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Africa's Transition from Fossil Fuels to Renewable Energy Toward the Circular Economy

Tu Ngoc Bui
Institute for South Asian, West Asian, and African Studies, Viet Nam
buingoctuttct@gmail.com

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Abstract

The term "circular economy" has gained popularity over the past decade, particularly in sustainability, resource management, and productivity. Increasingly, both public and private organizations are exploring its application in daily operations. This article reviews the literature on Africa's energy transition and whether it can be guided by circular economy principles. The study finds that Africa's energy demand will rise significantly due to industrialization and population growth. While Sub-Saharan Africa relies mainly on renewable energy, countries like Algeria, Nigeria, Morocco, South Africa, and Egypt still depend heavily on fossil fuels. Researchers suggest that a circular economy approach could promote renewable energy adoption. However, more research is needed to explore the potential of circular principles in supporting the energy transition.

Keywords: Energy Transition, Circular Economy, Renewable Energy, AfDB, Big Five Economies

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INTRODUCTION

According to the Paris Agreement (2016), governments were urged to create concrete plans to combat climate change. The UN set a global target to reduce greenhouse gas emissions by 45% in the next 10 years and achieve net-zero emissions by 2050. Rising emissions have caused severe global consequences, including sea-level rise, deforestation, heatwaves, and droughts. Solutions focus on six areas: renewable energy, sustainable infrastructure, resilient cities, sustainable agriculture, climate adaptation, and integrating public-private finance into a net-zero economy. Climate change is a key driver for the shift from fossil fuels to renewable energy. The energy transition refers to the gradual replacement of fossil-fuel-dependent systems with clean energy from renewable sources. Algeria, Nigeria, Morocco, South Africa, and Egypt, known as Africa's Big Five, are the largest consumers of fossil fuels for energy production. This paper aims to explore Africa's energy transition in relation to the circular economy, discussing whether a circular approach can be applied. The circular economy emphasizes reuse, refurbishing, and clean energy production while keeping resources in use as long as possible.

However, scientific literature on both circular economy and energy transition is limited. Chen & Kim (2019) found that while both concepts are 21st-century ideas, their relationship is underexplored. The paper also investigates the Big Five's transition from fossil fuels to renewable energy. The African Development Bank (AfDB) is a multilateral financial institution established in 1964 to promote economic and social development in Africa by improving living conditions and reducing poverty through public and private sector projects. As of 2018, the AfDB has 80 member countries: 54 African nations and 26 non-African countries from Europe, Asia, and the Americas. The bank funds projects in areas such as infrastructure, agriculture, health, education, public utilities, environment, climate change, gender, telecommunications, industry, and the private sector. These projects align with the AfDB's five key priorities: integrating Africa, industrializing Africa, feeding Africa, powering and lighting Africa, and improving the quality of life for African people.

Energy is the lifeblood of economic development, powering homes, services, transport, and industries (Than et al., 2022). However, growing concerns over fossil fuels' negative impact on the climate are driving efforts toward decarbonization through energy transition. In 2018, the Intergovernmental Panel on Climate Change (IPCC) declared that

the global energy transition must occur within 12 years. Over 190 nations, part of the UN Framework Convention on Climate Change (UNFCCC), have pledged to reduce carbon emissions. Africa contributes only 2-4% of global CO2 emissions but is disproportionately affected by extreme weather. Despite its low emissions, Africa's economy, the second largest after Asia, is growing rapidly. GDP is expected to rise from 3.8% (2020) to 4.2% (2024) due to urbanization, population growth, and industrialization. East Africa is the fastest-growing region, with North Africa contributing 37% of Africa's total GDP. More than 17 African countries have a real GDP growth rate exceeding 5%. Countries like Burkina Faso, Rwanda, and Ethiopia are among the fastest-growing economies globally. Meanwhile, the African population is expected to contribute half of the global population growth by 2050, increasing energy demand alongside urbanization and posing challenges for clean, affordable energy access.

Fossil fuels account for nearly 40% of Sub-Saharan Africa's energy mix, with coal at 13% and natural gas at 16%. Coal is mainly used in South Africa and parts of Mozambique, while natural gas is common in North and West Africa, notably in Algeria, Egypt, Nigeria, and East African nations like Kenya and Tanzania. Major oil producers include Angola and Nigeria. Renewable energy sources like solar, wind, and hydropower are increasingly meeting energy demands in regions such as North and East Africa, with large-scale solar and wind projects gaining traction through AfDB and Independent Power Producers (IPPs).

Globally, renewable energy has increasingly contributed to electricity generation over the past decade. By 2017, renewables accounted for 60% of new global installed capacity. The falling costs of solar and wind technologies have led many countries to shift subsidies from fossil fuels to clean energy. Hydropower, natural gas, biomass, and wind are expected to dominate additional capacity by 2030. However, over 75% of the population in 13 countries, particularly in Central Africa, remains without electricity. In West and East Africa, countries like Senegal, Kenya, and Ethiopia have made significant progress, increasing renewable energy access from 40% to 60% in some regions. Despite these advancements, Central Africa still faces major energy access challenges due to geopolitical issues and infrastructure limitations (Amir & Khan, 2022).

Transitioning from fossil fuels to renewable energy is complex, with fossil fuels comprising 70-80% of the global energy supply. Countries like the U.S., China, and India

rely heavily on coal and oil, while only a few African nations, such as the Big Five, depend significantly on fossil fuels. Challenges include high upfront costs for renewable infrastructure, underdeveloped grids, and scattered populations. Political and economic barriers also hinder progress, as seen in Nigeria's slow adoption of renewables. Utility companies play a vital role in electrification but face financial losses and inefficient management, leaving 600 million Africans without access to electricity. There is growing demand to reform African utilities, ensuring decarbonization and universal electricity access by 2030 (Hafner et al., 2018).

There are several options to enhance the energy transition. First, phasing out fossil fuel subsidies and implementing carbon taxes can curb emissions, with over 70 global economies already applying such taxes. South Africa is the only African country with a carbon tax, while Côte d'Ivoire is in the process of implementation. Second, innovative financing for energy efficiency is crucial for the transition. Third, systematically phasing out coal plants through carbon taxes, as seen in China and Italy, can be a sensitive approach to addressing job losses and union concerns. Lastly, improving electricity access and clean energy adoption through community-driven entrepreneurship holds significant socio-economic potential. However, peer-reviewed research on Africa's energy transition remains limited, with most studies focusing on the U.S., EU, and Asia.

It is crucial to view circular economy principles as key enablers for achieving the Sustainable Development Goals (SDGs) (Tran et al., 2022). These principles serve as tools to support decision-makers and industry advocates. The energy transition can be accelerated through a circular economy approach by optimizing resource use and achieving maximum efficiency in an economically and environmentally sustainable way, as demonstrated in biological cycles. In the energy sector, this approach involves "designs, processes, and solutions that maximize the efficient use of natural resources for energy production, final energy use, surplus energy, and byproduct flows." One key aspect of the circular economy is increasing resource efficiency (Tran et al., 2022). However, despite this concept not being new, its potential impact on reducing natural resource consumption is sometimes diminished or erased by the rebound effect, known as Jevon's Paradox, where increased efficiency lowers raw material costs but raises demand.

RESULTS AND DISCUSSION

Many multinational and regional financial institutions recognize the need for greater climate awareness and energy efficiency. Their response has been to reduce funding for coal projects in an economically, socially, and environmentally responsible way. In Africa, AfDB's mission is to contribute to socio-economic development by providing financial tools to support renewable energy and combat climate change. Current data shows that 40% of Africa's energy supply is from fossil fuels. This study examines Africa's energy transition concerning the circular economy and explores whether circular economy principles could foster energy transformation. The paper demonstrates how circular economy models can optimize renewable energy generation and efficiency. While numerous studies address circular economy principles, few focus on energy transition, particularly in Africa. Although there are brief mentions of Africa in studies by Allam, Jones, Aliyu, and Voulvoulis, detailed links between circularity, energy, and transition are rare. This gap highlights an opportunity for future research to integrate circular economy models into Africa's energy transition strategy. Finally, policies and legal frameworks tailored to individual countries are essential for implementing circular approaches in alignment with socio-economic and environmental goals.

The previous section revealed that the energy transition could accelerate by applying circular economy principles. Although no widely accepted definition of the circular economy exists, many studies explore its concepts and discuss how various business models can be integrated. A total of 25 peer-reviewed journals and five AfDB reports were systematically reviewed and analyzed. Of the 25 journals, only 11 specifically addressed renewable energy, energy transition, and Africa. All of these discussed renewable energy's importance in the context of sustainable development. Eight out of 11 (72.7%) analyzed energy transition in countries like Azerbaijan, Nigeria, Kazakhstan, South Korea, and Russia. The primary theme was the need to increase renewable energy use and the positive impacts and challenges of the transition. Akuru et al. (2017)and Gielen et al. (2019) examined energy transition in Africa, highlighting its importance for national development and the role of individuals in driving the transition rather than solely relying on governments. Energy efficiency, tax incentives, and technological innovation were also discussed as facilitators of the transition. While the review explored renewable energy use in Africa, specific examples of how and where the transition occurs in the Big Five countries were absent.

The World Energy Outlook (2020) reports that countries like Kenya, Ethiopia, Senegal, and Rwanda have high renewable energy usage due to their cleaner energy sources compared to fossil fuels. The Big Five countries, however, continue to rely heavily on oil, natural gas, and coal. Economic growth in these nations has been strong and is expected to continue. Algeria and Nigeria both saw a GDP growth rate of 2.3%, while Egypt led with a 5.6% growth in 2019, projected to reach 5.8% in 2020. Morocco's growth is expected to rise from 2.9% in 2019 to 3.7% in 2020, while South Africa, with the lowest growth rate of 0.7%, is projected to increase to 1.1% in 2020 (Rotimi, 2021). Key industries, such as agro-processing, transportation, oil and gas, telecommunications, and mining, are set to drive this growth, all of which require sustainable energy supplies. The transition to renewable energy is expected to be slow and challenging due to political and socio-economic factors, including intentional or unintentional policies, a detailed energy mix, and strong stakeholder involvement to prevent job loss. Researchers have summarized key insights from eight of the 11 drafts, outlining energy transition considerations in the graphic below.

Three key drivers of energy transition should be considered not only by the governments of the Big Five but also by AfDB and other decision-makers, such as large and small enterprises, industry associations, civil society, and academia. First, governments need to guide or develop more flexible national energy frameworks that promote energy efficiency, encourage renewable energy technology adoption, and phase out fossil fuel plants. These frameworks should detail not only the desired capacity but also how to achieve it. Innovative financial tools, tax incentives, and subsidies can be offered to renewable energy providers, while carbon taxes can penalize fossil fuel-based producers. Including stakeholders directly or indirectly impacted by the transition is crucial. As seen in some developed countries, a "just transition" is vital for socio-economic sustainability. Two essential elements aligned with a just transition are technical and economic drivers, requiring the selection of scalable and efficient renewable technologies that benefit consumers. Large and small businesses, regional agencies, and governments can drive technological advancements and other opportunities to support a fair transition. Stakeholder engagement and partnerships are areas that require further research and exploration.

CONCLUSION

The AfDB plays a critical role in supporting the continent's energy development through financial mechanisms and technical assistance for governments. Its decision to stop funding coal power plants from 2020 onwards marks a significant step towards promoting the transition to renewable energy. However, considering that some of Africa's largest economies still rely heavily on fossil fuels for industrialization and economic growth, this transition must not undermine their development prospects, as fossil fuels are expected to remain dominant in global economies and industries. This study has two objectives: (1) to provide insights into Africa's energy transition concerning the circular economy and (2) to explore the Big Five's shift from fossil fuels to renewables and assess whether this transition can be guided by circular economy principles. The research examines whether the circular approach could be integrated into the energy transition based on existing literature. It concludes that Africa's largest economies will likely continue to grow between 2030 and 2050, and given the climate commitments to achieving net-zero emissions, both scientific and industrial literature emphasize the need for renewable energy adoption. While global energy transition literature is more accessible, the African context is underrepresented. Energy is a key driver of economic development, and Africa must transition to renewables soon to meet rising energy demands across various sectors. Circular economy principles and models provide a feasible approach, and from 2009 to 2019, there has been increasing literature discussing this concept. Many authors have shown how circular principles can promote renewable energy adoption, but limited data on this interdisciplinary approach exists for Africa. AfDB is well-positioned to be a key player in accelerating the energy transition, especially across the Big Five economies (Algeria, Nigeria, Egypt, Morocco, and South Africa), in a more resource-efficient manner. Finally, there is great potential for researchers to further explore circularity and energy transition within the African context, including existing energy transition projects, integrating circularity into energy strategies and policies, defining stakeholder roles, and developing small grid technologies for circularity in remote settlements. These research outcomes promote innovation and encourage breakthroughs.

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