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Renewable Energy Systems as Catalysts for Green Energy Transition: a comprehensive review of existing literature

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ABSTRACT

This systematic review, conducted in accordance with the PRISMA guidelines, investigates renewable energy systems as a critical strategy for advancing United Nations Sustainable Development Goal 7 (SDG 7) ensuring access to affordable, reliable, sustainable, and modern energy, particularly within the context of global climate change and energy poverty, with a focus on Sub-Saharan Africa (SSA). Using the PRISMA framework, a thorough literature search was performed across Google Scholar, Scopus, Web of Science, EBSCOhost, and Emerald. This process identified 32 peer-reviewed studies utilising keywords such as "Sustainable Development Goals," "Renewable Energy Systems," and "Green Energy Transition." Inclusion criteria focused on peer-reviewed publications that address energy transition pathways, barriers, and policy frameworks, while non-peer-reviewed sources were excluded. Data extraction involved a thematic synthesis of sector-specific dynamics, investment requirements, technological innovations, and governance challenges. Findings revealed that globally, renewable energy sources now account for over 40% of electricity production, primarily driven by technological advancements in solar photovoltaic, wind, and hydrogen electrolysis. In SSA, approximately 600 million people lack access to electricity, necessitating estimated investments of around US dollars 200 billion annually, equivalent to about 4% of regional GDP to expand capacity and upgrade existing grids. Achieving a renewable share of at least 32.63% is essential for sustainable productivity growth. Major barriers include high capital expenditure, governance issues, grid intermittency, and policy delays, whereas opportunities exist in regional hydropower integration, mini-grid deployment, and digitalisation initiatives. Theoretical implications affirm that, building upon the Multi-Level Perspective, the study introduces concepts such as "regime fragility thresholds" and polycentric transition models to elucidate systemic inertia despite technological advancements, incorporating frameworks of energy justice and planetary boundaries. Furthermore, the practical implications suggest policy recommendations encompass blended financial instruments, just transition funds, GIS-based site selection, regulatory simplification through one-stop shops, and AI-driven smart grid technologies. These measures aim to enable SSA to achieve 60–80% renewable energy penetration by 2030, fostering equitable and resilient decarbonization pathways.

1. Introduction

The United Nations' Sustainable Development Goals (SDGs) serve as a framework for addressing a broad spectrum of global challenges. Among these, Sustainable Development Goal 7 prioritises the provision of affordable and clean energy in response to the growing global demand for energy and the need to meet higher environmental standards. Advancements in renewable energy technologies are seen as a critical pathway toward realising this objective (He, Yang, Liao, Xu & Fang, 2022). Yan, Khan, Adebayo and Olanrewaju (2024) elucidate that the existing economic growth model is giving rise to various forms of ecological degradation, sparking a contentious policy debate. The emergence of the SDGs has underscored the imperative need to realign current economic growth patterns to restore ecological equilibrium. Human progress has been marked by transformative milestones such as globalisation, industrialisation, the Green Revolution, urbanisation, and the ongoing shift toward digitalisation. However, many of these advancements have occurred without integrating sustainability principles, leading to significant environmental repercussions as the planet responds to these imbalances. As humanity advances technologically and approaches the threshold of a Type-I civilisation, there is a growing recognition of the need for a more mature model of development, one that embeds sustainability at its core. This awareness gave rise to the 17 Sustainable Development Goals (SDGs) established by the United Nations (Galan-Ladero, Sarmento & Marques, 2023), aimed at guiding human actions to ensure the co-evolution of society and the environment as an integrated, self-sustaining system. Nonetheless, with the 2030 deadline approaching, progress toward achieving these goals remains below expectations, highlighting the urgent need for renewed commitment and intensified efforts. Compounding this challenge, the outbreak of the COVID-19 pandemic has further hindered global progress, presenting an unprecedented test to humanity's pursuit of sustainable development (Elavarasan, Pugazhendhi, Jamal, Dyduch, Arif, Kumar, & Nadarajah, 2021).

2 Literature Review

Theoretical Background

The Global Energy Landscape and the Rationale Behind the Energy Transition

As the third decade of the 21st century unfolds, the world finds itself at a critical juncture in the realm of energy (Viox, 2023). The growing urgency of climate change challenges, combined with the simultaneous need for energy security and economic stability, has sparked a heightened global conversation about the future of our energy sources. Central to this discussion is the shift towards renewable energy, which is increasingly seen not just as an alternative to traditional power sources but as a pivotal element in fundamentally reshaping our relationship with the environment, our economy, and broader societal values (Holmes, Clemoes, Marriot & Wynne-Jones, 2022; Kallio, 2023). Hafner and Tagliapietra (2020) also provide an outlook of how the global energy transition will play out among the different major global geoeconomic/geopolitical blocks and how it may affect and be affected by global governance. They argue that four main unfolding drivers will lead to major tectonic shifts in the global energy system: i global energy demand, spurred largely by Asia; ii "top-down" climate policies that contribute to decarbonisation of the global economy; iii bottom-up technology and market-driven digitalisation that favour new energy approaches and also a more decentralised energy system; iv technological innovation that drives the energy industry both in the fields of renewable energy and low-carbon vehicles, but also in unconventional oil and gas production.

Green Energy Transition in Critical Sectors

The transition to green energy presents sector-specific technical challenges and opportunities. In manufacturing, primary barriers include substantial capital expenditure, technological maturity constraints, and workforce skill deficiencies, whereas opportunities involve cost reduction, enhanced energy efficiency metrics, and bolstered corporate sustainability profiles (Usman et al., 2024). The energy sector encounters intricate integration issues necessitating advances in technological innovation and the effective synchronisation of diverse low-carbon solutions; recent developments in renewable power generation, energy storage systems, and smart grid infrastructures offer viable pathways for progress (Arent et al., 2022). The transportation sector's decarbonization hinges on a comparative analysis of electric vehicles (EVs) and hydrogen fuel cell vehicles, with infrastructural deficiencies, economic impediments, and technological limitations impeding widespread adoption (Gainutdinova, Kukushkin, & Gainutdinov, 2024). Hydrogen serves as a flexible energy carrier capable of mitigating intermittency in renewable energy sources; however, challenges related to hydrogen production, containment, and distribution continue to be significant obstacles to commercialisation (Ishaq et al., 2021). Achieving sector-wide success necessitates the implementation of supportive policy frameworks, stakeholder engagement, and ongoing technological innovation.

Investment Needs in Electricity Generation

Sub-Saharan Africa requires significant investment in its electricity infrastructure to address widespread energy deficits and promote economic growth. Approximately 66% of households, representing around 600 million people, lack access to electricity (Eberhard et al., 2016). To achieve development objectives, annual investments amounting to approximately 4% of regional Gross Domestic Product (GDP) were necessary before 2015 (Rosnes & Vennemo, 2009). Specifically, Southern and Eastern Africa need to invest between 2–3% of GDP annually through 2015 to meet growth and electrification goals. These investment needs are driven by the demographic expansion and the goal of increasing the regional electrification rate from the 34% recorded in 2005. The primary expenditure involves expanding electricity generation capacity, which exceeds the costs associated with transmission infrastructure development. Establishing integrated regional power markets that utilise the continent's abundant hydropower resources could help reduce generation costs, decrease reliance on volatile oil prices, and lower carbon emissions (Rosnes & Vennemo, 2009).

The Role of Renewable Energy in Green Energy Transitions

Renewable energy plays a crucial role in advancing sustainable energy solutions across sub-saharan africa (SSA), despite numerous challenges. Research indicates that transition to renewable sources can significantly enhance green productivity growth, with a threshold of at least 32.63% of energy consumption coming from renewables needed to achieve long-term productivity gains (Diallo, 2025). Funding remains a key obstacle; while public debt can support renewable energy initiatives, its effectiveness is often constrained by governance quality (Onuoha et al., 2023). SSA possesses substantial renewable energy resources, including hydropower, wind, solar, biofuels, and geothermal energy; however, obstacles such as limited technical and financial support, weak institutional frameworks, and political instability hinder development (Bishoge et al., 2020). Additional issues include underdeveloped electricity infrastructure, outdated systems, and inadequate maintenance (Ebhota, 2021). To facilitate a successful transition, efforts should focus on strengthening governance, reforming institutions, enhancing capacity building, supporting local renewable energy projects, and implementing policies that attract investment and reduce energy poverty within the region.

Technological Advancements in Renewable Energy Systems

In an era marked by heightened environmental consciousness and the urgent need to combat climate change, sustainable development has emerged as a central focus on the global stage. At the forefront of this movement is the rapid evolution of renewable energy technologies. This dynamic and interdisciplinary field spans a wide range of innovations from state-of-the-art solar panels and wind turbines to innovative biofuel production techniques and cutting-edge energy storage systems. Collectively, these technological advancements have the potential to transform not only how energy is generated and utilised, but also to significantly reduce the environmental consequences associated with conventional fossil fuel-based energy systems (Østergaard, Duic, Noorollahi & Kalogirou, 2023).

Barriers to Renewable Energy Systems Deployment

Barriers to the adoption of renewable energy are multifaceted, encompassing social, technological, regulatory, economic, and institutional factors. Social, technological, and regulatory challenges tend to have a direct and immediate impact, while economic obstacles often exert an indirect influence by affecting investments in research and development (Seetharaman et al., 2019). In Chile, significant obstacles include difficulties in grid connection, lengthy approval procedures, issues related to land and water lease agreements, and limited access to funding (Nasirov et al., 2015). In Ghana, political and regulatory issues—particularly corruption and favouritism—represent primary concerns, alongside notable contributions from technical, economic, social, institutional, and geographical factors (Dennis Asante et al., 2020). Financial barriers are prevalent globally, as renewable energy projects often involve higher per-unit costs, increased transaction expenses, extended development timelines, and dependence on robust financial systems. Additionally, the intermittent nature of renewable energy sources and the complexities of integrating them into existing power grids further complicate deployment efforts (Wang, Stern, Limaye, Mostert, & Zhang,2013). Addressing these challenges requires targeted policy reforms, financial incentives, and strengthened institutional frameworks.

Policy Frameworks and Global Initiatives

Hafner and Tagliapietra, (2020) explore the strategies currently being adopted by major global actors in response to the evolving energy and climate landscape. They contend that Europe, as a significant energy importer, possesses a strong incentive to champion decarbonisation policies, which not only align with climate goals but also enhance energy security. This stands in contrast to the United States, which, due to the ongoing boom in unconventional oil and gas production, enjoys access to inexpensive energy and has emerged as a major natural gas exporter with the potential to become a net oil exporter as well (Hafner & Tagliapietra, 2020). Despite differing motivations, the United States driven by its robust entrepreneurial ecosystem along with China, through state-led initiatives, and other actors like Europe and Japan, are all investing extensively in the development of low-carbon technologies, aiming to secure technological and economic advantages in a decarbonising global economy. Conversely, countries heavily dependent on hydrocarbon exports, such as Russia and those in the Middle East, face considerable obstacles in transitioning their energy sectors due to entrenched systemic inertia (Hafner & Tagliapietra, 2020). The authors evaluate the strategic responses of these global powers under three prospective scenarios: (i) Weak Climate Governance, (ii) Global Efforts for Climate Action, and (iii) Muddling Through. In the first scenario, Hafner and Wochner (2020) argue that energy-exporting nations like the Gulf States, Russia, and the United States would maintain their advantageous positions, whereas Europe could experience short-term economic strain as returns on its low-carbon investments may be delayed. Nonetheless, in the medium to long term, Europe is likely to benefit from reduced dependence on increasingly volatile international energy markets (Hafner & Tagliapietra, 2020). Ultimately, it is emphasise that the existing weak global energy governance network lacks the capacity to facilitate an effective transition. They advocate for a more inclusive governance approach that fosters shared responsibility across countries at different stages of development and across various social strata. Such an approach, they suggest, would require the equitable redistribution of the costs and benefits associated with climate policies, ensuring that all stakeholders perceive tangible benefits. Furthermore, Hafner and Tagliapietra (2020) stress the need to enhance the Paris Agreement's review mechanisms, compelling states to align their national strategies with the overarching goal of safeguarding the planet.

Strategic Recommendations for the Deployment of Renewable Energy Systems

Research into strategic approaches for deploying renewable energy emphasises several critical factors essential for the success of such projects. Comprehensive resource assessments, utilising tools such as Geographic Information Systems (GIS) and multicriteria analysis, are necessary to identify optimal locations for energy development. According to Pandisha (2025), Africa possesses significant potential for solar, wind, and biomass energy sources. Effective planning of these projects should incorporate structured methodologies, including feasibility assessments, risk analysis, and compliance with regulatory frameworks. Both traditional and contemporary engineering management practices have proven valuable in this context (Eleiwi, & Habeeb, 2025). Key challenges hindering progress include complex regulatory environments, insufficient funding, and a shortage of technical expertise. Addressing these issues requires consistent national policy frameworks and enhanced financial mechanisms (Al Balushi & Matriano, 2024). For successful implementation, robust policy support, well-defined renewable energy targets, and a gradual market integration process like strategies employed in Nordic countries are vital (Mundaca et al., 2013). Essential success factors encompass stakeholder engagement, strong regulatory systems, innovative financing solutions, and international collaboration to develop and enforce policies across various regions.

3 Methodology

The PRISMA framework statement, published in 2009, was developed to support systematic review authors in transparently articulating the objectives, methodology, and findings of their reviews. (Page,et. al. 2021). According to Gurevitch, Koricheva, Nakagawa, and Stewart (2018), systematic reviews serve a vital function in research by synthesising existing knowledge on a given topic, thereby informing future investigation efforts. They can address questions that individual studies may not be able to answer and can identify limitations or gaps within the current body of research. Furthermore, Gough, Thomas, and Oliver (2019) suggest that systematic reviews contribute to the development and evaluation of theoretical frameworks that explain underlying mechanisms or phenomena. Consequently, they offer a diverse range of insights tailored to the needs of various stakeholders and users. In line with the ongoing discussion, the study approaches a systematic review with support of a PRISMA framework statement. The PRISMA framework statement was considered important because it helps track items that have been reported.

Eligibility Criteria

Information Sources: Taking into consideration the research aims, information was sourced from respectable academic databases namely, Google Scholar, Ebsco-host, Scopus, Web of Science and Emerald. The results from the systematic review showed that current data indicate that renewable energy sources contribute over 40% to global electricity generation, predominantly driven by technological advancements in solar photovoltaic, wind, and hydrogen electrolysis systems. Sub-Saharan Africa encompasses substantial untapped potential, including hydropower and geothermal resources. Major impediments comprise high capital expenditure, governance deficiencies, energy intermittency, and inadequate infrastructure, resulting in approximately 600 million individuals without reliable electrical access. To address these challenges, an estimated annual investment of approximately US dollars 200 billion is required to expand generation capacity and modernise grid infrastructure across SSA. While international frameworks such as the Paris Agreement support decarbonization initiatives, the development of robust global governance mechanisms remains necessary. Recommended strategies include implementing regulatory reforms, fostering public-private partnerships, advancing the deployment of mini-grids, integrating artificial intelligence technologies into energy management, enhancing institutional capacity to attract investments, and strengthening international collaborative efforts. These actions are critical to achieving a renewable electricity share of 60–80% in SSA by 2030, facilitating an equitable energy transition, and significantly mitigating energy poverty.

Search strategy: A systematic review of 32 research papers and journal articles published was conducted. The keywords were searched.

Selection process

Inclusion: The inclusion criteria focused on published and peer-reviewed studies that addressed renewable energy systems as a lever to energy transitions, associated barriers, and policy considerations**.**

Exclusion: The exclusion criteria non peer non-peer-reviewed documents, including unpublished papers devoid of issues addressing renewable systems and green energy transition, were excluded.

Data Extraction

Data extraction involved thematic synthesis of findings related to sectors, investments, and technological innovations.

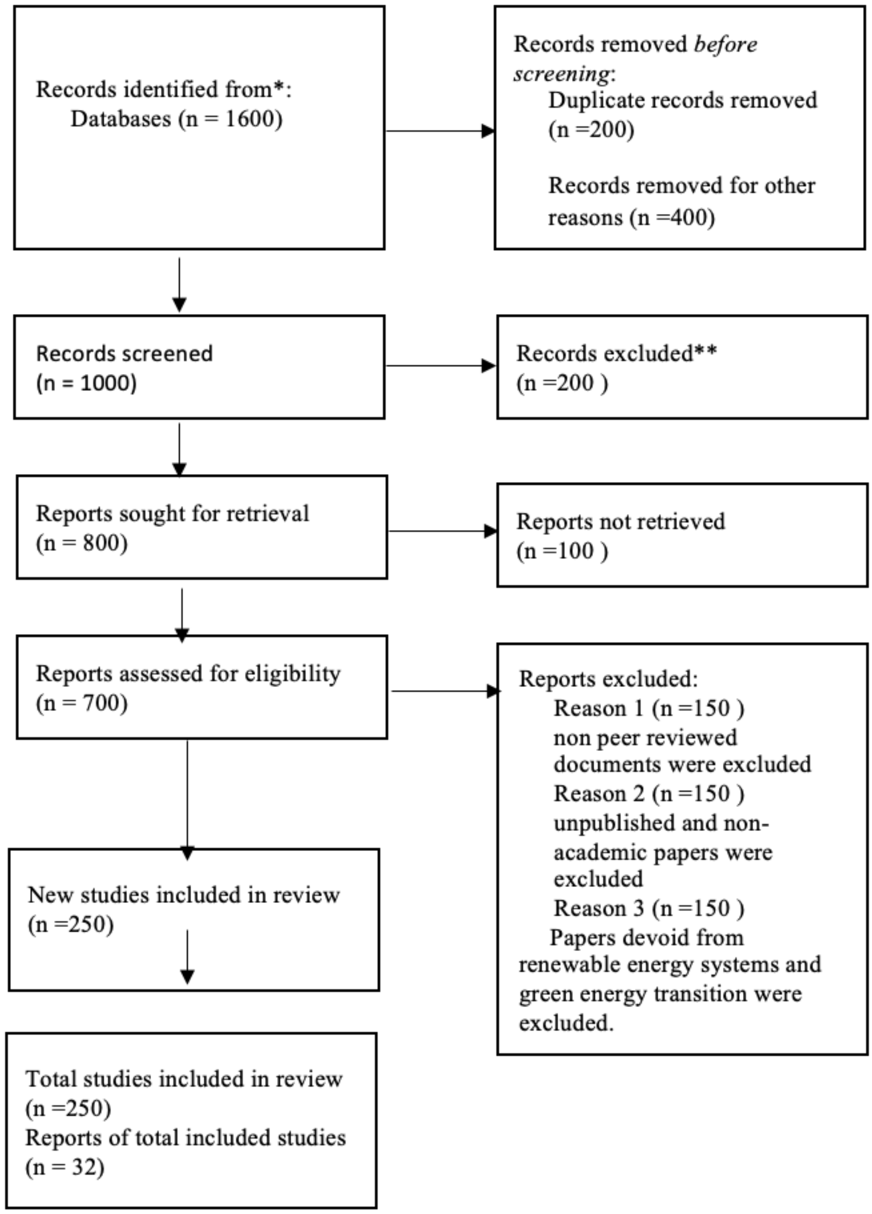

FIGURE 1: PRISMA FRAMEWORK

Source**:** Page et.al (2021).

4 Results

The global efforts to achieve Sustainable Development Goal 7 (SDG 7) highlight both significant opportunities and pressing challenges within the energy sector. Factors such as increasing demand in Asia, comprehensive climate policies, digitalisation, decentralisation, and technological advancements in renewable energy and low-carbon solutions are shaping this landscape (Hafner & Tagliapietra, 2020). Sector-specific dynamics reveal manufacturing difficulties related to high capital requirements and skill shortages, though these are mitigated by efficiency improvements (Usman et al., 2024). The energy sector faces ongoing needs for energy storage, smart grid development, and system synchronisation (Arent et al., 2022). In transportation, infrastructure constraints hinder the adoption of electric vehicles and hydrogen fuel cells (Ishaq et al., 2021; Gainutdinova et al., 2024). In

Sub-Saharan Africa, approximately 600 million people, 66% of households, lack access to electricity. Achieving universal electrification will require annual investments amounting to around 4% of regional GDP, with 2–3% allocated specifically in Southern and Eastern Africa. Investment in generation capacity is crucial, with regional hydropower resources offering the potential for significant emission reductions (Eberhard et al., 2016; Rosnes & Vennemo, 2009). Despite the abundance of renewable resources, their utilisation remains limited due to governance weaknesses, infrastructural deficiencies, and corruption. To stimulate green productivity growth, a renewable energy share of at least 32.63% is recommended (Diallo, 2025; Onuoha et al., 2023; Ebhota, 2021; Asante et al., 2020). Barriers to renewable energy deployment include regulatory delays in countries such as Chile and Ghana, as well as broader challenges like high upfront costs and grid integration issues (Seetharaman et al., 2019; Nasirov et al., 2015; Wang et al., 2013). Governance scenarios range from limited climate action common in the U.S. and hydrocarbon-dependent economies to more coordinated global efforts that benefit regions like Europe and China. However, a tendency to "muddle through" often results in inefficiencies (Hafner & Tagliapietra, 2020). This paradox of technological maturity versus systemic inertia is particularly pronounced in Sub-Saharan Africa’s low-electrification context, with geopolitical differences risking a bifurcated pace of decarbonization, urban-focused sector development, and economic setbacks exacerbated by COVID-19 (Elavarasan et al., 2021). Addressing these challenges necessitates policy coherence through phased integration, stakeholder engagement, geographic information system (GIS) site selection, and innovative financing mechanisms (Mundaca et al., 2013; Pandisha, 2025; Eleiwi & Habeeb, 2025; Al Balushi & Matriano, 2024). It is also vital to balance technological optimism with pragmatic considerations related to intermittency and supply chain resilience. While renewable energy is essential and feasible, achieving SDG 7 requires a revised approach that combines blended financing, just transition funds, binding international agreements such as the Paris Accord, regional grid development, and capacity-building initiatives. These strategies are crucial to avoiding irreversible environmental trajectories and fostering a sustainable, balanced energy future by 2030.

Theoretical Implications

The analysis of global and regional efforts toward Sustainable Development Goal 7 (SDG 7), which aims to ensure affordable, reliable, sustainable, and modern energy for all, highlights a key theoretical challenge: the paradox of technological maturity amid systemic inertia. Building upon frameworks such as Geels' Multi-Level Perspective 2002 (Sovacool & Geels, 2016), it demonstrates how advanced renewable technologies coexist with deeply entrenched socio-technical regimes resistant to change. This paradox refines the MLP by illustrating asymmetric misalignments, particularly in regions like Sub-Saharan Africa, where urgent landscape pressures, such as 600 million people lacking electricity, are hindered by fragile regimes marked by governance weaknesses, corruption, and infrastructural deficits. An extended model incorporating "regime fragility thresholds" below 4% of regional GDP helps explain persistent lock-in, contrasting with Asia’s demand-driven energy expansion. The analysis also introduces geopolitical fragmentation through a layered view of landscape diversity, challenging assumptions of uniform pressure and proposing a polycentric transition model. This model reflects uneven diffusion of global innovations, exacerbating North-South and urban-rural divides, especially in the context of post-COVID-19 recovery. Expanding on energy justice and just transition theories (e.g., Newell & Mulvaney, 2013), the study highlights procedural and distributive inequities, such as regulatory delays in Chile and Ghana and high upfront costs. These barriers often serve the interests of capital-rich actors, while intermittency challenges disproportionately impact vulnerable populations. A quantitative benchmark of 32.63% renewable energy share is proposed to support green productivity growth and promote equitable access. In regions like Sub-Saharan

Africa, where 66% of households lack electrification, overlooking opportunities like hydropower, often due to corruption, underscores the need for context-specific just transition strategies. These include phased integration, stakeholder engagement, and GIS-based site selection to improve efficiency. Blended financing approaches and dedicated just transition funds strive to develop a hybrid justice framework that balances market mechanisms with path-dependent equity, incorporating mechanisms aligned with Paris Agreement commitments.

Incorporating resilience and complexity theories (Holling, 2001), the analysis recognises that intermittency and supply chain vulnerabilities temper technological optimism. Energy systems are viewed as non-linear networks where decentralisation can enhance resilience, but grid failures pose risks of cascading disruptions. Investment thresholds of 2–3% of GDP in Southern and Eastern Africa are identified as critical tipping points, either locking in emissions or enabling adaptive green growth cycles. The digitalisation and decentralisation nexus further refines diffusion models (Rogers, 1962), emphasising the importance of addressing skill shortages and cyber-resilience in socio-digital transition pathways. Finally, emerging policy paradigms advocate for coherence within a polycentric governance landscape (Ostrom, 2010). This approach calls for binding agreements, regional grids, and capacity-building initiatives to enable adaptive, stakeholder-driven strategies. Incorporating planetary boundaries theory (Rockström et al., 2009), SDG 7 is positioned as a vital threshold; crossing it risks irreversible decarbonization bifurcations by 2030. A precautionary approach is recommended—balancing optimism with pragmatism—to foster sustainable energy futures through integrated, equitable action that overcomes systemic barriers via coherent, regionally synchronised mechanisms.

Practical implications

The analysis highlights that, although renewable energy technologies are well-developed and widely available, particularly in Sub-Saharan Africa, systemic barriers such as governance challenges, high capital requirements, infrastructure gaps, and geopolitical fragmentation may impede progress toward universal access by 2030. To address these issues, policymakers, investors, utilities, and development organisations should prioritise strategic investments and innovative financing mechanisms. Specifically, scaling blended finance through public development banks such as the African Development Bank and the World Bank can leverage private sector capital via first loss guarantees and viability-gap funding. A target of approximately 4% of regional GDP annually in Sub-Saharan Africa (around US dollars 100–120 billion per year), with 2–3% allocated to Southern and Eastern Africa, is recommended. Additionally, establishing just-transition funds by allocating 10–15% of energy budgets toward reskilling fossil-fuel workers and supporting affected communities, drawing on models like South Africa's Just Energy Transition Partnership, is crucial. To promote the deployment of mini-grids and off-grid solar solutions, standardising power purchase agreements, utilising currency-hedged loans, and aiming for a renewable energy share of at least 32.63% can stimulate green productivity gains. Policy and regulatory reforms should focus on reducing permitting delays by implementing one-stop shops in markets such as Chile and Ghana and limiting grid-connection approval times to six months through GIS-based pre-screening. Regional interconnection should be expedited by upgrading the Southern African Power Pool and East African Power Pool to synchronise hydropower-rich basins with demand centres, aiming for a cross-border capacity of 20 GW by 2030. Furthermore, enforcing anti-corruption clauses in energy procurement processes and publishing beneficial ownership registries can enhance transparency and mitigate rent-seeking behaviours. A comprehensive technology deployment roadmap is vital. In the short term (2025–2027), efforts should focus on deploying 100 million solar home systems with battery storage and piloting smart micro-grids in 500 rural districts to increase electrification by 15% and reduce storage costs below $100/kWh. In the medium term (2027–2030), scaling up to 50 GW of utility-scale solar and wind capacity, integrating hybrid hydro systems, and installing electric vehicle (EV) charging corridors on major highways will help achieve the targeted renewable share of at least 32.63% and reduce grid losses to under 12%. Long-term strategies post-2030 should include full system synchronisation via HVDC links and phased adoption of green hydrogen for heavy transport to reach net-zero goals for high-income countries. Sector-specific strategies include establishing regional training centres in Kenya and Nigeria to address skills shortages, offering tax incentives for local manufacturing of inverters and batteries, and integrating EV infrastructure with renewable mini-grids. Additionally, mandating all new connections incorporate open-API smart meters with satellite IoT technology will enable real-time theft detection and improved digitalisation. Mitigating geopolitical risks involves reaffirming commitments under the Paris Agreement through verifiable national energy plans reviewed annually at COP meetings. The creation of a UN-Energy-led Global SDG 7 Acceleration Facility can coordinate donor commitments and address stagnation by incentivising progress. Monitoring and adaptive management should involve publishing annual SDG 7 progress reports, disaggregated by urban versus rural populations, income levels, and gender access gaps. Satellite night-light data and GIS tools can be employed to validate reported electrification rates in real time. In summary, achieving SDG 7 requires viewing energy development as an integrated system rather than isolated projects. Prioritising regional grid enhancement, de-risked financing, and robust governance frameworks is essential; without these efforts, the 600 million Africans currently without electricity may remain unconnected by 2030, perpetuating cycles of poverty and climate vulnerability.

5 Conclusions

This systematic review, conducted in accordance with the PRISMA framework, highlights the critical importance of renewable energy systems in supporting the United Nations' Sustainable Development Goals, particularly SDG 7, focused on affordable and clean energy. Based on an analysis of 32 peer-reviewed studies, it is evident that the global energy transition is accelerating, with renewable sources now accounting for over 40% of electricity generation worldwide. This progress is driven by technological advancements in solar photovoltaics, wind energy, green hydrogen, and the integration of artificial intelligence in grid management. In Sub-Saharan Africa (SSA), where approximately 600 million people face energy poverty and electrification rates remain below 50%, the development of hydropower, solar, wind, and geothermal resources presents significant opportunities for sustainable growth. Nonetheless, persistent challenges such as high capital costs, governance issues, infrastructure gaps, energy intermittency, and regulatory obstacles continue to hinder progress. Addressing these barriers will require estimated investments of around US dollars 200 billion annually through 2030 to expand capacity and modernise grids. The review identifies sector-specific opportunities and hurdles: manufacturing industries can benefit from cost reductions and efficiency improvements through renewable energy, while the transportation and energy sectors need advancements in electric vehicles, hydrogen fuel cells, and smart infrastructure to enhance integration. Effective policy frameworks, such as those aligned with the Paris Agreement and strategic initiatives including regulatory reforms, public-private partnerships, mini-grid expansion, and capacity building, are vital to ensuring a fair and sustainable transition. These measures will help mitigate environmental degradation, combat climate change, and support economic stability, energy security, and social inclusion, contributing to broader SDG objectives by addressing ecological imbalances driven by industrialisation and urbanisation. Despite challenges posed by the COVID-19 pandemic and mixed progress globally toward the 2030 targets, the review affirms that achieving a renewable electricity share of 60–80% in

SSA is attainable through enhanced international cooperation, innovative financing mechanisms, and technology transfer.

The future direction for the study is premised on the fact that the systematic review highlights the significant potential of renewable energy systems to advance Sustainable Development Goal 7. It also identifies ongoing challenges in implementation, particularly in Sub-Saharan Africa (SSA). To achieve the 2030 targets, a renewable electricity share of 60–80% and universal electrification is required through an integrated, adaptive, and equitable approach that emphasises scalability, resilience, and inclusivity. This approach must address barriers such as governance fragility and intermittency, while leveraging opportunities like digitalisation and regional hydropower development. Future initiatives should prioritise long-term impact assessments and scenario modelling, including multi-decade socio-economic simulations using agent-based models and integrated assessment frameworks. These tools can help quantify trade-offs between the current 32.63% renewable threshold for green productivity and higher ambitions, and evaluate the effectiveness of transition strategies through cohort studies in pilot regions such as South Africa's Just Energy Transition Partnership. Metrics should include income redistribution, gender-disaggregated benefits, and satellite night-light data analysis.

Advancement in emerging technologies is essential, with efforts focused on accelerating research and development in perovskite tandem solar cells, solid-state batteries, and green hydrogen electrolysis. Target costs to aim for include below $50 per kWh for energy storage and $1 per kg for hydrogen by 2030. Additionally, integration of artificial intelligence for maintenance, blockchain-based peer-to-peer trading, and hybrid systems such as combining hydropower with floating solar and wind, utilising GIS analysis can unlock over 50 GW of capacity in Eastern and Southern Africa. Supporting infrastructure should include localised manufacturing hubs. Policy and governance enhancements are crucial, requiring strengthened accountability from global to local levels under an improved Paris Agreement framework. This should involve binding SDG 7 milestones, regional dashboards targeting at least 4% of SSA's GDP in energy investments, and de-risking mechanisms such as blended finance to mobilise an estimated $200 billion annually. This includes dedicated funds for just transition initiatives, community-owned projects, and reskilling programs in approximately 1,000 rural districts.

Sector-specific and regional roadmaps should outline phased actions: in manufacturing, deploying 100 million solar home systems and training 500,000 workers in the short term; achieving 20% renewable integration in the medium term; and establishing circular economies over the long term. In transportation, pilot projects for electric vehicle corridors, subsidisation of one million e-mobility units initially, scaling hydrogen-powered fleets, and reaching net-zero logistics should be prioritised. For energy in SSA, goals include installing 500 smart micro-grids, upgrading power pools to 10 GW of cross-border capacity in the near term, and adding 50 GW of utility-scale renewables with grid losses below 12% by 2030. Post-2030, development of high-voltage direct current (HVDC) supergrids can facilitate 100% renewable exports. Cross-sector efforts should focus on standardising power purchase agreements, mandating open API smart meters, and aligning global carbon pricing mechanisms. Capacity building must include investing in 100,000 technical specialists skilled in cyber-resilient decentralised systems, fostering public-private-civil society partnerships to reduce regulatory delays, and addressing urban-rural and North-South disparities through gender-sensitive programs and technology transfer initiatives. Ensuring that 50% of new capacity benefits rural communities is critical. By pursuing these comprehensive strategies cohesively, Sub-Saharan Africa can position itself as a leader in resilient, equitable energy systems by 2030. This will contribute to climate risk mitigation and support the transition toward a more advanced civilisation, contingent on renewed multilateral commitment to translate evidence into effective action. Future research should focus on long-term socio-economic analyses of renewable energy deployment in SSA, in-depth empirical studies that will investigate emerging technologies such as perovskite solar cells and blockchain for energy trading and assess the effectiveness of just transition strategies in vulnerable communities will suffice. Ultimately, integrating sustainability into development paradigms is essential for progressing toward a Type-I civilisation, ensuring the harmonious development of society and the environment. A renewed commitment from policymakers, investors, and stakeholders is critical to close the gap between aspirations and implementation, paving the way for a resilient, low-carbon future.

Declaration of Conflicting Interests:

"The author declares no potential conflicts of interest with respect to the research, authorship and/or publication of this article."

References

Arent, D. J., Green, P., Abdullah, Z., Barnes, T., Bauer, S., Bernstein, A. and Turchi, C. (2022). Challenges and opportunities in decarbonising the U.S. energy system. *Renewable and Sustainable Energy Reviews, 169*, 112939. doi: 10.1016/j.rser.2022.112939

Asante, D., He, Z., Adjei, N. O., & Asante, B. (2020). Exploring the barriers to renewable energy adoption utilising MULTIMOORA-EDAS method. Energy Policy, 142, 111479. https://doi.org/10.1016/j.enpol.2020.111479

Al Balushi, A. K., & Matriano, M. T. (2024). Strategic recommendations for enhancing renewable energy investments and economic diversification: The case of Oman. International Journal of Innovative Research in Engineering & Multidisciplinary Physical Sciences, 12(4). https://doi.org/10.37082/IJIRMPS.v12.i4.231084

Bishoge, O. K., Kombe, G. G., & Mvile, B. N. (2020). Renewable energy and sustainable development: A review. Journal of Renewable and Sustainable Energy, 12(5), 052702. https://doi.org/10.1063/5.0009297

Diallo, S. (2025). Renewable energy transition and green productivity growth in sub-Saharan African countries: A convergence analysis. Natural Resources Forum, 49(3), 2794–2813. https://doi.org/10.1111/1477-8947.12511

Eberhard, A., Gratwick, K., Morella, E., & Antmann, P. (2016). *Independent power projects in Sub-Saharan Africa: Lessons from five key countries*. Washington, DC: World Bank. doi:10.1596/978-1-4648-0800-5

Ebhota, W. S. (2021). Leveraging on sustainable energy transition to change the energy narrative of the Dark Continent. International Journal of Energy Economics and Policy, 11(3), 1–10. https://doi.org/10.32479/ijeep.10663

Elavarasan, R. M., Pugazhendhi, R., Jamal, T., Dyduch, J., Arif, M. T., Kumar, N. M., & Nadarajah, M. (2021). Envisioning the UN Sustainable Development Goals (SDGs) through the lens of energy sustainability (SDG 7) in the post-COVID-19 world. *Applied Energy*, *292*, 116665.

Eleiwi, M. A., & Habeeb, L. J. (2025). Strategic engineering management for renewable energy projects: Trends, challenges, and future outlook. African Journal of Economics and Business Research, 1(2). https://doi.org/10.71229/njemcs.v1i2.1

Gainutdinova, D. F., Kukushkin, D. A., & Gainutdinov, F. R. (2024). Comparative analysis of electric charging and hydrogen refueling stations. In *Achievements of Science and Technology, Cultural Initiatives, and Sustainable Development: The III All-Russian Scientific Conference with International Participation (DNiT-III-2024)*. Kazan, Russia: Kazan State Power Engineering University. https://doi.org/10.47813/dnit-III.2024.11.1009

Galan-Ladero, M.M., Sarmento, M. & Marques, S. Social Marketing to achieve the Sustainable Development Goals (SDGs) in 2030 Agenda by the United Nations. *Int Rev Public Nonprofit Mark* **20**, 521–527 (2023). https://doi.org/10.1007/s12208-023-00381-7

Gough D, Thomas J, Oliver S. (2019) Clarifying differences between reviews within evidence ecosystems. Syst Rev.8:170. https://doi.org/10.1186/s13643-019-1089-2.

Gurevitch, J., Koricheva, J., Nakagawa, S. and Stewart,G.(2018) Meta-analysis and the science of research synthesis. *Nature* **555**, 175–182 . https://doi.org/10.1038/nature25753

Hafner, M., Tagliapietra, S. (2020). The Global Energy Transition: A Review of the Existing Literature. In: Hafner, M., Tagliapietra, S. (eds) The Geopolitics of the Global Energy Transition. Lecture Notes in Energy, vol 73. Springer, Cham. https://doi.org/10.1007/978-3-030-39066-2_1.

He, J., Yang, Y., Liao, Z., Xu, A., & Fang, K. (2022). Linking SDG 7 to assess the renewable energy footprint of nations by 2030. *Applied Energy, 317*, 119167. https://doi.org/10.1016/j.apenergy.2022.119167

Holmes, G., Clemoes, J., Marriot, K., & Wynne-Jones, S. (2022). The politics of the rural and relational values: Contested discourses of rural change and landscape futures in West Wales. *Geoforum*, *133*, 153–164. https://doi.org/10.1016/j.geoforum.2022.05.014

Ishaq, H., Dincer, I., & Crawford, C. (2022). A review on hydrogen production and utilization: Challenges and opportunities. International Journal of Hydrogen Energy, 47(62), 26238–26264. https://doi.org/10.1016/j.ijhydene.2021.11.149

Kallio, M. (2023). *Energy security in the EU solar energy strategy: Solar PV supply chain vulnerability and China* (Master's thesis, University of Helsinki, Faculty of Arts). Helsinki University Library.

Moher, D. (2018). Reporting guidelines: Doing better for readers. BMC Medicine, 16(1), 233. https://doi.org/10.1186/s12916-018-1226-0

Moher, D., Liberati, A., Tetzlaff, J., Altman, D. G., & PRISMA Group (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS medicine*, *6*(7), e1000097. https://doi.org/10.1371/journal.pmed.1000097

Mundaca, L. T., C. Dalhammar, D. Harnesk (2013), 'The Integrated NORDIC Power Market and the Deployment of Renewable Energy Technologies: Key Lessons and Potential Implications for the Future ASEAN Integrated Power Market' in Kimura, S., H. Phoumin and B. Jacobs (eds.), Energy Market Integration in East Asia: Renewable Energy and its Deployment into the Power System, ERIA Research Project Report 2012-26, Jakarta: ERIA. pp.25-97.

Nasirov, S., Silva, C., & Agostini, C. A. (2015). Investors' Perspectives on Barriers to the Deployment of Renewable Energy Sources in Chile. *Energies*, *8*(5), 3794-3814. https://doi.org/10.3390/en8053794

Onuoha, F. C., Dimnwobi, S. K., Okere, K. I., & Ekesiobi, C. (2023). Funding the green transition: Governance quality, public debt, and renewable energy consumption in Sub-Saharan Africa. *Utilities Policy, 82*(C), Article 101574. https://doi.org/10.1016/j.jup.2023.101574

Østergaard, P. A., Duić, N., Noorollahi, Y., & Kalogirou, S. (2023). Advances in renewable energy for sustainable development. *Renewable Energy*, *219*(Part 1), Article 119377. https://doi.org/10.1016/j.renene.2023.119377

Pandisha, H. K. (2025). Renewable energy resource assessment and deployment: A comprehensive review. *African Journal of Economics and Business Research, 4*(1). https://dx.doi.org/10.4314/ajebr.v4i1.4

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ, 372*, n71. https://doi.org/10.1136/bmj.n71

Rosnes, O., and Vennemo, H. (2009). *Powering up: Costing power infrastructure spending needs in Sub-Saharan Africa*. Washington, DC: World Bank. Retrieved from http://hdl.handle.net/10986/28073

Seetharaman, Moorthy, K., Patwa, N., Saravanan, & Gupta, Y. (2019). Breaking barriers in deployment of renewable energy. Heliyon, 5(1), e01166. https://doi.org/10.1016/j.heliyon.2019.e01166

Usman, F. O., Ani, E. C., Ebirim, W., Montero, D. J. P., Olu-lawal, K. A., & Ninduwezuor-Ehiobu, N. (2024). Integrating renewable energy solutions in the manufacturing industry: Challenges and opportunities: A review. Engineering Science & Technology Journal, 5(3), 674-703. doi:10.51594/estj/v5i3.865. Retrieved from http://www.fepbl.com/index.php/estj

Viox, A. R. (2023). *American Deathscapes: The Ritual of the Sacred Ordinary Reimagining Approaches to Death Architecture in 21st Century America* (Master's thesis, University of Cincinnati).

Wang, X., Stern, R., Limaye, D., Mostert, W., & Zhang, Y. (2013). *Unlocking commercial financing for clean energy in East Asia. World Bank. https://hdl.handle.net/10986/15934

Yan, Y., Khan, K., Adebayo, T. S., & Olanrewaju, V. O. (2024). Unveiling energy efficiency and renewable electricity's role in achieving Sustainable Development Goals 7 and 13 policies. *International Journal of Sustainable Development & World Ecology, 31*(3), 279–292. https://doi.org/10.1080/13504509.2023.2300006