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An Analysis of Electrification in Kenya

Tex Antony Marigi Wambui

Clark Atlanta University, Atlanta, Georgia

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I. INTRODUCTION

In today's interconnected global landscape, the pursuit of equitable technology accessibility stands as a paramount objective, especially in regions facing developmental challenges such as Kenya. The United States Agency for International Development (USAID), recognizing the global significance of these issues, plays a key role in addressing them. This research centers on Kenya's imperative need for energy access and its profound implications for bridging the digital equity gap, especially in education and economic development.

Persistent educational disparities and technology access gaps are challenges experienced globally, with Kenya exemplifying the struggles faced by developing nations. In Kenya, access to reliable electricity emerges as a linchpin for broadening technology accessibility. Diverse energy sources power technological innovations that hold the potential to revolutionize the institutional landscape. In turn, equitable practices in education, agricultural and industrial are vital for preparing individuals to actively participate in an evolving energy landscape characterized by sustainability, digitalization, and inclusivity.

The availability and reliability of electricity traditionally serve as key indicators of a nation's development. Electricity, beyond powering homes and industries, has now become a catalyst for the knowledge economy, serving as the conduit through which information is delivered and accessed on a global scale. However, in Kenya, disparities in access to electricity persists as a significant barrier to achieving equitable education and technology accessibility.

The research delves into the intricate relationship between electricity, and the energy sector in Kenya. It not only highlights challenges, but also analyze strategies to develop sustainable energy solutions in Kenya. The paper delves into the fundamental components enhancing electricity access, with a particular focus on their impact on fostering technology accessibility. Moreover, the paper provides an analysis on energy consumption in Kenya, offering insights into the sector's dynamics. The convergence of energy and technology in Kenya presents challenge

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and a transformative opportunity to reshape the nation's future for the better. The discussion that follows focuses on organizational overviews that help understand the study's landscape.

II. ORGANIZATIONAL OVERVIEW

The United States Agency for International Development (USAID) assumes a pivotal role in the United States' commitment to global development and humanitarian aid. Established in 1961, USAID's core mission centers around the alleviation of poverty, promotion of economic growth, and enhancement of stability on a worldwide scale (Organization | U.S. Agency for International Development, 2019). The agency operates with the primary objective of nurturing resilient societies, fortifying democratic institutions, and extending essential assistance to individuals and communities, both within the United States and across the globe. Within this context, the present research is oriented toward addressing Kenya's acute necessity for accessible energy and the consequential implications for equitable education (Organization | U.S. Agency for International Development, 2019).

The mentorship experience at Stand Together Foundation combined individualized education with direct work experience to empower a social entrepreneur approach to develop principled, and mutual benefit projects. The mentorship experience facilitated connecting with government agencies such as the USAID, Bureau of Africa, and think tanks to engage in a series of conversation that pushed for advancing renewable energy initiatives within the United States and Africa. Additionally, the mentorship experience supported in developing policy briefs, reports, and research findings to program managers, and policy makers. This was achieved through conferences, attending webinars and seminars, interviewing experts in the field, and drafting an op-ed related to energy policy. Alongside the mentorship, the internship experience at the Independence Institute centered on energy policy. The duties of the intern involved participating in institute events, policy analysis, in-depth research on energy, and navigating the political landscape. Specifically, the intern supported in projects that focused on state-based think tanks as well as facilitating a project that promotes a free market in energy production and advocates for a government to remain neutral and level the playing so that the consumer reaps the benefits of a healthy-energy market-competition, lower prices, and more options. Thus, through this experience an observation was made that the USAID, Kenya Ministry of Energy and Ministry of Education are fundamental organizations to closing the energy disparity and using education as a benchmark within sub-Saharan Africa, especially Kenya.

USAID comprises several key roles that synergize their efforts to further the agency's mission. The **Director of USAID** serves as the highest authority, offering direction and oversight for all the agency's activities. Assisting the Director in ensuring the effective execution of programs and initiatives is the **Deputy Director**. Working in tandem with the Director and Deputy Director, the

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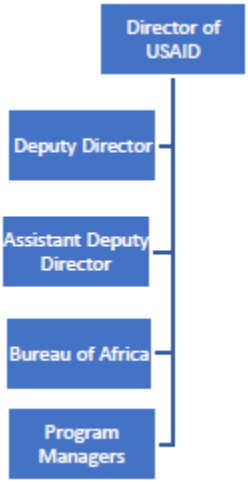
Assistant Director plays a vital role in program management and coordination, fostering the coherence of numerous initiatives.

Program Managers take charge of directing and overseeing specific programs, with some dedicated to education and energy, themes at the core of this research.

Pertinently, the researcher's experience as a Stand Together Fellow at the Independence Institute, focused on Energy Policy, enriched the understanding of energy-related matters and policy development, providing unique insights that align with the research focus. The internship experience focused on identifying innovative methods to provide a reliable grid system within the state of Colorado with nuclear energy. This work resulted in developing an op-ed to facilitate conversation between policymakers on why it is significant to have a forward-thinking approach on energy policy in the State of Colorado. Additionally, through the internship experience a problem was identified that collaboration with agencies across intercontinental spaces is lacking due to minimal conversation within policymakers on what is needed to provide equitable energy access to bridge the digital equity gap. Chart 1 below provides the layout of the roles within USAID.

Chart 1



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USAID's bureau for Africa is a multifaceted entity comprising various offices with specific functions. In fiscal year 2021, USAID and the U.S. Department of State provided $8.5 billion of assistance to 47 countries and 8 regional programs in sub- Saharan Africa. The **Office of the Assistant Administrator (AFR/AA)** provides direction and supervision for the bureaus overseas operations, while the **Office of Development Planning (AFR/DP)** leads in strategy

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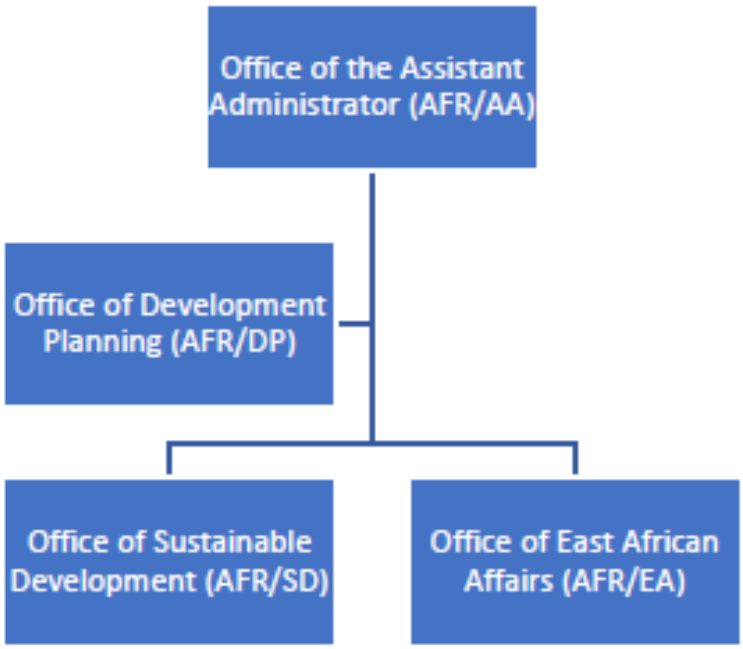
development, program monitoring, and funding. The **Office of Sustainable Development (AFR/SD)** offers strategic leadership, specializing in sectors like health, education, conflict resolution, and economic growth. Additionally, the Office of East African Affairs (AFR/EA) supports programs in East Africa (Bureau of Africa | Organizations, 2023). Chart 2 below displays the layout.

Chart 2



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Within the **Kenya Ministry of Energy**, pivotal divisions operate to facilitate the country's energy-related objectives. The Renewable Energy Division dedicates its efforts to the promotion and development of renewable energy sources, encompassing wind, solar, and hydropower. This aligns with Kenya's commitment to sustainable and clean energy practices. The Electricity Regulatory Division formulates regulatory and policy frameworks, ensuring the equitable and efficient operation of the nation's energy systems (Organisation Structure | Energy, 2023).

Crucially, the Energy Access and Rural Electrification Division is actively involved in extending electricity access to underserved areas, often employing innovative approaches like micro-grid technology and off-grid solutions. These initiatives are indispensable elements of addressing energy disparities in Kenya. Additionally, the Energy Planning and Policy Division is engaged in the formulation of energy policies and long-term planning strategies, aligning Kenya's energy

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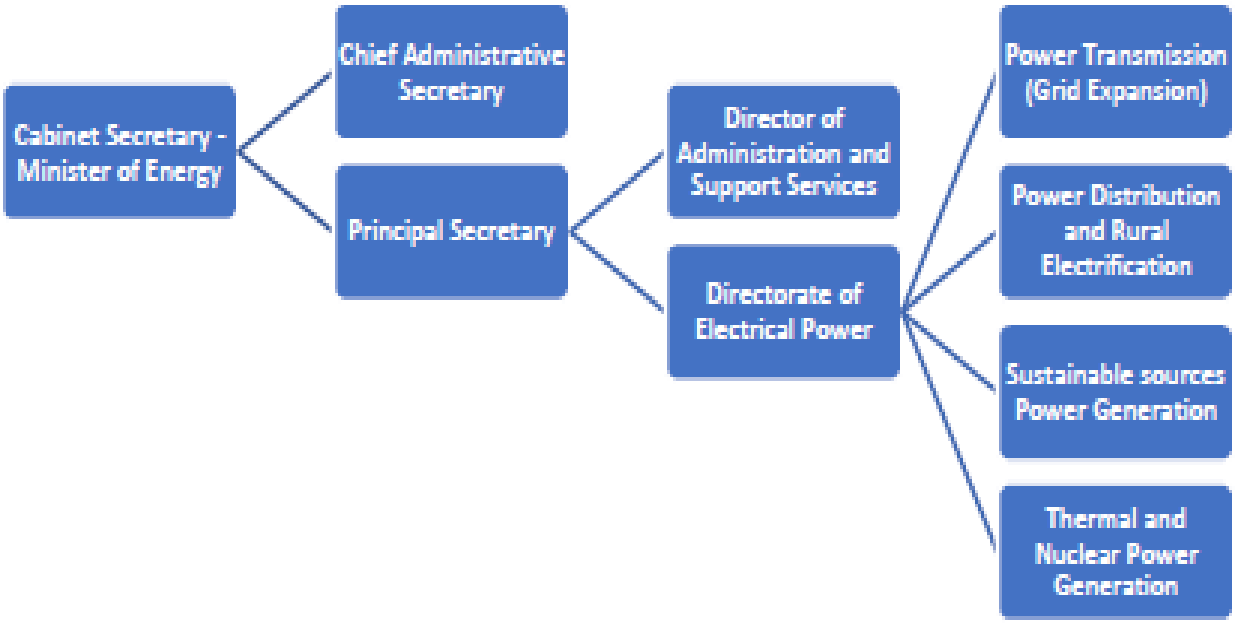
landscape with broader development objectives (Organisation Structure | Energy, 2023). Below in chart 3 displays the key roles within the Kenya ministry of Energy.

Chart 3



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The **Kenya Ministry of Education** occupies a central role in the nation's development, as quality education is integral to Kenya's future. Several divisions within this ministry work in tandem to ensure the quality of education. The Curriculum Development division directs its efforts toward the continuous development and enhancement of the educational curriculum, ensuring that the education system remains responsive and relevant to the evolving needs of students.

Concurrently, the Education Infrastructure division focuses on the development and maintenance of educational infrastructure, encompassing schools and related facilities. Ensuring that students have access to conducive and well-equipped learning environments is central to the division's responsibilities. These divisions within the Kenya Ministry of Education collectively strengthen the nation's education system, intrinsically linked with the research objectives outlined in this study. Below chart 4 displays the layout of the key roles.

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Chart 4

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The researcher benefited from the invaluable mentorship and internship received from Feedback Labs. The guidance provided the researcher with deep insights into the critical importance of feedback mechanisms for governments, non-profits, and the private sector. The understanding of the value of community engagement, gleaned through this mentorship and internship, became an integral part to the research and adds an invaluable perspective to the research process due to understanding that for governments and organizations to meet the needs of the population, when it comes to electricity, there is a need for collecting information from the population.

The mentorship and internship experience were in the United States, Africa, and Europe. This experience significantly underscored the disparities in electricity access for communities in sub-Saharan Africa and electricity access in Kenya. It emphasizes the urgency of addressing this

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issue to ensure equitable access to electricity.

This research is diligently dedicated to addressing the challenge of energy disparities in Kenya, with a distinct emphasis on its impact across diverse segments of the population. It examines how insufficient energy access disproportionately affects underserved communities, particularly in rural areas, and how these disparities impact their accessibility to technology and the quality of their educational experiences. The research centers on accessible energy and its direct implications for the achievement of electricity access. This approach ensures that the study maintains its focus and manageability while robustly addressing the crucial issue of energy disparities and their far-reaching influence in Kenya.

III. PROBLEM IDENTIFICATION

In the 21st century, access to reliable and affordable electricity is a cornerstone of development, economic growth, and social well-being. However, within Kenya, a persistent disparity in electrification presents a formidable challenge. Millions of Kenyan citizens, especially those residing in rural and underserved areas, still lack access to this fundamental resource. The incomplete electrification of Kenya has far-reaching consequences, impacting not only the daily lives of its citizens but also hindering the nation's progress in education and technology accessibility.

As of 2018, Kenya's electricity access rate stood at 75%, indicating that a quarter of Kenyans lack access to electricity (Kenya Charts Path to Achieving Universal Access to Electricity , 2018). In 2020, Kenya's electricity access rate was 71.44%, demonstrating substantial progress but revealing room for further development (Ritchie & Roser, 2019). The International Trade Administration reports that Kenya has increased access to the power grid from 32% in 2013 to 75% in 2022 (Kenya - Energy-Electrical Power Systems, 2022). Since 2006, rural electrification has shifted from 4% to 32%, especially in rural areas (Kenya - Energy-Electrical Power Systems, 2022).

Several factors contribute to Kenya's inability to achieve universal electrification.

These include rural-urban disparities in access, limited infrastructure development, economic constraints, policy and regulatory challenges, and a reliance on specific energy sources, such as hydroelectric power and fossil fuels. Despite commendable progress in electrification efforts, rural areas remain at 65% electrification, underscoring a substantial gap, particularly in remote and disadvantaged regions (Kenya - Energy-Electrical Power Systems, 2022).

The COVID-19 pandemic had negative effects on the sector, with power demand declining as company. ies scaled down operations and business grappled with staying afloat. The Government

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of Kenya (GOK) is keen to renegotiate existing power tariffs with IPPS to help cushion the population from rising costs of goods. Additionally, the Finance Act 2020 and the Tax Amendment Act 2020 abolished tax exemptions previously enjoyed by businesses in the renewable energy sector (Kenya - Energy-Electrical Power Systems, 2022). The two acts introduced a combined 14% value-added tax (VAT) charges on supplies imported into the country for use in the construction of power generating plants and off-grid solar power equipment. This resulted in increased capital expenditure costs for IPPS and the imposition of 14% VAT on solar home system equipment (Kenya - Energy-Electrical Power Systems, 2022)

The impact of incomplete electrification in Kenya is multifaceted, profoundly affecting the technology accessibility. This situation hampers the quality of education, impedes digital literacy, and restricts access to modern teaching tools. Furthermore, it exacerbates inequalities among students, amplifying disparities within the nation. The United Nations Department of Economic and Social Affairs (2014) highlights the stark disparity in reliable electricity access, noting that four out of every five schools in sub- Saharan Africa, including Kenya, lack this essential resource (United Nations Department of Economic and Social Affairs, 2014).

Over 80% of Kenya's electricity is generated from renewable/clean energy sources. Of these, geothermal remains the most significant source with an estimated potential of 10,000MW, but it remains relatively unexploited with the current installed capacity of less than 863MW (Kenya - Energy-Electrical Power Systems, 2022). Wind energy is another key growth area. Kenya is estimated to have a wind power potential of 3,000MW (Kenya - Energy-Electrical Power Systems, 2022). Solar Power is also increasingly in use in rural Kenya. In 2015, Kenya signed a nuclear power cooperation agreement with China, enabling Kenya to obtain expertise and technical support (Kenya - Energy-Electrical Power Systems, 2022). Kenya is also pursuing a similar cooperation agreement with the United States. Kenya experiences approximately 16% system loss of generate power due to aging transmission and distribution networks. To address this, Kenya Electricity Transmission Company (KETRACO) is constructing 4,500 kilometers of new power lines, more than doubling the transmission network and introducing Kenya's first high voltage 400kV and 500kV DC lines, as well as three major regional interconnectors to Ethiopia, Uganda, and Tanzania. Beyond these lines, KETRACO is planning a further 4,200 kilometers of lines to expand and strengthen the grid. Kenya Power is currently the sole distribution company in Kenya and operates Kenya's interconnected grid.

IV. LITERATURE REVIEW

This literature review section explores scholarly assessments of the general causes and effects of technology accessibility due to lack of electricity in certain global areas.

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Having a decent and accessible technology remains a dilemma for most people within sub-Saharan Africa, especially in a country that is progressing forward, Kenya. Lack of adequate electricity is one of the most urgent problems facing communities in rural areas in United States and Kenya. A large body of literature has examined the problem of lack of electricity that is due to having limited grid systems. It highlighted in the literature the need to discuss innovative solutions to alleviate the burden of suffering from educational advancement just because electricity is not available. For instance, Abidoun (2022) notes that micro-grids promote energy equity, access, and resilience which can aid in helping underserved communities gain better access to reliable energy sources and enhance their resilience during energy related challenges. Accessibility to electricity plays a vital role in progressing towards a clean environment because electricity is a cleaner way of using energy (Abiodun, Guatam, Newman, Nock, & Pandey, 2022). Another literature emphasizes the pivotal role of electricity in achieving greenhouse emissions cuts because this is important to note due to the importance of electricity distribution play's role in reducing emissions (Williams, et al., 2012). By encouraging the usage of electricity upgrades in certain areas, it will advance the discussion of achieving carbon-emission reduction. Manne (1991) explores the rising energy cost and its impact on electricity because this impacts the lifestyle and social progression of the population, especially within the education sector (Manne, 1991). Now, there are barriers to certain areas within sub-Saharan Africa that lack electrification. Pahwa (2016) argues that there is a barrier to rural electrification since some areas have not been exposed to development initiatives that are aiming to mitigate the issue (Pahwa, 2016). Also, Sergi (2018) delves into the challenges related to rural electrification and power sector investments in Kenya and Tanzania offering valuable insights into the barriers and opportunities in the on- and off- grid energy sectors. This was addressed by the Obama Administration through the Power Africa Initiative in 2013 to strive to build new power generation facilities, including grid systems that can sustain those areas based on their size and location and the issue of accessibility to technology has been addressed through different projects (PowerAfrica Conference and Exposition, 2016). Additionally, the work of Ahlborg and Hammar (2011) have contributed significantly to the discourse on these initiatives by emphasizing the need to develop areas that lack electricity, thus, a shift in accessibility for these areas increases, decreasing educational inequity to technology accessibility (Ahlborg & Hammar, 2011). Pahwa (2016) posits that the micro-grid projects in Kenya have served to supplying electricity, which factor into reducing emissions and allows for accessibility to a success model in education and financial sector (Pahwa, 2016).

The excessive cost of micro-grids is a big barrier to rural areas in sub-Saharan Africa. The world energy congress produced a report in 2011 that highlighted the major barriers to electricity accessibility: policy, social, political, financial, and technical (Pahwa, 2016). The United States has made collaborations with African nations to supply technical help and support in developing

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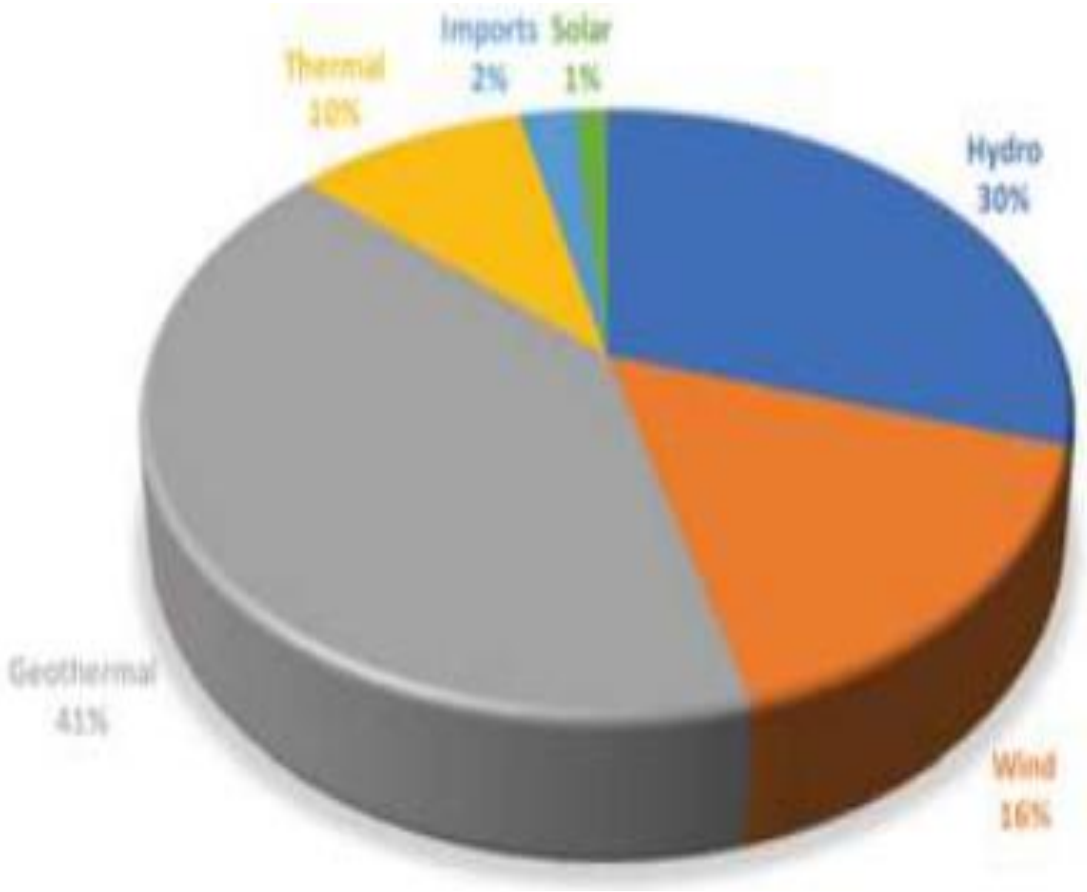
policy initiatives that further the agenda of Power Africa Initiative (PowerAfrica Conference and Exposition, 2016). For example, the United States Agency for International Development has invested projects in Kenya to increase the usage of electricity generation by using Kenya resources of renewable energy (United States Agency for International Development, n.d.). This type of investment from the United States in Kenya's clean energy sector because Kenya is a country in sub-Saharan Africa that is a leader in using renewable energy. According to the USAID, 90% of Kenya power is generated from renewable sources, with 40% being generated through geothermal, 45% from hydropower, and the rest through wind and solar (Kenya - Energy-Electrical Power Systems, 2022). The aid and collaboration of United States and Kenya government has allowed for the accessibility to reduce electricity disparity due to the developments of off-grid and on-grid connections for facilities across the country. Below figure 1 and 2 shows the energy sources of Kenya and United States.

Figure 1



(Kenya - Energy-Electrical Power Systems, 2022)

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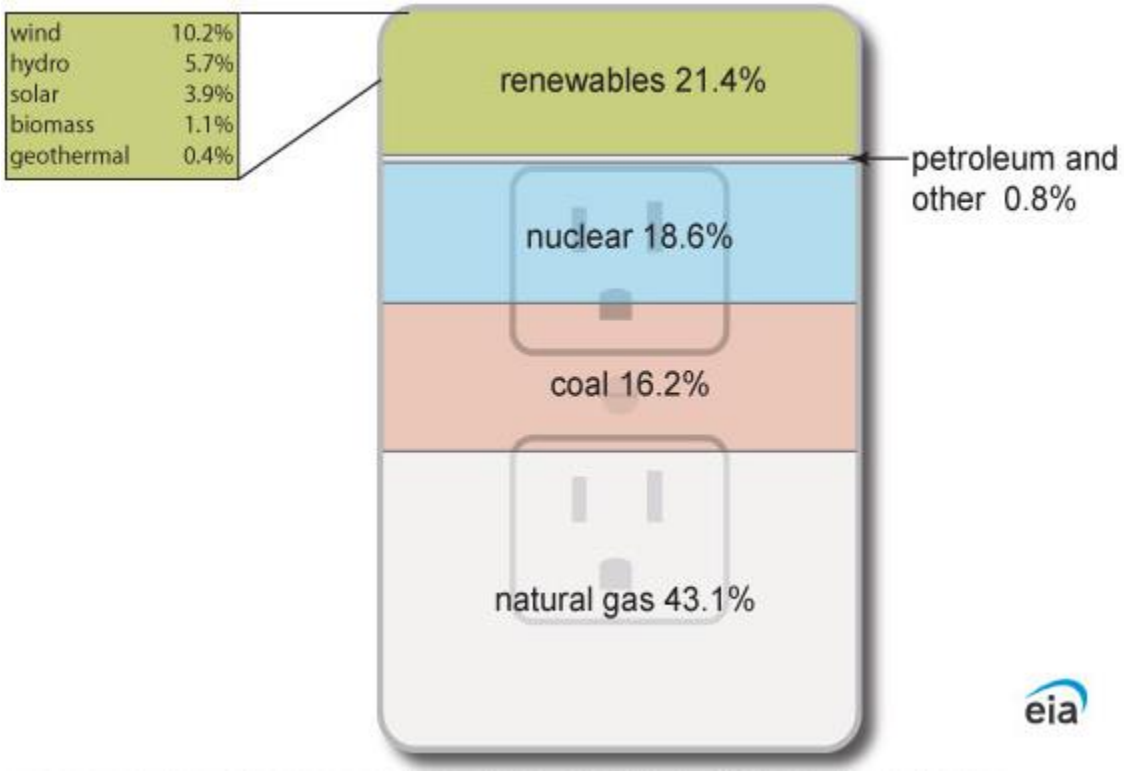
Figure 2



(Electricity in the U.S. - U.S. energy information administration (EIA), 2021)

When it comes to addressing fair education, various scholars have attributed it to several factors that have caused inadequate education; however, the literature review focuses on the factors of energy accessibility, especially electricity. It is evident that development and expansion of infrastructure will improve the education in Kenya for primary and secondary students (Ngware, Onsomu, Muthaka, & Manda, 2006). The expansion of infrastructure through micro grid implementation will further close the technology accessibility gap since accessibility to technology within education institutions gradually grows. Thus, the educational integration of technology is a success because it will increase fair access to the student's educational experience (Heinrich, Darling-Aduana, & Martin, 2020). Relatively, Ibrahim and Waziri examine the challenges and opportunities to improve information and communication technology (ICT) and renewable energy in sub-Saharan Africa to foster environmental sustainability since Kenya has displayed a great in pushing for cleaner use of energy when developing infrastructure (Ibrahim & Waziri, 2020). Their study shines light on how energy access enables for a country like Kenya to progress into methods of technology accessibility, especially within education. This study by Ibrahim and Waziri demonstrates there is a push for integrating ICT and renewable energy to

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promote environmental sustainability, which aligns with aims of improving technology and educational enhancement.

To delve deeper into the complex relationship between energy and transition and economic development, the publication 'The POWER Initiative: energy transition as economic' development asserts that promoting economic growth through energy transition empowers sectors of education to ensure there is reliability and connectivity (Cecire, 2019). Also, more elaboration on how the initiative addresses the challenges related to energy transition and its impact on economic development, shedding light on the changing dynamics of the energy industry in promoting how energy access further develops technology accessibility within education institutions, thus, pushing for equitable education (Cecire, 2019). Furthermore, there is a case study that demonstrates how a push for energy transition enables for understanding on-and off-grid energy in Kenya (Sergi, et al., 2018). This case study highlights on the complexities of energy investments in East African countries and their direct implications for education and technology access. With that, it is also vital to analyze foreign direct investment (FDI).

For instance, organizations like the USAID assisting in development of grid systems as well as technology transfer offer growth in equitable education, which also provides economic growth demonstrating that foreign direct investment is vital to advance equitable energy access and education (Osano & Koine, 2016). This offers a comprehensive perspective of the role FDI in technology transfer and its impact on economic growth, with a specific focus on Kenya's energy sector. The study mentions that FDI is crucial to developing systems that enable energy access and economic development because the dynamics of FDI in the energy industry operate publicly and privately. On top that, the study argues that FDI plays a significant role in expanding educational infrastructure and enhancing accessibility to technology (Osano & Koine, 2016).

Moreover, through energy access equitable education is achieved in regions such as Kenya due to the historical lack of electricity. Odek and Oloo present preliminary thoughts on achieving equity in education in Kenya. Their insights into the educational landscape in Kenya shed light on the challenges and opportunities related to education equity in the country and relate to how the lack of electricity and technology accessibility causes a barrier in performance and educational experience (Odek & Oloo, 2012).

Achieving equity in education aligns closely with the core objectives of advancing technology accessibility and equitable education. With that, there is also a study that sheds light to enhancing educational quality and access through the utilization of information communication technology (ICT) and open educational resources (OER) in Kenya (Adala, 2016). This adoption of OER and ICT is a significant stride in the pursuit of equitable education and technological accessibility, highlighting why it is crucial to develop systems and initiatives that collectively

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advance the accessibility to electricity. In addition, Awuor, Khisa, and Rambi address the delivery of equitable and quality education to remote areas of Kenya using ICT since their work emphasizes the role of technology in improving access to quality education in remote regions (Awuor, Khisa, & Rambi, 2015).

V. ANALYSIS OF THE PROBLEM

A. Research Design

The research design for the study on electrification in Kenya is anchored in a robust mixed-methods approach that seamlessly integrates secondary data analysis with insights garnered from industry experts. This methodological choice stems from the acknowledgment that a comprehensive understanding of Kenya's electrification challenges necessitates the incorporation of diverse data sources and expert perspectives. By amalgamating quantitative data from sources such as the World Bank and the International Energy Agency with qualitative insights obtained through interviews, this study provides a holistic examination of the multifaceted factors influencing Kenya's journey towards universal electrification.

Moreover, the formulation of this research design was significantly influenced by the researcher's professional background and internship experiences, particularly in the analysis of electricity prices across various countries. Through these experiences, the researcher gained valuable insights into the intricate interplay between electricity affordability, educational outcomes, societal well-being, and economic development.

Recognizing the pivotal role that electricity prices play in shaping these dynamics, the research design places a particular emphasis on examining the affordability challenges faced by households in Kenya and their implications for education, societal equity, and economic prosperity. By grounding the research in both theoretical frameworks and real- world insights derived from professional experiences, this study aims to offer nuanced and actionable recommendations for policymakers and stakeholders involved in Kenya's electrification efforts.

B. Data Collection

In this study, data were sourced from reputable institutions such as the World Bank, the International Energy Agency, and governmental websites. These sources provided a comprehensive array of data pertaining to various aspects of Kenya's energy landscape, including infrastructure development, electrification rates, and energy consumption patterns. Specifically, reports from conferences and longitudinal data tracking offered valuable historical insights into the evolution of Kenya's energy sector over time. The research focused on explaining the multifaceted factors contributing to Kenya's ongoing challenges in achieving universal

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electrification. These factors encompass rural-urban disparities in access, limited infrastructure development, economic constraints, policy and regulatory challenges, and a dependency on specific energy sources. Moreover, leveraging pre-existing datasets facilitated a nuanced understanding of the rural-urban disparities and temporal trends in electrification rates. By analyzing these datasets, we were able to discern patterns of growth and identify persistent barriers to universal electrification across different regions of Kenya.

C. Analysis

Rural-Urban Disparities

Over the past years, equality has become a driving motivation within the landscape of global development, particularly concerning concepts such as race and gender. This paper specifically studies equality as it applies to electricity access in the Republic of Kenya, focusing on the rural-urban electrification rate. Significant disparities exist in power distribution, grid accessibility, and energy connectivity between urban and rural areas. While academics and policymakers agree that modern energy is crucial for development, there is fundamental disagreement on the most effective strategies to increase and expand access in rural areas (Bonan et al., 2017). The primary distinction in electricity access between rural and urban areas lies in the lack of electricity delivery infrastructure, such as grid connectivity, in rural areas. Affordability, documentation, and tenure issues also contribute to this lack of access. Additionally, the scattered housing in rural areas, due to sparse population, poses another challenge to electricity connectivity. In contrast, in urban areas, a single pole connection on the grid line can serve multiple households, which is not always the case in rural areas, making connectivity and installation more costly. Although regulations and policies are implemented to address energy poverty in rural Kenya, rural-urban disparities remain a significant obstacle to universal electrification (Lee et al., 2016) A study by the World Bank on the welfare impact of rural electrification (2008) underscores the importance of electrification in rural and remote areas. It highlights the benefits ranging from lighting, access to information, and education to technological advancement and improved business opportunities, all contributing to overall development and poverty reduction.

Additionally, a report from the world bank shows the disparity between rural and urban areas having access to electricity. In 2021, 97% of the population in Kenya had access to electricity compared to the 68.17% of the population in the rural (*World Development Indicators | Databank*, 2024). Kenya's ability to achieve the Sustainable Development Goals (SDGs) and its Vision 2030 relies, among other variables, on its capacity to increase access to and supply of electricity to its populace, especially in rural areas. Rural-urban disparities significantly hinder Kenya's progress towards universal electrification. The significance and benefits of rural electrification in Kenya are well articulated in Sessional Paper No. 4 on energy (*SESSIONAL*

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PAPER NO. 4 on ENERGY, 2004). Electrification in rural areas will transform the country into a universally electrified nation, signifying complete electrification attainment. Universal electrification serves as a catalyst for transformative development in various sectors, including education, technology, business investment, healthcare, and security. Availability of lighting and conducive studying environments will drive positive changes in the education sector, fostering innovation and creativity by extending study hours and enhancing access to information.

The urbanization trend in Kenya, particularly evident in Nairobi, underscores a pressing issue of escalating urban poverty and vulnerability (Taylor & Goodfellow, 2009). Approximately 60% of Nairobi's population resides in slums, highlighting the widening gap between the rich and poor, with basic services such as water, sanitation, housing, education, and healthcare remaining inaccessible to many urban dwellers. This situation is compounded by disproportionately high mortality rates, gender inequalities, and economic challenges faced by the urban poor, emphasizing the urgency for coordinated action to address the urban crisis. Poor urban governance and institutional deficiencies exacerbate the challenges of urban poverty (Taylor & Goodfellow, 2009).

Inadequacies in institutional, policy, and legislative frameworks, along with deficient land-use policies and ineffective coordination of poverty reduction interventions, underscore the need for comprehensive strategies to address the root causes of urban poverty and vulnerability. Efforts to alleviate urban poverty are evident through various initiatives (Taylor & Goodfellow, 2009). Overarching strategies such as urban governance enhancement, sustainable livelihood development, and disaster preparedness emphasize practical interventions to mitigate urban poverty and vulnerability. Specific projects within Nairobi target crucial areas such as water and sanitation, waste management, and food security enhancement, demonstrating the importance of coordinated action by various stakeholders. Collaborative solutions are imperative in addressing the multifaceted challenges of urban poverty and vulnerability. The involvement of governmental bodies, donors, and non-governmental organizations is crucial in implementing effective interventions (Taylor & Goodfellow, 2009). Poverty and inequality exacerbate disparities in electricity access, affecting both rural and urban populations. Addressing the rural-urban electrification gap necessitates comprehensive strategies encompassing poverty alleviation, infrastructure development, and equitable resource distribution.

Limited Infrastructure Development

Globally, countries are prioritizing infrastructure projects to achieve economic prosperity and improve the wellbeing of their citizens. Investment in infrastructure serves as a potential catalyst for development. However, Kenya's limited infrastructure poses a critical challenge to its goal of universal electrification. Underdeveloped infrastructure in the most rural parts of Kenya renders

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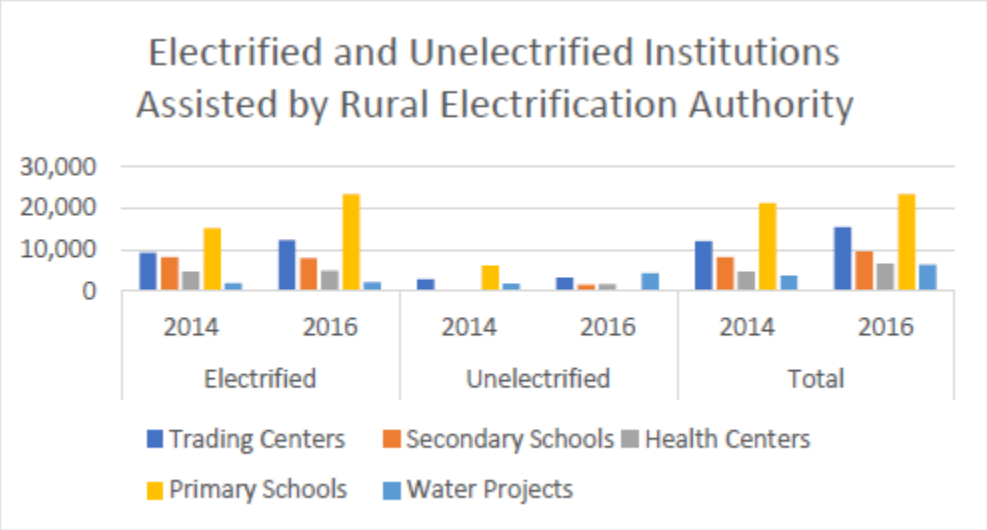
them inaccessible, hindering the electrification process. The lack of access makes it challenging to install necessary energy resources such as grid lines and transformers. Most rural areas lack adequate roads, and existing roads are often impassable, especially during rainy seasons. These infrastructure deficiencies contribute to underdevelopment, inadequate social amenities such as healthcare facilities, low investment levels, and limited opportunities, perpetuating poverty and hindering access to quality education and economic growth (Lee et al., 2016) Chapter 27 of the UN's Agenda 21 underscores the critical role of infrastructure development in economic transformation and the development of countries (*DSD: Resources - Publications - Core Publications*, n.d.). Despite Kenya's Vision 2030 and efforts to achieve universal electrification, underdeveloped infrastructure remains a significant barrier, particularly in rural areas (World, 2018).

Figure 3



(Kenya National Electrification Strategy: Key Highlights 2018, 2018)

The Kenya National Electrification strategy displays the several types of facilities In Kenya for the years 2014 and 2016 being electrified and unelectrified. Electrification of facilities in the education sector, such as primary and secondary school, is of paramount importance. Looking at figure 3, there is a substantial increase in the electrification of primary and secondary schools from 2014 to 2016. In 2014, 157 primary schools were electrified, a number that surged to 23,375 by 2016. While the number of electrified schools slightly decreased from 8,195 in 2014 to 7,845 in 2016, it's noteworthy that there was a dramatic increase in the number of previously unelectrified secondary schools, which reached 1,586 in 2016. Access to electricity is a fundamental prerequisite for technological integration in schools. The increased electrification of

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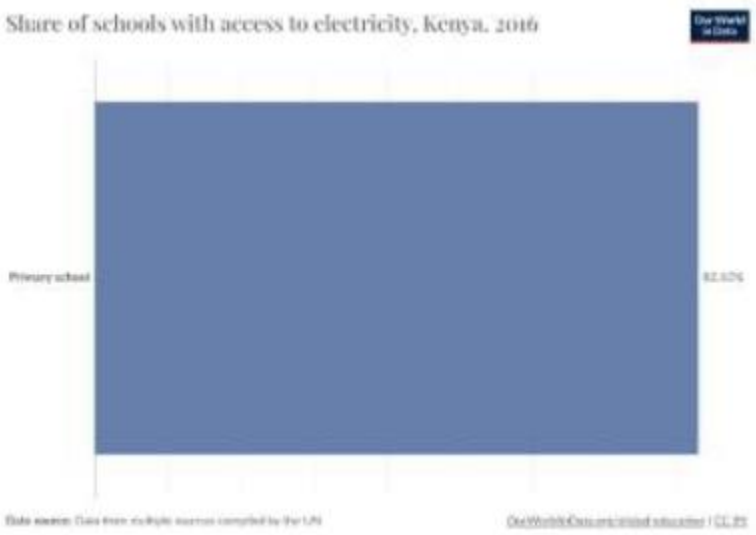
these educational facilities is crucial for enabling the use of modern teaching tools and resources. With electricity access, education institutions, health facilities, manufacturing areas there is enhanced digital literacy, access to digital materials, and facilitated distance learning and connectivity, which has become increasingly important, as demonstrated during the COVID-19 pandemic. The electrification of primary and secondary schools is a vital step in fostering equal opportunities for students, as it ensures that a broader range of students, regardless of their location, benefit from technology-assisted education. It is notable that in 2016, there were no unelectrified primary schools, demonstrating that all primary schools had gained access to electricity. While there was a decrease in the number of electrified secondary schools, this was accompanied by an increase in previously unelectrified secondary schools that were brought into the electrified category. This indicates a clear commitment to improving education sector electrification, with the goal of providing electricity access to all primary and secondary schools. Additionally, figure 4 displays that in 2016 access to electricity for primary schools increased significantly to 82.62%.

Figure 4



Share of Schools with access to electricity, 2020

This underlines the importance of national electrification strategies and policies aimed at bridging the electricity access gap in educational institutions. The allocation for electrification, particularly within the energy sector, remains of paramount importance for Kenya's holistic development. Electrification acts as a catalyst for economic growth, fostering industrial development, job creating, and productivity enhancements. It enables businesses, especially in rural areas, to operate more efficiently, contributing to overall economic advancement. Kenya's

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prowess in technology innovation, highlighted in the USAID Digital Ecosystem Country Assessment (2020), aligns with the role of electrification in fostering industrial development. A strong digital infrastructure, as outlined in the report, contributes significantly to industrial growth by fostering innovation and technology-drive enterprises (Dean , Donkor, Paul, & Olutola, 2020). Adequate electrification in rural regions is pivotal for enhancing livelihoods, supporting agricultural activities, and promoting small-scale enterprises. This, in turn, directly addresses poverty by uplifting communities and narrowing the urban-rural development gap. The digital ecosystem, as illuminated by the USAID report (2020), reveals challenges in rural connectivity (Dean , Donkor, Paul, & Olutola, 2020). This aligns with the importance of electrification in uplifting rural areas. Both initiatives collectively empower rural communities and contribute to poverty alleviation. Electrification fuels technological innovation and supports the transition towards sustainable energy sources. It encourages the adoption of clean energy technologies, aligning with global efforts towards environmental conservation and climate change mitigation. The digital economy blueprint, as outlined in the USAID report (2020), identifies technology as a key driver for innovation and growth (Dean , Donkor, Paul, & Olutola, 2020). This seamlessly aligns with the electrification efforts contributing to sustainable development through the adoption of clean energy technologies. A robust electrification framework ensures equal access to energy resources, promoting social equity, and inclusivity. It aids in empowering marginalized communities, fostering social cohesion, and enhancing overall quality of life. The five pillars outlined in the Digital Economy Blueprint, including digital skills and values as highlighted in the USAID report (2020) emphasize the synergy between digital inclusion and electrification (Dean , Donkor, Paul, & Olutola, 2020). Together, they foster social equity and inclusivity.

In Kenya, the progress towards universal electrification is impeded by a trifecta of obstacles: underdeveloped infrastructure, political instability, and financial constraints (Yañez-Barnuevo, 2023). The lack of adequate infrastructure, especially in rural regions, makes it challenging to extend the main grid, hindering access to electricity for millions. Additionally, political instability introduces uncertainty in government policies and priorities, impacting long-term infrastructure projects such as transmission line development. Moreover, limited financial resources constrain the government's ability to allocate funds for electrification initiatives, exacerbating the infrastructure deficit.

Conversely, rural areas in the mountainous regions of the United States face distinct challenges in electrification. Geographical barriers and high implementation costs make traditional grid extension economically unfeasible in remote communities. However, innovative solutions such as solar-powered microgrids with battery storage have emerged as viable alternatives to enhance resilience and ensure reliable electricity access in these areas (Yañez-Barnuevo, 2023).

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Parallels can be drawn between Kenya's electrification efforts and microgrid development in rural U.S. areas, particularly in addressing energy insecurities. Both contexts emphasize the importance of resilience against extreme weather events and reducing energy insecurities, crucial for the socio-economic well-being of rural communities. While Kenya focuses on extending the main grid to remote regions, the United States invests in decentralized energy systems like microgrids to provide sustainable electricity access (Yañez-Barnuevo, 2023). Government support and funding play pivotal roles in advancing electrification initiatives in both Kenya and the United States. Programs like the U.S. Department of Energy's Energy Improvements in Rural or Remote Areas (ERA) program allocate funds to support clean energy projects, including microgrids, in rural communities. Similarly, Kenya relies on government support to overcome infrastructure challenges and promote access to clean energy projects, especially in disadvantaged communities (Yañez-Barnuevo, 2023). However, investment challenges present significant barriers in both contexts. Political instability in Kenya and regulatory uncertainties in the United States deter investors from committing to long-term infrastructure projects, delaying progress in electrification and microgrid development.

Moreover, technological advancements in microgrid development in the United States may outpace Kenya's adoption due to financial constraints and limited resources, highlighting disparities in technological innovation (Yañez-Barnuevo, 2023).

Maintenance and skilled labor shortages further compound electrification challenges, particularly in Kenya (Yañez-Barnuevo, 2023). The United States' rural electric cooperatives invest in local renewable energy generation and battery storage, emphasizing the importance of skilled labor for infrastructure development and maintenance. In contrast, Kenya's shortage of skilled labor and limited resources pose significant hurdles in constructing and maintaining transmission lines, impacting the reliability of electricity supply (Yañez-Barnuevo, 2023). Despite differing challenges and contexts, both Kenya's electrification efforts and microgrid development in rural U.S. areas underscore the importance of infrastructure development and government support in enhancing energy access and resilience. By addressing investment challenges, technological limitations, and skilled labor shortages, stakeholders can advance sustainable energy solutions to improve the resilience and efficiency of energy transmission networks globally (Yañez-Barnuevo, 2023).

Economic Constraints

Another major challenge hindering Kenya's progress towards universal electrification, both in rural and urban settings, is affordability for users. In a middle- lower-income economy like Kenya, where the country is striving to overcome poverty, achieving 100% electrification presents a significant challenge. Despite being a middle- lower-income economy and the most

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developed in Eastern and Central Africa, Kenya still has 16.1% (as of 2023/2024) of its population living below the international poverty line, with around 7.8 million people residing in rural areas. These economic constraints, coupled with the struggle to meet basic daily needs, make it difficult for many to afford electricity. Despite efforts to subsidize electricity connections, many households cannot afford the initial connection charges, resulting in low access rates. Moreover, the rising cost of modern energy sources further exacerbates energy poverty. Despite Kenya's significant energy production capacity, high electricity costs, exacerbated by increases in electricity prices, reduce consumption among households. Consequently, many households' resorts to using alternatives such as fuelwood to meet their energy needs, perpetuating energy poverty and negatively impacting literacy levels, living standards, and life expectancy (Njiru & Letema, 2018).

Kenya's pursuit of universal electrification is hindered by notable economic constraints, particularly concerning of electricity for its populace. Data from the World Bank reveals that as 2015, Kenya's national poverty line stood at 36.1%, with rural areas experiencing a more pronounced decline in poverty compared to urban counterparts (*Poverty & Equity Brief Kenya Africa Eastern & Southern*, 2023). However, persistent disparities persist, especially in regions like north and northeast, where well-being indicators lag, resulting in challenges such as food insecurity and low educational attainment. Between 2005/2006 and 2015/2016, consumption growth for the bottom 40% of Kenya's population averaged 2.86% per year, with rural areas witnessing considerable progress (*Poverty & Equity Brief Kenya Africa Eastern & Southern*, 2023). Despite these strides, income inequality, declined from 46.5 in 2005 to 40.8 in 2015, indicating a pro- poor pattern of growth (*Poverty & Equity Brief Kenya Africa Eastern & Southern*, 2023). The economic dynamics directly impact electricity access in Kenya. While efforts have been made to subsidize electricity connections, persistent poverty levels and income disparities present challenges for many households in affording electricity. Consequently, despite Kenya's significant energy production capacity, high electricity costs exacerbate energy poverty, prompting a reliance on alternative, often unsustainable, energy sources.

The observed reduction in the allocation for energy, infrastructure, and ICT from KES 407.7 billion to KES 364.1 billion on the fiscal year 2023/2024 indicate a recalibration of fiscal priorities (The National Treasury and Economic Planning 2023/24 Budget, 2023). This impedes progress towards achieving Kenya's energy access and sustainability goals. The allocation breakdown, including KES 33.8 billion for the National Grid System, KES 12.1 billion for rural electrification, KES 11.4 billion for geothermal development, and KES 3.2 billion for alternative energy technologies, underscores specific areas of despite the reduced sectoral budget (The National Treasury and Economic Planning 2023/24 Budget, 2023). While this decrease reflects a strategic focus on key sectors like agriculture, micro-enterprises, healthcare, and digital

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infrastructure, it raises concern about potential repercussion on Kenya's electrification efforts.

Electrification stands as a catalyst for economic growth, propelling industrial development, enhancing productivity, and fostering job creation. It facilitates efficient business operations, particularly in rural areas, contributing significantly to Kenya's economic development. Within the East African context, the economic forecast anticipates growth in the African economy by 4 percent in 2023 and 4.3 percent in 2024 (Kinuthia, Akora, & Ng'ang'a, 2023). However, localized challenges like high inflation rates, currency depreciation, and global financial market fluctuations impacted Kenya's economic performance. The real GDP growth in Kenya declined to 4.4 percent in 2022, influenced by factors such as drought, rising fuel prices, and currency depreciation (Kinuthia, Akora, & Ng'ang'a, 2023). Kenya's economic landscape, heavily reliant on foreign currency borrowing for infrastructure projects, faced challenges due to currency depreciation and increased debt servicing costs. With Kenya's debt nearing the ceiling at 60% of GDP in 2022, pressures arose to plug fiscal deficits (Kinuthia, Akora, & Ng'ang'a, 2023). This-debt-related strain posed challenges in settling recurrent expenditures, impacting development initiatives, including electrification projects. The electrification drive remains pivotal amid Kenya's economic rebound strategies post- pandemic. Notably, the government's focus on the agricultural sector growth by subsidizing production inputs reflects efforts to address rising prices (Kinuthia, Akora, & Ng'ang'a, 2023). However, these economic strategies necessitate a careful balance between addressing inflationary pressure and sustaining essential development projects, including electrification. The reduction in the energy and infrastructure budget, amidst economic challenges, poses hurdles in realizing Kenya's electrification and sustainable energy access goals. Balancing increased tax revenues and reduced borrowing, as proposed by the Kenyan government, presents challenges in financing crucial electrification projects while ensuring fiscal sustainability.

Over the period from 2007 to 2017, the country experienced significant GDP growth, averaging 5.0% annually in total and 2.3% per capita (OECD, 2018). However, amidst this economic growth, there exists a concerning trend in energy-related CO2 emissions. Over the same period, these emissions surged by an average of 33.0% per year in total and 0.6% per capita, indicating a notable environmental challenge. Despite lacking specific carbon taxation or CO2 emissions trading systems in 2018, Kenya implemented energy taxes, including excise taxes on petroleum products and levies on electricity consumption. Additionally, a subsidy program aimed at supporting low-income households using LPG was in place. These initiatives collectively contributed to net energy tax revenues amounting to 1.5% of GDP, showcasing the government's efforts to mobilize domestic resources (OECD, 2018). However, an analysis of Kenya's effective carbon rates reveals a nuanced scenario. While certain fuel types, such as fuel oil, diesel, kerosene, and gasoline, exhibit higher effective carbon rates compared to the TEU-SD average

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(OECD, 2018), they still fall short of the OECD average (OECD, 2018).

Conversely, effective carbon rates for coal, LPG, and natural gas closely align with the TEU-SD average (OECD, 2018). This suggests that while Kenya's carbon taxation policies demonstrate some adherence to global standards, there are notable disparities, particularly concerning specific fuel types. It becomes clear that Kenya faces a critical juncture in its pursuit of sustainable economic development. The positive GDP growth indicates the country's economic potential, yet the concurrent rise in CO2 emissions underscores the urgent need for environmental stewardship. Moving forward, Kenya must prioritize sustainable development policies that strike a balance between economic prosperity and environmental conservation. Such policies should aim to enhance energy efficiency, promote renewable energy sources, and incentivize low-carbon technologies (OECD, 2018). Kenya's energy sector plays a pivotal role in driving economic growth and domestic resource mobilization. However, the disparity between GDP growth and CO2 emissions trends highlights the imperative for strategic intervention. Through the implementing of sustainable development initiatives, Kenya can ensure long-term economic prosperity while safeguarding the environment for current and future generations. (OECD, 2018).

Revenue generation in the energy sector for infrastructure development in Kenya primarily comes from various sources such as tariffs and electricity sales, private sector investments, government funding and subsidies, public-private partnerships (PPPs), international aid and financing, and tariff adjustments and regulatory fees (Energy Sector – GET.invest, n.d.). In summary, revenue generation in the energy sector for infrastructure development in Kenya is a multifaceted process involving electricity sales, private investments, government funding, partnerships, and regulatory mechanisms to support the growth and sustainability of the country's energy infrastructure (Energy Sector – GET.invest, n.d.). The challenges faced by Kenya Power in sustaining its revenue model are significant (Barasa, 2020). A drastic 92% reduction in profit from US$ 49 million in 2018 to US$ 3 million in 2019, coupled with an increase in system losses and the impact of the COVID-19 pandemic, have put immense pressure on the utility's financial stability (Barasa, 2020). This financial strain has not only led to a decline in profits but has also triggered widespread concerns about service delivery, as evidenced by the social media campaign under the hashtag #shutdownKPLC. Three fundamental problems with Kenya Power's revenue model have been identified (Barasa, 2020).

Firstly, the rapid expansion of connections, particularly through initiatives like the Last Mile Connectivity Project, has led to a substantial increase in the total number of customers. However, this expansion has resulted in a noteworthy decrease in net income per customer, posing challenges to the utility's fiscal viability and performance (Barasa, 2020). Secondly, there is a concerning trend of declining revenue from core commercial- industrial (CI) customers, despite

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their significant contribution to Kenya Power's total sales (Barasa, 2020). The migration of these customers to alternative, more cost-effective solutions like solar PV and coal-fired plants threatens the sustainability of Kenya Power's revenue model (Barasa, 2020). Lastly, despite maintaining steady total revenue per unit of electricity sold, Kenya Power has experienced declining profits, attributed to various factors including operational costs, mismanagement, and system losses (Barasa, 2020).

This has led to a high level of debt, with a debt-to-equity ratio of 1.8, further exacerbating the utility's financial challenges (Barasa, 2020). To address these pressing economic challenges, potential solutions have been proposed (Barasa, 2020). These include expanding and diversifying revenue streams, mitigating government influence in corporate governance, and stimulating demand through innovative initiatives such as offering ultra-low time-of-use tariffs for cooking and promoting the uptake of electric vehicles (Barasa, 2020). The economic challenges facing Kenya Power show the urgent need for strategic interventions to stabilize its revenue model and ensure sustainable growth in the region (Barasa, 2020).

Policy and Regulatory Challenges

In analyzing Kenya's barriers to achieving 100% electrification, it's crucial to consider the historical context and the enduring legacies of colonialism, as highlighted by Ndege (2009). The colonial period in Kenya left profound social, economic, and political imprints that continue to shape the country's development trajectory, including its energy sector (Ndege, 2009). One of the critical challenges facing Kenya's electrification efforts is the legacy of colonial economic policies, particularly in relation to land alienation and resource exploitation. During colonial rule, the economy was structured to serve the interests of European settlers, leading to the concentration of land and wealth in the hands of a privileged few (Ndege, 2009). This historical injustice has contributed to persistent inequalities in access to resources, including energy, with marginalized communities often left underserved. Additionally, the authoritarian governance structures established during colonialism have had enduring effects on Kenya's political landscape (Ndege, 2009). The centralization of power and decision-making processes can hinder effective energy planning and implementation, leading to bureaucratic inefficiencies and delays in electrification projects. Moreover, the legacy of authoritarianism may foster corruption and rent-seeking behaviors within the energy sector, diverting resources away from essential electrification initiatives. Furthermore, the division and competition among Kenya's diverse ethnic communities, exacerbated by colonial boundaries and policies, pose significant challenges to achieving universal electrification (Ndege, 2009). Negative ethnicity and inter-community tensions can impede collaboration and cooperation in energy infrastructure development, hindering progress towards electrification targets.

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Addressing these deep-seated divisions requires inclusive policies and governance structures that prioritize community engagement and participation in decision-making processes. Moreover, the socio-cultural transformations brought about by colonialism, including the influence of Christian missionary activities and the emergence of quiescent elites, may shape attitudes towards modernization and development, including the adoption of electrification technologies (Ndege, 2009). Cultural beliefs and practices regarding energy use and conservation may impact the uptake of electrification initiatives, necessitating culturally sensitive approaches to energy planning and promotion. In confronting these challenges, it's essential for policymakers and stakeholders to critically assess the historical and structural factors that underpin Kenya's electrification gaps. A nuanced understanding of the country's colonial legacy can inform more holistic and equitable approaches to energy access, addressing underlying inequalities and fostering sustainable development. By challenging entrenched power dynamics, promoting inclusive governance, and embracing culturally appropriate strategies, Kenya can overcome its barriers to achieving 100% electrification and pave the way for a brighter, more equitable energy future.

Corruption remains a pervasive challenge that significantly impedes progress in achieving electrification goals (Volkert & Klagge, 2022). The intertwining of corruption with the energy sector undermines efforts to expand access to electricity and develop reliable infrastructure. Corrupt practices, such as embezzlement, bribery, and kickbacks, distort decision-making processes, diverting funds away from essential electrification projects and siphoning resources meant for infrastructure development. For instance, funds allocated for the construction of power plants, transmission lines, and distribution networks may be misappropriated, leading to delays or substandard implementation of electrification initiatives. Moreover, corruption fosters a culture of impunity and undermines accountability mechanisms within the energy sector, allowing perpetrators to act with impunity (Volkert & Klagge, 2022). The lack of transparency and accountability in procurement processes and contract awards creates opportunities for rent-seeking behavior and collusion among government officials, contractors, and private companies.

This not only undermines the integrity of electrification projects but also erodes public trust in government institutions and diminishes investor confidence in the energy sector.

The impact of corruption on electrification efforts is felt at both the macro and micro levels. At the macro level, corruption distorts resource allocation and hampers overall economic development, limiting the government's capacity to invest in critical infrastructure and provide essential services such as electricity (Volkert & Klagge, 2022). This, in turn, perpetuates the cycle of poverty and inequality, disproportionately affecting marginalized communities who lack access to reliable electricity for basic needs, education, healthcare, and economic opportunities. At the micro level, corruption increases the cost of doing business in the energy sector, deterring

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investment and innovation (Volkert & Klagge, 2022). Companies operating in Kenya's energy market may face extortionate demands for bribes or face unfair competition from well-connected firms that benefit from preferential treatment. This stifles competition, innovation, and efficiency, ultimately hindering the expansion of electrification coverage and access to affordable, reliable electricity for all Kenyan citizens. Modern-day corruption in Kenya poses a significant barrier to achieving electrification goals, undermining the integrity of the energy sector and impeding progress towards universal access to electricity (Volkert & Klagge, 2022). Addressing corruption requires comprehensive reforms, including strengthening institutional capacity, enhancing transparency and accountability measures, and fostering a culture of integrity within government institutions and the private sector. Only through concerted efforts to combat corruption can Kenya realize its vision of providing sustainable and inclusive electrification for all its citizens.

Despite Kenya's ranking as a top-10 worldwide generator of renewable energy, its ambition to achieve complete electrification has remained elusive. In alignment with the UN Sustainable Development Goal 7, ensuring access to affordable, sustainable, and reliable energy for all is crucial. Energy accessibility is increasingly prioritized in global development agendas. Policies and regulations are recognized as essential channels for achieving this goal. Public policies and associated mechanisms play a pivotal role in ensuring accessible, dependable, and universal electrification. An effective national rural electrification plan serves as a cornerstone for policymakers to establish policy direction and develop a program roadmap for energy accessibility.

The Kenya National Electrification Strategy (KNES) was launched by the government in partnership with the World Bank to achieve universal access to electricity for all Kenyans by 2022 (*Kenya Launches Ambitious Plan to Provide Electricity to All Citizens by 2022*, 2018). The strategy focuses on utilizing off-grid options, mini-grids, and stand-alone solar systems, with a key emphasis on the role of the private sector in providing for remote areas. The strategy aligns with Kenya’s development goals, including Vision 2030, and aims to address the electricity access deficit in Sub-Saharan Africa. Kenya’s National Electrification Strategy (KNES) sets forth the ambitious goal of achieving universal access to electricity (Kenya Charts Path to Achieving Universal Access to Electricity , 2018). Employing geospatial technology, grid extension, and off- grid solutions, KNES identifies cost-effective approaches for expanding electricity access. Complementing KNES, the Kenya National Energy Policy provides a comprehensive framework for sustainable energy development, emphasizing diversification of energy sources, efficiency access, and equity (REPUBLIC OF KENYA Ministry of Energy NATIONAL ENERGY POLICY, 2018). The USAID report (2020) enriches our understanding of KNES by robustly emphasizing how digital technologies, such as geospatial technology,

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contribute to cost-effective approaches (Dean , Donkor, Paul, & Olutola, 2020). This alliance highlights the interplay between electrification and the digital ecosystem. The World Bank has been a key partner in Kenya's energy expansion endeavors (Kenya Charts Path to Achieving Universal Access to Electricity , 2018). Programs supported by the World Bank such as the Last Mile Connectivity and Slum Electrification, have significantly contributed to extending electricity access, particularly in previously underserved areas. The Last Mile Connectivity resonates with the USAID report (2020) identifications of challenges in the last-mile connectivity, both initiatives present the importance of digital and electrification solutions in extending access (Dean , Donkor, Paul, & Olutola, 2020).

Electrification, notably in schools, emerges as a pivotal aspect in ensuring equitable education and technological accessibility. The Kenya Off-Grid Solar Access Project (KOSAP), funded by the World Bank, focuses on providing electricity and clean cooking solutions in traditionally underserved regions (SUSTAINABLE OFF-GRID SOLAR DELIVERY MODELS TO POWER HEALTH AND EDUCATION, 2019). By prioritizing stand-alone solar home systems and electrifying community facilities, including educational institutions, KOSAP addresses critical gaps in education infrastructure and healthcare services. Government-led initiatives in collaboration with international organizations underscore a concerted effort to bridge electricity access gaps (SUSTAINABLE OFF-GRID SOLAR DELIVERY MODELS TO POWER HEALTH AND EDUCATION, 2019). The KOSAP project, in partnership with the World Bank and USAID, exemplifies the dedication to electrification, ensuring sustainable energy solutions and employment opportunities in underserved regions. Additionally, the USAID report (2020) exhibits the role of digital technology in extending internet access, which falls along with the KOSAP projects focus on electrifying traditionally underserved regions (Dean , Donkor, Paul, & Olutola, 2020). This intersection emphasizes the dual impact of digital and electrification initiatives on education and healthcare services.

Policy uncertainty, political priorities, and underdeveloped policies are well- documented challenges hindering universal electrification in Kenya. Poor understanding and communication between legislators, utilities, and citizens contribute significantly to growing animosity toward government-funded utility projects. Additionally, unclear, and misplaced political priorities, coupled with neocolonialism's pervasive influence on policy development in many sub-Saharan countries, including Kenya, pose further challenges. Policy models often adopted from advanced economies fail to address the unique developmental needs and nuances of developing countries, neglecting crucial considerations such as resource availability, supply shortages, and costs. These models exacerbate political tensions and reinforce neocolonialist structures, eroding citizen trust in development initiatives (Boamah & Williams, 2019).

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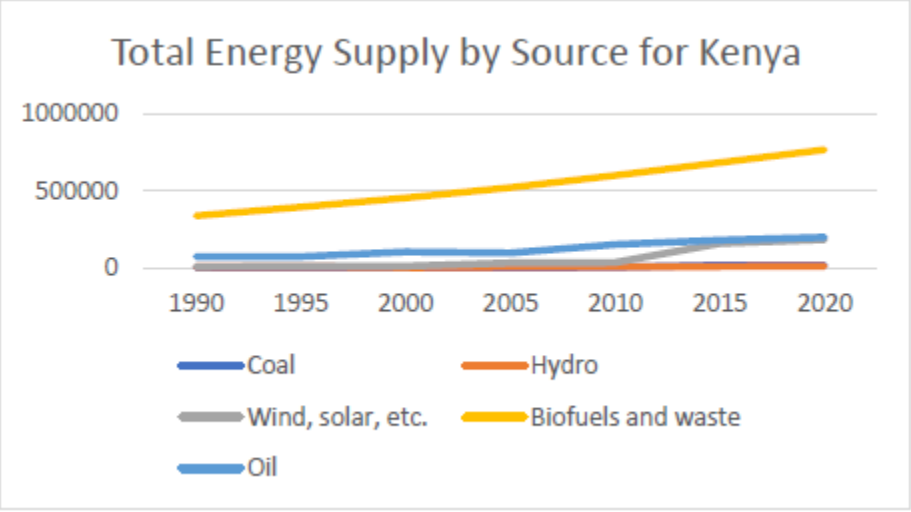
Reliance on Specific Energy Sources

Innovative approaches are imperative to address the energy needs of the 1.3 billion people worldwide lacking electricity while transitioning to a decarbonized energy system. Countries yet to achieve universal electrification, like Kenya, must innovate new ways to increase energy production, focusing on underserved populations. One causal factor hindering Kenya's path to universal electrification is its reliance on specific energy sources. This paper presents an analytical and conceptual framework elucidating the heterogeneous continuum of reliance on certain energy sources, while untapped potential for cleaner energies remains underutilized. Electricity supply in Kenya originates from renewable sources, with geothermal power and hydroelectricity leading the mix. Despite recent advancements, Kenya's installed electricity capacity remains low for a population exceeding 50 million. The Government of Kenya (GoK) is actively pursuing strategies to diversify its energy mix, incorporating cheaper renewable sources like geothermal, wind, and solar, while reducing reliance on expensive heavy fuel oil plants. It aims to achieve a generation capacity of 5,000MW by 2030, primarily sourced from geothermal, natural gas, wind, and solar energy. Long-term goals include the development of nuclear power, with the first project slated to commence in 2035. These initiatives present trade and investment opportunities, particularly in renewable sources such as geothermal, solar, and wind (Stein et al., 2022).

Figure 5



World Energy Statistics and Balances - Data product, 2022

First, there is a significant increase in total energy supply. Figure 5 shows a substantial increase in total energy supply in Kenya over the years. In 1990, the total energy supply was 420,191

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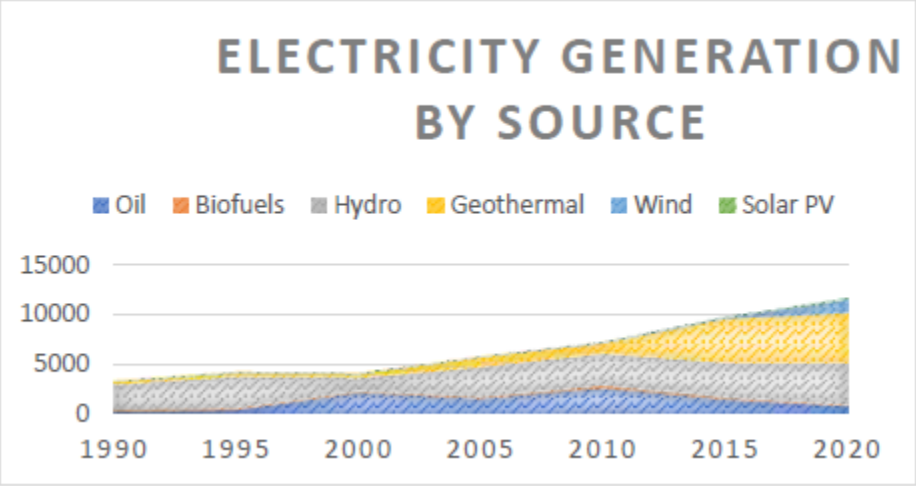
terajoules and by 2020, it had grown to 1,208,999 terajoules (IEA, 2022). This represents a more than two-fold increase over three decades. Second, there is a shift from traditional to modern energy sources illustrating a transition in energy sources. 1n 1990, biofuels and waste constituted the largest share of energy supply, followed by oil. However, by 2020, modern renewable sources, such as wind, solar, and hydroelectric power had significantly expanded, contributing to the energy supply. Third, there is substantial growth in wind and solar energy. Wind and Solar and other modern renewable sources have experienced remarkable growth over the years.

There is an impressive growth in trajectory from 1990 to 2020. Fourth, Kenya demonstrated a reliance on biofuels and waste where it maintained a substantial reliance on biofuels and waste as an energy source. Fifth, when it comes to oil there has been a consistent dependence on oil. Sixth, hydroelectric power has played a crucial role in Kenya's energy supply, making it one of the mainstays on Kenya's energy generation. This displays Kenya's efforts to diversify its energy supplies, particularly by expanding modern renewable energy options like wind, solar, and hydroelectric power. This shift aligns with the global trend of transitioning to cleaner and more sustainable energy sources, contributing to energy security and environmental stability. Therefore, the access to electricity is dwelled upon the diverse sources of energy; however, the limited accessibility to various sources restricts Kenya from utilizing all energy sources.

Figure 6



Electricity Information - Data Product, 2022

There are diverse sources of electricity generation in Kenya. The sources are oil, biofuels, hydro, geothermal, wind, and solar. From 1990 to 2010 there was a substantial increase in oil-based generation, but it was followed by a significant decline (IEA, 2022). Figure 6 below shows the

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various sources of electricity generation. Electricity generation from biofuels remained stable during the early years. Though a slight decrease in the mid-1990s was followed with an increase from 2000 to 2010, then after it remained steady. Hydroelectric power generation steadily increased over the years which contributed to Kenya's electricity generation positively impacting the disparity in electricity access across the country from 10% to 70% (IEA, 2022). Geothermal power generation increased during the entire period. Kenya has tapped into its geothermal resources, making it a major source of electricity. Wind and Solar generation were introduced in the latter half of the period and displayed a steady growth. While their contributions were low compared to other sources, they are gaining importance in Kenya's energy mix.

The implications for electrification based on electricity generation reveals crucial insights into Kenya's energy landscape and technology access. The fluctuations in oil- based electricity generation highlight the need to diversify energy sources to ensure energy security and reduce the impact of oil price volatility. Reducing reliance on oil can contribute to more stable electricity prices and support economic growth. Stable biofuels and substantial hydroelectric, geothermal, wind and solar generation underscore the importance of renewable energy sources. These sources are vital for sustainable and environmentally friendly electricity generation enabling to address the concerns of limited connectivity and insufficient resource utilization. A diversified energy mix ensures reliability, affordability, and sustainability, all of which have positive effects on and technology access and enables for the development of infrastructure, closes the gap of rural-urban disparity, and empowers the economic development. Geothermal energy stands out as a significant contributor to electricity generation in Kenya. Given its reliability and sustainability, further investments in this source enhance energy access and the reliability of power supply, benefiting institutions, households, and infrastructure accessibility to technology. The introduction and growth of wind and solar generation are promising developments, showing Kenya's commitment to adopting cleaner energy sources. These sources facilitate electrification in remote and underserved areas, enabling access to technology for those living in these regions. The importance of diversifying energy sources and investing in renewable energy ensures a stable and sustainable electricity supply. These efforts are critical for addressing electrification challenges and fostering equitable technology access in Kenya. Additionally, it provides a foundation for further research and policymaking in the energy sector to support technology accessibility in the country and reaching the goal of 100% electricity by 2030. Despite Kenya's significant energy production, 22% of its populace lacks electricity access.

Investments in nuclear energy and solar power hold promise for increasing energy supply and addressing incomplete electrification. Electricity access has brought substantial improvements to Kenyan households, enhancing quality of life through lighting, and powering various appliances. Additionally, electricity has revolutionized transportation, communication, industrialization,

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healthcare, and the adoption of renewable energy technologies, contributing to economic growth and sustainable development.

D. Findings

The findings of the research shed light on the intricate interplay between electricity access, infrastructure development, economic growth, and policy challenges in Kenya's quest for universal electrification. Firstly, the analysis uncovers significant rural- urban disparities in electricity access, attributed to infrastructure limitations and affordability hurdles in rural areas. Sparse population distribution and higher installation costs exacerbate the gap between rural and urban electrification rates, highlighting the need for targeted interventions to bridge this divide and ensure equitable access to electricity across the country.

Secondly, the study underscores the critical barrier posed by limited infrastructure development, particularly in rural regions, to achieving universal electrification.

Inadequate roads and infrastructure deficiencies hinder the installation of necessary energy resources, perpetuating underdevelopment and hindering access to essential services like healthcare and education. Addressing these infrastructure gaps is essential for extending electricity access to underserved communities and fostering inclusive development.

Moreover, economic constraints emerge as a major obstacle to universal electrification in Kenya, especially for rural populations. Despite efforts to subsidize connections, extreme poverty rates and income disparities impede access to electricity, leading to reliance on unsustainable energy sources and perpetuating energy poverty. To overcome these challenges, comprehensive strategies are needed to enhance affordability, promote income generation, and improve access to financing for electrification projects.

Additionally, the study highlights the significance of addressing policy and regulatory challenges in Kenya's electrification efforts. Policy uncertainty, political priorities, and underdeveloped policies hinder progress towards universal electrification, emphasizing the importance of coherent and robust policy frameworks tailored to the country's unique developmental needs. Furthermore, the findings underscore the need for diversifying energy sources to ensure a stable and sustainable electricity supply. While efforts to incorporate renewable sources like geothermal, wind, and solar are underway, further investment in cleaner energy technologies is essential to support Kenya's electrification goals and foster sustainable development.

Overall, the research findings underscore the multifaceted nature of the challenges facing Kenya's

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electrification efforts and highlight the need for comprehensive strategies addressing infrastructure development, affordability, policy coherence, and energy source diversification. By addressing these challenges, Kenya can pave the way for universal electrification, unlocking socio-economic opportunities and driving sustainable development across the country.

VI. LIMITATIONS

While conducting this research, several inherent limitations were encountered, which influenced the depth of the study. Firstly, the comparative analysis between two distinct regions presented challenges in accessing grassroots information. The absence of physical presence in one region constrained the direct gathering of insights, affecting the depth of understanding regarding local nuances and perceptions. Secondly, the exploration of the relationship between electricity access necessitated an extensive review of scholarly work. This comprehensive analysis extended the duration of the study, adding complexity to the interpretation of energy-related data. Moreover, regions with limited electricity access posed significant obstacles in obtaining available and reliable data. This limitation impacted the depth and accuracy of the study's findings, hindering a comprehensive analysis of the energy landscape.

Resource constraints also played a role in shaping the research's scope. The limitations in resources restricted the extent to which the study delved into certain aspects, while the geographical variability among the studied areas introduced complexities in data collection and interpretation. The dynamic nature of the energy industry and education sector further complicated the research. Constant changes in baseline conditions, regulations, resource allocation, and their impacts on the target region required ongoing adaptation strategies throughout the study duration.

Additionally, external influences such as shifts in government policies, external events, and ethical considerations had notable impacts on the research process and outcomes.

However, despite these limitations, the research was conducted with rigor, employing meticulous data collection methods, collaborative efforts, and adaptive strategies. These measures aimed to mitigate the effects of limitation, ensuring that the findings uphold validity and reliability to the greatest extent possible.

VII. CONCLUSIONS AND RECOMMENDATIONS

In conclusion, the electrification landscape in Kenya presents a complex interplay of challenges and opportunities. While substantial progress has been made in expanding electricity access, especially in urban areas, significant hurdles persist, particularly in rural and underserved regions. The disparity between rural and urban electrification rates remains a formidable

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obstacle, exacerbated by factors such as limited infrastructure development, economic constraints, policy and regulatory challenges, and reliance on specific energy sources. Efforts to address these challenges must be multifaceted and comprehensive, incorporating strategies to enhance infrastructure development, improve affordability, refine policies and regulations, and diversify energy sources. Investments in expanding transmission networks, especially in rural areas, are crucial for bridging the rural-urban electrification gap and driving economic growth. Moreover, initiatives to make electricity more affordable and accessible to all, particularly those in low-income households, are essential for achieving universal electrification. This may involve targeted subsidies, innovative financing mechanisms, and public-private partnerships to ensure sustainable energy access for all Kenyan citizens. Furthermore, diversifying Kenya's energy mix by tapping into its abundant renewable energy resources, such as geothermal, wind, and solar power, holds promise for increasing energy supply and reducing reliance on costly and environmentally damaging energy sources. Ultimately, achieving universal electrification in Kenya is not only a matter of infrastructure development but also a catalyst for transformative development across various sectors, including education, healthcare, and economic prosperity. By addressing the persistent challenges and leveraging opportunities for innovation and collaboration, Kenya can realize its vision of becoming a universally electrified nation, driving sustainable development, and improving the quality of life for all its citizens. These recommendations aim to guide resource allocation, foster partnerships, and explore innovative financing mechanisms, improve efficiency, incentivize renewable energy adoption, engage local communities, facilitate capacity building, implement effective monitoring and evaluation, and align policies for long-term electrification planning.

Investment in expanding transmission infrastructure is crucial to address the problem of inadequate infrastructure hindering economic growth in Kenya. The analysis demonstrates a significant relationship between economic growth and infrastructure development length, highlighting the necessity of expanding transmission infrastructure. Findings indicate that this investment is essential to meet increasing electricity demand and drive economic growth. The decisions to implement this recommendation will primarily be made by the Ministry of Energy in Kenya, as it holds the authority over energy infrastructure development and policy formulation. Collaboration with relevant government agencies, regulatory bodies, and international partners are required to secure funding and support for infrastructure projects. Implementation of this recommendation will involve various stakeholders, including government agencies, utility companies, contractors, and technical experts. The Ministry of Energy will oversee the planning and execution of transmission infrastructure projects, with support from international partners like USAID in terms of funding, technical assistance, and capacity building. The recommendation for investment in transmission infrastructure should be implemented promptly to address the pressing need for expanding electricity access and supporting economic growth in

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Kenya. A detailed project timeline should be developed, considering factors such as project planning, procurement, construction, and commissioning, with clearly defined milestones and deadlines. Transmission infrastructure projects should be strategically implemented across Kenya, focusing on areas with high electricity demand, economic potential, and underserved populations. Priority should be given to regions with inadequate transmission infrastructure to ensure equitable access to electricity and promote balanced regional development. This recommendation involves significant investment in expanding transmission infrastructure, which often requires collaboration between public and private entities. PPPs can be utilized to finance, construct, and operate transmission infrastructure projects, leveraging the expertise and resources of both sectors to achieve common goals. Additionally, the involvement of international partners like USAID suggests the potential for PPP arrangements to facilitate funding and technical assistance from external sources. Upon implementation of this recommendation, several outcomes are anticipated: Improved electricity access: Expanded transmission infrastructure will enhance electricity access, particularly in rural and underserved areas, contributing to improved quality of life and economic opportunities for local communities. Economic growth stimulation: Enhanced electricity supply will support economic activities, attract investments, and stimulate job creation and income generation, driving overall economic growth and development in Kenya.

Enhanced efficiency: A well-developed transmission infrastructure will improve the efficiency of electricity distribution, reduce transmission losses, and optimize electricity utilization, leading to cost savings and improved service delivery.

Balanced Approach to electricity infrastructure development: Ensuring a coordinated approach between substation capacities and transmission improvements is essential to optimize Kenya's electricity infrastructure and meet growing demand effectively, thus avoiding electricity shortages or overproduction that hinder economic growth. The recommendation for maintaining a balanced approach to infrastructure development is essential to avoid electricity overproduction, which could negatively impact economic growth. By ensuring a coordinated approach between substation capacities and transmission improvements, Kenya can optimize its electricity infrastructure to meet growing demand effectively. This recommendation is supported by the analysis, which emphasizes the importance of balancing infrastructure development to sustain economic growth. Findings suggest that an imbalance between substation capacities and transmission improvements could lead to inefficiencies and hinder economic progress. The decisions to implement this recommendation will involve collaboration between the Ministry of Energy, regulatory bodies, and utility companies. A coordinated approach to infrastructure development will require consensus among key stakeholders to ensure alignment with national electrification goals and objectives.

Implementation of this recommendation will be the responsibility of government agencies, utility

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companies, and contractors involved in electricity infrastructure development. Close collaboration and communication among these stakeholders will be essential to ensure that substation capacities and transmission improvements are coordinated effectively. Implementation of a balanced approach to infrastructure development should begin immediately to address potential inefficiencies and avoid disruptions to economic growth. A phased approach may be necessary, with priority given to regions experiencing electricity shortages or facing challenges related to overproduction. A balanced approach to infrastructure development should be implemented nationwide, with a focus on regions experiencing electricity shortages or facing challenges related to overproduction. Priority should be given to areas with high electricity demand and economic potential to maximize the impact on economic growth and development. Upon implementation of this recommendation, several outcomes are anticipated: Optimized electricity infrastructure: A balanced approach to infrastructure development will ensure that substation capacities and transmission improvements are aligned with electricity demand, minimizing inefficiencies and disruptions to economic activity. Enhanced economic growth: By avoiding electricity shortages or overproduction, Kenya can maintain a stable and reliable electricity supply, supporting economic activities and attracting investments. Improved resource utilization: Coordinated infrastructure development will optimize resource utilization, reducing costs and maximizing the effectiveness of electrification efforts.

Universal Electricity Access: It is imperative that the government of Kenya continues to adopt policies that achieve universal electricity access, as this is essential for fostering economic development and enhancing living standards nationwide. Achieving universal electricity access in Kenya is imperative for fostering economic development and improving living standards. Extending electricity coverage to underserved areas is crucial, as indicated by the positive correlation between economic growth and electricity availability. Recommendations include increased aid allocation to the urban poor sector, promotion of good urban governance, and acknowledgment of chronic poverty, highlighting the importance of collective efforts in fostering sustainable progress towards poverty reduction and inequality alleviation. This recommendation aligns with the identified problem of inadequate access hindering economic growth. The analysis underscores the significance of universal electricity access in promoting economic development. Findings suggest that extending electricity coverage will facilitate economic growth and enhance living standards, particularly in rural and underserved areas. The decision to implement this recommendation will be led by the Ministry of Energy, with support from relevant government agencies and international partners. Political will and commitment at the highest levels of government will be essential to prioritize universal electricity access and allocate resources accordingly.

Implementation of this recommendation will require collaboration between government

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agencies, utility companies, and community stakeholders. Local governments and community organizations will play a crucial role in identifying underserved areas and implementing electrification projects tailored to the specific needs of each community. Universal electricity access should be implemented as a priority, with a phased approach to reach all underserved areas within a specified timeframe. Short-term and long-term electrification plans should be developed, with clear targets and milestones to track progress and ensure accountability. Universal electricity access initiatives should be implemented nationwide, with a focus on rural and underserved areas where access to electricity is limited or non-existent. Priority should be given to areas with the highest need, considering factors such as population density, economic potential, and infrastructure readiness. Upon implementation of this recommendation, several outcomes are anticipated: Improved quality of life: Universal electricity access will provide households and businesses with reliable and affordable energy, improving living standards and enabling socio-economic development. Enhanced economic opportunities: Access to electricity will stimulate economic activities, create job opportunities, and attract investments, particularly in rural and underserved areas. Empowerment of communities: Electrification projects tailored to the specific needs of each community will empower residents and foster community development and resilience.

Efficiency Promotion: It is essential for the government of Kenya to implement policies aimed at promoting the efficient utilization of electricity, as this is significant for stimulating economic growth, enhancing sustainability, and ensuring optimal resource utilization across the electricity value chain. Promoting the efficient utilization of electricity is vital for stimulating economic growth and enhancing sustainability. Encouraging the adoption of energy-efficient technologies and policies to optimize electricity distribution will maximize the impact of electrification efforts. This recommendation is supported by the analysis, which emphasizes the role of efficiency in driving economic growth. Findings suggest that promoting efficiency will not only stimulate economic activity but also contribute to environmental sustainability. The decision to promote efficiency in electricity utilization will involve collaboration between the Ministry of Energy, regulatory bodies, and relevant government agencies.

Policy interventions and incentives may be necessary to encourage the adoption of energy-efficient technologies and practices. Implementation of efficiency promotion initiatives will require collaboration between government agencies, utility companies, and private sector stakeholders. Awareness campaigns, capacity building programs, and financial incentives may be necessary to facilitate the adoption of energy-efficient technologies and practices. Efficiency promotion initiatives should be implemented as part of a comprehensive electrification strategy, with short-term and long-term goals to improve efficiency across the electricity value chain.

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Immediate action should be taken to address low-hanging fruit, while long-term investments should focus on transformative technologies and practices. Efficiency promotion initiatives should be implemented nationwide, targeting key sectors and stakeholders across the electricity value chain.

Priority should be given to areas with the highest potential for efficiency gains, such as energy-intensive industries, commercial buildings, and residential communities. Upon implementation of this recommendation, several outcomes are anticipated: Reduced energy consumption: Energy-efficient technologies and practices will reduce electricity consumption, leading to cost savings for consumers and utilities. Enhanced competitiveness: Improved efficiency will reduce production costs for businesses, making them more competitive in domestic and international markets. Environmental benefits: Energy efficiency measures will reduce greenhouse gas emissions and mitigate the environmental impact of electricity generation and consumption.

Learning from Similar Studies: Kenya government should prioritize the integration of insights from other countries about expanding electricity grids. This will help the government make better decisions about electricity projects and improve how well they work. Drawing insights from similar studies, such as those examining electricity grid expansion effects in other countries, can inform decision-making and policy formulation in Kenya. Understanding the impact of transmission infrastructure on local economic growth is essential for guiding electrification efforts effectively. This recommendation aligns with the identified problem of inadequate infrastructure hindering economic growth. The analysis highlights the importance of learning from international experiences to inform Kenya's electrification strategies. Findings suggest that leveraging lessons from similar studies will enhance the effectiveness of electrification initiatives in Kenya. The decision to learn from similar studies will involve collaboration between the Ministry of Energy, research institutions, and international development partners. A dedicated research and knowledge-sharing platform may be necessary to facilitate the exchange of information and best practices. Implementation of knowledge-sharing initiatives will require collaboration between government agencies, research institutions, and development partners. Capacity building programs, workshops, and seminars may be necessary to disseminate findings and lessons learned from similar studies. Learning from similar studies should be incorporated into the policy-making process and electrification planning from the outset. Continuous monitoring and evaluation will be necessary to assess the effectiveness of knowledge-sharing initiatives and adjust strategies accordingly. Knowledge-sharing initiatives should be implemented nationwide, targeting key stakeholders involved in electrification planning and implementation. Collaboration with international partners and research institutions will be essential to access relevant studies and expertise. Upon implementation of this recommendation, several outcomes are anticipated: Informed decision-making: Insights from

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similar studies will inform policy formulation and electrification planning, ensuring that interventions are evidence- based and aligned with international best practices. Enhanced capacity: Knowledge- sharing initiatives will build the capacity of government agencies, research institutions, and development partners to effectively implement electrification projects and initiatives. Accelerated progress: Learning from international experiences will expedite the implementation of electrification projects and initiatives, maximizing the impact on economic growth and development.

References

Abiodun, K., Gautam, A., Newman, A., Nock, D., & Pandey, A. (2022). The Role of Microgrids in Advancing Energy Equity Through Access and Resilience. In Tutorials in Operations Research: Emerging and Impactful Topics in Operations, pp. 175-190.

Adala, A. A. (2016). Current state of advancement of Open Educational Resources in Kenya. UNESCO Institute for Information Technologies in Education. Retrieved from http://iite.unesco.org/pics/publications/en/files/3214744.pdf

Ahlborg, H., & Hammar, L. (2011). Drivers and barriers to rural electrification in Tanzania and Mozambique – grid extension, off-grid and renewable energy sources. In World Renewable Energy Congress, Linkoping, Sweden, pp. 2493 – 2500, May 2011.

Awuor, F. M., Khisa, J. W., & Rambi, D. A. (2015). Delivering equitable and quality education to remote Kenya using ICT. In Emerging issues and prospects in African E-Government (pp. 108-117). IGI Global.

Ayres, R. U., Van den Bergh, J. C., Lindenberger, D., & Warr, B. (2013). The underestimated contribution of energy to economic growth. *Structural Change and Economic Dynamics.*

Bayar, Y., & Özel, H. A. (2014). Electricity consumption and economic growth in emerging economies.

Boamah, F., & Williams, A. (2019). *Kenyapowerless - corruption in electricity as'problem-solving' in kenya's periphery*. Www.u4.No. https://www.u4.no/publications/kenyapowerless-corruption-in-electricity-as-problem- solving-in-kenyas-periphery.pdf

Bonan, J., Pareglio, S., & Tavoni, M. (2017). Access to modern energy: a review of barriers, drivers and impacts. *Environment and Development Economics*, *22*(5), 491–516. https://doi.org/10.1017/s1355770x17000201

Bureau for Africa | Organization. (2023, November 1). U.S. Agency for International

ISSN: 2455-8834

Volume:09, Issue: 11 "November 2024"

Development. https://www.usaid.gov/about-us/organization/bureau-africa

Cecire, M. H. (2019). The POWER Initiative: energy transition as economic development. Congressional Research Service, 16(1), 1-17.

DSD :: Resources - Publications - Core Publications. (n.d.). Www.un.org. https://www.un.org/esa/dsd/agenda21/res_agenda21_27.shtml

Electricity Information - Data product. (2022). IEA. https://www.iea.org/data-and-statistics/data-product/electricity-information

Energy Information Administration. (2021, March 18). *Electricity in the U.S. - U.S. energy information administration (EIA)*. Eia.gov; U.S. Energy Information Administration. https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php

Gumbe, L. (2016). Electrifying Kenya through conventional and renewable sources. *2016 ASABE Annual International Meeting (p. 1)*. American Society of Agricultural and Biological Engineers.

Heinrich, C. J., Darling-Aduana, J., & Martin, C. (2020). The potential and prerequisites of effective tablet integration in rural Kenya. British Journal of Educational Technology, 51(2), 498-514.

Ibrahim, K. M., & Waziri, S. I. (2020). Improving ICT and renewable energy for environmental sustainability in sub-Saharan Africa. Journal of Research in Emerging Markets, 2(3), 82- 90.

IEA. (2022). *World Energy Balances Highlights - Data product*. IEA. https://www.iea.org/data-and-statistics/data-product/world-energy-balances-highlights

International Trade Administration. (2022, August 19). *Kenya - Energy-Electrical Power Systems*. Www.trade.gov. https://www.trade.gov/country-commercial-guides/kenya- energy-electrical-power-systems

Kenya Launches Ambitious Plan to Provide Electricity to All Citizens by 2022. (2018). World Bank. https://www.worldbank.org/en/news/press-release/2018/12/06/kenya-launches- ambitious-plan-to-provide-electricity-to-all-citizens-by-2022

Kenya National Electrification Strategy: Key Highlights 2018. (2018). http://pubdocs.worldbank.org/en/413001554284496731/Kenya-National-Electrification- Strategy-KNES-Key-Highlights-2018.pdf

Kenya Poverty Assessment 2023 – From Poverty to Prosperity: Making Growth More Inclusive.

ISSN: 2455-8834

Volume:09, Issue: 11 "November 2024"

(2023). World Bank Group.

Kirikkaleli, D., Sokri, A., Candemir, M., & Ertugrul, H. M. (2018). Panel cointegration: Long-run relationship between internet, electricity consumption and economic growth.

Koima, J. (2019, September). *School electrification and academic outcomes in rural Kenya*. 2019 Sixth International Conference, September 23-26, 2019, Abuja, Nigeria; African Association of Agricultural Economists (AAAE). https://ideas.repec.org/p/ags/aaae19/295851.html

KPMG East Africa . (2023). *Kenya 2023/24 budget brief*. https://assets.kpmg.com/content/dam/kpmg/ke/pdf/tax/2023/Kenya%202023-24%20National%20Budget%20Insights_Brief.pdf. Theme: Bottom-up Economic Transformation and Climate Change Mitigation/Adaptation for Improved Livelihoods of Kenyans.

Lee, K., Brewer, E., Christiano, C., Meyo, F., Miguel, E., Podolsky, M., Rosa, J., & Wolfram, C. (2016). Electrification for "Under Grid" households in Rural Kenya. *Development Engineering*, *1*, 26–35. https://doi.org/10.1016/j.deveng.2015.12.001

Lipscomb, M., Mobarak, A. M., & Barham, T. (2013). Development effects of electrification: Evidence from the topographic placement of hydropower plants in Brazil. *American Economic Journal: Applied Economics*, *5*(2), 200-231.

Manne, A. S. (1991). ETA-MACRO: A model of energy–economic interactions. Energy, 16(7), 1117-1140.

Ministry of Energy and Petroleum. (2016). Development of a Power Generation and Transmission Master Plan, Kenya Long Term Plan 2015 – 2035.

Mossavar-Rahmani, B. (2013). Energy policy in Iran: domestic choices and international implications. *Elsevier.*

Ngware, M. W., Onsomu, E. N., Muthaka, D. I., & Manda, D. K. (2006). Improving access to secondary education in Kenya: what can be done? Equal Opportunities International, 25(7), 523-543.

Njiru, C. W., & Letema, S. C. (2018, November 14). *Energy poverty and its implication on standard of living in kirinyaga, kenya*. Journal of Energy. https://www.hindawi.com/journals/jen/2018/3196567/

Odek, A. W., & Oloo, J. A. (2012). Achieving equity in education in Kenya: Some preliminary thoughts. *Organisation Structure | Energy*. (2023). Energy.go.ke.

ISSN: 2455-8834

Volume:09, Issue: 11 "November 2024"

https://energy.go.ke/organisation- structure

Osano, H. M., & Koine, P. W. (2016). Role of foreign direct investment on technology transfer and economic growth in Kenya: a case of the energy sector. Journal of Innovation and Entrepreneurship, 5, 1-25.

Poverty & Equity Brief Kenya Africa Eastern & Southern. (2023). World Bank Group. PowerAfrica Conference and Exposition (2016 : Livingstone, Zambia), IEEE Power & Energy

Society, & Institute of Electrical and Electronics Engineers. (2016). 2016 Ieee pes powerafrica : june 28 2016-july 3 2016. IEEE.

Power Africa: The Roadmap, USAID Report, February 2016. www.usaid.gov/powerafrica/roadmap

REPUBLIC OF KENYA Ministry of Energy NATIONAL ENERGY POLICY. (2018).https://kplc.co.ke/img/full/BL4PdOqKtxFT_National%20Energy%20Policy%20October%20%202018.pdf

Ritchie, H., & Roser, M. (2019). *Energy Access*. Our World in Data. https://ourworldindata.org/energy-access

Ritchie, H., Roser, M., & Rosado, P. (2020). Energy. Published online at OurWorldInData.org. Sergi, B., Babcock, M., Williams, N. J., Thornburg, J., Loew, A., & Ciez, R. E. (2018).

Institutional influence on power sector investments: A case study of on-and off-grid energy in Kenya and Tanzania. Energy research & social science, 41, 59-70.

SESSIONAL PAPER NO. 4 ON ENERGY. (2004). https://repository.kippra.or.ke/bitstream/handle/123456789/1371/SESSIONAL%20PAPER%204%20ON%20ENERGY%202004.pdf?sequence=3&isAllowed=y

Share of schools with access to electricity. (2020). Our World in Data. https://ourworldindata.org/grapher/schools-access-to-electricity?country=~KEN

Stein, Dr. A., Messinger, J., Wang, Dr. S., Lloyd, J., McBride, J., & Franovich, R. (2022, July 6).

Advancing nuclear energy. The Breakthrough Institute.

https://thebreakthrough.org/articles/advancing-nuclear-energy-report

SUSTAINABLE OFF-GRID SOLAR DELIVERY MODELS TO POWER HEALTH AND EDUCATION. (2019).

ISSN: 2455-8834

Volume:09, Issue: 11 "November 2024"

https://www.seforall.org/system/files/2019-04/Powering- Health_042019.pdf

The National Treasury and Economic Planning 2023/24 Budget. (2023). https://www.treasury.go.ke/wp-content/uploads/2023/06/Budget-Highlights-The- Mwananchi-Guide-for-the-FY-2023-24-Budget.pdf

Tracking SDG7: The Energy Progress Report, 2022 – Analysis. (2022). IEA. https://www.iea.org/reports/tracking-sdg7-the-energy-progress-report-2022

United Nations Department of Economic and Social Affairs. (2014). United Nations. https://sdgs.un.org/gsdr/gsdr2014

United States Agency for International Development. (n.d.). About USAID. https://www.usaid.gov/who-we-are/organization

USADI REPORT, DIGITAL ECOSYSTEM COUNTRY ASSESSMENT (DECA). (2020). https://www.usaid.gov/sites/default/files/2022-05/DECA_Report_KENYA_EXTERNAL_2OCT2-2-_2.pdf

USAID. (2020, November 9). *Power Africa in Kenya | Power Africa | U.S. Agency for International Development*. Www.usaid.gov. https://www.usaid.gov/powerafrica/kenya

Waiyaki, H. (2023, December 18). *Brighter Futures: Navigating Electrification Challenges in Kenya* (T. Wambui, Interviewer) [Interview].

https://spotifyanchor- web.app.link/e/GXr3jXChDGb

Williams, J. H., DeBenedictis, A., Ghanadan, R., Mahone, A., Moore, J., Morrow III, W. R., ... & Torn, M. S. (2012). The technology path to deep greenhouse gas emissions cuts by 2050: the pivotal role of electricity. Science, 335(6064), 53-59.

World development indicators | databank. (2024). Databank.worldbank.org. https://databank.worldbank.org/reports.aspx?source=2&series=EG.ELC.ACCS.UR.ZS&country=KEN#

World Energy Statistics and Balances - Data product. (2022). IEA. https://www.iea.org/data-and-statistics/data-product/world-energy-statistics-and-balances

World, B. (2018, December 6). *Kenya Charts Path to Achieving Universal Access to Electricity*. World Bank. https://www.worldbank.org/en/news/feature/2018/12/06/kenya-charts-path- to-achieving-universal-access-to-electricity

ISSN: 2455-8834

Volume:09, Issue: 11 "November 2024"

Ye, G. (2017). *THE IMPACT OF ELECTRICITY ACCESS ON EDUCATION IN KENYA*. https://core.ac.uk/download/pdf/158321603.pdf

