

DOI: <https://doi.org/10.63332/joph.v5i8.3201>

## Differential Inequalities in Energy Access and Utilization in Selected Sub-Saharan African Countries

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### Abstract

Energy access and utilization remain highly unequal across sub-Saharan Africa (SSA) countries, despite the region's vast natural resources and growing energy needs. This study examines the differential inequalities in energy access and utilization in selected SSA countries, focusing on demand and supply-side constraints, technological opportunities, and the role of government and private sector interventions. The review paper highlights the persistent energy poverty affecting over 600 million people in SSA, particularly in rural areas, where reliance on traditional biomass remains prevalent. Infrastructure deficiencies, high energy costs, and inadequate policy frameworks further exacerbate these inequalities. The paper underscores the critical role of governments in formulating effective energy policies, implementing subsidies, and fostering public-private partnerships to expand sustainable energy access. The private sector's involvement in financing and deploying decentralized energy solutions is identified as a key driver of progress. Recommendations include strengthening policy and regulatory frameworks, expanding regional power pools, investing in decentralized energy solutions, and promoting financial inclusion through innovative funding mechanisms. By addressing these challenges, SSA can move towards achieving equitable and sustainable energy access, fostering economic growth, and improving overall quality of life as key objectives of achieving the sustainable development goals (SDGs).

**Keywords:** Access, Development, Energy Inequality, Sdgs, Sub-Saharan Africa.

### Introduction

Access to reliable and affordable energy is a crucial component of human development and economic progress worldwide (Babatunde, Munda and Hamam, 2020; Olabi and Abdelkareem, 2022). At the global level, energy consumption per capita is often used as a measure of quality of life and industrialization (Mazur, 2011; Ajlouni and Alsamamra, 2019). Yet, the distribution of energy access and utilization is far from equitable, with stark disparities observed between and within regions. Africa, as a continent, has long struggled with chronic power problems that have stifled its economic growth, despite the abundance of natural resources in the region (Ebhotu and Inambao, 2016). Sub-Saharan Africa, in particular, is home to over 600 million people without access to modern energy services, and the projected timeline for achieving adequate power accessibility in the region is as far as 2080 (Ebhotu and Inambao, 2016). This energy poverty is a significant barrier to the region's development, limiting economic and agricultural opportunities, negatively impacting the environment, promoting gender inequality, and constraining the delivery of critical social services such as healthcare and education (Fatona et al., 2013; Getie, 2020; Africa - Countries and Regions, 2024).

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The energy landscape in sub-Saharan Africa is characterized by a complex interplay of demand and supply-side factors. On the demand side, the region faces a growing population, rapid urbanization, and rising energy needs for industrial, commercial, and residential purposes (Kebede, Kagochi and Jolly, 2010; Warner and Jones, 2018, 2018; Lecaros et al., 2019; Africa Energy Outlook 2022, 2022). On the supply side, the region's energy infrastructure is often inadequately developed, with outdated and inefficient systems that struggle to meet the growing demand, leading to chronic power outages and insufficient energy access across the region (U.S. Energy Information Administration, 2020; Ebhota and Inambao, 2016) The underlying drivers of these energy access and utilization disparities within sub-Saharan Africa are multifaceted and require a comprehensive understanding to develop effective and sustainable solutions.

Access to reliable and affordable energy is a critical component of socioeconomic development, yet many sub-Saharan African countries continue to face significant disparities in energy access and utilization (Bhattacharyya, 2018). Despite the region's vast potential for renewable energy sources, the majority of the population remains without access to modern energy services, limiting economic and social progress (Mukhtar, 2015). The energy paradox in sub-Saharan Africa, where the region's wealth in fossil and renewable resources is not translating into widespread energy access, raises important questions about the underlying factors contributing to this differential inequality (Sarkodie and Adams, 2020). Additionally, the lack of reliable energy access is closely linked to the region's high levels of poverty, inadequate social services, and low rankings on the Human Development Index and Energy Development Index (Mukhtar, 2015). This review paper critically analysed the differential inequalities in energy access and utilization in sub-Saharan African countries, identifying key barriers, opportunities, and policy recommendations for achieving sustainable and equitable energy distribution. This was achieved through the following specific objectives:

- i. Assessing the inequalities in energy access and utilization across selected SSA countries, examining both demand- and supply-side constraints that contribute to energy poverty and regional inequalities.
- ii. Evaluating the role of technological innovations and renewable energy solutions in transforming the energy landscape within SSA, highlighting opportunities for bridging the energy gap through decentralized and sustainable energy systems.
- iii. Analysing the contributions of government policies and private sector initiatives in addressing energy access disparities, providing recommendations for strengthening institutional frameworks and fostering inclusive energy development strategies.

### **Energy Needs, Access, and Utilization in Sub-Saharan Africa**

Energy access remains a critical challenge in sub-Saharan Africa (SSA), with significant disparities in both rural and urban areas. According to the International Energy Agency Theu and Kimambo, (2023), Africa Energy Outlook 2022 (2022), and IEA (2022), approximately 43% of the population in SSA lacks access to electricity, with rural areas experiencing the most severe shortages. The demand for energy in SSA is growing due to increasing urbanization, industrialization, and population growth (World Bank, 2021). Yet, the supply side remains constrained by inadequate infrastructure, inefficient transmission networks, and a heavy reliance on biomass for household energy consumption (The State of Access to Modern Energy Cooking Services, 2020; TheEnergy Challenge in Sub-Saharan Africa: Addressing Energy Poverty, 2023; Mainimo *et al.*, 2022).

In SSA, the reliance on traditional biomass, such as firewood and charcoal, contributes to deforestation and adverse health effects due to indoor air pollution (Karekezi, 2002; Karekezi and Kimani, 2002). Despite the abundance of renewable energy resources, the region struggles with underinvestment in clean energy projects. Many governments have made efforts to increase grid connectivity, but rural electrification remains a challenge (Karekezi and Kithyoma, 2002; Warner and Jones, 2018). Limited financial resources and the high cost of extending national grids make decentralized energy solutions, such as solar mini grids, a more viable alternative (Yaqoot, Diwan and Kandpal, 2016). The economic disparities between urban and rural households influence energy consumption patterns. Wealthier urban households have better access to electricity and modern cooking fuels, while poorer rural populations depend on inefficient energy sources (Africa's energy future matters for the world, 2019; Africa Energy Outlook, 2019). Thus, addressing these inequalities requires a multifaceted approach, including policy reforms, increased investment in renewable energy, and improved affordability of energy solutions for low-income populations (U.S. Energy Information Administration, 2020; UNEP, 2020).

### **Available Opportunities in Energy Architecture in the African Continent**

The energy landscape in Africa is evolving, with technological advancements offering opportunities to transform the sector. Decentralized energy systems, particularly off-grid solar solutions, have emerged as a viable option for electrification in remote areas (Global energy crisis shows urgency of accelerating investment in cheaper and cleaner energy in Africa, 2022; Dechamps, 2023). Innovations such as mini-grids, smart metering, and energy storage solutions are enhancing the efficiency and reliability of electricity distribution (Anastasiadis *et al.*, 2019). In addition to decentralized energy solutions, regional power pools, such as the Southern African Power Pool (SAPP) and the West African Power Pool (WAPP), are improving cross-border electricity trade, enhancing energy security, and reducing costs (Meyer, Eberhard and Gratwick, 2018). These initiatives foster regional cooperation and optimize energy generation and distribution across multiple countries. With growing interest in sustainable development, governments and private enterprises are exploring hybrid energy solutions that combine solar, wind, and hydroelectric power to meet growing demand efficiently (IRENA, 2023).

Smart grid technologies and digitalization are also playing a significant role in transforming the energy sector. By incorporating digital monitoring systems, energy providers can enhance efficiency, reduce losses, and offer consumers better access to electricity. Also, energy storage technologies, such as advanced battery systems, are helping to integrate renewable energy into national grids, addressing intermittency issues (UNEP, 2020). These innovations present substantial opportunities for SSA to overcome energy access challenges and move towards a more sustainable future.

### **The Role of Private Sector and Government in Sustainable Energy Production**

Both the private sector and government play critical roles in addressing energy inequalities in SSA. Governments have a responsibility to create an enabling environment through policies, regulations, and incentives that attract private sector investments in the energy sector (World Bank, 2021). Public-private partnerships (PPPs) have been instrumental in financing large-scale energy projects, including solar farms and hydropower plants (Brew-Hammond, 2010).

The private sector has also contributed to the proliferation of decentralized renewable energy solutions, such as solar home systems and mini grids, which have provided millions of

households with access to electricity (IEA, 2022). However, policy inconsistencies, bureaucratic hurdles, and financial constraints often limit the effectiveness of private sector engagement (Eberhard *et al.*, 2016). Governments must implement clear regulatory frameworks and financial incentives to encourage private investment in clean energy initiatives (Karekezi and Kimani, 2002).

Additionally, government-led initiatives such as rural electrification programs and subsidies for renewable energy have proven to be effective in increasing energy access. By integrating community-based energy projects, governments can empower local populations and ensure long-term sustainability in energy solutions ((Anastasiadis *et al.*, 2019). The success of sustainable energy production in SSA requires a collaborative effort between policymakers, private investors, and international organizations to promote innovation, affordability, and inclusiveness in energy access.

### **Efforts at Addressing Differential Inequalities in Energy Access and Utilization in Selected Sub-Saharan African Countries**

#### ***Selected findings on energy needs, access, and utilization in sub-Saharan Africa***

Energy access remains highly uneven across sub-Saharan African countries, with significant inequalities between urban and rural populations. Countries such as South Africa and Ghana have relatively higher electrification rates, while nations like Chad, the Central African Republic, and South Sudan continue to struggle with energy poverty. The International Energy Agency (IEA, 2022) reports that approximately 600 million people in SSA lack access to electricity, with rural electrification rates in some countries as low as 10% (World Bank, 2021). The reliance on traditional biomass, such as firewood and charcoal, is predominant in rural areas, leading to deforestation and negative health effects from indoor air pollution (Karekezi and Kimani, 2002).

While some nations, such as Kenya and Ethiopia, have made significant strides in promoting off-grid renewable solutions, the affordability of modern energy remains a challenge for many low-income households. Governments and private sector players have implemented various initiatives, such as Kenya's Last Mile Connectivity Project and Rwanda's rollout of solar mini grids, to enhance access (Africa Energy Outlook, 2019). Nonetheless, the high cost of grid extension and lack of financing mechanisms for renewable energy projects continue to hinder progress.

#### ***Selected findings on opportunities in energy architecture in the African continent***

The growing adoption of renewable energy technologies presents vast opportunities for SSA's energy sector. Countries such as Morocco and South Africa have invested heavily in solar and wind power, positioning themselves as leaders in Africa's energy transition. The Grand Ethiopian Renaissance Dam (GERD) is another example of large-scale hydropower investments aimed at boosting regional energy supply (IRENA, 2021).

Innovative solutions, including decentralized energy systems and mobile-based pay-as-you-go (PAYG) solar technologies, have transformed energy access in countries like Nigeria, Kenya, and Uganda. These advancements have enabled households to bypass expensive grid connections and adopt affordable off-grid solutions (Couture *et al.*, 2019). Regional power pools, such as the Southern African Power Pool (SAPP) and the West African Power Pool (WAPP), have also facilitated cross-border electricity trade, allowing countries with surplus energy to

distribute it to neighbouring nations (Eberhard et al., 2017, 2021). Despite these advancements, financing remains a major constraint to scaling up renewable energy projects. Many African governments rely on donor funding and private sector partnerships to implement energy projects, which can result in policy inconsistencies and delays. Strengthening regulatory frameworks and fostering collaboration between governments, international organizations, and private investors are essential to unlocking SSA's energy potential (UNEP, 2020).

### ***Selected findings on the role of private sector and government in sustainable energy production***

The private sector has played a pivotal role in driving sustainable energy production in SSA, particularly through investments in renewable energy. Companies such as M-KOPA in Kenya and d.light have introduced affordable solar home systems, allowing millions of low-income households to access electricity (IEA, 2022). Additionally, public-private partnerships (PPPs) have facilitated large-scale energy projects, such as South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP), which has attracted billions in investment (Brew-Hammond, 2010).

Government policies and regulatory frameworks significantly impact the effectiveness of energy access programmes. Countries like Ghana and Tanzania have established supportive energy policies, such as subsidies and tax incentives for renewable energy investments, to encourage private sector participation (World Bank, 2021). However, bureaucratic barriers, inconsistent policies, and financial constraints continue to deter investors in many SSA nations. Strengthening institutional capacity and ensuring policy coherence are necessary for scaling up sustainable energy initiatives (Karekezi and Kimani, 2002). The international collaborations, such as the African Development Bank's Desert to Power initiative, aim to accelerate solar energy production across the Sahel region. These efforts demonstrate the potential of leveraging global partnerships to address energy disparities in SSA (IRENA, 2021).

### **Conclusion and Recommendations**

The review paper highlights that energy access and utilization in SSA are highly unequal, with rural populations disproportionately affected by energy poverty. While some countries have made commendable progress through renewable energy investments and decentralized energy solutions, affordability and infrastructure limitations remain significant barriers. Advancements in solar, wind, and hydroelectric power provide promising solutions, but the effectiveness of these efforts depends on strong policy frameworks, private sector participation, and international cooperation.

Findings reveal that while some countries, such as South Africa and Ghana, have made progress in expanding electrification, others, including Chad and South Sudan, continue to face significant energy deficits. The study also explores the potential of renewable energy technologies, such as solar mini-grids and off-grid solutions, in addressing these differences. Innovative financing models have demonstrated success in improving energy accessibility in countries like Kenya and Nigeria. The paper recommends the following:

*Expand Decentralized Energy Solutions* - Governments should support off-grid solar and mini-grid solutions to reach remote areas, ensuring affordability and accessibility for low-income households.

*Enhance Policy and Regulatory Frameworks* - Policymakers should streamline regulations,

reduce bureaucratic hurdles, and introduce incentives to attract private sector investment in renewable energy.

*Strengthen Regional Energy Cooperation* - expanding regional power pools and cross-border electricity trade can enhance supply efficiency and reduce energy costs. *Increasing Public-Private Partnerships* - Governments should collaborate with private investors and international organizations to fund large-scale energy projects and improve infrastructure.

*Promote Financial Inclusion for Energy Access* - Innovative financing models, such as microfinance and PAYG solar solutions, should be scaled up to make energy services more affordable.

*Invest in Energy Storage and Smart Grid Technologies* - Enhancing grid reliability through energy storage solutions and smart meters can optimize electricity distribution and minimize losses.

*Foster Community Engagement and Awareness* - Educating communities on the benefits of modern energy solutions and sustainable practices can accelerate adoption and long-term sustainability. By implementing these recommendations, SSA can work towards reducing energy inequalities and achieving universal access to sustainable and affordable energy. As well as covering the vision 2060, which aims to create a clean energy-dependent economy, aligns with the Paris Agreement and the United Nations Framework Convention on Climate Change, demonstrating a commitment to energy security, sustainable growth, and environmental protection (Baye, Ahenkan and Darkwah, 2021).

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