The Role of Bioenergy in Achieving SDG 7 in Africa

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Abstract—**Energy lies at the heart of sustainable development, underpinning progress across economic growth, social well-being, and environmental protection. Globally, the energy sector accounts for over three-quarters of total greenhouse gas (GHG) emissions, making it central to climate change mitigation efforts. While the ongoing energy transition is largely framed around solar, wind, and hydropower, the African context, particularly in sub-Saharan regions, reveals a critical yet underexplored role for bioenergy. As many African countries grapple with limited energy infrastructure, high dependence on traditional biomass, and widening energy access gaps, sustainable bioenergy offers a unique opportunity to advance Sustainable Development Goal 7 (SDG 7: Affordable and Clean Energy). Bioenergy can simultaneously expand access to modern energy services, enhance energy security, reduce emissions, and stimulate rural development through local value chains. However, realising this potential requires addressing key challenges, including weak governance systems, inadequate financing and infrastructure, and the risk of environmental degradation from poorly managed bioenergy projects. Achieving the dual goals of energy access and sustainability, therefore, calls for robust policy frameworks, technological innovation, and regional cooperation. This paper argues that with the right enabling environment, bioenergy can complement solar, wind, and other renewables, positioning Africa to accelerate its energy transition while contributing to global climate and development agendas.**

Keywords— **Bioenergy, Energy Transition, Energy Access, Climate Mitigation.**

I. Introduction

Access to affordable, reliable, sustainable, and modern energy is fundamental to achieving the United Nations Sustainable Development Goals (SDGs), particularly SDG 7, which seeks to “ensure access to affordable, reliable, sustainable and modern energy for all” by 2030 [1], [2]. Energy fuels economic development, drives industrialisation, supports social infrastructure, and is essential for poverty reduction, yet its production and use account for 75.7% of global GHG emissions - 37.6 Gt CO2 in 2024 alone [3], [4], [5]. This dual role makes the energy sector both a challenge and a key opportunity in addressing the climate crisis and achieving sustainable development.

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In Africa, the energy landscape presents a complex paradox. The continent is endowed with abundant renewable energy resources, solar, wind, hydro, geothermal, and biomass, yet it remains the region with the world’s lowest access to modern energy services. As of 2025, 600 million Africans still lack access to electricity, while more than 1 billion people are without clean cooking -contributing to 815,000 premature deaths annually and 1.3 million hectares of deforestation [6], [7].

Bioenergy, derived from biological sources such as agricultural residues, forestry by-products, animal waste, and energy crops, emerges as a critical, though often undervalued, component of Africa’s sustainable energy future [8]. Unlike intermittent renewables such as solar and wind, bioenergy offers flexible and dispatchable energy that can support both electricity generation and thermal applications. Moreover, sustainable bioenergy systems can generate multiple co-benefits: valorising agricultural waste, creating rural employment, promoting circular economy practices, and reducing dependency on imported fossil fuels. When managed responsibly, bioenergy can help decarbonise not only the power sector but also industries and transport, where electrification remains limited.

However, the potential of bioenergy in Africa is yet to be fully explored. Current bioenergy use is dominated by traditional biomass, which is inefficient and harmful to the environment. Transitioning from traditional to modern forms (biogas, bioethanol, biomass-based electricity) could avert 410 Mt CO2-eq emissions annually via clean cooking [7]. This would require overcoming significant institutional, financial, and technical barriers. Key challenges include the lack of coherent policy frameworks, weak governance and regulatory systems, limited investment in research and infrastructure, and inadequate public awareness of the benefits of bioenergy. Additionally, poorly planned large-scale bioenergy production poses risks to food security, biodiversity, and land rights, underscoring the need for sustainable governance models that balance energy, environmental, and social priorities.

In the pursuit of SDG 7, bioenergy holds the potential to bridge the gap between energy access and sustainability. Its integration into national and regional energy strategies can enhance energy diversification, improve grid stability, and contribute to achieving universal access. Regional cooperation through platforms such as the African Union (AU) and the Economic Community of West African States (ECOWAS) is crucial to harmonise standards, mobilise financing, and promote technology transfer. Countries like Tanzania, Ethiopia, Kenya, Burkina Faso, and South Africa are already implementing bioenergy initiatives, ranging from waste-to-energy projects to biogas production, offering replicable models for other African nations [9].

This paper explores the role of bioenergy in achieving SDG 7 in Africa by analysing its status, opportunities, challenges, and enabling policy conditions. It argues that a sustainable bioenergy transition, anchored in good governance, technological innovation, and regional collaboration, can significantly contribute to Africa's clean energy goals while supporting broader climate and socio-economic objectives. By highlighting pathways to integrate bioenergy within Africa's energy transition, the paper seeks to inform policy and research directions that will advance both SDG 7 and the global net-zero agenda.

II. Overview of Bioenergy in Africa

A. *The Bioenergy Landscape*

Bioenergy plays a central role in Africa's energy mix, accounting for 54% of total final consumption in 2024 and 47.9% from biomass in primary supply [10]. In rural households, it exceeds 85%, mostly traditional (firewood, charcoal) in inefficient stoves, contributing to deforestation and severe health problems from indoor air pollution [7].

The transition from traditional to modern bioenergy represents one of the most viable pathways for Africa to achieve the targets of SDG 7. This shift aligns with SDG 7 targets: 7.1 (universal access), 7.2 (increase the share of renewable energy in the global energy mix), 7.3 (doubling energy efficiency) [11]. By modernising bioenergy systems, Africa can reduce reliance on unsustainable biomass, expand access to clean energy, and create circular value chains that turn waste into productive energy.

Africa's vast agricultural base and biomass endowments provide substantial feedstock potential for sustainable bioenergy production. The continent generates millions of tonnes of agricultural residues each year from maize, rice, cassava, sugarcane, oil palm, and forestry operations, which are often left unused or burned in the open. Additionally, animal waste and municipal solid waste streams offer opportunities for biogas and waste-to-energy generation.

Agricultural residues play a crucial role in bioenergy production across various African nations. Countries such as Nigeria, Ghana, and Ethiopia generate significant amounts of maize stalks, rice husks, and cassava peels, which are well-suited for producing bioethanol and briquettes [12], [13]. In addition to agricultural resources, Central African countries boast abundant forestry residues. Implementing sustainable forest management programs can facilitate biomass harvesting for power generation, further contributing to the region's energy needs.

Energy crops are another promising avenue for biofuel production, with sugarcane and jatropha being cultivated as potential feedstocks in Mozambique, Malawi, and Tanzania [14]. As urbanisation accelerates in cities like Nairobi, Accra, and Lagos, new waste-to-energy initiatives are emerging. These initiatives not only address the increasing problem of municipal solid waste but also reduce landfill emissions while generating power, creating a dual benefit for urban environments.

Recent estimates indicate that Africa has the potential to sustainably produce up to 62.62 Mtoe of bioethanol, 83.05 Mtoe of biomethane, and 139.79 Mtoe of solid biofuels, provided that proper land-use and environmental safeguards are implemented [15]. Utilising even a fraction of this potential could significantly expand the continent's clean energy portfolio, showcasing the importance of leveraging local resources to meet energy needs sustainably.

B. *Regional Initiatives and Country Examples*

Several African countries have initiated programs and policies to scale up bioenergy within their national energy transitions. Regional institutions such as the African Union (AU), the ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE), and the Southern African Development Community (SADC) are also fostering cross-country cooperation through policy harmonisation, capacity building, and investment facilitation. Table 1 summarises examples across countries and regions, focusing on key bioenergy initiatives and developments in Sub-Saharan Africa.

Emerging research and pilot projects indicate a shift towards integrated bioenergy systems that link energy production with waste management, agriculture, and industry. Technologies such as biomass gasification, pyrolysis for biochar production, and anaerobic digestion for biogas generation are gaining traction across universities, private firms, and development agencies. These innovations point toward a more circular and resilient energy system that can meet Africa's growing energy demand in a sustainable manner.

However, to fully realise these opportunities, bioenergy development must be guided by sustainability principles, ensuring that land-use change, biodiversity loss, and food security risks are mitigated. Strengthening governance frameworks and ensuring inclusivity, particularly for smallholder farmers and women, remain crucial for equitable energy transitions.

TABLE I: SELECTED COUNTRIES AND REGIONAL BIOENERGY INITIATIVES

Country/ Region	**Key Initiative (Years)**	**Focus**	**Impact**	**Ref**
Ghana	Renewable Energy Act (Act 832) (2011–ongoing)	Biomass for electricity generation, biofuels, and institutional biogas digesters	Over 1 million efficient stoves distributed; USD 2 million invested for 2 million more units, reducing indoor pollution and deforestation	[16]
Kenya	Bioenergy Strategy (2020–2027)	Sustainable production of bioethanol and biogas; clean cooking solutions via networks like KOKO	Targets 100% clean cooking access by 2028; serves 1 million households, averting 815,000 health-related deaths annually across SSA analogues	[17]
Ethiopia	National Household Biogas Programme (2009–ongoing, scaled 2024)	Rural decentralised biogas digesters for cooking and fertiliser co-production	1,600 new units installed in 2024; unlocks >10 bcm biogas potential, benefiting 750 farmers (40% women) with irrigation and emission cuts of 329 t CO_2 -eq/year	[18]
South Africa	Integrated Resource Plan (IRP 2023–2030)	Biomass co-firing and waste-to-energy for grid stability; Ngodwana Biomass Plant	Contributes to 7% renewable share (half from biomass); 25 MW operational capacity, creating jobs and reducing wildfire risks	[19]
Nigeria	Lagos Waste-to-Energy Project (2024–2026)	Municipal solid waste conversion to electricity at Epe landfill	€120 million Dutch funding; processes 15 Mt waste/year, generating power for 40,000 homes and cutting landfill emissions by 40%	[20]
ECOWAS (Regional)	Bioenergy Development Strategy and Investment Plan (2020–2025)	Harmonised standards for waste-to-energy and biogas across West Africa	Mobilises USD 2.2 billion in financing; builds capacity in 15 countries, enhancing cross-border tech transfer	[21]
SADC (Regional)	SADC Renewable Energy and Energy Efficiency Strategy and Action Plan (2016–2030)	Biomass integration in Southern Africa grids; sugarcane bioenergy hubs	Scales up 544,000 ha sugarcane for biofuels; fosters cooperation in 16 countries, projecting 460,000 jobs by 2040	[12]

III. Opportunities and Challenges for Bioenergy Development in Africa

A. *Opportunities for Bioenergy Expansion*

Africa's vast agricultural and forestry base offers a rich and renewable supply of biomass feedstock. Agricultural residues, animal manure, and municipal waste streams serve as raw materials for biogas, briquettes, and biofuels, thereby avoiding direct competition with food crops [15]. Countries such as Ghana, Kenya, and Nigeria generate millions of tonnes of organic waste annually, much of which could be converted into useful energy through improved collection and conversion technologies. Harnessing this potential can simultaneously address energy poverty, waste management, and rural economic development.

Africa's population is projected to reach 2.4 billion by 2050 [22], driving up energy demand for households, industries, and transport. Yet over half the continent still relies on traditional biomass for cooking. The clean cooking crisis presents a major opportunity for bioenergy solutions such as biogas digesters, pellet stoves, and bioethanol cookers, which provide affordable and health-friendly alternatives.

Continental and international initiatives are increasingly recognising bioenergy's role in the green transition. The African Union's Agenda 2063, ECOWAS Renewable Energy Policy, and SADC Renewable Energy Strategy all emphasise sustainable biomass utilisation. At the global level, instruments such as the Paris Agreement and Sustainable Energy for All (SEforALL) platform encourage bioenergy development within national climate and energy plans. Many African countries have also incorporated bioenergy in their Nationally Determined Contributions (NDCs) as part of their mitigation strategies [23].

The growth of African research institutions, innovation hubs, and private-sector participation has accelerated the development of cost-effective bioenergy technologies. Improved cookstoves, small-scale biogas systems, biomass gasifiers, and advanced pyrolysis units are increasingly available and locally manufactured. Universities are leading applied research on biomass conversion, energy efficiency, and waste valorisation.

Sustainable bioenergy projects generate multiple socio-economic co-benefits, including rural employment, income diversification, and value addition in agricultural sectors. Bioenergy can also strengthen local resilience by reducing dependence on imported fossil fuels and providing decentralised energy options. Environmentally, it contributes to GHG reduction through carbon sequestration in biochar systems, the displacement of fossil fuels, and reduced deforestation from efficient biomass use [24], [25].

B. Key Challenges and Barriers

Despite its promise, bioenergy development in Africa faces significant barriers that hinder its large-scale deployment. These challenges are multidimensional, spanning governance, finance, infrastructure, and social acceptance.

A major constraint lies in the lack of coherent and enforceable bioenergy policies across many African countries. Overlapping mandates between ministries, fragmented regulations, and limited technical capacity undermine policy implementation. In some cases, bioenergy strategies exist only as sub-components of broader renewable energy policies, with insufficient funding and coordination mechanisms [26], [27]. The absence of clear sustainability standards also exposes the sector to risks of resource depletion and social conflict.

Bioenergy projects often require high upfront capital for feedstock collection, processing infrastructure, and technology acquisition. However, limited access to affordable financing, underdeveloped markets, and perceived investment risks deter both local and international investors. The small-scale and decentralised nature of many bioenergy projects further complicates financing due to the lack of economies of scale and creditworthiness. Innovative financing models, such as results-based finance, public-private partnerships, and carbon credit schemes, remain underutilised.

While technology transfer and innovation are improving, bioenergy infrastructure in most African countries remains inadequate. Weak feedstock supply chains, poor logistics, and a lack of quality control hinder the reliability and scalability of bioenergy systems. In rural areas, limited access to spare parts, technical expertise, and maintenance services leads to short system lifespans and user dissatisfaction. Developing local manufacturing capabilities and technical training programs is crucial for sustaining the deployment of bioenergy.

Poorly planned bioenergy expansion can lead to land-use conflicts, deforestation, and competition with food production. The cultivation of energy crops such as sugarcane and jatropha may displace smallholder farmers if not properly regulated. Additionally, monoculture plantations pose risks to biodiversity and soil health. To avoid negative outcomes, bioenergy development must be guided by sustainability certification, integrated land-use planning, and adherence to environmental safeguards.

Public perception of bioenergy remains mixed, particularly where past projects have failed due to poor design or lack of community engagement [9]. Many rural populations are unaware of modern bioenergy technologies or view them as expensive and unreliable. Cultural preferences for traditional cooking fuels further complicate the adoption process. Building community awareness, promoting inclusive decision-making, and demonstrating tangible benefits are essential to foster social acceptance.

IV. Policy Recommendations and Pathways for Scaling Bioenergy in Africa

Achieving the targets of SDG 7 requires coordinated and systemic interventions that link bioenergy development with national, regional, and global sustainability agendas. African countries must transition from fragmented, small-scale projects to integrated and scalable bioenergy systems embedded within long-term development strategies. The following policy directions and pathways are proposed to guide this transformation.

A. Strengthening Policy, Regulatory, and Institutional Frameworks

A robust and coherent policy environment is a prerequisite for the sustainable development of bioenergy. Governments should establish comprehensive bioenergy policies that clearly define production standards, sustainability criteria, and the roles of key institutions. Integrating bioenergy targets into National Energy Plans, Climate Action Strategies (NDCs), and Green Growth Frameworks can ensure alignment with broader socio-economic and environmental goals.

Key actions include developing national bioenergy roadmaps that identify resource potential, technology options, and priority investment areas. This involves harmonising standards for feedstock sustainability, emissions accounting, and technology performance across regions through platforms such as ECOWAS, IGAD, and SADC. It is also essential to strengthen institutional coordination among ministries responsible for energy, agriculture, environment, and finance to ensure policy coherence. Additionally, establishing independent regulatory authorities or dedicated units within energy ministries will help oversee bioenergy governance, certification, and monitoring.

B. Mobilising Finance and Investment

Financing remains a significant bottleneck for bioenergy development in Africa, necessitating that governments and development partners promote innovative financing mechanisms to de-risk investments in this sector and attract private capital. Strategies to achieve this include establishing green investment funds or bioenergy development banks that can offer concessional loans and guarantees for small and medium-scale projects. Additionally, leveraging results-based financing and carbon credit mechanisms under the Voluntary Carbon Market and Article 6 of the Paris Agreement can reward verified reductions in emissions. Encouraging public-private partnerships is also essential to mobilise both

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local and international investors for infrastructure development and technology deployment. Furthermore, providing tax incentives, import duty exemptions, and feed-in tariffs can support bioenergy producers and technology manufacturers. To enhance financial inclusion, it is essential to promote microfinance and cooperative models that enable smallholder farmers and rural entrepreneurs to participate in bioenergy value chains.

C. Advancing Research, Innovation, and Capacity Building

Building Africa's technological base is essential for developing cost-effective and locally appropriate bioenergy systems, and to achieve this, governments should prioritise research and development (R&D) alongside technical capacity building through collaboration among universities, research centres, and industry. Policy interventions should focus on supporting universities and innovation hubs to conduct applied research in areas such as biomass conversion, waste valorisation, and hybrid energy systems. It is also important to establish centres of excellence for bioenergy research, potentially under the framework of the African Union's Pan-African University. Furthermore, promoting technology transfer partnerships with international research institutions and private firms will facilitate local manufacturing and adaptation. Additionally, the development of vocational training programs and extension services for technicians, farmers, and entrepreneurs engaged in bioenergy systems is crucial. Finally, investing in digital technologies such as remote sensing and data analytics can further enhance resource mapping, monitoring, and operational efficiency in bioenergy production.

D. Promoting Sustainable Feedstock Supply Chains

Sustainable feedstock sourcing is essential for the long-term viability of the bioenergy sector, and policymakers should adopt integrated land-use planning and circular economy principles to minimise competition between food and energy production while safeguarding ecosystems. Key approaches include prioritising residues, wastes, and degraded lands for bioenergy feedstock production instead of prime agricultural areas, encouraging agroforestry systems and energy crop diversification to balance productivity with environmental conservation, and supporting community-based resource management to ensure equitable access to biomass resources. Additionally, implementing sustainability certification schemes, such as the Roundtable on Sustainable Biomaterials (RSB), can promote responsible production and trade. Developing reliable feedstock supply chains can further foster rural industrialisation by linking farmers, processors, and distributors through structured contract farming and cooperative models.

E. Enhancing Regional Cooperation and Knowledge Sharing

The transboundary nature of energy systems and biomass resources makes regional integration essential for scaling bioenergy in Africa. Institutions such as ECREEE, AREI, and the African Continental Free Trade Area (AfCFTA) can play catalytic roles in harmonising regulations, facilitating investment, and enabling technology transfer. Policy priorities should include creating regional bioenergy data platforms for information exchange on resource potential, market trends, and policy best practices, as well as promoting cross-border trade in sustainable biomass and biofuels under standardised quality and sustainability criteria. Additionally, organising regional capacity-building programs and joint research initiatives can strengthen expertise and foster innovation networks. Such cooperation has the potential to accelerate Africa's collective progress toward Sustainable Development Goal 7 while reinforcing regional energy security and climate resilience.

F. Ensuring Inclusivity, Equity, and Social Acceptance

Bioenergy development must prioritise social inclusivity and gender responsiveness to ensure its long-term acceptance and success. Policymakers should design interventions that empower women, youth, and marginalised groups by facilitating their active participation in bioenergy value chains. This can be achieved through practical measures such as incorporating gender mainstreaming in all stages of bioenergy planning and project implementation, supporting community ownership models where local users co-manage and benefit from bioenergy systems, and implementing public awareness campaigns to educate citizens about the environmental, economic, and health benefits of modern bioenergy. Additionally, promoting affordable clean cooking solutions and integrating them into national health and social protection programs is essential. By aligning bioenergy development with equity and empowerment goals, Africa can foster a just and inclusive energy transition.

G. Establishing Monitoring, Evaluation, and Sustainability Indicators

Finally, progress toward SDG 7 necessitates the establishment of robust monitoring and evaluation (M&E) systems by governments and regional organisations, which should include standardised indicators to effectively track bioenergy deployment, sustainability outcomes, and socio-economic impacts. For instance, measuring the share of bioenergy within the national renewable energy mix, tracking reductions in greenhouse gas emissions and deforestation rates, monitoring job creation, income generation, and gender participation, as well as evaluating technology performance, maintenance, and user satisfaction, are all critical components of this process. Furthermore, implementing transparent reporting and data-sharing mechanisms will not only strengthen accountability but also enable evidence-based policy adjustments.

V. CONCLUSION

Bioenergy stands at the intersection of Africa's energy access, climate action, and sustainable development ambitions. As this paper has demonstrated, the continent's vast and diverse biomass resources, ranging from agricultural residues and animal waste to forestry by-products and municipal solid waste, present an immense, yet underexploited, opportunity to advance Sustainable Development Goal 7 (SDG 7): ensuring access to affordable, reliable, sustainable, and modern energy for all. Unlike other renewables, bioenergy offers a uniquely versatile and decentralised energy option that can simultaneously deliver electricity, heat, and clean cooking solutions while promoting rural development and environmental stewardship.

However, realising bioenergy's full potential in Africa requires a paradigm shift from the current reliance on inefficient traditional biomass toward modern, sustainable bioenergy systems. This transformation calls for robust policy frameworks, inclusive governance, and strategic investments that integrate bioenergy into national and regional energy transitions. Strengthening institutional coordination, establishing sustainability standards, and mainstreaming bioenergy within national energy and climate strategies are critical first steps. At the same time, building local technological capacity, supporting innovation, and developing sustainable feedstock supply chains will ensure that bioenergy expansion contributes positively to livelihoods, biodiversity, and food security.

Financing remains a major constraint, but innovative approaches – such as green investment funds, carbon markets, and public-private partnerships – offer pathways for mobilising the needed capital. Equally important is community participation and gender inclusivity, ensuring that bioenergy projects are socially equitable and locally owned. Regional collaboration through organisations such as ECOWAS, SADC, and the African Union can accelerate policy harmonisation, technology transfer, and cross-border trade in sustainable bioenergy products.

Looking ahead, bioenergy's contribution to SDG 7 extends beyond the energy sector. It supports SDG 2 (Zero Hunger) through biofertilizer production and sustainable agriculture, SDG 8 (Decent Work and Economic Growth) by creating rural employment, and SDG 13 (Climate Action) through emission reductions and carbon sequestration. In this way, bioenergy can serve as a cornerstone of Africa's green and inclusive energy future.

In conclusion, the transition to sustainable bioenergy is not only an environmental necessity but also a development imperative. With coherent policies, regional cooperation, and the active participation of governments, private actors, and communities, Africa can harness bioenergy to close its energy access gap, enhance energy security, and contribute to global climate goals.

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REFERENCES

[1] United Nations, "The Sustainable Development Goals Report 2024," 2024. [Online]. Available: https://unstats.un.org/sdgs/report/2024/The-Sustainable-Development-Goals-Report-2024.pdf

[2] United Nations, "Transforming our World: The 2030 Agenda for Sustainable Development," UN, 2015. Accessed: Nov. 05, 2025. [Online]. Available: https://sustainabledevelopment.un.org/post2015/transformingourworld/publication

[3] W. R. I. WRI, "4 Charts Explain Greenhouse Gas Emissions by Sector | World Resources Institute." Accessed: Nov. 05, 2025. [Online]. Available: https://www.wri.org/insights/4-charts-explain-greenhouse-gas-emissions-countries-and-sectors

[4] M. Crippa *et al.*, "GHG emissions of all world countries - 2025 Report," Publications Office of the European Union, Luxembourg, JRC143227, 2025. [Online]. Available: https://op.europa.eu/en/publication-detail/-/publication/09f00a92-8df7-11f0-bfe2-01aa75ed71a1/language-en

[5] IEA, "Global Energy Review 2025 – Analysis," Paris, Mar. 2025. Accessed: Nov. 05, 2025. [Online]. Available: https://www.iea.org/reports/global-energy-review-2025

[6] IEA, "World Energy Investment 2025," Paris, 2025. [Online]. Available: https://www.iea.org/reports/world-energy-investment-2025

[7] IEA, "Universal Access to Clean Cooking in Africa," Paris, July 2025. Accessed: Nov. 05, 2025. [Online]. Available: https://www.iea.org/reports/universal-access-to-clean-cooking-in-africa

[8] S. Barot, "Biomass and bioenergy: resources, conversion and application," *Renewable Energy for Sustainable Growth Assessment*, pp. 243–262, 2022. https://doi.org/10.1002/9781119785460.ch9

[9] S. O. Dahunsi, O. O. Fagbiele, and E. O. Yusuf, "Bioenergy technologies adoption in Africa: A review of past and current status," *Journal of Cleaner Production*, vol. 264, p. 121683, Aug. 2020, doi: 10.1016/j.jclepro.2020.121683.

[10] A. E. C. AFREC, "Key Africa Energy Statistics," AU, 2024. [Online]. Available: https://au-afrec.org/sites/default/files/2025-02/Digital%20KEY%20AFRICA%20ENERGY%20STATISTICS%20EN%20A5%20.pdf

[11] IEA, IRENA, UNSD, World Bank, and WHO, "Tracking SDG 7: The Energy Progress Report.," Washington, D.C., 2024. [Online]. Available: https://www.seforall.org/system/files/2024-06/Tracking%20SDG7%20-%20final%20report.pdf

[12] SADC, "SADC Renewable Energy and Energy Efficiency Strategy and Action Plan," 2016.

[13] IRENA, "Sugarcane bioenergy in Southern Africa Economic potential for sustainable scale-up," Abu Dhabi, Mar. 2019. Accessed: Nov. 05, 2025. [Online]. Available: https://www.irena.org/publications/2019/Mar/Sugarcane-bioenergy-in-Southern-Africa-Economic-potential-for-sustainable-scale-up

[14] African Union, "African Bioenergy Policy Framework and Guidelines," Addis Ababa, 2013. [Online]. Available: https://au.int/sites/default/files/documents/32183-doc-africa_bioenergy_policy-e.pdf

[15] C. Uzoagba *et al.*, "Bioenergy potential assessment of crop residue biomass resources in africa towards circular economy," *Cureus Journals*, vol. 1, no. 1, 2024. https://doi.org/10.7759/1

[16] Government of Ghana, "Renewable Energy ACT 832." 2011. [Online]. Available: https://www.purc.com.gh/attachment/631538-20201207031245.pdf

[17] Ministry of Energy, "Bioenergy Strategy, Kenya," 202 AD. [Online]. Available: https://www.energy.go.ke/sites/default/files/KAWI/Other%20Downloads/Bioenergy-strategy-final-16112020sm.pdf

[18] SNV, "National Biogas Programme of Ethiopia (NBPE)," Addis Ababa, 2015. [Online]. Available:

https://assets.fsnforum.fao.org/public/contributions/2024/REPORT%20SNV%20Getaneh%20FINAL%205%20Seleshi-SAROJ.pdf

[19] Department of Mineral Resources and Energy, "Integrated Resource Plan," 2023. [Online]. Available: https://www.gov.za/sites/default/files/gcis_document/202401/49974gon4238.pdf

[20] E. Okogba, "Lagos waste-to-electricity project gets €120m Dutch support - Commissioner," Vanguard News. Accessed: Nov. 05, 2025. [Online]. Available: https://www.vanguardngr.com/2024/10/lagos-waste-to-electricity-project-gets-e120m-dutch-support-commissioner/

[21] African Union, "Bioenergy Development Strategy and Investment Plan for The West African Region," Addis Ababa, 2020.

[22] A. D. B. AfDB, "Human Development," African Development Bank Group. Accessed: Nov. 05, 2025. [Online]. Available: https://www.afdb.org/en/knowledge/publications/tracking-africa%E2%80%99s-progress-in-figures/human-development

[23] UNFCCC, "Ghana Updated Nationally Determined Contribution under the Paris Agreement (2020 - 2030)," 2021. [Online]. Available: https://unfccc.int/sites/default/files/NDC/2022-06/Ghana%27s%20Updated%20Nationally%20Determined%20Contribution%20to%20the%20UNFCCC_2021.pdf

[24] A. Adu-Poku *et al.*, "Assessment of aboveground, belowground, and total biomass carbon storage potential of *Bambusa vulgaris* in a tropical moist forest in Ghana, West Africa," *Renew. Energy Environ. Sustain.*, vol. 8, p. 3, 2023, doi: 10.1051/rees/2023001.
https://doi.org/10.1051/rees/2023001

[25] G. W. Sileshi, "A critical review of forest biomass estimation models, common mistakes and corrective measures," *Forest Ecology and Management*, vol. 329, pp. 237–254, Oct. 2014, doi: 10.1016/j.foreco.2014.06.026.

[26] Ministry of Energy, "National Energy Transition Framework." [Online]. Available: https://www.energymin.gov.gh/sites/default/files/2023-09/FINAL%20GHANA%27S%20NATIONAL%20ENERGY%20TRANSITION%20FRAMEWORK_2023_compressed%20%281%29_compressed%20%282%29.pdf

[27] SEforALL, "Ghana Energy Transtion and Investment Plan." [Online]. Available: https://www.seforall.org/our-work/initiatives-projects/energy-transition-plans/ghana