International Journal of Multidisciplinary Research and Growth Evaluation.

Balancing Fossil Fuels and Renewables: Pathways for a Just and Sustainable Energy Transition in Africa

Jerome Onoja Okojokwu Idu [1*], Rasheedah Fola Abioye [2], Sadat Itohan Ihwughwavwe [3], Ojong Felix Enow [4], Michael Okereke [5], Opeyemi Morenike Filani [6], Joshua Seleuese Okojie [7], Stephanie Blessing Nnabueze [8]

[1] University of Nebraska, Lincoln, USA
[2] Independent Researcher, Oulu, Finland
[3] Independent Researcher, Nigeria
[4] Independent Researcher, Buea, Cameroon
[5] Independent Researcher Dubai, United Arab Emirates
[6] Proburg Ltd, Lagos Nigeria
[7] Vanguard AG, Berlin, Germany
[8] Starsight Energy, Abuja, Nigeria

* Corresponding Author: **Jerome Onoja Okojokwu Idu**

Article Info

ISSN (Online): 2582-7138
Impact Factor (RSIF): 7.98
Volume: 06
Issue: 05
September - October 2025
Received: 31-07-2025
Accepted: 01-09-2025
Published: 22-09-2025
Page No: 409-423

Abstract

This study examines the complex interplay between fossil fuels and renewable energy within the African context, with a focus on pathways for a just and sustainable energy transition. Recognising Africa's dual challenge of addressing widespread energy poverty while meeting global climate imperatives, the paper examines the continent's current energy landscape, the entrenched role of fossil fuels, and the vast but underutilised renewable energy potential. Drawing on an extensive review of scholarly literature, the study employs a conceptual and analytical framework to interrogate the political economy of transitions, the imperatives of energy justice, the requirements for institutional readiness, and the mechanisms for financing and regional cooperation.

The findings indicate that fossil fuels, particularly coal, oil, and natural gas, continue to underpin African economies, providing fiscal revenues and immediate energy security. However, reliance on these resources is increasingly incompatible with sustainability and exposes states to economic volatility and environmental degradation. Renewable energy sources, especially solar, wind, hydro, and geothermal, offer transformative opportunities for inclusive and decentralised electrification but remain constrained by financing gaps, governance weaknesses, and infrastructural limitations. The analysis further highlights that energy transitions cannot be divorced from issues of justice, equity, and inclusion, as vulnerable groups risk marginalisation without deliberate policy interventions. Regional cooperation, exemplified by power pools and cross-border initiatives, emerges as a vital strategy for pooling resources, harmonising policies, and leveraging economies of scale.

The paper concludes that Africa's energy transition must be both pragmatic and inclusive, balancing fossil fuels' transitional role with a bold acceleration of renewables. Recommendations include reforming fossil fuel subsidies, embedding justice frameworks in policy, strengthening institutional capacity, and mobilising blended financing models. Such strategies, if effectively implemented, will enable Africa to achieve energy security while advancing sustainable development.

DOI: https://doi.org/10.54660/.IJMRGE.2025.6.5.409-423

Keywords: Africa, Energy Transition, Fossil Fuels, Renewable Energy, Energy Justice, Regional Cooperation

1. Introduction

The transition from fossil fuels to renewable energy sources is increasingly recognized as a global imperative in response to climate change, environmental degradation, and socio-economic inequalities linked to energy access. Nowhere is this imperative more urgent and complex than in Africa—a continent characterized by vast untapped renewable energy potential and a significant dependency on fossil fuel resources. The African energy paradox lies in the coexistence of energy abundance and

widespread energy poverty (Mutezo & Mulopo, 2021). As Africa pursues sustainable development pathways, it faces the challenge of ensuring energy access for all while aligning with global decarbonization targets.

Historically, fossil fuels have played a central role in Africa's economic development. Major economies such as Nigeria, Angola, and Algeria rely heavily on oil and gas exports to sustain their fiscal budgets (Nalule, Anaman & Acheampong, 2022). Simultaneously, the exploitation of coal in Southern Africa remains integral to electricity generation (Kabeyi & Olanrewaju, 2022). However, fossil fuel reliance has exposed African economies to commodity price volatility, geopolitical risks, and environmental consequences, including pollution and habitat loss. As global attention shifts toward cleaner alternatives, Africa must confront the dilemma of whether to phase out these traditional energy sources or incorporate them into a more sustainable energy mix.

The renewable energy landscape in Africa offers immense opportunities, with the continent richly endowed with abundant solar radiation, extensive wind corridors, geothermal resources, and significant untapped hydropower potential (Pappis *et al*., 2019). Countries such as Morocco, Kenya, and South Africa have already made notable strides in scaling renewable projects. Yet, structural challenges remain, including limited financing, inadequate grid infrastructure, and inconsistent policy frameworks (Akrofi, 2021). These barriers continue to hinder the widespread deployment of renewable technologies, delaying the transition toward a low-carbon economy.

A just energy transition in Africa must extend beyond environmental goals to encompass social equity. Grounded in energy justice principles, such a transition calls for the redistribution of energy resources in ways that empower marginalised groups, ensure inclusive participation, and generate tangible socioeconomic benefits for the poor. With more than 600 million people across the continent still lacking access to electricity, advancing a just transition is not only a developmental priority but also a fundamental human rights obligation. This approach requires carefully balancing the urgency of decarbonisation with the imperative of expanding affordable and reliable energy access, particularly in rural and underserved regions (Shyu, 2021).

The concept of justice within energy transitions must also encompass the workers and industries historically reliant on fossil fuel production. For countries with substantial oil and gas reserves, the risks of stranded assets, widespread job losses, and economic disruption are significant if transitions are not carefully managed. A phased and inclusive approach—integrating clean technologies, retraining workforces, and fostering economic diversification—is therefore essential. To mitigate these risks, energy transition strategies must be closely aligned with broader socio-economic policies, ensuring that the shift toward sustainability does not exacerbate poverty or inequality but instead supports resilience and shared prosperity (Wilson, 2022).

The intricacy of Africa's energy transition is further intensified by the persistence of fossil fuel subsidies. While designed to lower energy costs for consumers, such subsidies distort market dynamics and undermine the competitiveness of renewables by discouraging investment in cleaner alternatives (Özdemir *et al*., 2020). Reforming these subsidies is politically sensitive yet crucial to unlocking green energy markets. At the same time, governments need to create enabling environments through regulatory certainty, public-private partnerships, and risk-sharing mechanisms to attract sustainable energy investments.

While the global North advances rapidly toward clean energy, Africa faces asymmetrical burdens in the transition process. The continent contributes minimally to global carbon emissions but is disproportionately vulnerable to climate change impacts. This paradox has led to growing advocacy for a differentiated approach to energy transition—one that considers Africa's development needs, historical emissions, and capacity constraints (Nalule & Acheampong, 2021). Climate justice advocates also emphasize the need for technology transfer, climate financing, and capacity building as pillars of global solidarity.

Energy storage systems play a vital role in enhancing the reliability of renewable sources, especially given the intermittent nature of solar and wind energy. The adoption of battery technologies, pumped hydro, and other storage solutions is gaining traction, although affordability remains a barrier (Kalair *et al*., 2021). Innovations in decentralized energy systems, including mini-grids and solar home systems, are also redefining access pathways in off-grid areas, offering scalable solutions to chronic energy deprivation.

One of the defining features of Africa's energy transition is regional diversity. While countries like Ethiopia and Rwanda have embraced hydropower and off-grid solar, others like South Africa remain deeply entrenched in coal dependency (Kabeyi & Olanrewaju, 2022). These disparities call for context-specific strategies that reflect local realities, resource availability, and institutional capacities. Cross-border energy trade and regional integration through platforms like the African Power Pools can also enhance efficiency and resilience.

Despite notable progress, the financing gap remains a persistent obstacle. Africa receives a disproportionately low share of global clean energy investments. Bridging this gap requires innovative financial instruments such as green bonds, results-based financing, and blended capital models (Mutezo & Mulopo, 2021). It also necessitates institutional reforms that mitigate investor risks and enhance project bankability. Development finance institutions and multilateral climate funds have a pivotal role to play in de-risking investments and supporting early-stage renewable ventures.

This study aims to critically examine how African countries can achieve a balanced approach to energy transition by integrating fossil fuel resources with renewable energy solutions in a manner that is both just and sustainable. The primary objective is to explore the policy, economic, and socio-technical factors that influence Africa's dual reliance on fossil fuels and renewables. The scope includes an assessment of regional dynamics, institutional readiness, energy justice considerations, and emerging technologies that shape transition pathways. By synthesizing insights from recent literature, this review contributes to informed policymaking and academic discourse on Africa's role in the global energy transition.

2. Conceptual Framework for a Just and Sustainable Energy Transition

The quest for a just and sustainable energy transition in Africa is not merely an environmental issue; it is a deeply embedded socio-economic transformation challenge that intersects with questions of equity, justice, governance, and development. Conceptualizing this transformation involves understanding the interplay of distributive, procedural, and restorative justice within the context of historically marginalized regions. A robust conceptual framework for a just and sustainable energy transition in Africa must take into account the continent's unique developmental context, historical energy inequalities, and the growing urgency of climate action (Swilling, Musango & Wakeford, 2016).

Africa's energy transition cannot follow the same linear decarbonization path observed in the Global North. Most African nations remain heavily reliant on biomass, lack universal electricity access, and have constrained institutional and infrastructural capacity (Dahunsi, 2013). Therefore, the starting point for the conceptual framework is the recognition that justice in energy transitions must be multidimensional and context-specific. Müller, Neumann, and Elsner (2021) argue that energy justice in Africa requires attention to both access (distributive justice) and participation (procedural justice), while also addressing past injustices that have excluded entire communities from modern energy services.

The conceptual foundation for just energy transition draws significantly from energy justice theory, which identifies three core tenets: distributive justice (fair allocation of benefits and burdens), procedural justice (inclusive and transparent decision-making), and recognition justice (acknowledging and addressing socio-cultural marginalization) (Loehr *et al*., 2022). These dimensions are critical for designing transition pathways that empower communities, avoid exacerbating existing inequalities, and foster resilience against climate and economic shocks.

Samarakoon (2019) develops a justice- and wellbeing-centred framework for analysing energy poverty in the Global South, stressing the need for metrics that encompass not only access and affordability but also governance quality, community participation, and ecological sustainability. This perspective makes clear that, in the absence of robust measurement tools, policy interventions risk perpetuating structural inequalities rather than fostering equitable energy transitions.

Financial justice also emerges as a central pillar in Africa's transition. Traditional finance models often exclude high-risk regions or require sovereign guarantees that are not feasible for many African states. Soumonni and Ojah (2022) propose a mission-oriented finance approach, advocating for patient capital, blended finance, and development-oriented investment models that align profit motives with long-term socio-environmental goals. This conceptual shift broadens the traditional finance lens and repositions energy access as a public good rather than a market commodity.

Equally crucial is the governance framework that mediates the transition. Swilling, Musango, and Wakeford (2016) emphasize the need for developmental state structures that integrate energy planning into broader socio-economic policy. This approach calls for state capacity to steer and coordinate across sectors—such as education, labor, health, and industry—thereby ensuring that energy transition is not siloed but interconnected with the full spectrum of development goals.

Another key dimension of the conceptual framework is employment and livelihood transformation. A just transition must protect and transform labor markets by investing in green jobs, reskilling programs, and social protections for fossil fuel-dependent communities. Zondi (2022) highlights this in the case of South Africa's wind energy sector, where the deployment of renewables offers employment opportunities but also requires careful planning to ensure job quality, geographic equity, and gender inclusion.

Nalule, Anaman, and Acheampong (2022) contend that in oil- and gas-rich African states, natural gas can play a role as a transitional fuel by supporting grid stability and generating revenue to fund longer-term renewable energy investments. Nonetheless, they caution that overreliance on such resources risks locking countries into carbon-intensive pathways, making it essential to adopt time-bound strategies and clear exit plans that prioritise an eventual shift toward full decarbonisation.

Müller, Neumann, and Elsner (2021) also note that renewable energy deployment must be coupled with broader socio-technical transitions—such as energy efficiency measures, decentralized energy systems, and demand-side management. A truly sustainable transition requires not just replacing fossil fuels with renewables but redesigning the very systems through which energy is produced, distributed, and consumed.

Social inclusion is a cornerstone of a just energy transition. Marginalised groups—including rural communities, women, and informal workers—must be actively integrated into decision-making processes to ensure equitable outcomes. Without deliberate mechanisms for inclusion, energy transitions risk reinforcing existing inequalities by privileging urban elites or multinational investors while sidelining local populations. Embedding the principle of the "right to energy" within policy frameworks is therefore essential to advance energy justice, eradicate energy poverty, and uphold energy democracy in Africa's transition pathways (Shyu, 2021).

Furthermore, the ecological dimension of justice must be integrated into the conceptual framework. Dahunsi (2013) calls attention to the environmental limits of large-scale energy projects, cautioning against "green colonialism" where renewable projects displace communities or degrade ecosystems. A truly sustainable framework must ensure that environmental and climate goals do not override local rights, biodiversity, and cultural integrity.

Institutional capacity building is another cornerstone of the framework. Loehr *et al*. (2022) argue that weak institutions, fragmented policies, and regulatory uncertainty remain key obstacles to sustainable energy transitions in Africa. Building technical, financial, and administrative capacities at local, regional, and national levels is essential for implementing just transition strategies. This includes strengthening the role of local governments, civil society, and community-based organizations in monitoring and managing transition programs.

Justice-centered transitions also require attention to knowledge systems. Dominant narratives around energy efficiency, decarbonization, and innovation are often shaped by global North priorities. Swilling, Musango, and Wakeford (2016) advocate for epistemic justice—recognizing indigenous knowledge, local innovation, and traditional energy practices—as valuable inputs into transition planning.

Such recognition shifts the power dynamics in knowledge production and opens space for locally grounded solutions.

The temporal dimension of justice is a critical consideration in Africa's energy transition. Transition frameworks must uphold intergenerational equity by ensuring that present-day energy choices do not create burdens for future generations. At the same time, they must respond to the urgent realities of energy poverty, where millions remain without access to modern energy services. Delayed or symbolic reforms risk perpetuating harm for those already disadvantaged, while overly short-term approaches may compromise long-term sustainability. Embedding the "right to energy" within transition planning provides a balanced framework that reconciles immediate developmental needs with the responsibility to safeguard future generations through sustainable and inclusive energy systems (Shyu, 2021).

2.1. Energy Landscape in Africa: Current Realities

Africa's energy landscape is defined by complexity, disparity, and transformation. Shaped by diverse resource endowments, uneven technological capacities, and varied policy frameworks, the continent is experiencing profound structural shifts driven by climate imperatives, demographic growth, and developmental needs. This narrative is one of both scarcity and opportunity—widespread energy poverty set against the backdrop of abundant renewable potential and significant untapped fossil reserves, reflecting how discourses of scarcity intersect with visions of resource-based development (Scoones *et al*., 2019).

Sub-Saharan Africa remains among the most energy-deprived regions in the world. Although home to a significant share of the global population, its electricity consumption is disproportionately low, reflecting deep structural challenges in energy provision. While urbanisation has facilitated grid expansion in major cities, rural electrification continues to lag due to infrastructural deficits, geographical constraints, and financial limitations. This uneven access entrenches socio-economic inequalities and restricts opportunities for education, healthcare, and industrial development, illustrating the broader crisis of energy poverty within a hydrocarbon-dependent century (Dike, 2020).

The heavy dependence on biomass remains a defining feature of Africa's energy profile. In many regions, particularly rural areas, firewood and charcoal still account for over 80% of household energy consumption. This reliance has contributed to deforestation, indoor air pollution, and health complications, especially among women and children (Newell & Bulkeley, 2017). While there are policy intentions to reduce biomass reliance through liquefied petroleum gas (LPG) and improved cookstoves, implementation is inconsistent and often underfunded.

Simultaneously, fossil fuels continue to dominate Africa's grid-based energy systems. South Africa, the continent's most industrialized economy, still relies on coal for more than 70% of its electricity (Pollet, Staffell & Adamson, 2015). Elsewhere, oil and natural gas dominate in Nigeria, Angola, and Algeria, forming the fiscal backbone of national budgets. However, these fossil-based systems are increasingly unstable—prone to fuel price volatility, geopolitical tension, and infrastructure decay (Vines, 2012). Moreover, the climate imperative now demands an accelerated pivot away from carbon-intensive energy systems.

Although Africa is rich in renewable resources—solar irradiation, hydro potential, wind corridors, and geothermal reserves—renewables still constitute a marginal share of the overall energy mix. Investment flows into renewables have increased in recent years, particularly in Kenya, Morocco, and South Africa. Yet, the scale remains insufficient to meet growing demand, with renewable capacity additions often hindered by financing gaps, weak regulatory environments, and logistical constraints (Boamah, 2020).

The heterogeneity of Africa's energy infrastructure adds complexity to the transition discourse. While some countries, such as Ethiopia, have made substantial investments in hydropower, others, including Nigeria, continue to grapple with persistent inefficiencies in transmission and distribution networks. Fragile grid systems often result in frequent outages, voltage instability, and high technical losses. Consequently, many households and businesses resort to diesel generators as a backup source of power—an option that is both costly and environmentally damaging, thereby reinforcing dependence on fossil fuels (Foster, Eberhard & Dyson, 2021).

Energy investment across the continent remains heavily skewed. According to Kraemer and Stefes (2016), capital-intensive projects tend to cluster in politically stable or economically buoyant regions, leaving fragile or conflict-affected states behind. This uneven development trajectory risks entrenching new forms of energy inequality—where green transitions are realized in certain regions while others remain locked in outdated, inefficient, and polluting systems.

Policy frameworks vary widely across African nations. While some have adopted national energy transition plans, these are often disconnected from broader development strategies or lack implementation capacity. As Pollet, Staffell, and Adamson (2015) note, the policy-to-practice gap remains a major challenge, with ambitious targets frequently unmet due to weak institutional coordination, funding shortages, and political interference.

Donor-driven programs and multilateral initiatives have played a substantial role in shaping Africa's energy transition landscape. Projects like the African Development Bank's "Desert to Power" initiative or the World Bank-supported electrification efforts have injected critical funding and technical support. Yet, critics argue that externally driven models often overlook local contexts, bypass community ownership, and reproduce dependencies on external technologies and expertise (Newell & Bulkeley, 2017).

A notable development reshaping Africa's energy landscape is the growth of decentralised energy systems. Off-grid solar solutions, mini-grids, and pay-as-you-go models are increasingly extending access to communities previously excluded from national grids. In countries such as Rwanda and Senegal, community-based solar initiatives have demonstrated how decentralised systems can deliver reliable electricity to remote regions without the high costs of grid expansion. Beyond improving access, these innovations contribute to emission reductions, enhance local resilience, and support more inclusive forms of development, offering a viable pathway out of entrenched energy poverty (Dike, 2020).

Despite their advantages, decentralised energy systems continue to encounter significant obstacles. Operating within regulatory grey areas, facing persistent financing gaps, and marked by fragmented service delivery, these systems often struggle to achieve scale. While they have proven effective for basic needs such as lighting and powering small appliances, expanding their application to support productive

uses—such as irrigation, refrigeration, and small-scale industries—remains constrained. These challenges echo broader narratives of scarcity, where systemic limitations in governance and investment hinder the full realisation of available resources (Scoones *et al*., 2019).

Hydrogen is increasingly emerging in Africa's energy discourse, with particular momentum in North African countries pursuing green hydrogen projects aimed at supplying European markets. While this development signals new opportunities, it remains technologically unproven and financially challenging across much of the continent. There is also a risk that prioritising hydrogen could divert scarce resources and policy attention away from the more pressing goals of expanding electricity access and addressing energy poverty, which remain critical for inclusive development (Foster, Eberhard & Dyson, 2021).

Climate change is exerting increasing pressure on Africa's energy systems. Variability in rainfall affects hydropower generation; rising temperatures influence cooling demand; and extreme weather events threaten grid infrastructure. As such, climate adaptation must be embedded in energy planning—yet many African countries lack the data, resources, and institutional capacity for integrated climate-energy strategies (Boamah, 2020).

Cultural, gender, and social dynamics play a decisive role in shaping Africa's energy realities. Energy access is not merely a technical challenge but one embedded within broader structures of power and inequality. Women, in particular, shoulder the heaviest burdens of energy poverty, often spending long hours gathering firewood or cooking with traditional fuels that expose them to health risks. Approaches to energy provision that overlook gendered dimensions risk perpetuating, rather than reducing, existing inequities, underscoring the need for inclusive and socially grounded transition strategies (Dike, 2020).

The continent's youthful and rapidly growing population also creates a dual challenge and opportunity. On one hand, it escalates energy demand; on the other, it offers a demographic dividend—if investments are made in education, innovation, and green skills. As Boamah (2020) points out, supporting youth-led energy enterprises and localized energy innovation could unlock significant social and economic co-benefits.

Finally, Africa's role in the global energy transition is under increasing scrutiny. On one side, the continent contributes minimally to historical greenhouse gas emissions and asserts its right to development. On the other hand, it faces mounting pressure to decarbonize and align with global climate goals. Balancing these competing imperatives—development versus decarbonization—is the central dilemma shaping Africa's current energy landscape and its path forward (Newell & Bulkeley, 2017).

2.1.1. Fossil Fuels in Africa's Energy Mix

Fossil fuels continue to dominate the energy mix in Africa, underpinning much of the continent's power generation, industrial activity, and export revenue. Despite the increasing urgency for decarbonization globally, fossil fuels—particularly oil, coal, and natural gas—remain deeply entrenched in African economies due to infrastructural legacy systems, geopolitical interests, and economic dependence (Schwerhoff & Sy, 2019). This complex reliance represents both a challenge and a strategic pivot point in Africa's journey toward a just and sustainable energy transition.

Oil remains the most economically significant fossil fuel in Africa. Countries such as Nigeria, Angola, Libya, and Algeria are major exporters of crude oil, with the sector contributing significantly to national gross domestic product (GDP) and government revenue. However, the volatility of global oil prices and the limited refining capacity have left many oil-rich nations vulnerable to market shocks and value loss through crude exports without downstream processing (Mutezo & Mulopo, 2021). The African oil industry is thus marked by a paradox: resource abundance with concurrent domestic energy insecurity.

Natural gas has been increasingly positioned as a "transition fuel" due to its relatively lower carbon emissions compared to coal and oil. Significant reserves in Mozambique, Egypt, and Tanzania are being developed with hopes of supporting domestic electricity generation and exporting liquefied natural gas (LNG). However, despite these developments, the role of natural gas remains contentious. Akrofi (2021) argues that gas infrastructure investments risk carbon lock-in and could divert attention and funding from renewables, particularly in low-income and fragile states.

Coal remains dominant in countries like South Africa, which derives more than 70% of its electricity from coal-fired plants. The country's extensive coal reserves have enabled relatively low-cost electricity generation, but at a significant environmental cost. Ndlovu and Inglesi-Lotz (2019) detail the country's struggle to balance energy security with sustainability commitments under the Paris Agreement. The dominance of Eskom, South Africa's national utility, in coal-based generation underscores how state-led investments in fossil fuels have reinforced centralized and carbon-intensive energy systems.

While fossil fuels have powered much of Africa's economic development, they have also contributed to rising emissions and environmental degradation. Ayompe, Davis, and Egoh (2021) show that from 1990 to 2017, fossil fuel CO_2 emissions in Africa increased steadily, driven by population growth, urbanization, and expanding industrial sectors. Although Africa's overall emissions remain low by global standards, the growth trajectory reflects a dependence that is incompatible with long-term climate goals.

This reliance is also evident in the structural configuration of African energy markets. According to Kibria, Akhundjanov, and Oladi (2019), there is a positive correlation between fossil fuel share in the energy mix and economic output, especially in low-income countries. This suggests a developmental feedback loop wherein fossil fuels are viewed as essential inputs for economic growth. Yet, this model is increasingly being questioned, particularly as the global finance and investment landscape shifts toward decarbonization.

Institutional inertia and political interests further complicate efforts to reduce fossil fuel dependence. Many African states offer subsidies for fossil fuel consumption, which, although intended to improve energy affordability, often disproportionately benefit wealthier urban populations and drain national budgets (Schwerhoff & Sy, 2019). These subsidies also crowd out investment in cleaner alternatives and entrench fossil fuel dependence at both the household and industrial levels.

Vidal-Amaro, Østergaard, and Sheinbaum-Pardo (2015) highlight how optimal energy mix modeling, while essential for transition planning, is often hindered by data gaps and institutional fragmentation in Africa. This challenge results

in misaligned energy policies that fail to reflect long-term sustainability and energy justice objectives. In addition, fossil fuel infrastructure projects are often prioritized over decentralized or renewable systems, perpetuating urban-rural divides in energy access.

There are also geopolitical dimensions to Africa's fossil fuel landscape. International oil companies and foreign investors play an outsized role in extraction and infrastructure development. This external dependency raises concerns about resource sovereignty and the equitable distribution of fossil fuel revenues (Mutezo & Mulopo, 2021). The 'resource curse' phenomenon—where countries rich in fossil resources experience slower economic growth and weaker governance—remains relevant in several African states.

Furthermore, fossil fuel-based energy systems have proven insufficient in addressing Africa's persistent energy poverty. Despite abundant fossil fuel reserves, many countries continue to face frequent power outages, low electrification rates, and unaffordable tariffs. Ayompe, Davis, and Egoh (2021) emphasize that fossil fuel infrastructure, being capital-intensive and often export-oriented, has failed to deliver universal energy access. Thus, the social utility of fossil fuels in Africa's development trajectory is increasingly being questioned.

Some scholars advocate for a more balanced energy mix that incorporates both fossil fuels and renewables during the transition period. Oghenekaro and Kant (2022) argue that diversified energy strategies can align better with national development goals, particularly when fossil fuels are leveraged to fund and facilitate investments in sustainable infrastructure. However, the timing, scale, and scope of such transitional arrangements must be carefully managed to avoid reinforcing existing inequalities or creating new dependencies.

The environmental and health impacts of fossil fuel consumption also warrant attention. Adebayo, Awosusi, and Oladipupo (2021) point to the high particulate emissions and water contamination associated with coal mining and oil refining. These effects disproportionately affect low-income and marginalized communities, thereby exacerbating energy injustice. Fossil fuel projects, such as pipeline construction or drilling in ecologically sensitive areas, have often sparked local resistance and raised concerns about land rights and environmental degradation.

Despite these challenges, fossil fuels remain politically resilient. They are embedded in national identity, fiscal regimes, and industrial policy. Akrofi (2021) notes that energy transition plans must therefore grapple not only with technical and financial barriers but also with deeply rooted political economies of fossil fuel dependence. Successful transitions will require de-risking investments in renewables, phasing out subsidies, and strengthening regulatory frameworks that prioritize sustainability and inclusion.

2.1.2. Renewable Energy Potentials and Developments

Africa possesses one of the most significant renewable energy potentials in the world, yet the continent remains plagued by widespread energy poverty and an underutilization of clean energy sources. The African renewable energy landscape is diverse and rich, encompassing solar, wind, hydroelectric, geothermal, and bioenergy resources, many of which remain largely untapped. This discrepancy between potential and reality is rooted in infrastructural, financial, and policy-related constraints that continue to impede the full-scale development of renewable energy systems across the continent (Ouedraogo, 2019).

Among the renewable resources, solar energy stands out as the most promising due to Africa's high solar irradiation. Most regions receive more than 2,000 kWh/m² of solar radiation annually, with countries such as Niger, Chad, and Sudan exceeding even that. As Bugaje (2006) argued, Africa's solar energy potential could easily power the continent multiple times over if adequate systems and policies were in place to harness this abundant resource. The growth of solar photovoltaic (PV) installations in countries like Kenya, Rwanda, and South Africa illustrates the beginning of this shift, although large-scale penetration remains limited.

In recent years, technological advancements and cost reductions have made solar energy increasingly viable for both grid-connected and off-grid applications. Du *et al*. (2021) note that solar energy development has gained considerable momentum in Africa due to falling installation costs, modularity, and its compatibility with remote and rural electrification schemes. However, persistent barriers such as inadequate storage infrastructure, lack of skilled personnel, and weak regulatory environments continue to stifle progress.

Wind energy is another underexploited yet potent renewable resource. Countries such as Egypt, Morocco, Kenya, and South Africa boast high wind speeds and favorable topography, especially in coastal and elevated regions. Elsner (2019) conducted a continental-scale assessment that revealed substantial offshore and onshore wind energy potential, especially along the eastern and western seaboards. Despite these advantages, investment in wind infrastructure lags behind that of solar, often due to higher capital costs, longer lead times, and complex site evaluation procedures.

Hydropower remains the most developed renewable energy technology in Africa, contributing about 17% of electricity generation on the continent. Its dominance is particularly evident in countries like Ethiopia, Zambia, and the Democratic Republic of Congo, which host vast river systems and elevation gradients suitable for hydroelectric projects (Aliyu, Modu & Tan, 2018). Nevertheless, hydro developments often face social and environmental criticism due to displacement, ecosystem disruption, and vulnerability to climate-induced hydrological changes. As such, the sustainability of hydropower is increasingly being scrutinized in the context of long-term energy planning.

Biomass energy, primarily in the form of wood fuel and agricultural waste, is widely used across sub-Saharan Africa for cooking and heating. However, its traditional forms contribute significantly to deforestation and indoor air pollution, presenting severe health hazards. Du *et al*. (2021) emphasize the need for modernization of biomass technologies through the deployment of biogas digesters and improved cookstoves to enhance energy efficiency and reduce environmental and health burdens. Investment in second-generation bioenergy technologies remains scarce but presents long-term potential, particularly in agricultural economies.

Despite the breadth of renewable energy resources, only a small fraction is currently exploited. According to Bishoge, Zhang, and Mushi (2018), although Tanzania has immense renewable potential—including geothermal, wind, and solar—the current energy infrastructure heavily favors fossil fuels. The same pattern is observed across many African states, reflecting a continent-wide gap between technical

potential and actual implementation.

Financial barriers remain among the most significant obstacles to scaling renewable energy projects in Africa. Most renewable installations require high upfront capital, which deters investors due to perceived risks. Sweerts, Dalla Longa, and van der Zwaan (2019) argue that de-risking mechanisms such as guarantees, concessional loans, and blended finance models are essential to unlock private sector participation. International climate funds and multilateral development banks have been instrumental in this area, but challenges persist in reaching smaller, local projects that could have transformative grassroots impacts.

Institutional and policy frameworks also play a pivotal role in determining the trajectory of renewable energy development. While several African countries have adopted renewable energy policies, feed-in tariffs, and national energy plans, implementation often lags due to bureaucratic inefficiencies and political instability. Sambo (2015) notes that harmonization of energy policies across regional economic communities, such as ECOWAS and SADC, could accelerate cross-border renewable energy trade and knowledge sharing.

Another key limitation is the absence of localized innovation ecosystems. Most renewable energy technologies are imported, often resulting in high maintenance costs and incompatibility with local conditions. Ouedraogo (2019) contends that fostering indigenous research and development capacities could enhance technology adaptation and ownership. Local manufacturing of components, supported by technical training programs, could also stimulate employment and improve the sustainability of renewable energy initiatives.

Public awareness and community engagement remain low in many rural areas where renewable energy deployment is most needed. Cultural perceptions, limited exposure to clean energy technologies, and affordability concerns contribute to resistance or underutilization of installed systems. Bugaje (2006) underscores the importance of integrating socio-cultural factors into energy planning to ensure long-term adoption and success.

Ultimately, Africa's renewable energy sector sits at a crucial inflection point. With proper investment, supportive policy frameworks, and inclusive development strategies, the continent could not only alleviate its energy poverty but also become a global leader in decentralized, climate-resilient energy systems. The synergy between renewable energy deployment and sustainable development is especially significant in Africa, where clean energy can drive economic empowerment, reduce inequality, and enhance resilience to climate change (Aliyu, Modu & Tan, 2018).

2.2. Political Economy of Energy Transitions in Africa

The political economy of energy transitions in Africa reveals a complex interplay of institutions, vested interests, international influence, and socio-economic imperatives that shape the continent's pathway towards sustainable energy systems. Unlike the purely technological framing often found in transition discourse, the political economy approach emphasizes the contested nature of energy transitions—where power, inequality, and historical structures determine the pace, direction, and beneficiaries of change (Baker, Newell & Phillips, 2014). In Africa, this dynamic is particularly evident due to its history of colonial energy infrastructures, state-centric utility models, and external dependency on fossil fuel export revenues.

Energy systems are embedded in political structures that reflect broader patterns of control and accumulation. According to Newell (2019), energy transitions are not only about replacing fossil fuels with renewables, but also about transforming the institutions and actors that benefit from the current regime. In much of Africa, fossil fuel-based systems are deeply entrenched in state revenue models, elite patronage networks, and rent-seeking behavior. These entrenched interests often resist reforms that would diminish their control over energy flows and economic rents. As such, reforms are often partial, slow, or selectively implemented to accommodate dominant stakeholders (Baker, Newell & Phillips, 2014).

South Africa, with its coal-dominated energy system, provides a case in point. Despite policy commitments to reduce emissions and diversify the energy mix, coal continues to dominate due to the political and economic clout of Eskom—the state-owned utility—and the mining sector. Hanto *et al.* (2022) argue that the inertia in South Africa's energy transition is symptomatic of a broader challenge in aligning climate ambitions with powerful domestic interests. This lock-in effect is reinforced by legacy infrastructures and long-term contracts that tie governments to fossil-based energy production.

Elsewhere on the continent, donor and investor influence has become a central feature of energy planning. Power *et al.* (2016) explore how rising powers such as China and Brazil have played significant roles in shaping the energy infrastructure of countries like Mozambique and South Africa. Chinese investments, often tied to infrastructure loans or resource-backed financing, have reinforced centralised, fossil fuel-heavy energy systems. While these investments contribute to electricity access and economic growth, they can simultaneously undermine efforts to pursue more decentralized or renewable energy pathways. The geopolitical leverage of external actors can, therefore, serve as both a driver and inhibitor of energy transformation.

Coalitions within energy policy are central to shaping the course of transition pathways. In Tanzania, alliances formed between political elites, technocrats, and international donors significantly influence which energy technologies are prioritised and which stakeholders are awarded contracts. These coalitions are dynamic, adapting to shifts in political agendas, donor conditionalities, and public pressure. However, they often prioritise centralised, large-scale energy projects over decentralised, community-led initiatives. Although decentralised systems are better aligned with inclusive and locally responsive development, they frequently lack political support and sufficient financing, limiting their potential to transform energy access (Ferrall *et al.*, 2021).

A crucial aspect of the African energy transition is the geographical disparity in energy access and governance capacity. Bridge and Gailing (2020) emphasize the importance of spatial analysis in understanding the uneven distribution of energy resources, infrastructures, and political power. In many African countries, capital cities and industrial zones are prioritized for electrification and energy investments, while rural regions remain marginalized. This spatial inequality is not merely a developmental challenge; it is also a political one, reflecting the territorial logic of state-building and elite consolidation.

Moreover, transitions in Africa are shaped by global climate

governance structures and development finance mechanisms. The emphasis on climate mitigation and carbon markets has led to an influx of renewable energy investments, but often under frameworks that prioritize investor returns over local development goals. Newell (2021) notes that international development institutions sometimes impose neoliberal models of energy governance, which promote privatization, deregulation, and cost-recovery. These models can clash with the needs of populations that require subsidized or pro-poor energy services. As a result, energy transitions may advance technically while exacerbating energy poverty or political exclusion.

In this context, the question arises: transition for whom? If energy transitions are to be truly just and sustainable, they must be rooted in democratic governance, participatory planning, and equitable access to resources. Newell (2019) warns that without a fundamental shift in political structures, transitions may reproduce existing inequalities or create new forms of energy injustice. The term "trasformismo"—borrowed from Gramscian theory—describes how transformative agendas can be co-opted by incumbent elites to preserve their power while appearing progressive. This phenomenon is visible in instances where fossil fuel actors rebrand themselves as "green," or where transition funds are channeled into projects that reinforce elite control.

Yet there are also emerging opportunities for disruption and reconfiguration. Social movements, civil society organisations, and progressive municipalities are increasingly asserting their voices in energy governance debates. In countries like Kenya, local initiatives have pushed for decentralized solar systems that bypass state utilities. These grassroots movements often advocate for energy democracy—an approach that links renewable energy with broader demands for justice, autonomy, and rights. Such efforts, while still nascent, signal potential pathways for re-politicizing energy transitions from below.

2.3. Energy Justice: Ensuring Equity and Inclusion

Energy justice has become a vital lens for assessing how transitions from fossil fuels to renewable energy can be pursued in ways that are both environmentally sustainable and socially equitable. From this perspective, energy transitions extend beyond technical and economic considerations to include questions of access, fairness, recognition, and representation. In Africa, the uneven distribution of energy infrastructure, legacies of marginalisation, and persistent socio-economic inequalities render transitions deeply political and inseparable from broader struggles for justice and inclusion (Sovacool *et al*., 2019).

Africa's energy landscape reflects a striking paradox: although the continent possesses vast renewable energy potential, millions continue to live without reliable access to electricity. This persistent energy poverty disproportionately impacts rural populations, women, and other vulnerable groups. Addressing this challenge requires embedding the principle of the "right to energy" within development strategies, ensuring that transitions are not only environmentally sustainable but also socially equitable. Such an approach demands a fundamental rethinking of energy governance, moving beyond market-driven narratives to prioritise the rights, voices, and lived experiences of the energy poor, thereby advancing justice and inclusivity in Africa's transition pathways (Shyu, 2021).

The concept of energy justice encompasses three core tenets: distributive justice (who gets what), recognition justice (who counts), and procedural justice (who decides). These dimensions are particularly pertinent in Africa, where centralised fossil fuel-based systems have historically served urban elites while leaving rural areas in the dark. Monyei *et al*. (2018) argue that addressing energy insufficiency in Africa requires a more nuanced understanding of mobility, affordability, and the spatial dimensions of injustice. In this context, distributive justice is not merely about kilowatt-hours delivered, but about transforming energy systems to be inclusive, accessible, and attuned to local realities.

Gender is a critical dimension of energy justice in Africa. Women, particularly in rural areas, are disproportionately affected by energy poverty, often spending long hours collecting biomass fuels and suffering from the health impacts of indoor air pollution. Despite these burdens, they remain underrepresented in energy decision-making processes. As Komane (2022) argues from a decolonial feminist perspective, advancing justice requires dismantling patriarchal structures and creating spaces that enable women's active participation and agency. Integrating gender justice into energy policy not only promotes social equity but also strengthens the effectiveness and inclusivity of renewable energy transitions.

Recognition justice in Africa necessitates the meaningful inclusion of indigenous communities and residents of informal settlements within energy planning processes. Too often, these groups are marginalised by legal, spatial, or socio-economic barriers that exclude them from shaping transition outcomes. As Sankaran *et al*. (2022) note, even renewable energy megaprojects can replicate the injustices of fossil fuel systems when they lack adequate stakeholder engagement. Issues such as displacement linked to hydro developments, insufficient community consultation, and inequitable tariff structures exemplify these shortcomings. Ensuring justice, therefore, requires that affected populations move beyond passive consultation to become empowered co-creators in energy transitions.

Procedural justice highlights the importance of democratic governance in shaping energy systems. In much of Africa, however, energy policy has historically been driven by international donors, private investors, and central governments, often marginalising local participation. From an energy justice perspective, decentralising authority and strengthening transparency are essential to rebuilding public trust and accountability. Greater community involvement and ownership in renewable energy initiatives can foster outcomes that are not only more socially legitimate but also better aligned with local contexts and needs (Sovacool *et al*., 2019).

Justice within the energy transition requires that both the risks and benefits of large-scale renewable projects be distributed equitably. While developments such as solar farms and hydroelectric dams can deliver employment opportunities, infrastructure, and expanded power generation, they also carry risks of displacement and environmental harm if not carefully managed. As Odili (2021) underscores, adopting a rights-based approach is essential to ensuring environmental justice, particularly in contexts where community rights are vulnerable. Embedding legal protections, human rights frameworks, and corporate accountability mechanisms within transition processes is therefore critical to safeguarding communities and preventing exclusion or

exploitation.

The nexus between justice and policy is central to shaping Africa's energy transition. Policies that privilege financial viability at the expense of social outcomes risk entrenching inequality and excluding vulnerable populations. Tariff structures, subsidy frameworks, and licensing arrangements must therefore be designed with affordability and inclusivity in mind, rather than reflecting the interests of economic elites. Embedding the "right to energy" within policy frameworks provides a means of ensuring that social protection measures and pro-poor interventions are integral to transition strategies. Furthermore, aligning national energy agendas with the Sustainable Development Goals (SDGs) can foster a more holistic, equitable, and justice-oriented pathway for advancing universal energy access (Shyu, 2021).

The principle of intergenerational justice is central to Africa's energy transition, given that the continent's predominantly youthful population will bear the long-term consequences of today's energy choices. Transition strategies must therefore integrate considerations of enduring social and ecological impacts. As Sankaran *et al*. (2022) emphasise in the context of renewable energy projects, ensuring justice requires future-oriented planning that supports climate-resilient infrastructure, fosters green employment opportunities, and prioritises investment in education and capacity building. Such measures are essential to empower young people as active participants in shaping sustainable and equitable energy futures.

2.4. Role of Fossil Fuels in the Transition Process

Fossil fuels have long served as the backbone of energy production in Africa, and their role in the transition to a cleaner energy future remains a subject of significant debate. While many global climate frameworks advocate for a rapid phase-out of fossil fuels, the African context presents a more complex scenario—one in which fossil fuels continue to play a vital, albeit transitional, role in addressing developmental imperatives such as energy access, industrialization, and economic resilience (Mutezo & Mulopo, 2021).

Africa's heavy reliance on fossil fuels, particularly natural gas and coal, is underpinned by the accessibility of these resources and the underdevelopment of renewable alternatives. In countries such as Nigeria, Angola, and South Africa, fossil fuels remain crucial for national revenue generation and electricity provision. Nalule and Acheampong (2021) argue that a sudden withdrawal from fossil fuels without adequate renewable infrastructure could exacerbate energy poverty and undermine socioeconomic gains. For this reason, fossil fuels are often viewed as a "bridge" fuel—providing immediate energy needs while supporting the gradual integration of cleaner energy technologies.

The continent's dependence on fossil fuels is also reflected in the design of energy infrastructure, which in many regions remains optimized for centralized, fossil-based systems. This structural dependency creates inertia that is difficult to overcome without significant investment in grid reform and decentralization. Kalair *et al*. (2021) highlight that fossil fuel systems are often interconnected with existing energy storage and transmission technologies, which makes them more reliable in contexts where energy infrastructure is fragile or underdeveloped. Thus, fossil fuels continue to offer stability in systems where renewables face intermittency issues.

Moreover, fossil fuel development in Africa is often entangled with geopolitical and financial interests. Multilateral development banks and international investors have historically supported fossil infrastructure, embedding it in national development plans. Nalule (2019) notes that fossil fuel extraction projects are often tied to public financing, employment creation, and trade relations, making it politically difficult to divest even in the face of environmental imperatives. As such, the phase-down of fossil fuels is not only a technical challenge but also a political and economic negotiation.

Nevertheless, the persistent dominance of fossil fuels poses substantial barriers to Africa's energy transition. A critical challenge lies in fossil fuel subsidies, which artificially lower the cost of fossil energy, thereby distorting markets and reducing the competitiveness of renewables. Reforming these subsidies is widely recognised as essential for fostering renewable energy investment and creating a more balanced energy market. However, subsidy removal must be carefully managed to prevent adverse consequences, such as energy price shocks that would disproportionately burden low-income households (Özdemir *et al*., 2020).

Simultaneously, reliance on fossil fuels carries long-term risks, especially given the volatility of global oil prices and the tightening of international climate finance. Mutezo and Mulopo (2021) warn that clinging to fossil fuels could leave African economies exposed to "stranded assets" and divestment-related capital flight as the global financial system increasingly penalizes carbon-intensive investments.

2.5. The Rise of Renewables: Opportunities and Constraints

The growth of renewable energy across Africa reflects a critical shift in the continent's long-term energy planning. As nations strive to achieve universal electricity access and reduce their carbon footprints, renewables—especially solar, wind, hydro, and geothermal—offer immense opportunities for decentralised, sustainable energy delivery. However, the transition is not without significant constraints, ranging from infrastructural and financial barriers to governance-related and policy implementation challenges (Ouedraogo, 2019).

Africa possesses vast untapped renewable energy potential. For example, the continent receives some of the highest solar irradiance in the world, yet this is underutilised due to low technological penetration and financing limitations. Mohammed, Mustafa, and Bashir (2013) argue that the abundant natural resources, including sunlight, wind corridors, and hydropower potential, could play a transformative role in overcoming energy poverty. These resources offer decentralized solutions that are particularly effective in reaching remote and off-grid communities—places often neglected by centralised fossil-fuel-based power systems.

The cost of renewable energy technologies has also dropped significantly in the past decade, making them increasingly competitive with conventional fuels. According to Amir and Khan (2022), this trend has been amplified by global supply chains, innovation in battery storage, and digital grid management. These advancements offer a viable economic incentive for African governments to accelerate the adoption of renewables. Additionally, renewable energy projects can stimulate local economies through job creation in installation, maintenance, and manufacturing sectors.

Despite these advantages, a host of constraints continues to hinder renewable energy development. A major challenge is the lack of adequate regulatory and institutional frameworks. Pegels (2010) observes that policy uncertainty and weak

institutional capacities discourage private investment in renewable infrastructure, particularly in countries like South Africa. In many cases, procurement delays, political instability, and inconsistent tariff structures make the renewable energy investment landscape highly unpredictable.

Financing remains another critical bottleneck. Pueyo (2018) highlights that risk perceptions among international investors about Sub-Saharan Africa are exacerbated by governance deficits and macroeconomic volatility. As a result, renewable energy projects often struggle to secure long-term, low-cost capital. Even when funding is available, it is frequently skewed toward large-scale grid-connected projects, while smaller, decentralised systems—such as solar home kits or mini-grids—receive limited support despite their crucial role in expanding access in underserved regions.

Furthermore, the lack of skilled human capital and technical expertise hampers the maintenance and scalability of renewable energy systems. Ouedraogo (2019) stresses the importance of building local capacity to reduce reliance on imported technologies and foreign contractors. This skill gap also affects project sustainability, as poorly maintained systems can quickly fall into disrepair, eroding public trust in renewables as a reliable energy source.

Grid infrastructure is another major constraint. Many African countries face weak and fragmented transmission and distribution networks, which are ill-suited for integrating intermittent renewable energy. Mohammed, Mustafa and Bashir (2013) note that upgrading these systems requires significant investment and long-term planning. Without grid modernisation, the capacity of renewables to meet peak demand and ensure consistent supply will remain limited.

Social and political factors further complicate the renewable energy landscape. For instance, land tenure disputes and community resistance have delayed several wind and hydro projects. Pegels (2010) points out that project developers must engage more meaningfully with local populations to address concerns about displacement, environmental degradation, or cultural impacts. Inclusive planning processes that prioritise community benefits are essential for enhancing project legitimacy and sustainability.

Finally, the role of international donors and multilateral organisations is both a driver and a constraint. While these actors provide crucial funding and technical assistance, their influence can also lead to the imposition of external agendas and priorities that do not always align with local needs. Amir and Khan (2022) warn against one-size-fits-all solutions and stress the importance of context-sensitive, participatory approaches in project design and implementation.

2.6. Capacity Building and Institutional Readiness

The transition toward a sustainable and equitable energy future in Africa depends not only on technological deployment and financial investment but also on the robustness of institutional structures and human capacity. Capacity building and institutional readiness are therefore critical pillars in ensuring that renewable energy systems are effectively designed, implemented, and maintained. These processes go beyond technical training and infrastructure; they encompass systemic governance reforms, cross-sectoral policy coordination, and long-term workforce development (Kovacic *et al*., 2021).

A fundamental challenge facing many African countries is the institutional fragmentation that impedes coherent energy governance. In some cases, overlapping mandates between ministries and regulatory bodies delay decision-making and implementation. According to Hawila, Mondal and Kennedy (2014), institutional misalignment remains a central obstacle to energy planning in North Africa, where energy transitions require harmonised actions between national, regional, and local actors. Without clear roles and responsibilities, capacity building efforts may be redundant or fail to address core policy gaps.

Human capital development is equally vital. Skilled labour shortages, especially in engineering, project management, and energy systems design, restrict the scalability of renewable technologies. Winanti and Mas'udi (2022) stress that building state capacity entails more than bureaucratic efficiency—it involves equipping institutions with the knowledge, adaptive capabilities, and foresight to navigate complex transitions. Public sector staff must be trained in evolving regulatory frameworks, climate finance mechanisms, and energy modelling tools. Moreover, higher education curricula and vocational training programmes must evolve to meet the technical demands of a green economy.

The context of urban informality presents additional complexities. As many African cities are characterised by informal settlements and fragmented service delivery, energy transitions must be grounded in local realities. Kovacic *et al*. (2021) propose a framework that links institutional readiness to governance within informal urban contexts, arguing that mainstream capacity-building models often overlook the informal economies and networks that drive much of Africa's urban development. Effective transition governance, therefore, requires an inclusive approach that engages civil society, grassroots organisations, and informal actors.

Policy readiness and institutional legitimacy also influence investor confidence. Sokona, Mulugetta, and Gujba (2012) argue that consistent and transparent institutions are better positioned to attract climate finance and technology transfer. Uncertainty in policy direction, regulatory reversals, or political interference can deter private sector participation in energy markets. As such, strengthening the institutional ecosystem not only enhances administrative performance but also contributes to the financial viability of clean energy projects.

In many cases, regional coordination and knowledge exchange can help overcome national capacity constraints. Initiatives such as the African Union's Programme for Infrastructure Development in Africa (PIDA) and the Pan-African University Institute for Water and Energy Sciences (PAUWES) are examples of continental efforts to bolster institutional learning and strategic foresight. Dosso, Nwankwo, and Travaly (2021) highlight the importance of science, technology, and innovation (STI) policy capacity as a pathway toward long-term resilience and technological sovereignty in Africa.

Despite these efforts, structural inequalities, limited data availability, and political instability continue to undermine institutional readiness. Hawila, Mondal, and Kennedy (2014) underscore that renewable energy readiness is not just a matter of infrastructure or finance, but of "soft" systems—leadership, stakeholder engagement, and accountability. Therefore, capacity building must be embedded in national energy visions and long-term development strategies, rather than treated as an isolated or donor-driven activity.

2.7. Financing the Transition: Investment Gaps and

Solutions

One of the most significant obstacles hindering a just and sustainable energy transition in Africa is the persistent financing gap. Despite the region's immense renewable energy potential, access to the necessary capital remains highly constrained. Africa requires substantial investments—estimated in the hundreds of billions of dollars—to meet its Sustainable Development Goals (SDGs) and climate targets through clean energy deployment. This gap is not solely a matter of capital scarcity; rather, it is also driven by structural, institutional, and policy-related barriers that disincentivise investors (Kalu, Arize & Okoyeuzu, 2022).

Renewable energy technologies in Africa are increasingly cost-competitive, yet they still face considerable investment risk due to underdeveloped financial markets, regulatory unpredictability, and lack of credit guarantees. Schwerhoff and Sy (2017) argue that while global capital for green finance is growing, African countries struggle to attract these flows due to perceived political instability and weak institutional frameworks. International investors often demand high-risk premiums, making the cost of capital for energy projects in Africa disproportionately high.

In many cases, reliance on concessional finance and donor-driven funding models has led to fragmented financing strategies that are not scalable. Owusu-Manu, Mankata, and Debrah (2021) provide empirical insights from Ghana, showing that lack of project bankability, absence of long-term financial instruments, and the limited capacity to design financeable projects continue to undermine the success of renewable energy programs. The short tenors of available loans and the high-interest rates of local financing further discourage participation by small- and medium-sized enterprises in the renewable sector.

Public-private partnerships (PPPs) play a pivotal role in addressing Africa's renewable energy financing gap. Governments are central to this process, particularly in creating enabling environments that de-risk investments through clear regulatory frameworks, fiscal incentives, and sovereign guarantees. However, as Adelaja (2020) observes in the Nigerian context, policy fragmentation and inconsistencies generate uncertainty that discourages long-term investor commitments and undermines large-scale renewable energy deployment. In addition to national reforms, multilateral development banks (MDBs) and climate funds remain vital in bridging the financing divide, offering both capital and technical support to accelerate the continent's energy transition. However, their support is often conditioned on extensive technical requirements and time-consuming processes, which smaller African nations may not be fully prepared to navigate. Newell and Bulkeley (2017) suggest that these global climate finance mechanisms must evolve to become more adaptive to local contexts, ensuring inclusivity and accessibility for less-developed nations in Sub-Saharan Africa. Integrating local financial institutions into the climate finance architecture can also help improve transparency and accountability while building financial ecosystems conducive to energy innovation.

Domestic resource mobilisation is equally essential. Heavy reliance on external financing renders energy transitions vulnerable to global financial shocks. Kalu, Arize, and Okoyeuzu (2022) highlight the potential for leveraging national pension funds, sovereign wealth funds, and diaspora bonds to raise capital for energy transition projects. However, this requires strong governance and risk management capabilities, which are often lacking across many African states.

2.8. Socioeconomic Impacts of Energy Transitions

The socioeconomic impacts of energy transitions in Africa are multidimensional, encompassing employment, income distribution, poverty reduction, and broader developmental outcomes. While the move from fossil fuels to renewables is driven by climate imperatives, the process fundamentally reshapes economies and societies, creating both opportunities and challenges. In West Africa, Oyewo *et al*. (2020) demonstrate that decarbonising power systems could lead to job creation, improved energy security, and lower long-term costs, but the transition also requires managing short-term disruptions to fossil fuel-dependent sectors.

One of the most visible socioeconomic outcomes of energy transitions is employment generation. Renewable energy technologies, particularly solar photovoltaics and distributed systems, are more labour-intensive than fossil fuels during the installation and maintenance phases. This opens avenues for green jobs across skill levels, from engineering to local manufacturing and community-based servicing. Garcia-Casals, Ferroukhi, and Parajuli (2019) emphasise that the "footprint" of energy transitions includes not only direct employment but also indirect economic benefits, such as value chain development, local enterprise stimulation, and skills upgrading. However, these opportunities are unevenly distributed and depend heavily on institutional readiness and investment flows.

Energy transitions, if not managed with equity at their core, risk amplifying existing social and economic inequalities. Vulnerable groups—particularly low-income households and communities dependent on fossil fuel industries—are often the most exposed to transitional disruptions. The withdrawal of fossil fuel subsidies, though environmentally necessary, can disproportionately raise energy costs for the poor unless complemented by targeted social protection mechanisms. Likewise, populations reliant on coal mining or oil production face the dual threats of job losses and economic decline without deliberate investment in reskilling and diversification. Embedding the "right to energy" within transition strategies is therefore critical to safeguard affordability, promote inclusion, and ensure that decarbonisation efforts advance energy justice and democratic participation (Shyu, 2021).

Access to modern energy services is another critical socioeconomic dimension. Despite Africa's vast fossil fuel resources, many regions still face chronic energy poverty. Energy transitions oriented toward decentralised renewables have the potential to expand access more equitably, particularly in rural areas. Nwaiwu (2021) highlights how digitalisation, including pay-as-you-go models and smart metering, can enhance affordability and accessibility, fostering inclusive growth. However, these digital solutions also raise questions about data governance, the affordability of digital infrastructure, and the risk of excluding populations without digital literacy or access.

Adoption dynamics are shaped by socioeconomic determinants at the household and community level. In Nigeria, Anugwom, Anugwom, and Eya (2020) found that income, education, and awareness significantly influence the uptake of solar home systems. This underscores the role of social policy in complementing technological transitions. Without addressing structural inequalities in income and

education, renewable energy adoption may remain confined to middle- and high-income groups, reproducing existing divides.

Broader macroeconomic impacts also accompany energy transitions. As Garcia-Casals, Ferroukhi, and Parajuli (2019) note, transitions can influence trade balances by reducing reliance on fossil fuel imports, while simultaneously altering fiscal revenues in fossil fuel-exporting countries. This duality creates a need for prudent economic planning to cushion against fiscal shocks while leveraging renewable energy as a driver of industrial competitiveness.

2.9. Pathways for Regional Cooperation and Integration

Regional cooperation and integration represent pivotal strategies for Africa's energy transition, offering mechanisms to pool resources, harmonise policies, and leverage economies of scale. The continent's fragmented energy systems, characterised by isolated national grids and uneven resource distribution, create inefficiencies that hinder the pursuit of universal access and sustainable development. Monyei, Akpeji, and Oladeji (2022) argue that regional cooperation provides a practical pathway to mitigate energy poverty by improving access, sufficiency, and sustainability through cross-border collaboration and shared infrastructure. The role of regional economic communities such as the Economic Community of West African States (ECOWAS), the Southern African Power Pool (SAPP), and the East African Power Pool (EAPP) has been central to advancing energy integration. Akinyemi, Efobi, and Osabuohien (2019) highlight that regional integration within ECOWAS has shown promise in promoting energy sustainability, though political will, financial limitations, and infrastructural bottlenecks remain significant obstacles. Harmonising regulatory frameworks across borders is particularly challenging but essential for creating attractive investment environments and stable cross-border electricity markets.

The African Clean Energy Corridor (ACEC) exemplifies how regional initiatives can accelerate renewable energy adoption by connecting resource-rich areas with high-demand regions. Saadi, Miketa, and Howells (2015) emphasise that the ACEC initiative, spanning Eastern and Southern Africa, fosters renewable energy growth by reducing market fragmentation and enabling large-scale renewable investments. Such initiatives illustrate the potential of regional integration to address intermittency challenges inherent in renewable systems, ensuring grid stability through resource diversification.

Geothermal energy development in Eastern Africa also underscores the role of regional integration. Countries such as Kenya and Ethiopia have substantial geothermal reserves, which, if developed collaboratively, could supply power beyond national borders. Nzomo and Getachew (2021) argue that regional energy integration in this context promotes sustainable development by reducing reliance on fossil fuels, diversifying the energy mix, and building resilience against climate-related shocks. Regional collaboration allows smaller or resource-deficient nations to benefit from neighbouring countries' energy endowments.

Beyond the technical and infrastructural aspects, regional cooperation has broader political and economic implications. Tuluy (2016) points out that energy integration aligns with Africa's wider goals of regional economic integration, as outlined by the African Union's Agenda 2063. Efficient cross-border energy systems can reduce costs, stimulate intra-African trade, and enhance competitiveness in global markets. Moreover, by presenting a unified front, regional blocs can negotiate more effectively with international donors and investors, thereby attracting much-needed capital for large-scale renewable projects.

Nevertheless, challenges persist. Political instability, weak governance, and differing national priorities often undermine collective efforts. Monyei, Akpeji, and Oladeji (2022) caution that without trust-building mechanisms and equitable benefit-sharing, regional initiatives risk entrenching inequalities between energy-rich and energy-poor countries. Similarly, Akinyemi, Efobi, and Osabuohien (2019) stress that addressing energy integration requires not just technical alignment but also political commitment to long-term cooperation.

3. Conclusion

This study set out to examine the balance between fossil fuels and renewable energy within the context of Africa's pursuit of a just and sustainable energy transition. By systematically exploring the conceptual framework of energy transitions, the political economy that shapes decision-making, and the practical dimensions of capacity building, financing, and regional cooperation, the study has achieved its stated aim of advancing understanding of how Africa can navigate the dual imperatives of development and decarbonisation. The objectives—evaluating the current energy landscape, assessing the role of fossil fuels, identifying renewable potentials, examining justice and inclusion, and proposing cooperative strategies—were met through critical analysis grounded in scholarly evidence.

Key findings reveal that fossil fuels, while entrenched in Africa's economies and infrastructures, cannot indefinitely sustain developmental goals without exacerbating environmental and social costs. Yet, they retain a transitional role, particularly natural gas, in addressing immediate energy deficits. Conversely, the continent's abundant renewable resources—solar, wind, hydro, and geothermal—offer transformative potential for decentralised, inclusive energy systems. However, structural barriers, including inadequate financing, policy fragmentation, and limited institutional capacity, continue to impede their large-scale deployment.

The study further underscores that energy transitions in Africa must be framed through principles of justice and equity. Vulnerable populations, particularly rural communities and women, must not only benefit from but also participate in shaping transition processes. Regional cooperation emerges as a vital pathway to address infrastructural gaps, enhance energy trade, and harmonise policy frameworks, while financing solutions require a blend of domestic resource mobilisation, innovative instruments, and supportive global partnerships.

In conclusion, Africa's energy transition must be pragmatic, inclusive, and regionally coordinated. Recommendations include accelerating renewable investments, reforming fossil fuel subsidies, strengthening institutional capacity, embedding justice frameworks, and deepening regional power pool integration. By aligning developmental aspirations with climate commitments, Africa can chart a pathway that is not only sustainable but also just, resilient, and reflective of its unique socioeconomic realities.

4. References

1. Akrofi MM. An analysis of energy diversification and transition trends in Africa. Int J Energy Water Resour. 2021;5(1):1-12. Available from: https://doi.org/10.1007/s42108-020-00101-5.
2. Pappis I, Howells M, Sridharan V, Usher W, Shivakumar A, Gardumi F, *et al*. Energy projections for African countries. [Publication details incomplete]. 2019.
3. Özdemir Ö, Hobbs BF, van Hout M, Koutstaal PR. Capacity vs energy subsidies for promoting renewable investment: benefits and costs for the EU power market. Energy Policy. 2020;137:111166. Available from: https://doi.org/10.1016/j.enpol.2019.111166.
4. Kabeyi MJB, Olanrewaju OA. Sustainable energy transition for renewable and low-carbon grid electricity generation and supply. Front Energy Res. 2022;9:743114. Available from: https://doi.org/10.3389/fenrg.2021.743114.
5. Kalair A, Abas N, Saleem MS, Kalair AR, Khan N. Role of energy storage systems in the energy transition from fossil fuels to renewables. Energy Storage. 2021;3(1):e135. Available from: https://doi.org/10.1002/est2.135.
6. Nalule V, Acheampong T. Energy transition indicators in African countries: managing the possible decline of fossil fuels and tackling energy access challenges. J Sustain Dev Law Policy. 2021;12(1):1-48.
7. Shyu CW. A framework for 'right to energy' to meet UN SDG7: policy implications to meet basic human energy needs, eradicate energy poverty, enhance energy justice, and uphold energy democracy. Energy Res Soc Sci. 2021;79:102199. Available from: https://doi.org/10.1016/j.erss.2021.102199.
8. Wilson V. Stranded assets and the energy transition: evaluating country-level risk of fossil fuel stranded assets [dissertation]. [Publisher unknown]; 2022.
9. Nalule VR, Anaman P, Acheampong T. Energy transition and Africa's oil and gas resources: challenges and opportunities. In: Petroleum resource management in Africa: lessons from ten years of oil and gas production in Ghana. Cham: Springer International Publishing; 2022. p. 523-72. Available from: https://doi.org/10.1007/978-3-030-83051-9_16.
10. Samarakoon S. A justice and wellbeing-centered framework for analysing energy poverty in the Global South. Ecol Econ. 2019;165:106385. Available from: https://doi.org/10.1016/j.ecolecon.2019.106385.
11. Dahunsi FM. Conceptual framework for sustainable energy development in Africa. In: 2013 IEEE International Conference on Emerging & Sustainable Technologies for Power & ICT in a Developing Society (NIGERCON); 2013; Owerri, Nigeria. Piscataway: IEEE; 2013. p. 238-41. Available from: https://doi.org/10.1109/NIGERCON.2013.6715661.
12. Loehr K, Matavel CE, Tadesse S, Yazdanpanah M, Sieber S, Komendantova N. Just energy transition: learning from the past for a more just and sustainable hydrogen transition in West Africa. Land. 2022;11(12):2193. Available from: https://doi.org/10.3390/land11122193.
13. Müller F, Neumann M, Elsner C, Claar S. Assessing African energy transitions: renewable energy policies, energy justice, and SDG 7. Polit Gov. 2021;9(1):119-30. Available from: https://doi.org/10.17645/pag.v9i1.3615.
14. Soumonni O, Ojah K. Innovative and mission-oriented financing of renewable energy in Sub-Saharan Africa: a review and conceptual framework. WIREs Energy Environ. 2022;11(1):e416. Available from: https://doi.org/10.1002/wene.416.
15. Swilling M, Musango J, Wakeford J. Developmental states and sustainability transitions: prospects of a just transition in South Africa. J Environ Policy Plan. 2016;18(5):650-72. Available from: https://doi.org/10.1080/1523908X.2015.1107716.
16. Zondi NB. The impact of the just energy transition on job creation in South Africa: a case of the wind energy sector. Johannesburg: University of the Witwatersrand; 2022. Available from: https://hdl.handle.net/10539/45981.
17. Scoones I, Smalley R, Hall R, Tsikata D. Narratives of scarcity: framing the global land rush. Geoforum. 2019;101:231-41. Available from: https://doi.org/10.1016/j.geoforum.2018.06.006.
18. Boamah F. Emerging low-carbon energy landscapes and energy innovation dilemmas in the Kenyan periphery. Ann Am Assoc Geogr. 2020;110(1):145-65. Available from: https://doi.org/10.1080/24694452.2019.1629869.
19. Dike S. Contextualising energy crisis and energy poverty in a hydro carbon century. Port Harcourt Law J. 2020;9(1):40-47. Available from: https://ssrn.com/abstract=3767474.
20. Kraemer A, Stefes C. The changing energy landscape in the Atlantic space. In: Atlantic future: shaping a new hemisphere for the 21st century: Africa, Europe and the Americas. [Publisher unknown]; 2016. p. 88-102.
21. Newell P, Bulkeley H. Landscape for change? International climate policy and energy transitions: evidence from sub-Saharan Africa. Clim Policy. 2017;17(5):650-63. Available from: https://doi.org/10.1080/14693062.2016.1173003.
22. Pollet BG, Staffell I, Adamson KA. Current energy landscape in the Republic of South Africa. Int J Hydrog Energy. 2015;40(46):16685-701. Available from: https://doi.org/10.1016/j.ijhydene.2015.09.141.
23. Foster V, Eberhard A, Dyson G. The evolution of electricity sectors in Africa: ongoing obstacles and emerging opportunities to reach universal targets. In: Handbook on electricity markets. Cheltenham: Edward Elgar Publishing; 2021. p. 595-628. Available from: https://doi.org/10.4337/9781788979955.00029.
24. Vines A. Opportunities and challenges in Africa's changing energy landscape. Oxf Energy Forum. 2012;90.
25. Schwerhoff G, Sy M. Developing Africa's energy mix. Clim Policy. 2019;19(1):108-24. Available from: https://doi.org/10.1080/14693062.2018.1459293.
26. Ayompe LM, Davis SJ, Egoh BN. Trends and drivers of African fossil fuel CO2 emissions 1990–2017. Environ Res Lett. 2021;15(12):124039.
27. Ndlovu V, Inglesi-Lotz R. Positioning South Africa's energy supply mix internationally: comparative and policy review analysis. J Energy South Afr. 2019;30(2):14-27. Available from: https://doi.org/10.17159/2413-3051/2019/v30i2a5409.
28. Kibria A, Akhundjanov SB, Oladi R. Fossil fuel share in the energy mix and economic growth. Int Rev Econ Financ. 2019;59:253-64. Available from: https://doi.org/10.1016/j.iref.2018.09.002.

29. Oghenekaro RE, Kant S. Interactions between proposed energy-mix scenarios and non-energy Sustainable Development Goals (SDGs): a Sub-Saharan African perspective. Environ Res Commun. 2022;4(3):035002.
30. Vidal-Amaro JJ, Østergaard PA, Sheinbaum-Pardo C. Optimal energy mix for transitioning from fossil fuels to renewable energy sources—the case of the Mexican electricity system. Appl Energy. 2015;150:80-96. Available from: https://doi.org/10.1016/j.apenergy.2015.03.133.
31. Adebayo TS, Awosusi AA, Oladipupo SD, Agyekum EB, Jayakumar A, Kumar NM. Dominance of fossil fuels in Japan's national energy mix and implications for environmental sustainability. Int J Environ Res Public Health. 2021;18(14):7347. Available from: https://doi.org/10.3390/ijerph18147347.
32. Aliyu AK, Modu B, Tan CW. A review of renewable energy development in Africa: a focus on South Africa, Egypt, and Nigeria. Renew Sustain Energy Rev. 2018;81:2502-18. Available from: https://doi.org/10.1016/j.rser.2017.06.055.
33. Bishoge OK, Zhang L, Mushi WG. The potential renewable energy for sustainable development in Tanzania: a review. Clean Technol. 2018;1(1):70-88. Available from: https://doi.org/10.3390/cleantechnol1010006.
34. Bugaje IM. Renewable energy for sustainable development in Africa: a review. Renew Sustain Energy Rev. 2006;10(6):603-12. Available from: https://doi.org/10.1016/j.rser.2004.11.002.
35. Du J, Chang G, Adu D, Abbey A, Darko R. Development of solar and bioenergy technology in Africa for green development—addressing barriers and untapped potential. Energy Rep. 2021;7:506-18. Available from: https://doi.org/10.1016/j.egyr.2021.07.102.
36. Elsner P. Continental-scale assessment of the African offshore wind energy potential: spatial analysis of an under-appreciated renewable energy resource. Renew Sustain Energy Rev. 2019;104:394-407. Available from: https://doi.org/10.1016/j.rser.2019.01.034.
37. Ouedraogo NS. Opportunities, barriers, and issues with renewable energy development in Africa: a comprehensive review. Curr Sustain Renew Energy Rep. 2019;6(2):52-60. Available from: https://link.springer.com/article/10.1007/s40518-019-00130-7.
38. Sambo AS. Renewable energy development in Africa: issues, challenges and prospects. In: Renewable energy in the service of mankind Vol II: selected topics from the World Renewable Energy Congress WREC 2014. Cham: Springer International Publishing; 2015. p. 257-64. Available from: https://doi.org/10.1007/978-3-319-18215-5_23.
39. Sweerts B, Dalla Longa F, van der Zwaan B. Financial de-risking to unlock Africa's renewable energy potential. Renew Sustain Energy Rev. 2019;102:75-82. Available from: https://doi.org/10.1016/j.rser.2018.11.039.
40. Baker L, Newell P, Phillips J. The political economy of energy transitions: the case of South Africa. New Polit Econ. 2014;19(6):791-818. Available from: https://doi.org/10.1080/13563467.2013.849674.
41. Newell P. Trasformismo or transformation? The global political economy of energy transitions. Rev Int Polit Econ. 2019;26(1):25-48. Available from: https://doi.org/10.1080/09692290.2018.1511448.
42. Bridge G, Gailing L. New energy spaces: towards a geographical political economy of energy transition. Environ Plan A Econ Space. 2020;52(6):1037-50. Available from: https://doi.org/10.1177/0308518X20939570.
43. Hanto J, Schroth A, Krawielicki L, Oei PY, Burton J. South Africa's energy transition—unraveling its political economy. Energy Sustain Dev. 2022;69:164-78. Available from: https://doi.org/10.1016/j.esd.2022.06.006.
44. Power M, Newell P, Baker L, Bulkeley H, Kirshner J, Smith A. The political economy of energy transitions in Mozambique and South Africa: the role of the Rising Powers. Energy Res Soc Sci. 2016;17:10-19. Available from: https://doi.org/10.1016/j.erss.2016.03.007.
45. Ferrall I, Heinemann G, von Hirschhausen C, Kammen DM. The role of political economy in energy access: public and private off-grid electrification in Tanzania. Energies. 2021;14(11):3173. Available from: https://doi.org/10.3390/en14113173.
46. Newell P. Power shift: the global political economy of energy transitions. Cambridge: Cambridge University Press; 2021.
47. Sovacool BK, Martiskainen M, Hook A, Baker L. Decarbonization and its discontents: a critical energy justice perspective on four low-carbon transitions. Clim Change. 2019;155(4):581-619. Available from: https://doi.org/10.1007/s10584-019-02521-7.
48. Monyei CG, Jenkins K, Serestina V, Adewumi AO. Examining energy sufficiency and energy mobility in the global south through the energy justice framework. Energy Policy. 2018;119:68-76. Available from: https://doi.org/10.1016/j.enpol.2018.04.026.
49. Komane K. Rethinking the role of mediation in Africa: a decolonial feminist analysis of the Southern African Development Community Regional Strategy on Women, Peace and Security (2018-2022) [master's thesis]. Pretoria: University of Pretoria; 2022. Available from: https://doi.org/10.25403/UPresearchdata.21929652.
50. Sankaran S, Clegg S, Müller R, Drouin N. Energy justice issues in renewable energy megaprojects: implications for a socioeconomic evaluation of megaprojects. Int J Manag Proj Bus. 2022;15(4):701-18. Available from: https://doi.org/10.1108/IJMPB-06-2021-0147.
51. Odili CJ. A rights-based approach in ensuring environmental justice in Nigeria. [Publication details incomplete]. 2021.
52. Nalule VR. Transitioning to a low-carbon economy: is Africa ready to bid farewell to fossil fuels? In: The Palgrave handbook of managing fossil fuels and energy transitions. Cham: Springer International Publishing; 2019. p. 261-86. Available from: https://link.springer.com/chapter/10.1007/978-3-030-28076-5_10.
53. Pueyo A. What constrains renewable energy investment in Sub-Saharan Africa? A comparison of Kenya and Ghana. World Dev. 2018;109:85-100. Available from: https://www.sciencedirect.com/science/article/pii/S0305750X1830127X.
54. Amir M, Khan SZ. Assessment of renewable energy: status, challenges, COVID-19 impacts, opportunities, and sustainable energy solutions in Africa. Energy Built

Environ. 2022;3(3):348-62. Available from: https://www.sciencedirect.com/science/article/pii/S2666123321000210.
55. Mohammed YS, Mustafa MW, Bashir N. Status of renewable energy consumption and developmental challenges in Sub-Saharan Africa. Renew Sustain Energy Rev. 2013;27:453-63. Available from: https://www.sciencedirect.com/science/article/pii/S1364032113004358.
56. Pegels A. Renewable energy in South Africa: potentials, barriers and options for support. Energy Policy. 2010;38(9):4945-54. Available from: https://www.sciencedirect.com/science/article/pii/S0301421510002673.
57. Kovacic Z, Musango JK, Buyana K, Ambole A, Smit S, Mwau B, *et al*. Building capacity towards what? Proposing a framework for the analysis of energy transition governance in the context of urban informality in Sub-Saharan Africa. Local Environ. 2021;26(3):364-78. Available from: https://doi.org/10.1080/13549839.2020.1849075.
58. Hawila D, Mondal MAH, Kennedy S, Mezher T. Renewable energy readiness assessment for North African countries. Renew Sustain Energy Rev. 2014;33:128-40. Available from: https://www.sciencedirect.com/science/article/pii/S1364032114000884.
59. Sokona Y, Mulugetta Y, Gujba H. Widening energy access in Africa: towards energy transition. Energy Policy. 2012;47:3-10. Available from: https://www.sciencedirect.com/science/article/pii/S0301421512002455.
60. Winanti PS, Mas'udi W. Bringing state capacity into the debate: a key for energy transition in emerging economies. J World Energy Law Bus. 2022;15(5):333-45. Available from: https://academic.oup.com/jwelb/article-abstract/15/5/333/6637748.
61. Dosso M, Nwankwo CI, Travaly Y. The readiness of innovation systems. In: Entrepreneurship, technology commercialisation, and innovation policy in Africa. Cham: Springer International Publishing; 2021. p. 13. Available from: https://books.google.com/books?hl=en&lr=&id=fh8SEAAAQBAJ.
62. Kalu EU, Arize CA, Okoyeuzu CR, Nwafor FU, Okwueze FO. Financing the energy transition in a green sub-Saharan African (SSA) environment: does energy intensity matter? OPEC Energy Rev. 2022;46(4):413-23. Available from: https://doi.org/10.1111/opec.12265.
63. Schwerhoff G, Sy M. Financing renewable energy in Africa—key challenge of the Sustainable Development Goals. Renew Sustain Energy Rev. 2017;75:393-401. Available from: https://www.researchgate.net/publication/314132196_Financing_renewable_energy_in_Africa_-_Key_challenge_of_the_sustainable_development_goals.
64. Adelaja AO. Barriers to national renewable energy policy adoption: insights from a case study of Nigeria. Energy Strategy Rev. 2020;30:100519. Available from: https://doi.org/10.1016/j.esr.2020.100519.
65. Owusu-Manu DG, Mankata LM, Debrah C, Edwards DJ, Martek I. Mechanisms and challenges in financing renewable energy projects in sub-Saharan Africa: a Ghanaian perspective. J Financ Manag Prop Constr. 2021;26(3):319-36. Available from: https://doi.org/10.1108/jfmpc-03-2020-0014.
66. Oyewo AS, Aghahosseini A, Ram M, Breyer C. Transition towards decarbonised power systems and their socio-economic impacts in West Africa. Renew Energy. 2020;154:1092-112. Available from: https://www.sciencedirect.com/science/article/pii/S0960148120304109.
67. Nwaiwu F. Digitalisation and sustainable energy transitions in Africa: assessing the impact of policy and regulatory environments on the energy sector in Nigeria and South Africa. Energy Sustain Soc. 2021;11(1):48. Available from: https://link.springer.com/article/10.1186/s13705-021-00325-1.
68. Garcia-Casals X, Ferroukhi R, Parajuli B. Measuring the socio-economic footprint of the energy transition. Energy Transit. 2019;3(1):105-18. Available from: https://link.springer.com/article/10.1007/S41825-019-00018-6.
69. Anugwom EE, Anugwom KN, Eya OI. Clean energy transition in a developing society: perspectives on the socioeconomic determinants of solar home systems adoption among urban households in southeastern Nigeria. Afr J Sci Technol Innov Dev. 2020;12(5):653-61. Available from: https://doi.org/10.1080/20421338.2020.1764176.
70. Monyei CG, Akpeji KO, Oladeji O, Babatunde OM, Aholu OC, Adegoke D, *et al*. Regional cooperation for mitigating energy poverty in Sub-Saharan Africa: a context-based approach through the tripartite lenses of access, sufficiency, and mobility. Renew Sustain Energy Rev. 2022;159:112209. Available from: https://www.sciencedirect.com/science/article/pii/S1364032122001320.
71. Akinyemi O, Efobi U, Osabuohien E, Alege P. Regional integration and energy sustainability in Africa: exploring the challenges and prospects for ECOWAS. Afr Dev Rev. 2019;31(4):517-28. Available from: https://doi.org/10.1111/1467-8268.12406.
72. Saadi N, Miketa A, Howells M. African Clean Energy Corridor: regional integration to promote renewable energy-fueled growth. Energy Res Soc Sci. 2015;5:130-2. Available from: https://www.sciencedirect.com/science/article/pii/S2214629614001546.
73. Nzomo M, Getachew Z. Regional energy integration for sustainable development in eastern Africa: the case for geothermal energy. Mediterr J Soc Sci. 2021;12(5):38. Available from: https://doi.org/10.36941/MJSS-2021-0042.
74. Tuluy H. Regional economic integration in Africa. Glob J Emerg Mark Econ. 2016;8(3):334-54. Available from: https://doi.org/10.1177/0974910116677790.