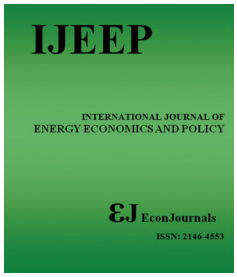

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Energy Poverty in Sub-Saharan African Countries: Harnessing Green Energy for Youth Employability and Economic Transformation

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ABSTRACT

Energy poverty remains a critical developmental challenge across sub-Saharan African (SSA) countries, where over 600 million people lack access to reliable, affordable, and sustainable electricity. This persistent energy deficit impedes socioeconomic progress, limits educational and health outcomes, and stifles industrialization and entrepreneurship. Youth, who constitute more than 60% of the region's population, are disproportionately affected, facing high unemployment rates and limited opportunities for meaningful engagement in the formal economy. This paper explores the intersection of energy poverty and youth employability, emphasizing the transformative potential of harnessing green energy to drive inclusive economic development. Green energy comprising solar, wind, biomass, hydro, and geothermal sources offers a scalable and sustainable solution to SSA's energy crisis. It presents an opportunity not only to expand energy access but also to create jobs, stimulate innovation, and foster entrepreneurship among youth. Through decentralized renewable energy systems such as mini-grids and solar home systems, rural and off-grid communities can be empowered to participate in local economies, enhancing resilience and reducing rural-urban drifts.

Keywords: Green Energy, Youth Employability, Sustainable Development, Entrepreneurship, Energy Transition
JEL Classifications: O10, O13. O40, O55, Q40, Q41, Q48

1. INTRODUCTION

The nexus between green energy development, enhanced youth employability, and comprehensive economic transformation represents a pivotal area of inquiry for sub-Saharan African nations. This region, characterized by a burgeoning youth population and significant energy poverty, stands at a critical juncture where strategic investments in sustainable energy solutions can simultaneously address socio-economic disparities and foster robust, inclusive growth.

Sub-Saharan Africa faces profound energy poverty, with a substantial portion of its population lacking access to reliable and affordable electricity, severely hindering economic development and quality of life. This deficit not only perpetuates a cycle of underdevelopment but also exacerbates social inequalities by limiting access to education, healthcare, and productive economic activities (Fox and Thomas, 2016). The pervasive lack of energy infrastructure impedes industrialization, restricts agricultural productivity, and stifles the growth of small and medium-sized enterprises, which are crucial for job creation and poverty reduction (Filmer and Fox, 2014).

Furthermore, the reliance on traditional biomass for cooking and heating, a direct consequence of energy poverty, contributes to significant health issues and environmental degradation across the region. This widespread energy deficit critically impacts youth employability by limiting access to modern tools and technologies

essential for skill development and hindering the establishment of energy-intensive industries that could otherwise provide substantial employment opportunities (Burnett, 2023).

The inability to consistently power educational institutions and vocational training centers further restricts human capital development, trapping a significant segment of the youth in cycles of underemployment or informal labor (Moore, 2010). The high rate of youth unemployment underscores a failure to harness the continent's demographic dividend for increased productivity and economic growth. This persistent challenge is largely attributed to inadequate infrastructure, including power supply, and suboptimal management within the electric power sector (Monyei et al., 2022).

Despite advancements in energy provision in some sub-Saharan African countries, millions of households still face insufficient or insecure access to modern energy services, highlighting the persistent challenges in achieving universal energy access (Lesala et al., 2024). This deficiency is particularly acute in rural areas, where grid expansion has been slow, perpetuating a cycle of chronic energy poverty that undermines broader development goals (Lesala et al., 2025). For instance, approximately 640 million Africans, or 40% of the continent, lack access to electricity, making Africa the least electrified continent and hindering its economic potential (Ngono and Benoît, 2024).

This lack of access is further compounded by the fact that over 580 million people in Africa contend with precarious electricity supply, even when connected, due to frequent outages that disrupt productivity and quality of life (Mensah, 2018). The frequent power outages significantly impact micro, small, and medium-sized enterprises, which are vital for economic stability and poverty alleviation in the region, by severely affecting their productivity (Avordeh et al., 2024). This issue is particularly pronounced in West Africa, where only 8% of rural settlements, representing about 42% of the overall population, have access to electricity, leading to acute energy poverty compounded by high electricity costs (Umar et al., 2024).

This severe energy deficit critically impedes the development of robust industrial and commercial sectors, thereby limiting the creation of high-quality, formal employment opportunities for the region's rapidly expanding youth population (Woldemichael and Joldowski, 2019). This pervasive energy poverty intersects critically with the escalating youth unemployment crisis, as the absence of reliable energy infrastructure directly constrains the expansion of sectors that could otherwise absorb the burgeoning workforce (Sumberg et al., 2020). The lack of foundational energy access perpetuates intergenerational poverty and exacerbates existing inequalities by denying marginalized communities the essential tools required to compete effectively in an increasingly globalized economy (Lesala et al., 2024).

The widespread energy deficit in Sub-Saharan Africa directly undermines the region's ability to achieve Sustainable Development Goal 7, which aims for universal access to affordable, reliable, sustainable, and modern energy by 2030, leaving approximately 600 million people without electricity and nearly 900 million reliant on traditional, harmful cooking methods (Tazvinga et al., 2020) (Arende and Gonçalves, 2022) (Dagnachew et al., 2023). This chronic energy deficit in Sub-Saharan Africa not only impedes socio-economic progress but also positions the region as the global epicenter of energy poverty, with 68 percent of the global energy access deficit concentrated within its borders (Hallinan et al., 2023).

Addressing this persistent challenge necessitates a comprehensive approach that integrates sustainable energy solutions with robust policy frameworks to stimulate economic diversification and youth empowerment (Mukhtar et al., 2023). This paper argues that harnessing the region's abundant green energy potential offers a viable pathway to mitigate energy poverty, foster industrial growth, and create sustainable employment opportunities for the youth (Mukhtar et al., 2023). This strategy aligns with broader global sustainability objectives, providing a unique opportunity for Sub-Saharan Africa to leapfrog traditional fossil fuel-based development models (Bishoge et al., 2020). This transition could unlock substantial economic growth by fostering new industries and enhancing the competitiveness of existing sectors through reliable, affordable energy (Oyewo et al., 2022).

It also presents a unique opportunity for job creation within the burgeoning green energy sector itself, from manufacturing and installation to maintenance and research (Pappis, 2022) This will not only address the critical issue of energy poverty but also contribute significantly to human capital formation, enabling young people to access decent and formal jobs. Despite the vast potential for renewable energy, current financial mechanisms and policy frameworks often fall short in mobilizing the necessary investments to realize these opportunities, thus perpetuating the region's energy crisis (Ackah et al., 2022).

However, with its abundant natural resources and vast potential for green energy, Africa can effectively combat climate change, foster socio-economic development, and create new industrial opportunities by transitioning to renewable energy sources, thereby avoiding carbon-intensive developmental pathways (Oyewo et al., 2022) (Mumini and Mwimba, 2022).

Thus, one of the biggest developmental challenges in Sub-Saharan Africa is to find effective and pragmatic solutions for increasing energy access, especially given the region's rich yet largely unexploited renewable energy resources such as biomass, wind, solar, hydropower, and geothermal energy. This transition is crucial given that renewable energy sources, excluding hydropower, currently constitute less than 1% of sub-Saharan Africa's installed capacity, with most countries relying on hydropower and fossil fuels for power generation (Li et al., 2020).

This paper therefore explores how leveraging green energy initiatives can unlock substantial employment opportunities for the youth, thereby serving as a catalyst for profound economic transformation across the sub-continent. It specifically examines the current landscape of youth unemployment, the prevalence of energy poverty, and the potential for green energy sectors to absorb and empower the large youth demographic, transforming

them into engines of economic progress (Fox and Gandhi, 2021; Iwara, 2025).

2. TYPOLOGIES OF GREEN ENERGY IN SUB-SAHARAN AFRICA

2.1. Solar Energy

Solar energy (Figure 1) is the most abundant of all energy resources and can even be harnessed in cloudy weather. The rate at which solar energy is intercepted by the Earth is a thousand times more than the rate at which humankind consumes energy.

With the aid of photovoltaic cells to capture and convert the sun's rays into electricity, solar panels can convert light into energy. Solar technologies convert sunlight into electrical energy either through photovoltaic panels or through mirrors that concentrate solar radiation. This energy can either be used directly or fed to the grid to lessen the amount of fossil fuels needed to power a populated area.

The costs associated with the manufacture of solar panels have plummeted dramatically in the last decade, which enhances their affordability and in turn gets often referred to as the cheapest form of electricity. Solar panels have an average life span of 25 years depending on the type of material used in the manufacturing process. Solar energy is one of the most widely accessible renewable resources across the globe.

Additionally, since nothing is being mined, burned, or consumed, it creates far less greenhouse gases than the traditional fossil fuels. Since solar systems can be utilized without being plugged into the grid, it allows countries and communities to become more energy independent, rather than relying on imported sources of oil or coal. Although solar panels could save money in the long run, solar panels and arrays can still be expensive to purchase and install, making the initial costs prohibitive for some. Additionally, not all homes or businesses have the space or ideal sun-facing surfaces (such as roofs) to make solar installation possible.

2.2. Wind Energy

Wind energy (Figure 2) harnesses the kinetic energy of moving air by using large wind turbines located on land (onshore) or in sea- or freshwater (offshore). Through the construction and installation of large turbines in traditionally windy areas, energy produced by air movement can be converted into useful electricity.

Depending on its size, an individual wind turbine can supplement a single home or business, while large scale windfarms may power entire cities. Like solar energy, harnessing wind energy requires nothing to be mined or burned, creating fewer greenhouse gases and pollution when compared to traditional fossil fuels. Since wind is plentiful in many areas across the globe, it is easily accessible and sustainable. Wind farms also create potential job opportunities, as the turbines will require maintenance from time to time. However, one major drawback for wind energy is the fact that wind farms are often built in remote areas due to the space required, hence, power lines must be constructed to transport electricity to cities and communities. Another concern includes the noise pollution large wind farms tend to generate.

2.3. Hydroelectric Power

Closely related to the capture of wind power is hydroelectric power which is produced by building turbines in moving water. The water spins the turbines which in turn generate electricity. This is typically achieved by building dams to create artificial waterfalls, or directional channels in fast-moving rivers. Hydro power (Figure 3) is created using the movement of flowing or falling water. Hydroelectric power plants are found at dams

Figure 1: Solar Panels for Energy Generation (Unsplash.com (n.d))

Figure 2: Wind Turbines for Energy Generation (Unsplash.com (n.d))

Figure 3: Hyroelectric Dam for Energy Generation (Unsplash.com (n.d))

and generate electricity through underwater turbines that turn a generator. Hydro power also encompasses wave and tidal power, which rely on ocean forces to generate electricity at the mouths of large bodies of water, using similar technology.

One advantage if the water flow is constant is that hydroelectric plant can generate energy constantly. Hydroelectricity also scales very well such that small turbines or water wheels can power an individual home or business, while large-scale hydroelectric plants, such as the Hoover Dam, can generate enough energy for a city. Meanwhile, the major drawback of hydroelectric energy is that, since it requires moving water to work, hydroelectric plants are restricted to rivers. This means that, like wind, power lines have to be built to transfer the electricity to populated areas. Furthermore, the construction of dams can interfere with fish and other wildlife by changing the water level and blocking migration paths.

2.4. Geothermal Energy

Geothermal energy (Figure 4) utilizes the accessible thermal energy from the Earth's interior. Heat is extracted from geothermal reservoirs using wells or other means. Reservoirs that are naturally sufficiently hot and permeable are called hydrothermal reservoirs, whereas reservoirs that are sufficiently hot but that are improved with hydraulic stimulation are called enhanced geothermal systems.

Once at the surface, fluids of various temperatures can be used to generate electricity. Because the equipment to harness geothermal energy is built underground, it has very little impact on the surface ecosystems. Additionally, this energy source is self-replenishing. On the other hand, geothermal plants can be costly to construct, which is why geothermal energy is an underutilized form of renewable energy. Areas that experience frequent earthquakes would not be suitable for geothermal plants, as they could damage or destroy the underground components.

2.5. Bioenergy

Bioenergy (Figure 5) is produced from a variety of organic materials, called biomass, such as wood, charcoal, dung and other manures for heat and power production, and agricultural crops for liquid biofuels. Most biomass is used in rural areas for cooking, lighting and space heating, generally by poorer populations in developing countries.

Energy created by burning biomass creates greenhouse gas emissions, but at lower levels than burning fossil fuels like coal, oil or gas. However, bioenergy should only be used in limited applications, given potential negative environmental impacts related to large-scale increases in forest and bioenergy plantations, and resulting deforestation and land-use change. While burning biomass does create carbon dioxide, the same amount of carbon dioxide is also consumed by plant growth. So, using wood as an example, if reforestation keeps pace with the amount of wood being burned, using biomass as a fuel source can be carbon neutral, in theory. However, biomass only works as a renewable source of energy if the living organisms it's derived from are being replaced at the same rate they are being harvested. Additionally, the most popular forms of biomass come from plants, and while it takes a very short amount of time to burn plant biomass, it takes a much longer time to grow it.

Figure 4: Geothermal Installation on for Energy Generation (Unsplash.com (n.d))

Figure 5: Biomass Station for Energy Generation (Unsplash.com (n.d))

3. GREEN ENERGY AS A CATALYST FOR YOUTH EMPLOYABILITY

Green technologies hold tremendous transformative potential for Africa, particularly in the context of addressing youth unemployment, fostering sustainable development and driving economic growth.

These technologies, centered on environmental sustainability, can unlock new opportunities across various sectors, promote inclusive growth and align with Africa's broader development goals. The International Renewable Energy Agency (IRENA) projects that appropriate investment policies could create around 4 million jobs in the African renewable energy industry by the year 2030, up from just 247,000 jobs in 2019. Moreover, the International Labor Organization (ILO, 2019) estimates that Africa could create 60 million new jobs by 2030 through green transitions in the energy, waste and natural resource sectors.

3.1. Potential Areas of Green Energy in Job Creation for African Youths

3.1.1. Sustainable agriculture

Sustainable agriculture is one important sector where green technologies can significantly impact both environmental sustainability and youth employment. Green technologies in agriculture involve the likes of precision farming, climate-smart

agricultural practices, organic farming and agroforestry, which improve resource efficiency and resilience to climate change. Given that agriculture is a primary source of employment in Africa, integrating green technologies into the sector offers a critical path to reducing youth unemployment, improving food security and boosting rural economies.

Business development services, management advice, technical support, extension services are tools required for the adoption of climate-smart farming techniques and the cultivation of crops that are more resistant. This would sustain the demand of the expanding consumer markets and inclusive agro-based value chains in rural areas. Hence, more opportunities for off-farm employment gets created.

An example of a related, well-integrated approach is the SNV's Opportunities for Youth Employment (OYE) programme in Tanzania, Mozambique and Rwanda. By bringing a market development perspective the programme has adopted a comprehensive approach. This programme intends to improve the livelihoods of 27,050 rural, out-of- school young people between 18 and 24 years by engaging them in local agriculture, renewable energy, and water and sanitation businesses. (SNV, 2019).

The Ethiopian Agricultural Integration Agency, for example, has been active in the modernisation and the adoption of techniques aimed at improving yields and conserving the environment. In Kenya and South Africa, the adoption of precision agriculture technologies, such as drip irrigation, mobile-based farm management systems and soil sensors, has led to significant increases in crop yields while reducing resource wastage (Getahun, 2024).

Companies now make use of digital platforms to connect smallholder farmers with markets, improving efficiency in food distribution while promoting sustainable agricultural practices and creating jobs for youth all over the cities. Youth are increasingly engaged in these new technologies, gaining employment as data analysts, mobile app developers and farm managers, while also receiving training in modern farming techniques. The development of sustainable agriculture in Nigeria where the largest number of climate-smart agriculture jobs in Africa are projected to be created by 2030 generates economic opportunities, including organic farming, agroforestry and permaculture, as well as the development of drought-resistant crops.

3.1.2. Waste management

For waste management, green technologies present many opportunities to turn waste into resources. This circular economy model, which emphasizes the reuse and recycling of materials, reduces the strain on natural resources while creating new economic activities and jobs. Waste remediation and recycling, for instance, is projected to create 197,000 African jobs by 2030.

Nigeria's waste management challenges, particularly in megacities like Lagos, have driven the adoption of waste-to-energy technologies. Projects such as the Lagos Waste Management Agency (LAWMA)'s collaboration with private companies in recycling and composting have led to the creation of 25,000 green jobs in waste collection, sorting and processing (NAN, 2015). These initiatives have not only reduced the amount of waste ending up in landfills but have boosted employment: Newly created recycling companies such as the Lagos-based Wecyclers company hire youth to collect and process recyclable wastes (Transform Global Network).

The circular economy is also gaining momentum in East Africa, where countries like Rwanda and Kenya have developed plastic bag bans and sustainable waste management strategies. Youth-led startups and initiatives in Rwanda such as EnviroReserve and Accelerate2030 are capitalising on these opportunities by developing innovative recycling solutions, such as converting plastic waste into construction materials and fashion items, contributing to both job creation and environmental sustainability. These instances illustrate how there is potential for green jobs in waste collection, recycling and upcycling, and in creating biodegradable materials that substitute plastic and lessen the impact on the environment.

3.1.3.Construction of green cities

The demand for green infrastructure will rise as African cities continue to grow. This opens new job markets and promotes the development of environmentally sustainable urban space. Green building technologies, including the use of sustainable materials, energy-efficient designs and eco-friendly construction practices, are transforming Africa's infrastructure sector.

In Ethiopia, the construction industry has embraced green building technologies, with several projects incorporating eco-friendly designs and materials. For example, the Hawassa Industrial Park, Africa's first eco-industrial park, utilizes renewable energy, water recycling systems and sustainable waste management practices. According to the World Bank, this park, which focuses on the textile industry, has created over 60,000 jobs and is a model for integrating sustainability into industrial development (World Bank, 2017). Young engineers and architects are increasingly trained in green building technologies, and these skills are in high demand as more African nations adopt sustainable urban planning models. These examples demonstrate that green technologies offer solutions that not only address environmental concerns but also drive economic development, job creation and social progress.

3.1.4. Installation and maintenance of renewable technology

Looking closely at solar and wind power sectors of renewable energy, there is a significant avenue for green technology-driven transformation in Africa. Several Sub-Saharan African countries are adopting large-scale renewable energy projects to meet growing energy demands while addressing energy access gaps in underserved rural areas. Solar PV creates, on average, twice the number of jobs per unit of electricity generation compared with coal or natural gas (IRENA, 2020). In some countries, the ratio could be as high as 5 jobs for each installed Megawatt (Schäfer, 2016).

The off-grid solar industry in East Africa has provided more than 350,000 jobs, many of which are available for youth with

differing levels of education (GOGLA, 2023). Morocco's Noor Solar Complex, the world's largest concentrated solar power plant, exemplifies how green technology can spur economic growth while creating thousands of jobs for Africa's youth. This ambitious project is part of Morocco's goal to generate 52% of its electricity from renewable sources by 2030, reducing reliance on imported fossil fuels. The plant offsets 240,000 t of CO_2 emissions a year and generated approximately 1,000 construction jobs and 60 permanent jobs during the operation and maintenance phase (Power Technology, 2020). This project has created a growing solar energy industry in the region, with opportunities for local manufacturing and engineering firms (Salime, 2021).

Similarly, South Africa's Renewable Energy Independent Power Producer Procurement Programme (REIPPPP) has not only contributed to energy security but also spurred local job creation. Since its inception, the REIPPPP is estimated to have generated over 40,000 jobs and brought in $14 billion in investment, establishing a vibrant green energy market (PPIAF, 2014). These projects showcase the ability of renewable energy technologies to address Africa's energy needs while fostering economic opportunities and job creation for young people.

3.2. Development of Skills for Green Job Opportunities

Skills for green jobs are a combination of knowledge, competencies, and attitudes needed to thrive in sustainable economies. They may include technical skills for which qualifications and training are needed along with transversal skills like problem-solving, innovative thinking and digital competencies. Skills for green jobs are essential in all sectors: the primary sector (such as urban agriculture), the secondary sector (like manufacturing and construction), and the tertiary sector (including education and health, care and community engagement sectors).

Skills development is a key component of national employment policies and can be highly instrumental for creating green jobs for young people. Adequate skills of workers and managers are a prerequisite for the advancement of the green economy and the creation of green jobs for youth. Given the sometimes-rapid development in green sectors such as renewable and buildings, market expansion has been hampered in many countries by a shortage of appropriate skills and technical expertise.

4. CHALLENGES AND BARRIERS TO SKILL DEVELOPMENT AND FULL-SCALE ADOPTION OF GREEN ENERGY IN SUB-SAHARAN AFRICA

4.1. Technical Barriers

Eberhard et al. (2014) highlights that the power grid of sub-Saharan Africa has inadequate infrastructure and lacks key technological facilities, like smart grids and energy storage systems. This makes it challenging for renewable energy projects to evolve. They also mention that many power utilities in sub-Saharan Africa operate old systems that cannot effectively manage the alternating supply of renewable energy.

Based on IRENA study, it is essential to build on some new architecture forms like microgrids and off-grid solar kits. These options are very useful in rural and remote areas. It also highlights the importance of investing in energy storage to improve grid stability and reliability. Addressing these gaps with technology transfer and localized capacity-building initiatives is critical for ensuring sustainable energy transitions in sub-Saharan Africa.

Karekezi and Kithyoma (2003) also discusses some technical challenges to using renewable energy in Africa. Many rural areas do not have the needed infrastructure, like power lines or energy facilities. Additionally, there is often limited local knowledge or skills to help design, install, and maintain renewable energy systems. The reliance on imported technologies further complicates implementation because many technologies are brought in from other countries, which makes it harder to use them effectively.

4.2. Economic Barriers

These economic challenges make it hard for the region to adopt renewable energy, according to reports from the World Bank and the International Renewable Energy Agency (IRENA). Most renewable energy projects exhibit high initial capital costs, often creating barriers for developers and small businesses undertaking renewable projects (World Bank, 2020). Also, the region's political instability and uncertainty of their regulations create an undisputable dangerous venture. This can scare local and international investors away from putting their money into the region. Weak public-private partnerships create more challenges in gathering resources and ensuring the success of larger renewable energy projects. These problems create a complicated financial situation that requires targeted solutions to unlock the economic potential of renewable energy in Sub-Saharan Africa.

Cai et al. (2024) identifies several economic barriers limiting the region's renewable energy use. High levels of initial investment are problematic for the countries with restricted budgets, and the absence of new innovative instruments, such as green bonds, complicates search for necessary financing. Also, the one that has received considerable attention with low investment from private players is due to perceived risks and regulatory uncertainties.

Many small and medium-sized enterprises (SMEs) in Africa face significant challenges in accessing capital, markets and technology needed to transition to green business models. Without stronger partnerships between the public and private sectors, the ability to catalyse widespread adoption of green technologies remains constrained. This financing gap is compounded by the limited availability of green financing mechanisms, such as climate finance, green bonds and concessional loans, making it difficult for small businesses and startups to enter and thrive in green technology sectors.

4.3. Social Barriers

Sovacool et al. (2019) point out that the unequal distribution of energy resources increases differences between urban and rural areas. Addressing these social issues with focused educational programs and planning involving the community is essential. Da Silva et al. (2018) found that economic growth and energy

support are linked positively to the growth of renewable energy in sub–Saharan Africa (SSA). However, population growth can be a negative factor. Poverty, lack of education, and traditional beliefs can make adopting renewable energy technologies harder. These social factors influence how willing and able communities are to use new technologies and participate in renewable energy projects. Many people lack enough knowledge about renewable technologies, which can lead to fear, misinformation, or a preference for older energy sources (Sen and Ganguly, 2017). To overcome these social challenges, involving local community members to raise awareness and build trust is very important (AcreValuePro, 2024).

4.4. Policy Barriers

Research shows that unclear policies, confusing rules, and too much red tape often slow the growth of renewable energy projects. For example, Obeng-Darko (2020) points out the difficulties countries like The Gambia and Nigeria face. In these countries, the absence of comprehensive renewable energy regulations has stifled progress. Even though there are some forms of renewable energy legislation in The Gambia today, it is tough for the authorities to provide clear regulatory frameworks and mandates that are effective for governance and implementation.

Many African countries have developed national frameworks and action plans to promote green growth. However, there remains a disconnect between policy formulation and implementation. Inconsistent policy environments, coupled with weak regulatory frameworks, prevent the effective rollout of green technologies. For instance, the Nigeria Renewable Energy Master Plan (REMP) to increase the renewable energy contribution to Nigeria's energy mix was aimed to generate 10% of electricity from renewable sources by 2025. The targets set by REMP have largely not been met, with renewable energy penetration remaining low despite the abundance of solar and wind resources in the country. This is due to a fact that Nigeria's regulatory framework for energy development has not adequately supported the integration of renewable energy sources into the national grid.

Due to the absence of specific legal framework in Nigeria for the renewable energy sector, there are formal loopholes that create ambiguities and high-risk factors that psychologically discourage potential investors from relocating business development.

4.5. Inadequate Infrastructure and Limited Private Sector Engagement

Africa's underdeveloped infrastructure poses a major hurdle to green technology adoption and its potential to create green jobs. Renewable energy projects, such as solar and wind farms, require extensive energy grids, transmission networks and storage systems, which are often lacking in many regions. Rural areas suffer from a lack of infrastructure to support renewable energy deployment and green technology solutions. Similarly, poor waste management infrastructure inhibits the adoption of circular economic practices such as recycling and waste-to-energy technologies.

Where these do exist, the private sector plays a crucial role in driving infrastructure development, innovation, investment and scaling up green technologies. However, many African economies are characterised by limited private sector involvement in the green technology space. Regulatory uncertainty, insufficient market incentives and the absence of clear investment signals from governments deter private sector actors from committing resources to green ventures. This hampers the ability of green technologies to create employment opportunities for youth in Africa.

Thus, while Africa holds vast potential for leveraging green technologies to drive economic growth, create jobs and address environmental challenges, financial barriers, inadequate infrastructure, policy gaps, private sector disengagement and governance issues all contribute to the slow pace of green technology adoption across the continent. Addressing these barriers will require coordinated efforts from governments, the private sector, international organisations and civil society to unlock the transformative potential of green technologies and ensure that Africa's youthful population can contribute meaningfully to the continent's green economy transition.

5. SUSTAINABLE PATHWAYS TO ADVANCING GREEN TECHNOLOGY FOR YOUTH EMPLOYMENT IN AFRICA

For Africa to unlock the full potential of green technology and boost youth employment, several preconditions must be met. These include addressing gaps in skills development, improving access to finance, encouraging entrepreneurship, fostering international collaboration and enacting supportive policies. This section outlines key strategies and necessary improvements while drawing on examples that can be adapted to the African context.

5.1. Strengthening Skills Development and Capacity Building

A major barrier to youth inclusion in green technology sectors is the skills gap, particularly the mismatch between educational outputs and labour market demands in emerging green industries. Closing this gap requires targeted investments in formal education, vocational training and digital literacy programmes.

5.2. Enhancing Access to Finance for Green Enterprises

Access to finance remains one of the most significant challenges faced by young African entrepreneurs looking to establish businesses in green sectors. Financial institutions often view these startups as high-risk ventures due to the uncertainties in technology, markets and the long-term viability of business models. To overcome these barriers, innovative financial solutions must be designed and scaled to ensure that more youth-led green enterprises can access the capital they need to grow. Similarly, blended finance models, which combine public, private and philanthropic capital, offer a promising way to reduce the risk for investors and make it easier for green enterprises to access funds.

5.3. Promoting Youth Entrepreneurship and Innovation

The entrepreneurial potential of Africa's youth must be harnessed to drive green job creation. This can be achieved through enterprise

support programmes, innovation hubs and collaborative spaces. To achieve this, Africa can adopt successful models like Kenya's Climate Innovation Center, which supports startups in climate-smart agriculture and clean energy through mentorship, technical assistance and access to finance (GDIH, 2023).

Initiatives such as the Lagos State Employment Trust Fund have shown that targeted support for green businesses through low-interest loans and business advisory services can foster green job creation and innovation. Scaling such initiatives would not only spur the growth of green industries but also open doors for youth employment.

In addition to promoting youth entrepreneurship and innovation programmes, the fusion of green technology and digital innovation offers significant opportunities for African youth by equipping them with skills in coding, data analysis and digital innovation are vital for their participation in emerging green sectors such as smart agriculture and environmental monitoring.

5.4. Strengthening Public-private Partnerships and International Collaboration

According to the Ogunsola et al (2024), there is a need for new policies and partnerships to promote green infrastructure development and inclusive growth across the continent. Public-private partnerships (PPPs) and international collaboration are essential in mobilising the resources and expertise needed to scale green technologies across Africa. The continent can draw inspiration from initiatives such as the Lake Turkana Wind Power Project in Kenya, where collaboration between the government, private investors and international agencies has significantly expanded renewable energy capacity and created jobs.

5.5. Public Awareness and Community Engagement

The adoption of renewable energy technologies in sub–Saharan Africa is contingent on overcoming socio-cultural barrier. To overcome socio-cultural barriers and accelerate widespread uptake of renewable energy technology adoption in Sub-Saharan Africa, these sociocultural barriers must be overcome via increasing public awareness and community engagement. This means that public awareness and community engagement are essential in influencing community to accept the adoption of renewable energy technologies. They too often have limited exposure and misinformation that bred skepticism about the reliability and benefits of renewable energy systems. To ease these challenges, targeted awareness campaigns can teach communities about renewable energy's economic, environmentally, and socio-economic advantages, such as cost savings, creation of jobs and less environmental impacts. Acceptance and successful long-term planning of renewable energy projects depend on involving local communities in the planning and decision-making processes. With participatory planning, communities have opportunity to discuss and communicate their wants and needs so they feel a sense of ownership and responsibility in making them happen.

5.6. Research and Development

Research and development (R&D) investment is essential in advancing renewable energy technologies and overcoming the energy challenges of sub-Saharan Africa. Such efforts should concentrate on pioneering innovative, cost-effective solutions that are customized to the region's diverse climatic and geographical conditions. More specifically, dust reducing technologies which prevent pollution of the solar panels surface or improving energy storage efficiency for off-grid systems will improve performance and reduce operational costs. These innovations are key to the region's scalability and sustainability of renewable energy goals. R&D is an intimate study, and their effectiveness relies on collaboration from governments, local universities, global research institutions, private sector players and development organizations formed for fostering a culture of innovation.

R&D driving requires both public and private funding. By giving financial preference to pilot projects and prototypes, stakeholders will be able to gain a feel for the potential and scale of new technologies. They offer actual lessons on how ideas can be used in real estate and the possibilities for impacting investors and policy makers. In addition, the partnering of local and international bodies of research promotes the accelerated development of state-of-the-art technologies that can be forged to suit the distinct socio-economic and infrastructural contexts of Sub-Saharan Africa.

6. CONCLUSION AND RECOMMENDATIONS

Energy poverty remains one of the most pressing development challenges in sub-Saharan Africa, affecting millions of lives and limiting opportunities for economic progress. Without reliable and affordable energy, industries stagnate, education and healthcare systems suffer, and the youth, who represent most of the region's population, are left without the tools to fully participate in the modern economy. However, this challenge also presents a transformative opportunity: the rapid advancement of green energy technologies offers a sustainable pathway to address energy poverty while simultaneously unlocking youth employability and economic transformation.

Harnessing green energy such as solar, wind, hydro, and bioenergy can subsequently provide decentralized and scalable energy solutions that reach remote communities beyond the grid. This shift not only aligns with global climate goals but also opens new economic frontiers. The renewable energy sector is labor-intensive, requiring skilled workers in areas such as installation, maintenance, research, and energy management. By investing in technical education and vocational training tailored to green energy, sub-Saharan African countries can equip their youth with the skills needed to thrive in an emerging green economy. Moreover, the development of local green energy enterprises can stimulate entrepreneurship and innovation, particularly among young people. Coupled with access to finance, digital tools, and supportive policy frameworks, this can drive the growth of small and medium-sized enterprises (SMEs) that are critical to economic diversification.

For this transformation to be successful, multi-stakeholder collaboration is essential. Governments, private sector players, development agencies, and civil society must work together to ensure inclusive and equitable access to energy and employment

opportunities. Therefore, tackling energy poverty through green energy is not just an environmental imperative but also a strategic investment in Africa's greatest asset: its youth. By empowering the next generation through sustainable energy solutions, sub-Saharan Africa can pave the way for a more resilient, inclusive, and prosperous future.

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