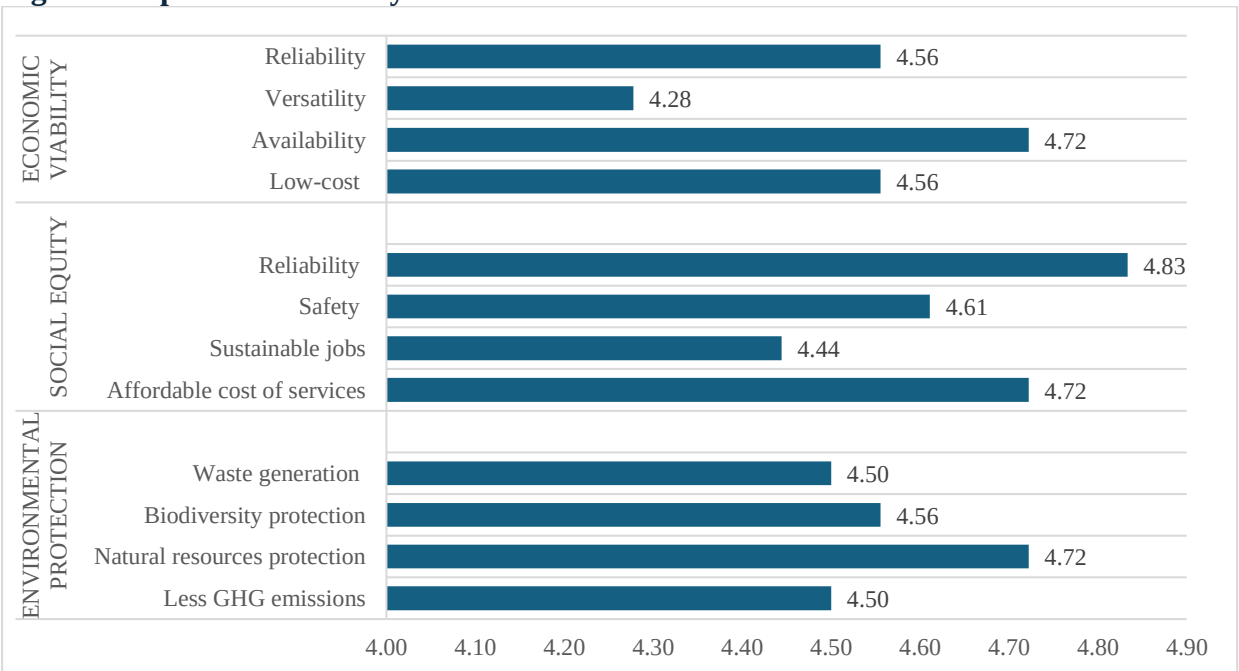
Source: Author's compilation of study participants' opinions

The opinions of different stakeholder groups in the power sector helped analyse the conditions that support their interests to inform viable energy transition policy frameworks. Table 2 summarises the perspectives of different groups on the sustainable pathways for investment in the power sector.

4.2 Unpacking the Three Dimensions of Sustainable Energy Transition

The research approached experts in various domains to provide opinions on what power sector investment should look at, as well as gathering non-expert opinions, considering the three sustainability dimensions: economic viability, social equity, and environmental protection. Thus informing the policy directions to support sustainable power investment pathways. Generally, there is a consensus that all three parameters are essential in designing policy for investing in the power sector for sustainable development. The findings indicate the consensus that the energy sector is people-centred and needs to invest in energy sources that do not harm the planet. In the three sustainability criteria, overlapping variables support energy service provision in support of the economy, protecting the environment, and fostering social well-being. Variables considered critical include the reliability of the power supply, affordability, and environmental protection. Figure 2 presents the aggregated ratings of the respondents in a numerical presentation.

Figure 2: Opinion on Priority Factors for Sustainable Investment in The Power Sector



Source: Author's Analysis

The environmental protection parameter was measured by looking at the sources prone to causing increased GHG emissions, natural resource and biodiversity protection, and waste generation. The findings in Figure 2 indicate a high acceptance level of considering these parameters when identifying energy sources that will safeguard the environment. The issue of power reliability, quality, and availability has emerged: power outages that compelled electricity users to resort to fossil-based sources, which in turn cause GHG emissions and effluent during servicing. According to EWURA reports, in 2021/22, Tanzania recorded 1397.38 hours of power outage, equivalent to 16 per cent of the time, an aggregate of two months a year (EWURA, 2023a). The findings further indicate that shifting to clean energy solutions should be across energy demand sectors, including transport, industry, and cooking.

The social equity parameter has considered issues directly affecting the population at hand; it aligns with issues related to the affordable cost of services, potential jobs created in line with power investments, power reliability, and the health and safety of the end users. As much as there has been an argument that renewable energy is increasingly becoming cheap, this does not guarantee any relief to the end users, such as providing an affordable cost of services. Solar and wind power generation technologies are too weather-dependent; their variability must be consistent with the current global push for them. The gigawatt-scale solar power takes up too much land at the expense of local communities; their post-construction operation and maintenance activities neither generate nor contribute to employment creation for local communities, as the jobs associated with these technologies need specific skill sets that are hardly available locally.

As for economic viability, investment in the power sector addresses four attributes: low cost, reliability, versatility, and affordability. African nations aim to achieve industrialisation by investing in energy sources that translate to affordable services. The economic viability parameter affects both the supply and demand sides. On the supply side, investors in the power infrastructure would consider those sources that guarantee the return on investments and can guarantee power supply. For industries, the issue of affordable services is critical as it determines the cost of the final product is vital. These end users would also prefer a source of energy that provides power for multiple uses without any limitations. The energy transition agenda for Tanzania needs to consider all these sustainability factors with a greater emphasis on a just transition. The transition supports socio-economic development while being mindful of environmental protection. A gradual transformation is necessary to use the available fossil fuels to support shifting towards a low-carbon power sector investment.

5. Discussion of Findings

The findings have been used to support the research objective: to understand critical dimensions required in designing power sector investment policy while considering the three sustainability factors: social, environmental, and economic. This study performs a qualitative analysis of the potential multidimensional considerations for the forward-looking power sector investments in times of competing but complimentary priorities between climate change and economic growth. The discussed outcomes address the supplementary perspectives on sustainable energy investment, the interpretations of sustainability dimensions, and the evaluation of the study hypotheses.

5.1 Sustainable Energy Investment Perspectives

The discussions with stakeholders indicate different understandings and priorities in this space. Those stakeholders affiliated with international policies align on prioritising addressing climate change, such as recent Multilateral Development Banks' stance of turning their backs on financing fossil fuels (Chason, 2024). Conversely, as argued by the African leaders, the continent needs to exploit its energy resources to achieve economic growth (Lawler, 2022). As evidenced by the findings, international climate policies tend to institute programmes and activities that do not necessarily align with the priorities of the global South. However, the findings have identified an interesting trend where the stakeholders affiliated with international policies are increasingly becoming flexible and trying to domesticate their support in the energy transformation, aligning with national priorities without necessarily sidelining fossil fuels (EU, 2021).

5.2 Dimensions of Sustainability in The Power Sector

The study findings provide a good insight into priority sustainability dimensions for a sustainable power sector investment; correspondingly, increased awareness of climate change impacts, addressing social equity, and accelerating economic development has gained interest among stakeholder groups; this makes all the dimensions largely interrelate rather than isolate. Despite stakeholders' differing views, they all concede that investing in the power sources and infrastructure that support the security of supply and guarantee the reliability and quality of supply is essential. As Peng et al. (2023) argued, investing in low-carbon power generation pathways positively affects general sustainable development (Peng et al., 2023). While the criteria for sustainable investment in the power sector do not numerically carry the same weights,

they all determine the future of power sector investments differently, with a common objective of achieving a just transition for people and the planet (IPCC, 2022).

The adopted methodology of this study may need to arrive at a solid theoretical basis for sustainable investment pathways for the power sector. The complexity of interlinkages between and amongst factors of sustainable investment pathways in the power sector is multidimensional and varies depending on context. The arguments in various literature on sustainable energy transition pathways often align with specific interests. International environmental advocates concentrate on environmental protection and climate change; conversely, energy transition links to geographies considering economic patterns and social activities (Bridge et al., 2013); wealthy nations tend to shift the burden to the developing world to adopt a new way of investment in the energy sector, developing world on the other hands argue that economic growth surpasses all the arguments. This energy transition is a region-by-region agenda (Tai et al., 2022).

Interestingly, the findings identified an overlap of the sustainability dimensions and laid an interesting foundation for how the three sustainability dimensions are interrelated. This provides a basis for further scrutiny for adopting a viable energy transition model with supporting policy tools tailored to the context of Sub-Saharan Africa. The findings underscore the theory of change laying a systemic mechanism (Serrat, 2013, 2017), which is critical to developing conducive frameworks to attract multi-stakeholder participation in the power sector investments to achieve energy sector decarbonisation gradually.

5.3 Revisiting Hypotheses: Policy Dimensions on SSA Energy Transition Pathways

The frequencies are calculated using the chi-square testing method from the sample population identified to fit the study objectives of understanding the appropriate energy transition pathways in the power sector; the study used twenty selected respondents to test the hypothesis using the chi-square statistical method. Table 3 presents a response distribution, presented in percentages. The first hypothesis has a null hypothesis, stating that the energy transition in the SSA does not include economic and environmental dimensions but emphasises economic factors. In this case, the alternative hypothesis is that the transition considers both parameters equally. The statistical method is employed to test the significance of the hypothesis, and the chi-square tool is used to test the significance of this argument. The results have used the standard confidence level of 95% significance; that is, in the chi-square table, the alpha value corresponds to 0.05 (L. Singh, 2022). The analysis has calculated the cut-off value below, for which the null hypothesis is considered

significant and retained. The analysis uses the two parameters and thus focuses on two degrees of freedom (df), in this case, the principle of df = k-1, where k is the number of response categories (Yu, 2011).

Table 3: Statistical Values and The Calculations from Chi-Square Hypothesis Testing

Parameters	First Hypothesis			Second Hypothesis	
	Expected	Observed		Expected	Observed
Economic	50	46.53		33.3	31.02
low-cost of energy	12.50	12.50		8.33	8.33
Reliability	12.50	12.50		8.33	8.33
Versatility	12.50	9.72		8.33	6.48
Availability	12.50	11.81		8.33	7.87
Environmental	50	45.83		33.3	30.56
GHG emissions	12.50	11.81		8.33	7.87
Natural resource protection	12.50	12.50		8.33	8.33
Biodiversity protection	12.50	11.11		8.33	7.41
Waste generation	12.50	10.42		8.33	6.94
Social Equity				33.3	31.02
Low cost of services				8.33	7.87
Sustainable Jobs				8.33	8.33
Safety				8.33	6.94
Reliability				8.33	7.87
Totals	100	92.36		100	92.59
Calculated Critical Value		0.589			0.553

Source: Author's calculations and analysis

The critical value is used to tally with the corresponding significance level (Learn Something, 2019). With a significance level of 0.05, thus the first line in the chi-square table is considered (Table 4).

Table 4: Extract of A Chi-Square Distribution Table Used for Hypothesis Testing

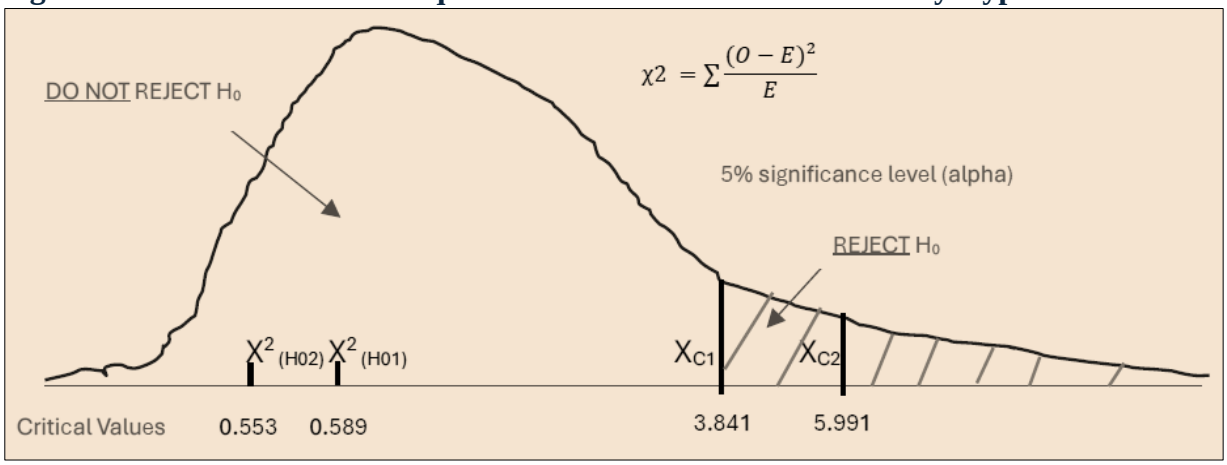
	Probability Level (Alpha)									
df/α	**0.005**	**0.01**	**0.025**	**0.05**	**0.1**	**0.995**	**0.99**	**0.975**	**0.95**	**0.9**
1	7.879	6.635	5.024	3.841	2.706	0.000	0.000	0.001	0.004	0.016
2	10.597	9.210	7.378	5.991	4.605	0.010	0.020	0.051	0.103	0.211
3	12.838	11.345	9.348	7.815	6.251	0.072	0.115	0.216	0.352	0.584
4	14.860	13.277	11.143	9.488	7.779	0.207	0.297	0.484	0.711	1.064
5	16.750	15.086	12.833	11.070	9.236	0.412	0.554	0.831	1.145	1.610

Source: Author generated, using standard calculations

The appropriate critical value is 3.841, and the decision rule is that the null hypothesis is rejected if $\chi 2 \geq 3.84$ (Singhal & Rana, 2015). The critical value corresponding with the significance level of 0.05 appears at the table's far right. From this statistical analysis, the null hypothesis is retained as the obtained critical value is less than the figure for rejecting the hypothesis. In this case, investments in the power sector in sub-Saharan African countries other than South Africa are likely to consider economic parameters rather than environmental factors primarily. However, with this testing method, the opinion is not the sole decision to conclude against other possible considerations as the relations between the parameters cannot be determined by this method (Singhal & Rana, 2015); thus, in the real world, it is possible to have other factors being considered in the power sector investments, apart from the economic aspects.

Employing the chi-square equation for a critical factor, the second hypothesis, which considers all the sustainability parameters (the null hypothesis), yields a critical value of 5.991; its corresponding significance level value in the second row is far on the right of the table (three parameters minus one). Thus, the value is smaller than the appropriate critical value. Like the first hypothesis, the resultant critical value in the second null hypothesis is 5.991, less than the critical value corresponding to the 0.05 significant level.

Figure 3: Presentation of Chi-Square Distribution for The Two Study Hypotheses



Source: Author generated through calculations and analysis

Thus, from a statistical point of view, the null hypothesis is retained as for the first hypothesis. The null hypothesis is maintained and considered highly probable; from this analysis, it is then likely that investments in the power sector do not consider all the sustainability factors. It means that a few parameters are considered and are sporadic. The study has considered two null hypotheses to prove the hypotheses in line with energy transition pathways for sub-Saharan

Africa by looking at the policy dimensions: Energy transition in Sub-Saharan Africa is primarily driven by economic growth rather than the climate change dimensions, and Policies in the region are not aligned with a multi-criteria approach in energy investments; as such, defeating sustainability and the purpose of addressing the prevailing needs and issues facing the countries. The study findings have proved the two hypotheses to be significant. The findings show that investments in the power sector in sub-Saharan Africa are primarily driven by the quest to provide more power to the population, such as increasing access and providing energy for economic development.

In line with the first hypothesis, the second hypothesis on considerations for multi-criteria in energy investments is largely true; the investments in the power sector can be argued to be biased on a few aspects of sustainability. Investments are mainly retroactive, and little attention is given to some of the sustainability criteria, such as the social impacts of the investments, looking at various parameters such as health, convenience, and the affordability of energy services. Lack of predictable policies and political interferences have been critical impediment factors for private sector investments in the power sector, especially renewable energy space (Azhgaliyeva et al., 2023).

6. Theorising Sustainable Power Investment Pathway for Tanzania

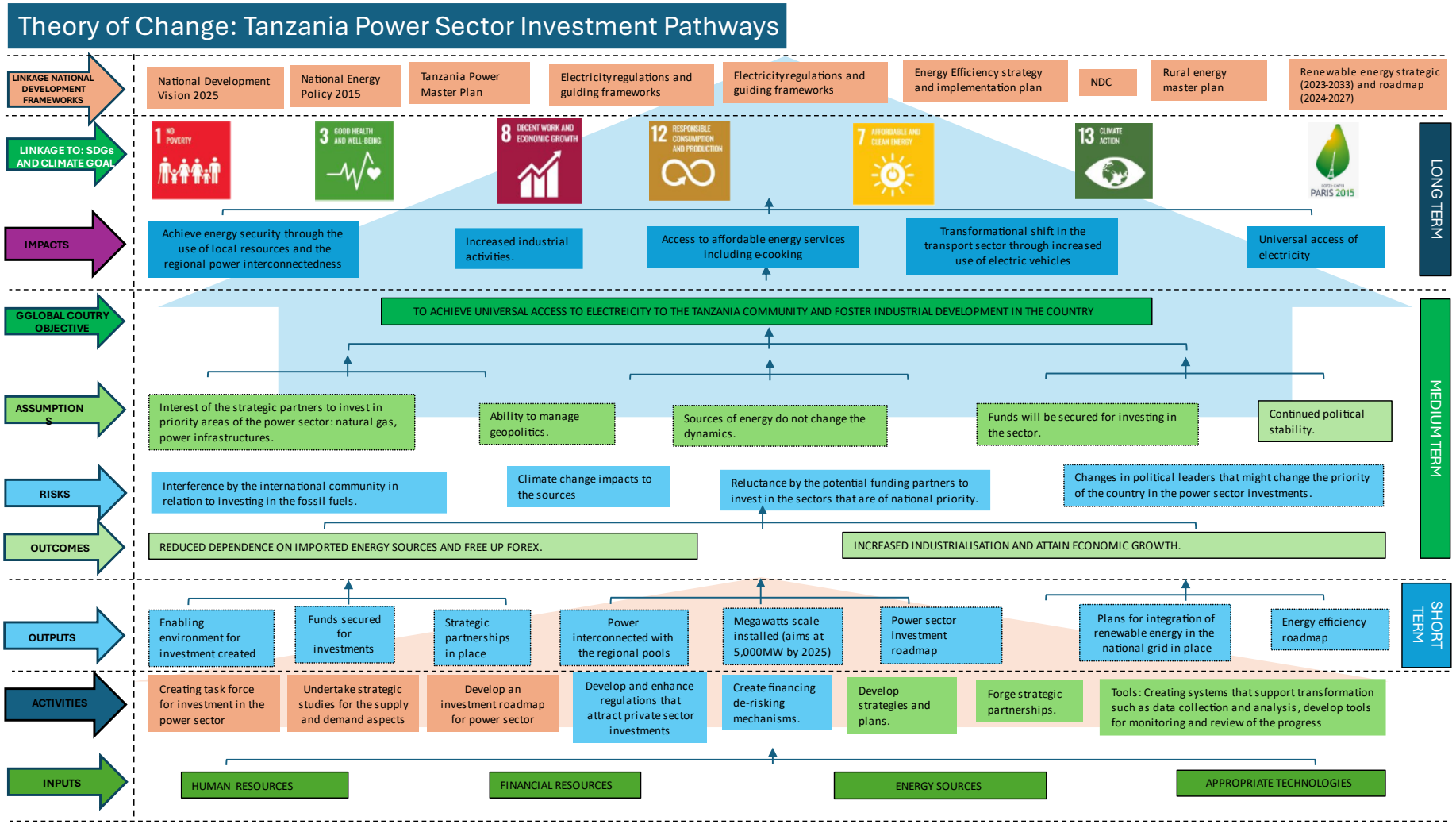
The study has not had access to the literature in the public domain regarding Theorising the energy transition in Tanzania; literature provides other aspects of energy transition from technology and resources available at the country's disposal (Andreoni et al., 2021; ASF et al., 2023; Miranda, 2023; Norconsult, 2022). in this process, the public must be involved in understanding their priorities in the energy sector and potentially what the government plans are in this discourse. It is argued that the energy transition from fossil fuels to clean energy options can only happen rationally, considering public opinions and needs (Arababadi et al., 2021). People’s perceptions and preferences feed the political decisions at local and global levels. The energy transition agenda often takes a linear form and generalises issues across the globe, overlooking the complexities of economic development, poverty alleviation, energy security, and affordability of services (Singh & Arya, 2024). According to the findings, Tanzania's sustainable power investment pathway can be presented in a Theory of Change format. Looking at the goal and bigger impact the country seeks to achieve, what are the short- and long-term plans (outputs), and how can these outputs be achieved? It is also possible to look at potential assumptions that

can be considered and the risks associated with what is viewed as the sustainable pathways for power sector investment in Tanzania.

The primary goal is to achieve universal access to electricity and foster economic growth; much as the global GHG reduction goal is not much featured in this theory of change, the investment is thought to be made in a manner that directly aligns with the international climate goal of achieving GHG emissions. Tanzania articulates its power master plan, which aims at investing substantially to scale and such sources that are better positioned to provide baseload and flexible and dispatchable; under this auspice, the country seeks to invest in its hydrocarbon resources, which include natural gas and coal. Natural gas discoveries reached 57.54 trillion Cubic Feet. As of 2020, Tanzania had around 1.24 trillion cubic feet of economically recoverable gas reserves (TPDC, 2024).

Tanzania has a coal reserve estimated at 1.2 - 5 billion tons; 25 per cent of this is proven. It is claimed that the estimated total reserves are 1.9 billion tons (Norconsult, 2020). The coal deposits are primarily for export (Christopher, 2023), and a few are used internally on process heat. The challenges in this pathway will be securing the necessary financing to invest in these internationally controversial sources. From the research findings gathered from Tanzania and other countries, it is possible to develop a theory of change for what can be viewed as sustainable investment in Tanzania's power sector, depicted in Figure 4.

Figure 4: Theorising Tanzania's Sustainable Power Sector Investment



Source: Literature and Findings

7. Conclusions

The research analysed factors critical to designing a policy framework that considers people and the planet, such as fostering socio-economic growth and addressing climate change concerns through mitigation and adaptation. The study interest was in sub-Saharan Africa. The study findings have identified a strong sentiment on the importance of the energy sector in accelerating economic growth. The sustainable energy transition can strategically prioritise investments in the power sector in the short, medium, and long terms to accelerate its journey towards a cleaner, more resilient, and inclusive energy future. This holistic approach addresses immediate energy needs and lays the foundation for long-term environmental sustainability, economic prosperity, and social development. In the short term, some potential measures could be to enhance energy efficiency on the demand and supply sides to free up some energy and avoid additional investments in the generation assets. The long-term pertains to integrating renewables and connecting to the grid of nearby countries and regions far from the generation stations. In addition, regulations are needed to force energy users to use energy-efficient systems and equipment, as high energy efficiency implies less energy requirements to produce the same output.

While a transition to a low-carbon development pathway is essential for climate change mitigation purposes, for sub-Saharan Africa, given the continent's minuscule contribution to the climate impacts and the vast unmet primary energy needs of its people, the continent should pursue a transition path and technologies that meet need for large dependable and affordable energy services. To that end, the continent should utilise its natural resources in pursuit of universal access to electricity. However, this should be approached cautiously; Africa being allowed to pollute just like industrialised countries is fallacious, as two wrongs cannot make it right. Climate change is global, and everyone is responsible for controlling its increased catastrophic impacts. However, the West is giving the South the benefit of the doubt by denying necessary support for a just, equitable and sustainable energy transition discourse, including investing in natural gas. This low-carbon option goes well with the transition towards renewables. However, someone needs to take some initiative to limit global GHG emissions; it should be a shared responsibility with differentiated roles. In this case, we must allow free riders to enjoy public goods in the contemporary economic context (Leo & Singh, 2022).

Adopting appropriate investment policies, having a robust regulatory framework, crafting an appropriate power sector development master plan, and developing resources in strict adherence to the recommendations in the power sector master plans will support promoting sustainable investment in the power sector.

8. Recommendations

The research findings have identified several issues that need consideration for policy dimensions to embrace sustainable power sector investments in Tanzania. They also converge to considerations for the country's policy direction, which aims at achieving universal access to electricity by 2030 and meeting its industrialisation goal in the medium term. The recommendations articulated in this research paper consider this priority to align with the need to achieve energy security and embrace socio-economic transformation while addressing potential environmental concerns. From this, the research offers some recommendations for policy and regulatory reforms to meet the national and global objectives of a sustainable future. The national energy policy provides key general statements on promoting renewable energy. Section 3.1.4 articulates the need to integrate renewable energy into the energy mix (MoE, 2015); several energy sources have been mentioned. Recently, other emerging technologies have gained traction, and increasingly, stakeholders are interested in them; such technologies include hydrogen development, which is not featured in the current energy policy. Other developments that could be better captured in the policy include biofuel technologies and electric mobility. It will be essential to include such developments in the policy review.

Policy objectives to promote clean cooking solutions need more regulatory backing. Section 3.1.6 of the National Energy Sector Policy 2015 encourages using alternative energy sources and fuels for cooking to avoid overdependence on unsustainable biomass sources (MoE, 2015). The government of Tanzania recently launched a ten-year clean cooking strategy for 2024-2034, aiming to achieve 80 per cent of the population using clean cooking solutions by 2034 (MoE, 2024). It calls for establishing the regulatory frameworks that will support this motive, such as standards for electric cooking solutions, which will be essential. It also goes with establishing special tariffs that will attract the population to use electricity for cooking and efficient methods.

It would be essential to consider reviewing the national electricity tariff structure, which has been in operation since 2016 (TANESCO, 2017), thus affecting the utility's financial performance as it needs to account for inflations and other financial changes over the years. It is also an important aspect of devising means of operationalising regulatory frameworks. One of the areas that will need to be closely examined is the net metering framework (EWURA, 2028) that would allow individual power generators to trade electricity with the power utility; however, since its establishment in 2018, it has yet to be in operation. It would be best to address the challenges that have been identified that impede its implementation through regular regulatory reviews.

Another regulatory gap essential for review is enhanced methods to collect data for the rollout of renewable energy systems in urban and rural areas. Currently, it takes work to locate data that reflect the trend. Only a few outdated reports that do not fully cover the trends (GOGLA, 2023a, 2023b). E-mobility is increasingly gaining traction; the developments have evidenced the retroactive culture, as there is an ongoing development of e-mobility policy, which, in a sense, has been overtaken by events. Under similar auspices, regulatory tools need to be established to guide the rollout of the e-mobility in terms of equipment standards, the potential for tax incentives to promote the transformation, and the need to mandate local assembly. With the identified policy and regulatory gaps and challenges in the sector, it would be paramount to review them alongside building necessary capacities, creating task forces to deal with issues inherent to the energy sector, and having a roadmap to supplement the national systems master plan, that will guide investments in the power sector. It would also be essential to invest in research and development to keep the nation abreast with the latest developments in the sector.

The study also gathered that the existing vertically integrated structure of the utility reduces operational efficiencies. Thus, there is a call to unbundle the power utility to increase its efficiency. Unbundling can take different forms: functional, accounting, legal, ownership, system operation, and transmission operation (Boulle, 2019). There is a need to undertake a proper assessment to inform the appropriate unbundling approach to be considered.

9. Limitations and Potential Areas for Further Studies

The research method adopted is primarily qualitative, related mainly to literature reviews and interviews; this will likely fall prey to biases. The study sampled respondents in different categories: policymakers, the private sector, energy end users, development partners, and research institutions. The analysis of findings is limited to data collected and the literature reviews. The research method assumes that the sources provided enough information to assist in arriving at appropriate conclusions that will shape the policy direction of a nation in matters of energy transition. It could be interesting to research further specific policy tools that can be used to achieve sustainable power sector investments. Such tools include creating conducive and necessary conditions for multi-stakeholder participation through clear incentives and distinctive structures, such as grant schemes, enhanced productive uses of energy, local participation in energy investments, special investment guarantee schemes, etc.

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References

Andreoni, A., Tasciotti, L., & Tayari, E. (2021). Feasible pathways for energy transition in Tanzania: Shifting unproductive subsidies towards targeted green rents. *ACE*. https://ace.soas.ac.uk/publication/feasible-pathways-for-energy-transition-in-tanzania-shifting-unproductive-subsidies-towards-targeted-green-rents/

Arababadi, A., Leyer, S., Hansen, J., Arababadi, R., & Pignatta, G. (2021). Characterising the Theory of Energy Transition in Luxembourg, Part Two-On Energy Enthusiasts' Viewpoints. Sustainability. https://doi.org/10.3390/su132112069

ASF, BHRT, HakiRasilimani, & IPIS. (2023). Tanzania and the energy transition: Potential, progress and challenges. IPIS. https://ipisresearch.be/weekly-briefing/tanzania-and-the-energy-transition-potential-progress-and-challenges/

AtlanticCouncil. (2022). The global energy and climate security challenge [Video recording]. https://www.youtube.com/watch?v=tyeQKHs1R_8

Azhgaliyeva, D., Beirne, J., & Mishra, R. (2023). What matters for private investment in renewable energy? *Climate Policy*, 23(1), 71–87. https://doi.org/10.1080/14693062.2022.2069664

Biririza, E. G. M. (2024a). A Review of Energy Security in The Face of Climate Security: Matching the Country Priorities with International Policies. *Journal of Energy Technologies and Policy*, 14(2), 77. https://doi.org/10.7176/JETP/14-2-06

Biririza, E. G. M. (2024b). Energy Transition Agenda in Tanzania Within the Auspice of Sub-Saharan Africa: A Review of the Power Sector. *International Journal of Economy, Energy and Environment*, 9(3), Article 3. https://doi.org/10.11648/j.ijeee.20240903.11

Boulle, M. (2019). Global Experience of Unbundling National Power Utilities. Graduate School of Business, University of Cape Town. https://www.gsb.uct.ac.za/files/Global_experiences_of_unbundling_national_utilities_MBoulle.pdf#:~:text=Overview.%20Globally%20we%20have%20seen%20a%20wave%20of

Bridge, G., Bouzarovski, S., Bradshaw, M., & Eyre, N. (2013). Geographies of energy transition: Space, place and the low-carbon economy. *Energy Policy*, pp. 53, 331–340. https://doi.org/10.1016/j.enpol.2012.10.066

Chason, R. (2024). African production of natural gas poses a vexing climate challenge. Washington Post. https://www.washingtonpost.com/world/2024/01/31/senegal-natural-gas-climate-change/

Christopher, J. (2023). Tanzania's coal exports rise to a record high. The Citizen. https://www.thecitizen.co.tz/tanzania/news/national/tanzania-s-coal-exports-rise-to-a-record-high-4227128

Energy and Water Utilities Regulatory Authority. (2023). Electricity Sub-Sector Regulatory Performance Report for The Financial Year 2021/22. Energy and Water Utilities Regulatory Authority.

Energy and Water Utilities Regulatory Authority. (2028). The Electricity (Net-Metering) Rules, 2018. EWURA. https://www.ewura.go.tz/wp-content/uploads/2018/04/SUPP-GN-No-76-The-Electricity-NET-METERING-Rules-2018.pdf#:~:text=%E2%80%9Cnet-metering%E2%80%9D%20means%20measuring%20the%20difference%20between%20an%20imported

Erdoğan, Ş. (2023). Investigation of Doctoral Theses in Physics Education in Turkiye in Terms of Theoretical and Conceptual Framework. 13, 362–368. https://doi.org/10.47750/pegegog.13.03.36

European Union. (2021). The government of Tanzania and the European Union signed six projects to boost the energy sector and private sector development. The Diplomatic Service of the European Union. https://www.eeas.europa.eu/delegations/tanzania/government-tanzania-and-european-union-sign-six-projects-boost-energy-sector-and-private-sector_en?s=124

Global Off-Grid Solar. (2023a). global off-grid solar market report semi-annual sales & impact data. GOGLA. https://www.gogla.org/wp-content/uploads/2024/05/GOGLA_Sales-and-Impact-ReportH2-2023_FINAL.pdf

Global Off-Grid Solar. (2023b). Tanzania Country Brief. GOGLA. https://www.gogla.org/wp-content/uploads/2022/12/Tanzania-Country-Brief.pdf#:~:text=Tanzania%20has%20a%20total%20population%20of%20over%2058

IEA, IRENA, UNSD, World Bank, & WHO. (2021). Tracking SDG 7: The Energy Progress Report 2021. World Bank. https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2021

International Energy Agency. (2022). Africa Energy Outlook 2022. International Energy Agency. https://www.iea.org/reports/africa-energy-outlook-2022/key-findings

IPCC. (2022). Climate Change: A Threat to Human Wellbeing and Health of the Planet. Taking action now can secure our future. IPCC. https://www.ipcc.ch/2022/02/28/pr-wgii-ar6/

Kim, Y., Tanaka, K., & Matsuoka, S. (2020). Environmental and Economic Effectiveness of The Kyoto Protocol. *PLOS ONE*, 15(7), e0236299. https://doi.org/10.1371/journal.pone.0236299

Kühne, O., Parush, D., Shmueli, D., & Jenal, C. (2022). conflicted energy transition—conception of a theoretical framework for its investigation. *Land*, 11(1), Article 1. https://doi.org/10.3390/land11010116

Lawler, A. (2022). Industry Officials Say Africa Must Use Its Gas Reserves to Drive the Economy. Reuters. https://www.reuters.com/business/energy/africa-must-use-its-gas-reserves-drive-economy-industry-officials-say-2022-11-01/

Learn Something. (2019). How to Calculate Chi Square Using Excel =CHISQ.TEST and =CHISQ.INV.RT [Video recording]. https://www.youtube.com/watch?v=ckcUt3EyD-Q

Lederman, N., & Lederman, J. (2015). What Is a Theoretical Framework? A Practical Answer. *Journal of Science Teacher Education*, 26. https://doi.org/10.1007/s10972-015-9443-2

Leke, A., Gaius-Obaseki, P., & Onyekweli, O. (2022). The Future of African Oil and Gas: Positioning for The Energy Transition. McKinsey & Company. https://www.mckinsey.com/industries/oil-and-gas/our-insights/the-future-of-african-oil-and-gas-positioning-for-the-energy-transition#/

Leo, U., & Singh, N. (2022). How the right incentives could solve "free-rider" problem in climate change mitigation. *World Economic Forum*. https://www.weforum.org/agenda/2022/06/incentives-free-rider-problem-climate-change-mitigation/

Linderhof, V., Dekkers, K., & Polman, N. (2020). The Role of Mitigation Options for Achieving a Low-Carbon Economy in the Netherlands in 2050 Using a System Dynamics Modelling Approach. *Climate*, 8, 132. https://doi.org/10.3390/cli8110132

Madurai Elavarasan, R., Nadarajah, M., Pugazhendhi, R., Sinha, A., Gangatharan, S., Chiaramonti, D., & Abou Houran, M. (2023). The untold subtlety of energy consumption and its

influence on policy drive towards Sustainable Development Goal 7. *Applied Energy*, 334, 120698. https://doi.org/10.1016/j.apenergy.2023.120698

Mayne, J. (2015). Useful Theory of Change Models. *Canadian Journal of Program Evaluation*, p. 30. https://doi.org/10.3138/cjpe.30.2.142

Mercer, H., & Simpson, T. (2023). Imperialism, colonialism, and climate change science. Wiley Interdisciplinary Reviews: *Climate Change*, p. 14. https://doi.org/10.1002/wcc.851

Ministry of Energy. (2015). Tanzania's National Energy Policy 2015. Ministry of Energy. https://www.nishati.go.tz/uploads/documents/en-1622283004-National%20Energy%20Policy%20(NEP),%202015.pdf#:~:text=Energy%20Conservation%20A%20measure%20to%20reduce%20energy%20consumption

Ministry of Energy. (2024). Tanzania's National Clean Cooking Strategy 2024-2034. Government of Tanzania. https://www.nishati.go.tz/uploads/documents/en-1717485663-NATIONAL%20CLEAN%20COOKING%20STRATEGY%20(2024-2034)....pdf#:~:text=%CB%9Ce%20National%20Clean%20Cooking%20Strategy%20arises%20from%20the

Miranda, R. (2023). Tanzania prioritises clean energy transition. The Citizen. https://www.thecitizen.co.tz/tanzania/news/national/tanzania-prioritises-clean-energy-transition-4317480

Mukhtar, M., Adun, H., Cai, D., Obiora, S., Taiwo, M., Ni, T., Ozsahin, D. U., & Bamisile, O. (2023). Juxtaposing Sub-Sahara Africa's energy poverty and renewable energy potential. *Scientific Reports*, 13(1)1. https://doi.org/10.1038/s41598-023-38642-4

Norad. (2020). *Joint Review of Swedish/Norwegian Support to the Southern African Power Pool and the Eastern African Power Pool: Norad Collected Reviews* 8/2019, https://www.norad.no/contentassets/2377b9a3ca674019815d2aca917be9b0/joint-review-of-swedish_norwegian-support-to-the-southern-african-power-pool-and-the-eastern-african-power-pool-.pdf

Norad. (2022). *Clean Energy Transition in Tanzania: Powering Sustainable Development*. Royal Norwegian Embassy in Dar es Salaam. https://www.norway.no/contentassets/00c56b3642e5429fbc917d5fa42ff869/clean-energy-transition-in-tanzania-report.pdf

Organisation For Economic Cooperation and Development. (2023). *Understanding and Applying the Precautionary Principle in the Energy Transition.* OECD Publishing. https://doi.org/10.1787/5b14362c-en

Pan, X., Shao, T., Zheng, X., Zhang, Y., Ma, X., & Zhang, Q. (2023). Energy and sustainable development nexus: A review. *Energy Strategy Reviews*, p. 47, 101078. https://doi.org/10.1016/j.esr.2023.101078

Peng, K., Feng, K., Chen, B., Shan, Y., Zhang, N., Wang, P., Fang, K., Bai, Y., Zou, X., Wei, W., Geng, X., Zhang, Y., & Li, J. (2023). The global power sector's low-carbon transition may enhance sustainable development goal achievement. *Nature Communications*, 14(1), 3144. https://doi.org/10.1038/s41467-023-38987-4

Ritchie, H. (2020, September 18). Sector by sector: Where do global greenhouse gas emissions come from? Our World in Data. https://ourworldindata.org/ghg-emissions-by-sector

Rogelj, J., Forster, P. M., Kriegler, E., Smith, C. J., & Séférian, R. (2019). Estimating and tracking the remaining carbon budget for stringent climate targets. *Nature*, 571(7765), Article 7765. https://doi.org/10.1038/s41586-019-1368-z

Rural Energy Agency and Bureau of Statistics. (2020). Energy Access and Use Situation Survey in Tanzania Mainland. Rural Energy Agency and Bureau of Statistics. https://rea.go.tz/Articles/energy-access-and-use-situation-survey-in-tanzania-mainland-april-2020

Serrat, O. (2013. A Guide to Theories of Change. https://www.researchgate.net/publication/274899393_A_Guide_to_Theories_of_Change

Serrat, O. (2017). Theories of Change. https://doi.org/10.1007/978-981-10-0983-9_24

Shaheen, M., Pradhan, S., & Ranajee, R. (2019). Sampling in Qualitative Research (pp. 25–51). In IGL. https://doi.org/10.4018/978-1-5225-5366-3.ch002

Singh, A., & Arya, A. (2024). *One planet, two realities: Realising energy transition in the Global South. S&P Global.* https://www.spglobal.com/en/research-insights/featured/special-editorial/look-forward/one-planet-two-realities-realizing-energy-transition-in-the-global-south

Singh, L. (2022). A Practical Application of Chi-square Test in Hypothesis Testing. *Empirical Economics Letters*, 21 (1) pp. 17–25.

Singhal, R., & Rana, R. (2015). Chi-square test and its application in hypothesis testing. *Journal of the Practice of Cardiovascular Sciences*, 1. https://doi.org/10.4103/2395-5414.157577

Smil, V. (2017). Table of Contents. In *Energy and Civilization: A History* (REV-Revised, 2, pp. v–viii). The MIT Press. http://www.jstor.org/stable/j.ctt1pwt6jj.2.

Smith, S., Geden, O., Gidden, M., Lamb, W. F., Nemet, G. F., Minx, J., Buck, H., Burke, J., Cox, E., & Edwards, M. (2024). *The State of Carbon Dioxide Removal—2nd Edition*. https://doi.org/10.17605/OSF.IO/F85QJ

Sokona, Y., & Denton, F. (2001). Climate change impacts: Can Africa cope with the challenges? *Climate Policy*, 1(1), 117–123. https://doi.org/10.1016/S1469-3062(00)00009-7

Tai, H., Samandari, H., Pacthod, D., Polymeneas, E., Bolano, A., Pratt, M. P., & Lodesani, F. (2022). *The energy transition: A region-by-region agenda for near-term action. McKinsey & Company*. https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-energy-transition-a-region-by-region-agenda-for-near-term-action#/

Tanzania Electrical Supply Company. (2017). *TANESCO - Tariffs. Tanzania Electric Supply Company Limited*. https://www.tanesco.co.tz/customer-services/tariffs

Tanzania Petroleum Development Corporation. (2024). *Overview of the Petroleum Sub-Sector*. The Energy Sector Public Dialogue.

Veazie, P. J. (2015). Understanding Statistical Testing. *Sage Open*, 5(1), 2158244014567685. https://doi.org/10.1177/2158244014567685

World Economic Forum. (2024). *What are carbon budgets, and how can they help us reach net zero?* World Economic Forum. https://www.weforum.org/agenda/2024/03/carbon-budget-climate-change-net-zero/

Yu, C. H. (2011). Degrees of Freedom. In M. Lovric (Ed.), *International Encyclopedia of Statistical Science* (pp. 363–365). Springer. https://doi.org/10.1007/978-3-642-04898-2_204