Social Entrepreneurship Review
2024, Vol. 1

10.15678/SER.2024.1.05

Decarbonization Efforts in Africa: Successes, Opportunities, and Challenges for Promoting the use of Renewable Energy by Social Economy

Joseph Mamman Ibbih, Samson Nyako Nicodemus

Abstract: **Background:** Africa contributes minimally to global warming, yet remains disproportionately vulnerable to the adverse impacts of climate change. African governments and policymakers have devised strategies aimed at mitigating climate change effects and promoting renewable energy adoption, decarbonization, and sustainable development pathways.

Research objectives: This article explores the intersection of decarbonization and the social economy sector in Africa, vis-a-vis renewable energy utilization. It examines the challenges and opportunities associated with integrating decarbonization efforts within social economy frameworks on the continent.

Research design and methods: The study employs narrative methodology cum content analysis to investigate the dynamics of decarbonization. It assesses the existing initiatives, policies, and challenges related to renewable energy adoption and decarbonization strategies.

Results: The findings indicate that while there is a growing recognition of the importance of decarbonization and renewable energy in Africa's social economy sector, challenges such as limited access to technology, funding, and infrastructure persist.

Conclusions: Addressing these obstacles is crucial for advancing decarbonization and climate change mitigation efforts across the continent.

Keywords: climate change, decarbonization, renewable energy, social economy, Africa
JEL Codes: Q42; Q52; Q54; O55; Z13

Suggested citation:
Ibbih, J. M., & Nicodemus, S. N. (2024). Decarbonization Efforts in Africa: Successes, Opportunities, and Challenges for Promoting the use of Renewable Energy by Social Economy. *Social Entrepreneurship Review*, *1*, 83–107, https://doi.org/10.15678/SER.2024.1.05

Introduction

The effect of climate change due to global warming is getting serious attention of governments and policymakers across the globe. While much focus has been placed on the largest carbon emitting economies such as China and the United States, Africa is also one of the continents to be considered because of its vulnerability to the effect of climate change. The largest carbon emission from Africa is about 4% when compared to the rest of the World (AJLabs, 2023), which can be traced to wrong agricultural practices such as deforestation for fuel wood and charcoal production, as well as carbon emission from fossil fuel – hence the call to decarbonization through the use of renewable energy for heating, cooking, transportation, and manufacturing. African countries have been implementing sustainable strategies for total dependence on renewable energy and hope to make substantial progress and impact by 2035. This is not proving easy, but efforts are being undertaken to ensure success. Governments and social economy organizations such as cooperatives, mutual associations, foundations, and social enterprises have a critical role to play in decarbonizing the continent. Although there are no significant activities relating to the decarbonization agenda by social enterprises and economy in Africa, the campaign to reduce the use of fossil fuels has been championed by the social economy. In this regard, it is worth mentioning that most developing nations have neither the capacity nor the means to adopt relevant policies that can enable them to control their annual discharges of carbon dioxide () and embark on pathways relevant for achieving the Paris Agreement objectives or sustainable development goals (SDG). First, regarding low capacity, the developing countries have conventionally exhibited rigidity against phasing out fossil fuel dependency, whereby one can state that these underdeveloped economies are yet to build ample capacities in cleaning their energy portfolios (Sharma et al., 2021). Second, due to limited options for choosing alternative low-carbon fuels, the clean energy transition mechanism in these countries often becomes delayed.

According to the United Nations Development Programme (UNDP, 2020), the intent of decarbonization is to reduce the impact of human activity on our planet's climate in order to slow down global warming. The 2015 Paris Agreement set the goal of limiting global warming to well below two degrees, preferably to 1.5 degrees Celsius, compared to preindustrial levels. In order to do this, countries, cities, regions, companies, and individuals all need to work ambitiously toward achieving carbon neutrality by 2050. The health of the planet depends on government policy, technology, innovation, and widespread public support working together to create a pro-climate culture, lower the cost of non-carbon energy, and accelerate the decarbonization efforts to meet climate goals. According to the experts at a side event held at the 8th Tokyo International Conference on African Development (TICAD, 2023), as the world moves toward greater decarbonization, it is also imperative that Africa's ongoing challenges regarding access to energy be addressed for the continent to achieve a fair and just transition to clean energy. According to UNDP, out of 2.6 billion people that still lack access to safe, clean fuels and technologies for cooking or heating their homes globally, over 75% live in sub-Saharan Africa (SSA). Moreover, to compound the already fragile situation, African countries have to contend with rising energy and food prices precipitated by the protracted recovery from the COVID-19 pandemic and the impact of the ongoing war in Ukraine (UNDP, 2020).

To confront these multifaceted threats, UNDP has urged an acceleration toward a just energy transition for the continent to counter the negative impact of climate change on livelihoods and open up new opportunities to create jobs. Stressing the significance of decarbonization and the transition from fossil fuels to renewable energy sources (RES), Africa and the global community need to focus on short-term solutions for clean energy accessibility as well as long-term solutions that will lead to sustainability. This campaign, however, is not limited to governments and policymakers; it also extends to social enterprises, which should promote the use of renewable energy. The main objective of the article is to discuss these efforts, showing their successes and challenges in promoting the use of renewable energy in Africa.

Following this introductory section, the article contains seven sections. The first two discuss the methodology, the global concept of decarbonization, Africa's decarbonization capacity, and the reasons why less developed countries (LDC) need to chart a path to decarbonization. The next two sections elaborate on renewable energy in Africa and describe the environmental, social, and techno-economic impacts of hybrid renewable energy systems. Finally, the last three sections look into social economy, decarbonization, and climate mitigation; they also present the successes, opportunities, and challenges of the efforts regarding social economy and decarbonization in Africa, and offer a brief conclusion.

Literature Review

The Global Concept of Decarbonization

Decarbonization is crucial for the global race toward net zero carbon emission as outlined in the Paris Agreement. Current action is not enough, with the global average atmospheric hitting a new height in 2022. The world continues to produce carbon much faster than nature can absorb it, which results in the greenhouse effect rapidly warming the earth. Decarbonization can be viewed as the process of reducing or eliminating carbon emissions. In this case, we refer to decarbonization when talking about the efforts to lower carbon emissions on a global scale. It can also be seen as the reduction of emissions through the use of low-carbon power sources, decreasing the output of greenhouse gases (GHG) into the atmosphere. Decarbonization typically refers to the process of reducing carbon intensity, thus lowering the amount of GHG emissions produced by the burning of fossil fuels. Generally, this involves decreasing output per unit of electricity generated. Reducing the amount of produced by transport and power generation is essential to meet the global temperature standards set by the Paris Agreement and the United Kingdom (UK) government (Nkatha, 2023).

United Nations (2023) assert that a critical additional consideration for LDC is the impact of accelerated decarbonization and renewable energy deployment, competing for land in the context of rapid population growth, rising internally displaced populations, deteriorating food security, and the potential for climate-induced conflicts. Decarbonization today is commonly associated with high-profile commitments from large corporations and is usually followed by reports on progress toward those commitments, including the corporations' pledges. However, it is a long way ahead until many of these promises are realized.

According to Kimani (2022), decarbonization involves increasing the prominence of low-carbon power generation and a corresponding reduction in the use of fossil fuels. This includes RES like wind power, solar power, and biomass. Carbon power can also be reduced through large-scale use of electric vehicles alongside cleaner technologies. Decreasing the carbon intensity in the power and transport sectors will allow for net zero emission targets to be met sooner and in line with government standards. Decarbonization also means cutting back carbon emissions. It entails transitioning into economic models that minimize or compensate for the emitted into the atmosphere alongside other GHG like nitrous oxide (N_2O) and methane (CH_4). The Paris Agreement on Climate Change breaks up with most international treaties in focusing primarily on national ambitions to be achieved through national institutions (Falkner, 2016). Emerging powers, including South Africa, have been at the center of this shift from top-down to bottom-up approaches, insisting that their national development ambitions must shape any international commitments to GHG emission mitigation (Nelson, 2016).

According to the World Bank (2018), estimates for renewable energy held a share of merely 22.02% in the final energy consumption profile of developing (i.e., low- and middle-income) countries combined, which is around eight percentage points lower compared to the level in 2000. Hence, it is quite evident that instead of reducing the use of fossil fuels, the developing countries have rather become even more reliant on them. The failure to phase out fossil fuel dependency and make a clean energy transition has not only hampered economic and environmental conditions, but also triggered social adversities in the forms of poor human health, lack of new job creation which could have resulted from the development of the clean energy sector, and so on.

Global leaders have agreed to stabilize climate change at about 2°C above preindustrial temperatures; to reach this target, global carbon emissions should be reduced to zero before 2100. Even if the target were higher than 2°C, carbon neutrality would still be needed to stabilize the climate. As long as we emit more than we capture or offset through carbon sinks such as forests, concentrations of in the atmosphere will keep rising, and the climate will keep warming. There are also other reasons to bring emissions to zero, which include other environmental problems unrelated to climate change, such as local air pollution and ocean acidification. With the scientific consensus suggesting we need to reach zero net emissions before 2100, the key question is what policymakers should do to get there. How can we achieve net zero emissions? The latest report of the Intergovernmental Panel on Climate Change (IPCC) identifies many technically feasible pathways to reach carbon neutrality by the end of the century, based on the consensus of 830 scientists, engineers, and economists from over 80 countries, formally endorsed by the governments of 194 countries (Fay et al., 2015).

According to Fay et al. (2015), those pathways rely on four pillars:

– **Pillar 1:** Decreasing carbon intensity of global electricity production to near zero around 2050 is at the core of the decarbonization transition. This objective implies that both high-income countries and emerging economies – such as China, India, and South Africa – would have to decarbonize electricity around mid-century. Low-income countries, which represent a small share of global electricity consumption, would have a few more decades, but they too would eventually need to converge to zero-emissions electricity.
– **Pillar 2:** Switching from fossil fuel to low-carbon electricity will drastically reduce GHG emissions in energy-intensive sectors, such as transportation, building, and industry. Technologies such as electric and plug-in hybrid vehicles, electric stoves, and heat pumps, and electric furnaces are more energy efficient than fossil-fueled alternatives and will reduce carbon emissions when powered by clean electricity.
– **Pillar 3:** Boosting energy efficiency can reduce emissions, make electrification easier, and save on energy bills. This has high potential for the building, transport, and industry sectors. In agriculture and forestry, efficiency entails minimizing the loss and waste of food, increasing the supply of less emission-intensive products – including biofuels and wood materials – and changing food demand to shift consumption toward low-carbon food products and to free land for other mitigation activities.
– **Pillar 4:** Managing landscapes better will help countries increase their ability to act as net carbon sinks. Models reviewed by the IPCC show that the agriculture and forestry sector will likely need to achieve carbon neutrality by 2030 if the 2oC target is to be reached. Mitigation policies can reduce emissions from land management and land use conversion, and increase the removal of carbon from the atmosphere. Stabilizing the climate requires bringing net emissions of long-lived GHG to zero. This means that specific positive emissions can be offset by negative emissions elsewhere: from improved natural carbon sinks, through reforestation or better soil management, to combining bioenergy – that is, renewable energy derived from biomass, such as wood, crops, or crop residues – with carbon capture and storage (CCS). Countries can therefore proceed at different speeds across the four pillars, but stabilizing the climate requires significant progress in all the pillars (Fay et al., 2015).

Timing is key and significant as technologies evolve, improve, become more affordable, and open up new options. But if all actors choose to wait, those technologies will not be invented, and they certainly will neither improve nor become more affordable. In the face of development pressure, especially in rapidly urbanizing countries, waiting for technological improvements is not always an option. Developing countries, which still need to build much infrastructure, should take the opportunity to plan ahead to grow and develop with their carbon footprint in mind. Action should focus on what provides co-benefits and synergies with development, but also on what is most urgent. Some choices may be irreversible, such as unplanned low-density urban expansion or the cutting down of old-growth forests. Certain abatement actions will take time to realize their benefits; examples include building clean transportation infrastructure or developing new technologies. In these cases, measures need to be implemented early in order to reach the end goal of full decarbonization. Considering the case of a low-carbon strategy analysis, when striving to reach a particular goal in 2025, the easiest route is to take marginal actions that are cheap and easy to implement but have a limited potential. By contrast, if this goal is a step toward a more ambitious one in 2030, it requires more ambitious actions such as investments in subways, trains, and waterways, which cost more and take longer to implement. The latter approach would result in the same amount of emission reduction by 2030, but it would keep the door open to deeper decarbonization by 2035 (Fay et al., 2015).

Applied to full decarbonization, the analysis shows the need to look not only at the cheapest emission reductions, but also at more cost-effective options that will be required to reach zero emissions. To avoid lock-ins and regrets in a few decades, developing countries in Africa can use short-term sectoral targets to trigger and monitor progress along the four pillars of decarbonization. Doing so would ensure not only that the appropriate quantity of emission reductions is achieved over the short term, but also that the quality of these abatements is appropriate, which means that they put the African continent on a cost-effective pathway toward decarbonization. For instance, a goal may be to produce 30% of electricity from renewable sources by 2030, drive cars that emit fewer than 80 grams of per kilometer by 2025, or use wood materials from sustainably managed forests instead of steel and cement in a half of new buildings by 2035. A short-term goal expressed as an economy-wide emission target is also useful but cannot replace those sectoral targets, since it could be reached with marginal actions that do not contribute sufficiently to meeting the long-term goal. Sectoral pathways also provide operational guidance for sector plans and make it possible to use existing regulators and institutions to design and implement the measures.

Global inequalities are a distinctive feature of climate change. First, the pattern of GHG emissions is highly unequal across countries, as are the negative externalities on the world climate system. Second, the impacts of climate change are widely different across global regions, with warmer and poorer countries likely to suffer significant income losses, while richer countries in mid-latitude regions may even benefit from rising mean surface temperatures. Such is the extent of this differential impact that a recent study argues that "anthropogenic warming constitutes a substantial international wealth transfer from the poor to the wealthy" (Callahan & Mankin, 2022, 53). Various factors influence renewable energy development, including climate change, global warming, energy security, cost reduction, and emission reduction (Osman et al., 2022).

In a study by Brodny et al. (2021), the authors evaluated the level of renewable energy development in European Union (EU) member states and found that the energy revolution in

Europe is progressing rapidly. The study found that the EU's average gross electricity output from RES increased from 21.18% to 32.11% between 2008 and 2013 and then reached 38.16% in the period from 2013 to 2018. This rapid shift toward renewable energy is expected to lead to the sustainable development of the economy and reduced emissions, in line with the European Green Deal concept. To achieve sustainable development, Tabrizian (2019) examined the role of technological innovation and the spread of renewable energy technologies in underdeveloped nations. The study found that RES are the best and cleanest substitutes for fossil fuels and have a wide range of beneficial environmental consequences, including a significant decrease in GHG emissions, which is crucial given the concerns about climate change. Green buildings may meet the needs of their residents by using RES such as solar, wind, and geothermal energy, while reducing their energy consumption and carbon footprint to zero (Chen et al., 2023). However, technology diffusion in this sector is slow, and renewable energy technologies are only gradually gaining traction in underdeveloped nations. Similarly, Hache (2018) notes that the spread of renewable energies would complicate global energy geopolitics and issues related to energy security. Therefore, the current increase in renewable energy installations must be considered alongside energy security and technological advancement for a smooth transition to renewable energy, which proceeds toward decarbonization. The trend of renewable energy integration is expected to continue growing, with solar and wind power projected to account for 50% of global power generation by 2050 (Gielen et al., 2019). Jacobson (2017) found that 139 of the world's 195 nations have plans to transition to 80% and 100% renewable energy by 2030 and 2050, respectively. Additionally, many countries plan to use only renewable energy by 2050. A study by Zappa, Ceppi and Shepherd (2019) shows that a 100% renewable energy power system would still require a significant flexible yet firm zero-carbon capacity to balance variable wind and photovoltaic generation and cover demand when wind and solar supply is low, even when the wind and photovoltaic capacity is spatially optimized and electricity can be transmitted across a fully integrated European grid. Hydropower, concentrated solar power, geothermal energy, biomass, or seasonal storage are all potential sources of this capacity. These studies indicate that renewable energy will continue to develop, and future integration developments are anticipated.

Integrating renewable energy into the electrical power grid offers several benefits for the energy, social, economic, and environmental sectors. From the environmental perspective, the electricity sector is currently a significant producer of emissions (Bella, Calvi, & D'Amico, 2014). Therefore, electrical grids should be a crucial component of any effort to mitigate the worst effects of climate change and global warming. This is why low-carbon electricity generation that heavily relies on RES is essential to a sustainable energy future as we progress toward deep decarbonization of the power industry (Bogdanov et al., 2021). In this context, renewable energy can significantly support energy security and GHG reduction (Khoie, Ugale, & Benefield, 2019). On this note, the use of fossil fuels and energy imports – the leading causes of emissions in Africa – can also be reduced.

Environmental, Social, and Techno-Economic Impacts of Hybrid Renewable Energy Systems

Fossil fuel consumption is increasing dramatically due to excessive anthropogenic activities and industrial expansion to meet energy demands. The increase in fossil fuel consumption has risen by 96% since 1965 (Caglar et al., 2022), leading to adverse environmental impacts. Fossil fuels negatively impact air quality, the environment, health, and water resources. The gaseous emissions released into the air due to fossil fuel consumption include GHG such as: carbon oxides – carbon monoxide and ; sulfur oxides – sulfur dioxide and sulfur trioxide; nitrogen oxides – nitrous oxide and nitrogen dioxide; and volatile organic compounds and aerosols such as particulate matter. It is reported that about 72.5% of the global equivalent emissions could be released from coal consumption (Sayed et al., 2021), causing the global warming phenomenon. Hence, most countries have faced the pressure to reduce fossil fuel consumption after the Paris Agreement and the United Nations Conference of the Parties (Fawzy et al., 2020).

According to Shouman (2017), energy security is crucial for enhancing the socioeconomic situation of those residing in rural regions. Residents in these areas frequently suffer from power shortages due to their remote locations from the national grid and poverty. Globally, RES such as solar, wind, biomass, and geothermal energy are considered the most effective solution to minimize the social and environmental problems associated with non-renewable energy sources (Osman et al., 2022). The transition to RES creates new jobs and reduces emissions. Predictions state that by the end of 2025, over 100 cities will be powered by 70% renewable electricity globally, and at least 40 cities will be powered entirely by renewable energy (Liu et al., 2020). Since RES produce naturally derived fuel, they can offer a sustainable energy source with minimal operating costs and regular energy supply. Owing to such little amounts of the waste produced, RES have no detrimental influence on the environment. Moreover, renewable energies such as solar, wind, and tidal sources need a minimal amount of water for generating power and thus can participate in saving water resources (Tanaka et al., 2022).

Nevertheless, the unstable availability of RES that depend on the weather conditions, such as wind availability and solar irradiation, is a major limitation. Energy storage systems can partially overcome this gap, but the overall cost and energy conversion efficiency is low (Elkadeem et al., 2019). Thus, hybrid renewable energy systems have been adopted as an alternative and cost-effective technology to address the above-mentioned issues. Hybrid systems integrate two or more RES with or without traditional energy sources (e.g., diesel) and storage. In general, RES and hybrid systems have gained more attention recently due to their continuously reduced costs and rising social, environmental, and techno-economic benefits. Based on the strategy of the International Renewable Energy Agency (IRENA), it is recommended to increase the utilization of RES to 85% by 2050 (Elkadeem et al., 2019; Wang & Zhang, 2022).

Following the prioritization of decarbonization outlined in the Paris Agreement, the UK government is committed to achieving net zero GHG emissions by 2050. After the Parliament's declaration on climate emergency, the Committee on Climate Change recommended that achieving this net zero was not only feasible, but also necessary and cost-effective. Rapid decarbonization is becoming more necessary as the transport sector electrifies, increasing the demand for electric power. Greater energy efficiency is therefore turning into a priority to meet the emission targets and improve the air quality and global temperature. More energy-efficient and less carbon-intense energy sources are among the most prominent ways decarbonization may be achieved. The global transport system operates primarily on carbon-based fuels such as diesel and petroleum, but a wider use of electric vehicles would improve the contribution of the transport sector to reducing carbon emissions. The commitment of African countries toward decarbonization presents opportunities for overcoming the underlying challenges and make more significant moves. The international community is fundamental in streamlining resources to help navigate the existing challenges, which can help Africa become energy-sufficient.

Africa's Decarbonization Capacity and Efforts

Phasing out fossil fuels is a key aspect of decarbonization that requires global economies to invest heavily in green technologies. The mineral resources needed to manufacture these technologies include cobalt, copper, lithium, manganese, iron, iridium, zinc, and nickel. For instance, minerals like manganese, cobalt, and lithium are used in the production of steel, rechargeable batteries, and lithium-ion batteries, respectively. This puts Africa on the frontline of decarbonization as it possesses plenty of these treasures. For instance, the Democratic Republic of Congo (DRC) holds close to half of the world's cobalt reserves. Kenya is one of the countries that have made significant efforts to achieve 100% decarbonization by 2035. The state has recognized the urgent need to address climate change, which significantly impacts its economy, environment, and livelihoods. In addition, Kenya has introduced incentives to promote electric mobility, such as reducing taxes and import duties on electric vehicles. The government has also launched a nationwide program to install charging stations, making it easier for people to embrace electric vehicles. This initiative will help to reduce GHG emissions from the transportation sector. As of 2021, approximately 86% of Kenya's electricity generation capacity comes from renewable sources. This is primarily due to the country's significant investments in geothermal, hydroelectric, and wind power. Kenya is a global leader in geothermal energy production and has the potential to become one of the world's top wind energy producers. In addition to grid-connected renewable energy, there are significant investments in off-grid renewable energy solutions, such as solar home systems and minigrids, which provide electricity access to rural communities in Kenya. However, despite the efforts in place, challenges still prevent attaining these goals. Kenya's energy demand is rapidly increasing due to population growth and economic development. Meeting this demand for renewable energy requires significant infrastructure and technology investments. This can be challenging for a developing country like Kenya, which has limited resources. Although it is estimated that about 70% of the world's supply of the vital metal comes from southern DRC, large deposits remain untapped. It is speculated that the DRC's untapped mineral deposits could be worth more than USD 24 trillion (Carter, 2023). Similarly, Zimbabwe is among the top five global lithium suppliers, while Gabon and South Africa account for 40% of the world's manganese reserves. Presently, resource extraction in Africa is marred by poverty, violence, state corruption, banditry, and environmental degradation (Nkatha, 2023). This is often the outcome because these natural treasures are controlled by foreign powers rather than African states. In the end, only these advanced economies and the continent's elites benefit from them. For example, Nigeria has large deposits of natural and solid minerals scattered all over the country, but they remain untapped, underused, or mismanaged due to endemic corruption and insecurity in the system.

According to UNDP (2023), as the world moves toward greater decarbonization, it is also imperative that Africa's ongoing challenges regarding access to energy be addressed for the continent to achieve a fair and just transition to clean energy (UNDP, 2023). The experts further assert that out of 2.6 billion people that still lack access to safe, clean fuels and technologies for cooking or heating their homes globally, over 75% live in SSA. Moreover, to compound the already fragile situation, African countries have to contend with rising energy and food prices precipitated by the protracted recovery from the COVID-19 pandemic and the impact of the ongoing war in Ukraine and Gaza (UNDP, 2023).

To confront these multifaceted threats, UNDP has urged an acceleration toward a just energy transition for the continent to counter the negative impact of climate change on livelihoods and open up new opportunities to create jobs. Stressing the significance of decarbonization and the transition from fossil fuels to RES, Africa and the global community has been urged to focus on short-term solutions to clean energy accessibility as well as long-term solutions that will lead to sustainability. In line with the new UN-Energy Plan of Action Towards 2025 to catalyze large-scale action and support for the transition to clean affordable energy for all, UNDP is working with partners to support an additional 500 million people around the world to gain access to clean energy over the next four years. Through its Africa Minigrids Programme – its largest-ever energy access project – UNDP is cooperating with UN agencies in the Sahel to expand access to clean, affordable energy to drive socioeconomic development and improve the financial viability of renewable energy minigrids in 18 countries, including Tunisia, where UNDP and the government are developing a program to transform the waste treatment sector into a source of biogas (UNDP, 2023).

The World Bank's analysis shows that Africa tops other regions across the world with excellent conditions for solar power. Still, large portions of the continent's energy supplies are imported from abroad, and many of them are based on fossil fuels. Further, the transition to renewable energy requires significant investments, which can challenge developing countries in Africa – such as Nigeria, Ghana, Kenya, South Africa, Malawi, Tanzania, Botswana, Cameroon, or the Ivory Coast. Many African countries need more technical expertise, financial resources, and political will to invest in RES. To minimize carbon emissions effectively, it is important to know their sources. Energy use is responsible for the highest amount of GHG emissions. The remaining emissions are shared between land use, agriculture, industry, and waste. Despite Africa's low carbon footprint, the continent's emissions have been on the rise over the years. For example, between 2000 and 2018, emissions from land use rose by 20%. In 2018, the agricultural sector emitted 2.2 Gt -eq, which accounted for 24% of global emissions, an increase from the 18% emitted in 2000 (World Bank, 2018). To keep the emissions from rising further, Africa needs to take the initiative and begin decarbonizing as early as now. Fortunately, the continent's low carbon footprint, natural treasure endowment, and substantial renewable energy potential provide a clear pathway to execute the decarbonization agenda. The policy interventions that are necessary for Africa in achieving the decarbonization agenda include the following factors:

- African governments must invest in the national capacity to produce high-quality human resources and institutions. Countries that have the ability and capacity to navigate the changing technological and regulatory environment are well-positioned to spur greater investment and develop local content policies that match their capabilities and aspirations.
- Africa needs a regional industrial policy coordination. A single country cannot hope to industrialize without stronger regional synergies. As such, building cross-border, regional value chains can offer a pragmatic framework to boost collaboration and attract investment in downstream activities. This would involve trade and cooperation between countries based on their comparative advantage, such that some countries provide key mineral inputs, while others ensure manufacturing technologies.
- Africa must develop justice-oriented national industrial policy. The renewable energy sector offers a system-wide opportunity for industrialization. However, this needs to embrace equal opportunities and an equitable distribution of the benefits of industrialization to all stakeholders. At the heart of this is a governance framework that engages all stakeholders including governments, mining companies, shareholders, investors, and affected commu-

nities in a constructive dialogue to shape the direction and character of the industrialization pathway.

Decarbonization efforts need to come from various stakeholders – from large corporations through governments to individual citizens – if Africa expects to make an impact sufficient to limit the most catastrophic effects of climate change.

Accelerating Energy Transitions Across Africa

The global shift from a fossil fuel-based to electricity-based society is commonly viewed as an ecological improvement. However, the electricity industry is a major source of emissions, and incorporating renewable energy can still negatively impact the environment. Despite the growing research on renewable energy, we still have poor knowledge about the impact of renewable energy consumption (RENC) on the environment. Technology developments, decreasing costs of renewable energies, innovative approaches, network effects, and digitalization are opening new opportunities and making an indisputable business case for renewables. With abundant indigenous resources, Africa is well-positioned to leverage this potential. However, the potential and availability of cost-effective technologies alone are insufficient. Seizing this opportunity will require strong political will, attractive investment frameworks, and a holistic policy approach to fully reap the benefits of renewable energy. It also means that current average annual investments in the African energy system should double by 2030 (Gerd & Francesco, 2019).

Hydrocarbons, specifically petroleum, coal, and natural gas, served as the primary energy sources for the past century. However, the ongoing threat of climate change and its effects on human health and well-being has dramatically increased the need for alternative energy sources. Hydrocarbons still account for over 80% of the world's energy supply. Furthermore, the production and use of fossil fuels generates a significant portion of global GHG emissions, including (Farghali et al., 2022). Additionally, reliance on imported fossil fuels has equally contributed to risks for energy security (Chen et al., 2022).

Regarding insufficient means for decarbonization, given the vast access to RES in Africa, the existing research works often acknowledge that the financial sectors in developing nations are not developed enough to sufficiently finance environmental welfare-improving initiatives. Consequently, developing nations need to look up to their developed counterparts for external financing of environment management and climate change resilience-building projects (Zhang et al., 2022). In this regard, it has been found that public climate finances and climate-related export credits from developed to developing nations have been growing steadily with time (OECD, 2022). Besides, the SDG agenda – especially the targets concerning SDG 13 – has also endorsed the need for the developed countries which are parties to the United Nations Framework Convention on Climate Change to annually mobilize USD 100 billion worth of green climate funds in order to finance the climate change-related initiatives of developing countries. Moreover, the relatively less-developed financial sectors in developing nations are also assumed to withhold the production and consumption of renewable energy. Consequently, the underdeveloped countries have no other option than relying on external finance for lessening the fossil fuel dependency and promoting renewable energy adoption (Shahbaz et al., 2021). Furthermore, insufficient funds in these countries are also largely responsible for the lack of investments in technological development projects, especially those focusing on CCS. Therefore, it is quite obvious that the aforementioned constraints have largely contributed to the failures of developing nations in addressing their traditional and ongoing environmental hardships. As a result, relieving these constraints is of paramount importance so that the quality of the environment in developing countries can be significantly improved in the future. In this regard, enhancing the energy productivity rate (EPR) can be hypothesized as one of the potential mechanisms through which the developing nations' energy demand can be met while containing the associated energy-related discharges of (Ramzan et al., 2022).

In terms of theoretical underpinnings, the rising EPR can be linked with lower use of fossil fuels, which, in turn, can temporarily assist in lessening the fossil fuel dependency before developing nations expand their renewable energy generation capacities (Talan et al., 2023). Besides, a report published by the International Energy Agency (IEA) argues that EPR improvement "reduces greenhouse gas emissions, both direct emissions from fossil fuel consumption and indirect emissions associated with electricity generation" (IEA, 2019). Thus, de-intensification of energy use often seems a central factor that can enable developing nations to build climate change resilience (Aldieri et al., 2021).

Beside reducing fossil fuel dependency by boosting EPR, adopting renewable energy can be deemed important for improving the environmental status, especially in developing countries. Since most of the global net energy-importing nations belong to the cohort of developing countries, one can state that those nations are traditionally fossil fuel-dependent when it comes to meeting their energy needs (Ansari & Holz, 2019). Moreover, since those countries generate the bulk of their electricity outputs using both locally extracted and externally sourced oil, coal, and natural gas, it is no surprise that the majority of those countries, especially in Africa, find themselves in the worldwide list of top -emitting countries. Thus, energy experts often recommend that the fossil fuel-intensive power sectors in developing countries should gradually undergo a renewable transition by scaling their RENC levels while simultaneously downsizing their fossil fuel use levels (Dar & Asif, 2023). On the other hand, many works endorse the environmental quality-influencing impacts exerted by the financial sectors in developing countries. However, these studies assert that the environmental repercussions linked with the development of the financial sector tend to vary, that is, the financial sector imposes equivocal impacts on environmental quality. The studies often argue that the negative consequences of financial progress in developing countries are driven by their relatively less advanced financial sectors compared with their developed counterparts. Thus, greening the financial development policies is hypothesized to enable developing countries, especially in Africa, to successfully tackle their environmental concerns. Moreover, due to the persistently surging fossil fuel dependency in the majority of developing nations, one can expect their emission figures to substantially increase in the future unless relevant emission-abating measures are taken. Accordingly, the findings from this study are expected to assist the African developing countries in designing decarbonization blueprints and enable them to keep their environmental pledges. Especially, these policies could help the African developing nations in mitigating their respective emission levels so that the targets related to SDG 13 and the Paris Agreement are fulfilled within the respective time frame.

This study offers two core contributions to the literature. First, although the energy use–environmental quality nexus is a well-researched issue, the existing works mostly scrutinize the environmental impact of rises in energy demand levels in developing countries. Hence, those studies have largely overlooked the question of how efficient management of energy demand can influence the environmental quality. Nevertheless, it is pertinent to evaluate the environmental impact of EPR improvement, because most developing countries in Africa are both fossil fuel-dependent states and net importers of fossil fuels. As a consequence, enhancing their energy consumption level for stimulating economic growth is especially likely to degrade the environment. Hence, under such circumstances, improving the EPR can serve as a more relevant option for developing countries in Africa to overturn their environmental hardships. Accordingly, this void in the related literature is bridged by assessing the EPR–environmental quality relationship in the context of numerous developing countries.

The Clean Cooking Imperative: Challenges and Opportunities

The Paris Agreement and the 2030 Agenda for Sustainable Development (UN, 2015), both signed in 2015, thrust energy access and climate change into the center of the development policy. Taken together, they commit the world's nations to work together to eradicate poverty in all its forms, advance sustainable development, and aggressively fight against climate change. Achieving the objectives of both agreements highlights the need for a global clean energy revolution to win the fight against energy poverty and to deliver climate protection. Today, electricity reaches only about half of the people in SSA, the lowest energy access among the major regions in the world. Currently, only one country in Asia has access below 25%, compared to 13 sub-Saharan countries (World Bank, 2018). This dramatic energy access problem is exacerbated by the parallel low availability of clean cooking, where only one-third of people living in SSA have access to clean cooking. Economic growth in the region is also relatively low at an estimate of 2.8% in 2018, compared, for example, to 7.1% in South Asia (IMF, 2018).

Energy access is put under even more pressure by rapid population growth. With one billion people today, SSA's population is expected to double by 2050 (UN, 2017). Under the current and planned policy aiming to tackle energy access, the IEA (2017) outlook shows that while the share of people in the region lacking access is expected to decline till 2030 for both electricity and clean cooking, the absolute numbers of those lacking access will increase. Further, the global energy access problem is increasingly concentrated in SSA, which by 2030 will account for nearly 90% of the world's population without electricity access and 40% without clean cooking (IEA, 2018). SSA's chronic shortage of electricity carries a high economic cost, with opportunity costs amounting to up to 2% of their gross domestic product (GDP) (IRENA, 2015; IEA, 2014). Achieving energy access via clean energy in SSA is a necessary pillar of economic transformation required to deliver on the promise of the Paris Agreement and Agenda 2030 Sustainable Development Goals. Indeed, clean energy can be a "golden thread" for development, connecting all the SDG and unlocking sustainable economic growth, while improving gender equality, human health, and well-being (UN, 2017). Importantly, clean energy access enables women and children to lead more productive lives and to contribute to the economy (NCE, 2018). Access to clean energy can help to raise millions from poverty and to improve livelihoods of city residents and the rural poor. Clean energy access strategies will help countries meet long-term climate objectives as set out in their Nationally-Determined Contributions (NDC) and beyond, per the objectives of the Paris Agreement. Beyond direct economic and social benefits, clean energy access will raise human security and build resilience in states and communities to help limit the risk of large-scale migration across the African continent (Rigaud et al., 2018).

Research Method and Material

The article employs narrative methodology and content analysis to discuss the subject of climate change, decarbonization, and the efforts put forward by social economy in Africa to achieve decarbonization. Sources of information include published journal articles and other related online materials.

Results and Discussion

Current Trends: Progress and Outlook

Generally, relatively good progress is made in achieving electricity access, yet the pace of progress is overwhelmed by population growth, keeping the absolute numbers of those without access high. Thus, sub-regions and countries achieve electricity access at dramatically different paces. East and West Africa make the most progress, planning to lower the share of those without access to electricity to less than 40% by 2030. Several other African countries like Ethiopia, Gabon, Ghana, Kenya, and South Africa are also on track to achieve universal access by 2030. For electricity, the primary challenge remains in rural areas, where grid connections are more difficult, expensive, or financially risky to install. Even in urban or peri-urban areas, where grid-based electricity is accessible, reliability is often a problem leading to expensive and polluting diesel back-up generation. In Nigeria, about 893 million people presently cook using solid biomass and other highly polluting fuels (e.g., kerosene), and even with the planned new policies, the number of people without access to clean cooking will rises slightly – to 900 million. Compared to electricity access, the clean cooking challenge is more evenly spread across growing urban and rural communities, where there is an urgent need to raise awareness and knowledge of the benefits of clean cooking alternatives, and to make these affordable and accessible. Most new power generation to 2030 will be provided via the grid (57%), albeit the share of renewable energy will provide 73% of the whole new generation, thus improving GHG emissions/kWh. In addition to enabling grid expansion, new business models are providing solutions to people previously unserved by the grid. Mobile communications and, to a lesser extent, mobile money platforms are firmly embedded in some countries and provide an important foundation for pay-as-you-go (PAYG) consumer finance, which drives rapid uptake of off-grid solar energy in several African countries (IEA, 2022).

IEA's Sustainable Development Scenario (SDS) (IEA, 2018) illustrates a pathway to achieve universal energy access compared to the current policy scenario. Each scenario provides an overview of the mix of energy sources, technologies, and investment that would be required to meet 2030 universal electricity access along with other sustainability goals. For clean cooking in the IEA–SDS, universal access is achieved by introducing better cooking options, ranging from improved biomass cookstove technologies to cookstoves using liquified petroleum gas (LPG). The long-awaited set of standards will help to ensure that technologies meet minimum performance criteria to save lives through lower emissions and save money for users through improved energy efficiency; it will also provide a framework for monitoring progress (Naden, 2018). LPG and improved biomass cookstoves are the two main routes to clean cooking access in SSA. Electricity use for cooking is widespread in South Africa, but it is largely impractical for most African countries because of the lack of reliable electricity supply and the relative high cost of electric cookstove devices (IEA, 2017).

The chronic failure to deal with the widespread lack of clean cooking burdens economies and limits productivity for the region's population. This welfare cost is borne largely by women and children through diseases and premature death. Yet, most countries in SSA lack comprehensive clean cooking strategies, and where they exist, their implementation is weak and poorly financed, so that even modest gains are hard to obtain (Hosier et al., 2017).

Raising the priority, profile, and ambition of clean cooking goals will help governments in Africa to attract development financing to support implementation. Policies and financing for clean cooking should be integrated into poverty alleviation and health strategies at the national level. The gender element is crucial, ranging from awareness-raising campaigns to directly engaging women as champions and as entrepreneurs. Engaging women in clean cooking businesses and distribution will boost results and make them more lasting (Shankar, Onyura, & Alderman, 2015).

With respect to financing, the absolute gap is much lower than for electricity, with an estimated need of USD 1.8 billion (IEA, 2018). But the required scale-up is more challenging than for electricity, partly since it lacks the benefit of institutions and infrastructure that exist in the electricity sector. Significant progress requires both greater financing and, perhaps more importantly, the building of domestic outreach and capacity.

The Perspective of Renewable Energy in Africa

Renewable energy offers a range of benefits, including a freely available source of energy generation. As the sector grows, there has also been a surge in job creation to develop and install the renewable energy solutions of tomorrow. Renewable sources also promise greater energy access in African developing nations and can reduce energy bills. Of course, one of the largest benefits is that much of renewable energy also counts as green and clean energy. This has created a growth in renewable energy, with wind and solar sources being particularly prevalent. However, these green benefits are not the sole preserve of RES (Bos & Gupta, 2019; Roe et al., 2021).

The advantages of renewable energy are numerous and affect the economy, society, environment, security, and human health. The benefits of using renewable energy in Africa include:

- enhanced reliability, security, and resilience of the nation's power grid;
- job creation throughout renewable energy industries;
- reduced carbon emissions and air pollution from energy production;
- Africa's increased energy independence;
- increased affordability, as many types of renewable energy are cost-effective and competitive with traditional energy sources;
- expanded clean energy access for non-grid-connected, remote, coastal, or island communities.

As mentioned above, many RES are not used all the time. For this reason, fossil fuels are still in use to scale up renewable sources in numerous countries. The variable production capacity means that large energy storage solutions are required to ensure that there is enough power when renewable energy generation dips. An alternative solution is to deploy several renewable technologies, creating a more flexible system of supply that can counteract dips in production for a given source. Some renewable resources, such as hydropower and biomass, do not suffer from these problems of supply, but they both have their own challenges related to environmental impact, as noted above. In addition to this, some RES, such as solar and wind farms, create complaints from most local people in Africa, who do not want to live near them.

Several countries in SSA have begun to pave the way to a new energy paradigm for electricity, one that could potentially fill the electricity access gap with cleaner and higher reliability. The resulting clean energy system would be more sustainable than traditional, grid-based power systems. The electricity sector in most countries is designed around a central, national grid, whose primary focus is providing electricity to urban areas and the secondary one is to supply rural or other unserved areas. With the important exception of areas with major hydropower resources, the grids are typically supplied with power generated from fossil fuels – coal, oil and natural gas – with the fuel choice often driven by the country's indigenous natural resources. In the past, increasing access to electricity essentially meant expanding the grid. However, grid expansion has increasingly encountered barriers related to both the high cost to reach more distant or hard-to-connect areas that have relatively low levels of demand, and the endemic problems of reliability and coverage within many existing grid-served areas. Indeed, many grids have such fundamental problems of reliability that access alone is not a robust measure of electricity service (World Bank, 2018).

New renewable electricity pathways could herald a fundamental restructuring of the power sector throughout SSA that can greatly expand electricity access to both unserved and underserved areas in a timely manner, as well as providing a high standard of service reliability. These options create new organizational structures and opportunities for new business models to emerge and provide services at the individual, household, and community level. Important gains in solar technologies have allowed stand-alone solar home systems (SHS) and minigrid service options to develop rapidly in recent years. However, the reliance on grid infrastructure is still important in providing electricity access in Africa. A policy priority is to ensure that new capacities and connections exploit the continuum of cost-effective, systemic off-grid, minigrid, and on-grid options, and are not biased toward the existing grid or the dominant energy sources of the past – that is, fossil fuels versus newer renewable energy technology options. Another key issue for a policy is to ensure a level playing field and/or targeted, time-bound subsidies to incentivize investment in renewable energy to deliver on the promise of these new technologies and services to capture the social, health-related, and environmental benefits of clean electricity and cooking energy access in Africa.

In the last few years, rapid advances in renewable energy technologies, especially solar and wind sources, have opened major opportunities for both decentralized supply options and the greening of the central grid. While decentralized electricity services at both the household and enterprise level have long existed, these applications have traditionally relied on diesel generators. However, electricity from diesel generators entails a cost three to four times higher than the unit cost from grid (McKinsey, 2018). Thus, it is not economically viable for many, including most of the rural population and the urban poor, to rely on a fuel that may not always be available. Local diesel generation represents a major cost for businesses and has serious local environmental impacts and relatively high emissions of . Solar technologies are changing the situation for decentralized services. Recent and continuing declines in the manufacturing costs of photovoltaics (PV) and battery storage technologies, as well as information technology control packages, are enhancing the case for decentralized renewables and fundamentally expanding electricity service options beyond the traditional grid system supplemented by diesel generators (World Bank, 2018).

Clean Cooking Access: Market Developments and Technologies

The transition to clean cooking across Africa could unlock human productivity, cut human health costs, improve well-being, and save the lives of hundreds of thousands of people, particularly women and children (WHO, 2016; IEA, 2017). In SSA, 17% of the population have access to clean cooking (IEA, 2018), while in the low-income countries, this number is even lower (IEA, 2017). Most of those without clean cooking access rely on traditional biomass causing deforestation and smoke and soot pollution, which negatively impacts the local and global environment and human health. Overall, traditional biomass remains the dominant source of energy in SSA, accounting for about 60% of the energy demand today largely due to cooking (IEA, 2017). Related forest area loss is accelerating a decline in ecosystem services with loss of related benefits for people, ranging from flood buffering to water capture and filtering. Continued dependence on biomass in SSA not only adds to GHG emissions, but also raises the vulnerability of people, infrastructure, and the economy to more extreme weather events, such as flood and drought due to loss of natural ecosystem services such as flood buffering provided by forests (Lambe et al., 2015).

The availability of electricity services is often viewed as primarily a rural–urban divide, yet a World Bank study (World Bank, 2018) estimates that the share of unconnected people living under the grid in SSA can be double the number of those actually connected. The number of unconnected people under the grids varies substantially among countries. A study in Kenya notes an area with ideal conditions for grid supply and finds that electrification rates remain very low, averaging 5% for rural households and 22% for rural businesses, and that this holds across time and for both poor and relatively well-off households and businesses (Lee et al., 2019). The study implies that simply constructing a grid and providing the technical means of an electricity connection does not automatically translate to access and usage. While a portion of those failing to connect is due to the connection cost, other barriers include a lack of policy or business model to connect those living in informal housing, organizational failings within the distribution companies, sociopolitical marginalization, and poverty among those without access (Lee et al., 2019).

From the perspective of a climate change policy, renewable energy should be incentivized throughout the electricity sector. Given the large public good benefits associated with the switch from fossil fuels to renewable power generation, there is a strong policy case not only for levelling the playing field for renewables to compete with fossil fuels, but also for time-bound, technology-neutral subsidization (OECD, 2012). Such policies can provide essential early-stage support for renewable energy options, helping to create markets and experience, which will help to deliver affordable financing for investment in emerging renewable technology options, thereby leading to efficient clean cooking access in Africa.

Social Economy and Decarbonization in Africa

Social economy, as a relatively new concept, is considered the "third sector" of economy in government discourse. It plays a significant role in the socioeconomic and political spheres of any nation. In Africa, the impact of the economic recession shows in the increased unemployment and poverty rates, resulting in maximization of discrepancies between the rich and poor, producing inequalities, and creating discouraging environments for foreign investments. These social problems have called for an examination of social economy's role in liberating African economies from their current dire state (Okeke-Uzodike & Subban, 2016).

Social economy is defined as the collection of different social objectives of the various organizations that form it. According to the European Commission, social economy organizations include cooperatives, mutual societies, voluntary organizations, foundations, and social enterprises. All are based on voluntary participation and membership, and are guided by their social objectives rather than a need to make a return on capital. Many social economy organizations simply deliver services to their members or others and they aim to serve without making use of the market. Other such organizations, known as social enterprises, engage in trade activities in order to benefit their members or those they serve. In the latter case, any surpluses or profits earned are reinvested in the enterprise, distributed to stakeholder groups, or used for the benefit of those served by the enterprise. Governance typically operates through the "one member, one vote" principle or through enterprise trustees (Restaki, 2006).

According to Eurofund (2022), social economy refers to all business activities that are not only driven by a strong social mission, but also intended to be economically viable. This includes cooperatives, mutual societies, nonprofit associations, foundations, and social enterprises, covering a wide range of activities. The aims of social economy organizations are generally to provide goods and services – including employment opportunities – to their members or the community, and pursue general-interest goals such as environmental protection. In this way, social economy organizations aim to make a profit for people other than investors or owners. To ensure that social economy enterprises can compete effectively and fairly, without regulatory discrimination and taking into account their particular needs, the European Commission launched the Social Business Initiative. Another Commission initiative launched in this field was Towards Social Investment for Growth and Cohesion, which promoted social innovation as a source of growth and jobs, supported innovative entrepreneurs, and mobilized investors and public organizations (European Commission, 2022).

OECD (2022) defines social economy as solidarity economy formed by a set of organizations such as associations, cooperatives, mutual organizations, foundations, and, more recently, social enterprises. In some cases, community-based, grassroots, and spontaneous initiatives are part of social economy in addition to nonprofit organizations, the latter group often being referred to as the solidarity economy. The activity of these entities is typically driven by societal objectives, values of solidarity, the primacy of people over capital and, in most cases, by democratic and participative governance.

According to Huybrechts (2012), social economy includes independent organizations acting independently toward particular objectives. Thus, social economy covers all economic activities conducted by enterprises, primarily cooperatives, associations, and mutual benefit societies whose ethics covey the following principles:

– Putting service to its members or to the community above profit;
– Autonomous management;
– A democratic decision-making process; and
– The primacy of people and work over capital in the distribution of revenues.

Social economy enterprises and organizations have different sizes, ranging from small and medium-sized enterprises (SME) to large companies and groups that are leaders on their markets and operate in all economic sectors.

Social economy and social innovation contribute to creating more inclusive, creative, and sustainable societies and economies. They provide innovative solutions to improve the quality of life and well-being of individuals, communities, and places, while addressing socioeconomic and environmental challenges, including those emerging with the COVID-19 pandemic crisis. Social economy organizations traditionally refer to the set of associations, cooperatives, mutual organizations, and foundations whose activity is driven by values of solidarity, the primacy of people over capital, and democratic and participative governance (Restaki, 2006).

OECD (2022) also views social economy as nonprofit or third-sector organizations that have grown in number and relevance, contributing to employment, social inclusion, democratic participation, and community building. Much remains to be done, however, to create the necessary enabling environment to support their establishment and development, and to mainstream the sector in economic and social policies. Social economy encompasses enterprises, organizations, and other entities engaged in economic, social, and environmental activities to serve the collective and/or general interest, which are based on the principles of voluntary cooperation and mutual aid; democratic and/or participatory governance; autonomy and independence; and the primacy of people and social purpose over capital in the distribution and use of surpluses, profits, and assets. Social economy entities aspire to long-term viability and sustainability, and to the transition from informal to formal economy, as they operate in all economic sectors. In addition, since worldwide trends tend to entail increasing services, production, and privatization of government activities, social economy or nonprofit enterprises – many of which address these domains – are likely to play greater economic roles in the future. This is reflected in more explicit recognition of social economy in the national economic policies of many African countries.

Africa boasts several social economy enterprises and foundations. Some of them originate from other developed countries but participate in numerous welfare-enhancing activities. These social enterprises have participated in decarbonization activities to improve climate change resilience and mitigation activities in Africa. They are discussed below.

The Miller Center for Social Entrepreneurship is a Premier University-based social enterprise accelerator, founded in 1997. Miller Center's goal is to end global poverty and protect the planet by accompanying social entrepreneurs focusing on climate change and women's economic empowerment. The center defines one of its two selected focus areas as climate resilience focusing on efforts to improve clean energy access, safe water, and climate-smart agriculture results by the social enterprises (Rasoanarivony, 2022).

The Tony Elumelu Foundation (TEF) is owned by a Nigerian and named after its founder Tony O. Elumelu CFR. It is the leading philanthropic entity empowering a new generation of African entrepreneurs, driving poverty eradication by enhancing job creation across all 54 African countries, and increasing women's economic empowerment. The foundation launched the TEF Entrepreneurship Programme in 2015, providing over 1.5 million young Africans with access to training on its digital hub, TEFConnect, and disbursed nearly USD 100 million in direct funding to 18,000 African women and men, who have collectively created over 400,000 direct and indirect jobs. The foundation is making deliberate efforts to promote green entrepreneurship and foster an environment where green entrepreneurs can invest in renewable energy (Tony Elumelu Foundation, 2023).

Generation Unlimited (GenU) is a leading global public-private-youth partnership (PPYP), bringing together global organizations and leaders including Heads of State, CEOs, Heads of UN agencies, and civil society champions with young people to co-create and deliver innovative solutions on a global scale. This was launched by the UN Secretary-General at the 2018 UN General Assembly. Generation Unlimited is on a mission to skill the world's 1.8 billion young people and connect them to opportunities for employment, entrepreneurship, and social impact (Generation Unlimited, 2023).

The IKEA Foundation is also a philanthropy organization that focuses on tackling poverty and climate change. It currently grants over EUR 200 million per year to help improve family incomes and quality of life while protecting the planet from climate change. Since 2009, the IKEA Foundation has granted more than EUR 1.8 billion for poverty eradication and climate change.

In recent time, these foundations – The Tony Elumelu Foundation, Generation Unlimited, and IKEA Foundation – have worked together in partnership to launch a pioneering Green Entrepreneurship Programme that is aimed at empowering the African youth to tackle the problem of climate change through investment in renewable energy. These social economy activities have the advantages of generating youth empowerment and green job creation in Africa by supporting the development of environmentally friendly businesses. Green entrepreneurship will help create jobs that contribute positively to the planet when the use of renewable energy is improved. This will also tackle climate change, biodiversity loss, and resource scarcity by fostering sustainable entrepreneurship and innovation, and will build a sustainable future in Africa (Generation Unlimited, 2023).

Successes, Opportunities, and Challenges in Promoting the Use of Renewable Energy by Social Economy

Social economy's drive to decarbonization is a welcome development in Africa. However, these efforts entail both successes and challenges.

Successes and Opportunities

Over the past 11 years, Miller Center has assisted 252 African social entrepreneurs – with an annual average of 22 entrepreneurs – in providing solutions for climate change and promotion of renewable energy (Rasoanarivony, 2022). In addition, Miller Center initiated an effort to scale up and double its impact by 2025, as measured by an increase from USD 500,000 to USD 1,000,000 in funding raised for each enterprise (Rasoanarivony, 2022).

The Tony Elumelu Foundation, Generation Unlimited, and the IKEA Foundation successfully initiated the Green Entrepreneurship Programme called BeGreen Africa, designed to provide young African entrepreneurs with the training, mentoring, and funding needed to develop innovative solutions for Africa's sustainable future (Generation Unlimited, 2023). The program has a wide coverage in Africa, spanning across South Africa, Senegal, Morocco, and five other countries. BeGreen trains at least 1,600 young people in green entrepreneurship and waste management and will provide more than USD 1 million in seed funding to 225 young entrepreneurs, which will enable them to generate revenue and create at least 8,000 jobs (Generation Unlimited, 2023).

Aside the BeGreen Africa program, several entrepreneurs have been engaged in the Tony Elumelu Foundation Entrepreneurship Programme operating in the green industry. Those beneficiaries are discussed below.

Bamboo Express empowers the youth and women locally in Africa. TEF has supported the company's owner, Lombola Lombola. Bamboo Express is solving the problem of deforestation, youth unemployment, and lack of income alternatives for rural women as they focus on a youth apprenticeship program and purchase 90% of raw materials from those women. The company tackles deforestation in an effort to reduce the problem of climate change (Tony Elumelu Foundation, 2023).

D'Rose Recycling Company is an eco-friendly business which upcycles solid waste like old tires, bottles, and plastics into recycled furniture suitable for homes, offices, playgrounds, and studios. TEF has assisted its owner, Bimpe Oni. The company seeks to address the challenge posed by the tons of plastics and tires which end up in the ocean each year, causing water pollution and driving sea life into extinction (Tony Elumelu Foundation, 2023).

BanaPads is yet another company assisted by TEF. Richard Bbaale, a social entrepreneur from Uganda, founded BanaPads in 2010. The entity uses banana pseudostem waste, usually left to rot after harvesting, to make sanitary pads. It is an award-winning social enterprise registered in Uganda and Tanzania with the aim of manufacturing affordable and eco-friendly

(100% biodegradable) sanitary pads to keep village girls in school and create jobs for local women. The pads are also collected to be used as manure, which means that the waste in local landfills will be reduced since the banana pseudostem is a recyclable product (Tony Elumelu Foundation, 2023).

Ecohub is a local start-up that innovatively uses plastic waste to produce affordable, architect-designed flat-pack ecobricks and ecohouses. Its founder is Letsogile Kennedy, an award-winning social entrepreneur and architect. Ecohub also obtained assistance from TEF. The company's plan is to manufacture green building materials from waste, providing affordable and sustainable housing that can last for 20 to 25 years (Tony Elumelu Foundation, 2023).

The Challenges of Africa's Decarbonization Agenda and How to Overcome Them

Social economies that promote the climate and decarbonization agenda as well as climate entrepreneurs face several challenges such as limited access to finance, technology, and infrastructure as well as regulatory barriers. These are discussed below.

– Limited access to finance: Social enterprises and foundations face challenges of inadequate financing to advance the agenda.
– Limited access to technology: This serves as a key challenge for young entrepreneurs in Africa in pursuing the decarbonization and climate change agenda. Inadequate access to new technologies prevents climate entrepreneurs from maintaining competitiveness and innovation.
– Lack of infrastructure: Africa lacks access to quality infrastructure such as transportation, electricity, and Internet connectivity. This can make it difficult for green businesses to operate efficiently and cost-effectively.
– Lack of skills and experience: Social entrepreneurs may lack the necessary skills and experience to succeed in green businesses. This can make it difficult to develop and implement effective business strategies, manage finances, and navigate the regulatory landscape (Tony Elumelu Foundation, 2023).

Overcoming these challenges requires access to finance, technology, and business development support, as well as policies that promote the growth of green businesses. This is essential for the growth of climate entrepreneurship and climate-oriented social economy. Although Africa possesses the natural treasures needed to decarbonize successfully, several obstacles hinder that from happening:

– Africa lacks adequate infrastructure to achieve decarbonization: Adequate grid infrastructure is needed to facilitate the integration of RES into the current energy mix. Unfortunately, African states are underequipped with such infrastructure. In addition, the current capacity can only support small-scale renewable source deployment.
– The initial cost of transitioning into green economy is too high: Africa does not have the necessary infrastructure to allow the integration of renewable energy projects yet. Building new systems from scratch is very expensive due to equipment purchases, installation expenses, and grid connection costs. Considering that Africa is also home to more than 70% of the world's less developed nations, the continent is not financially capable of meeting the upfront costs, thus delaying decarbonization projects longer than necessary.
– In an effort to meet immediate energy demands, Africa has become overdependent on fossil fuels: In the majority of African nations, the demand for energy is often higher than the supply due to inadequate or outdated energy infrastructure and electricity storage systems. Consequently, countries opt to put decarbonization projects on hold so they can

use the available resources to meet immediate energy demands. However, too high fossil fuel dependence leaves vast RES deposits in Africa untapped and fails to address energy poverty.

– Political obstacles and regulatory restrictions hinder decarbonization: Numerous political issues stall Africa's decarbonization efforts. Those include political instability, which discourages long-term investors. Countries experiencing political instability also tend to have regulatory challenges, such as inconsistent policies due to frequent changes or reversals by the government. Political and regulatory obstacles are often accompanied by corruption, which is a rampant issue in many African states and limits the successful execution of decarbonization projects.
– Directing all efforts toward adaptation as opposed to mitigation slows down decarbonization projects: Africa's vulnerability to climate change has increased over the years, as exemplified by the extreme weather events that have plagued the continent in recent years. The few projects that have been implemented focus on adapting to climate change impacts like food insecurity, floods, and drought, which have recently become rampant, leaving these nations with no other means to support their decarbonization initiatives.

The list below provides examples of decarbonization challenges faced by organizations:

– Large upfront investments for changes can deter decision-makers, who may prefer prioritizing funding in other areas that have a track record of benefits or profit, like sales or new technologies.
– Pushback and legislative protection of fossil fuel industries can make it difficult to legally eliminate fossil fuel usage in certain areas.
– The costs of new technologies and research can make the necessary changes inaccessible for companies lacking resources.
– Lack of climate education and buy-in at all levels can produce much bureaucracy for individuals who need capital and support to enact changes.
– Cooperation on a global scale is difficult when managing the various needs, values, and accessibility to resources of different countries and jurisdictions.
– Balancing policies like carbon taxes with the impact on citizens is necessary since families and individuals may be inadvertently affected by factors like high costs.

Conclusion

The article reveals that the challenges of limited access to finance and technology, as well as lack of infrastructure, skills, and experience, are serious limitations to Africa's decarbonization pursuit. The urgency to design, assess, and implement decarbonization pathways in Africa has been increasing. Although several initiatives by the social economy and social entrepreneurs are already operating to foster the growth of decarbonization and climate-oriented solutions, social economies and entrepreneurs still face several challenges. Tackling those challenges will go a long way in decarbonizing Africa and improving the implementation of climate change mitigation strategies.

The study was limited by a literature gap and lack of empirical data for empirical analysis. Time was also an important constraint.

Future research directions could focus on several areas and aspects, such as the place of technology and infrastructure in pursuing decarbonization and climate change, and the future energy demand so as to reduce African overdependence on fossil fuels.

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Zhang, D., Zheng, M., Feng, G.-F., & Chang, C.-P. (2022). Does an environmental policy bring to green innovation in renewable energy? *Renewable Energy*, *195*, 1113–1124.

About the Author

Joseph Mamman Ibbih, Ph.D.
Department of Economics
Nasarawa State University, Keffi
P.M.B 1022, Keffi, Nigeria
e-mail: jmibbih@gmail.com
ORCID: 0009-0001-4502-9486

Nicodemus Samson Nyako*
Department of Economics
Nasarawa State University, Keffi
P.M.B 1022, Keffi, Nigeria
e-mail: samnicsnn@gmail.com
ORCID: 0009-0004-3050-1591
* Corresponding Author

Author contributions

J.M.I., N.S.N.: conceptualization, writing, original draft preparation, writing, review and editing; J.M.I.: supervision. All authors have read and agreed to the published version of the manuscript.

Acknowledgements and Financial Disclosure

None reported.

Conflict of Interest

The authors declare that the research was conducted without any commercial or financial relationships that could be construed as a potential conflict of interest.

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Published by Krakow University of Economics – Krakow, Poland

Ministry of Education and Science
Republic of Poland

The journal is co-financed in the years 2022-2024 by the Ministry of Education and Science of the Republic of Poland in the framework of the ministerial programme "Development of Scientific Journals" (RCN) on the basis of agreement no. RCN/SP/0391/2021/1 concluded on December 9, 2022 and being in force until December 8, 2024.