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Solutions to the Challenges Facing Full Adoption of Renewable Energy Transition in Africa: Nigeria as Acase Study

[1]Haruna, M.S., [1*]Ezeanayanaso, C.S.&[1]Olagoke, M.F
[1]Research and Development Unit of Science Infrastructure, National Agency for Science and Engineering Infrastructure (NASENI), Abuja, Nigeria
Email addresses: msharuna@gmail.com, chikaeze2@yahoo.com and idowumemunat82@gmail.com respectively
Corresponding Email address: chikaeze2@yahoo.com
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ABSTRACT
The future of renewable energy in Africa is at risk at a time when evidences suggest that African continent needs "just renewable energy transition" more than ever before. Many studies have confirmed the benefits of switching to renewable energy.Studies at a global level indicate that renewable energy is the answer to the challenges associated with climate change and a critical step towards attaining climate neutrality. Despite the availability of such evidence, African nations and Nigeria in particular, have done little to ensure that full adoption of renewable energy transition is sufficient to meet current and future energy needs. The need to switch to renewables is expected to grow at a faster rate in Africa, while the continent's abundance of renewables is underutilized. Reasons behind these untapped renewable resources are multi-faceted. Key factors include inadequate policy implementation, low technological advancement, inadequate skilled manpower, insufficient funds, initial capital costs of installations, lack of sufficient maintenance service and infrastructure as well as pricing instabilities which have placed renewable energy at a disadvantage. Hence, comprehensive strategies are needed to halt and reverse the challenges faced with full adoption of renewable energy transition in Africa, Nigeria in particular. This paper offers a set of policy recommendations to address the challenges facing renewable energy transition in Africa using Nigeria as a case study.

I. INTRODUCTION

The significance of electric power sector in any nation cannot be overestimated because it contributes to the country's socio-economic development. Over 80% of the current Nigerian primary energy source is met by fossil fuels (Sambo, 2009). These fuels are non-renewables (Petroleum, coal and natural gas) and are available in finite quantities only. As they are continuously extracted, they will run out sooner or later simply because they do not replenish as quickly as being consumed despite the fact that they are produced in natural processes (Sambo, 2009). It is quite evident that the use of fossil fuels results in greenhouse gas emissions that are harmful to both the environment and health. Its huge use is also responsible for the emergence of global warming. All of these environmental concerns have indeed necessitated the need to conserve the environment and enhance sustainability by transitioning to clean energy sources (SDGs, 2020).

Clean energy otherwise known as renewable energy is obtained from unprocessed resources that restore themselves without deteriorating the planet's resources (Sambo, 2009). These renewables such as sunlight, wind, rain, tides, waves, biomass and thermal energy are often deposited in the lithosphere and they have the benefits of being obtainable in different forms across the globe. These renewables are in effect measureless with little climate or environmental damage (Okoye, Taylan and Baker, 2016). In the coming decades, African continent is expected to attain ubiquitous access to low-priced, reliable, sustainable and contemporary energy sources by 2030, according to United Nation's Sustainable Development Goal-7.

II. Why is an Investment in Renewable Energy Transition Important?

Several studies have been conducted to demonstrate the value of clean energy transition (Okoye et al., 2016). Countries in the African continent have not fully harnessed the potentials of their renewable energy resources, yet highest in consumption in the case of Nigeria (Sambo and Bala, 2012). Three reasons have been highlighted why renewable energy investment is important and these are:

a. Clean energy generates economic returns three to eight times higher than the startup investment.

b. The unstable price of fossil fuels and other non-renewables stimulates a worldwide opportunity to speed up the shift to clean energy.

c. Committed funding or investment in clean energy and energy efficiency has a huge potential of generating 63 million new jobs by 2050 (SDG, 2020).

African nations, Nigeria in particular has not fully risen to the forefront of the global investment agenda despite several reasons motivating green investment across the continent and these reasons are multi-sector opportunities, demonstrated political will, high demand for energy, scalability and deliverability offered by renewable energy technologies and significant economic potentials.

III. Renewable Energy Potentials in Africa and Nigeria

Series of studies have demonstrated that renewable and clean energy sources have played a huge part in Nigeria's energy mix in the last few decades. This segment of the review looks into the available and potentials of renewable and clean energy sources in Nigeria.

3.1 Biomass Energy

This is a form of energy derived from organic materials of flora and fauna that store light from sun in a chemical energy form. In the near future, this source of energy will be highly important. Sources of biomass include virgin wood,sawmill residues, industrial wastes, energy crops and agricultural wastes. This energy source is commonly utilized in developing countries for rural agricultural purposes (Sesan, 2008). Biomass energy exists in different forms in Nigeria such as animal wastes, fuelwoods, municipal solid wastes, energy crops and residues from agriculture (Sambo, 2009b; Agba, Ushie, Abam, Agba and Okoro, 2010).

3.2 Hydroelectric Energy

This form of renewable energy has indeed assumed great significance at a global level since the commencement of 20th century because it is a non-polluting energy source. In the year 2011, around 3,402.3 TWH of hydroelectric energy was generated globally, accounting for approximately seventeen percent of the entire energy production worldwide. Hence, this type of energy plays a crucial role in the generation of energy at a global level (Ogwueleka, 2009; Olukanni and Salami, 2012). Nigeria as a case study has three main hydropower plants located in Kainji, Jebba and Shiroro power stations. These plants give about 35.6% power to the national grid and as a result, this source of energy is identified as the country's largest renewable energy source (Kennedy-Darling, Murao and Ross, 2008; Olukanni and Salami, 2012).

3.3 Solar Energy

This form of energy is prevalent in virtually all countries of the African continent but its full potential is yet to be fully exploited (Oyedepo, 2012a). Nigeria as a country is abundantly blessed with energy from sunlight radiation with an annual average daily sunlight of seven hours, ranging from four hours at the coastal areas to nine hours at the far northern boundary (ECN, 2005; Fadare, 2009; Oyedepo, 2012c). Over 80% of photovoltaic installations are possessed by the government agencies of Nigeria for water pumping, street lightings, vaccine refrigerators and community lightings. Its household and domestic applications are not yet fully pronounced as a result of the fact that its viability over diesel and gasoline generators has not yet convinced citizens due to its high capital cost. It is imperative to point out that comprehensive research on solar cell development and manufacturing in Nigeria is not well funded. However, the National Agency for Science and Engineering Infrastructure (NASENI), being a federal government agency in Nigeria took a giant step towards having the nation's indigenous solar photovoltaic (Solar PV) by birthing an assembly plant of solar in Karsi, Abuja in the year 2011 (NASENI, 2011). This solar assembly plant commenced operation same year despite the fact that none of the component parts is being manufactured locally yet.Vigorous and determined attempts likethis is expected to be aided by the government and non-public sector to guarantee sustainability. The researchers in the country should not also be left out in the task of embarking on pertinent research work that will skyrocket the nation to a level of manufacturing those component parts locally in earnest. With this initiative followed with actions, cost of installations of solar PV will be drastically down for it to be affordable and promote availability, accessibility and adoption of solar energy as a viable alternative source of energy in the country.

3.4 Wind Energy

Countries in the African continent and Nigeria in particular have not really explored this form of energy because nearly all existing wind energy systems are deserted as a result of unbefitting appraisal of its prospects, operations and management (Oyedepo, 2012b). It is recommended that using wind energy conversion systems to supplement the hydro-thermal power generation will be good considering the unstable power supply in the country.

IV. Challenges Facing Full Adoption of Renewable Energy Transition in Africa and Nigeria

Despite the torrent of benefits that can be accrued from the use of renewable energy as a clean or green energy to ameliorate the challenges of climate change, the full adoption and implementation of this alternative energy across the African continent and Nigeria in particular, suffers various challenges and impediments. These challenges are responsible for the decline of renewable and clean energy transition in Nigeria and other African countries as a whole. Also, these challenges are hindering reaching the full potentials of green energy to meet up with thefuture energy needs of the African continent. This section of the paper highlights those challenges as discussed below.

4.1 Continued Use of Fossil Fuels (coal)

The persistent use of fossil fuels has been recognized as one of the factors militating against full adoption of renewable and clean energy transition for example in Nigeria and this is simply a wonderful concern. According to International Energy Agency (2017), fossil fuels make a contribution one-third of world electricity supply, accounting for about 40% of electrical strength generation. This digit absolutely makes fossil fuels to be taking part in a very tremendous sized industrial role. This figure sincerely corroborates that it will be difficult to exchange coal as a supply of energy, especially in industries. The form of infrastructural changes required in full adoption of renewable energy transition is prohibitive in the area of pricing and time (Sambo, 2009a). Also, large scale industries require a large quantity of power and in this case, coal is constantly diagnosed to have a distinct net strength yield when in distinction with other sources of energy. This has proven that for a unit of coal, a lot of electrical strength is produced. As a result, coal has numerously stood out pleasant and tough to trade with as an exclusive energy source in the manufacturing of massive volume of electrical strength required for most operations of large scale industries. Furthermore, coal is in abundance which makes it easily accessible and affordable unlike an energy that is restricted in supply. Also, technological tendencies in the area of coal technological records have made it distinctly efficient and cleaner to mine and burn coal to produce excessive aggregate of energy. Therefore, it appears difficult for torrent of individuals to be persuaded in the abandonment of coal electrical energy for renewable energy.

It is quintessential to point out that the cost of infrastructural enhancement required for the improvement of renewable energy plant is prohibitive. Despite the abundance of renewables in many African countries particularly in Nigeria, coal is nonetheless signaled as a less luxurious energy compared to renewable fuel and as a result, it is identified to be favourable. In most cases, an inexpensive approach that is economical is often desired by any country. The integral intention of any financial gadget is to limit the price of manufacturing and enlarge its profit. Since coal electricity plants have already been established, other sources of electrical energy generation that are economically costly need not to be created. Therefore, most African nations will be reluctant to alternate from the existing electricity source and set up new smooth renewable and clean energy source (such as solar, wind and biomass energy).

Another thing which hinders the full adoption of clean-tech transition is that fewer personnel are required to produce massive extent of electrical power from fossil fuels such as coal than from renewable strength like solar industries. Despite the huge team of workers in renewable electrical power industries which is normally twice of the team of people of fossil fuels industries, fossil fuels remain the larger electricity production source than renewable energy source like the combination of solar and wind electrical energy (Sambo, 2009a). Therefore, due to the fact that fossil fuel requires fewer people for energy generation, it becomes easier for it to be identified as a less luxurious electrical energy manufacturing method, and this is why both developed and growing international nationsacross the globe unavoidably depend on its utilization till date. It has emerged ironical using greater human capacity in an industrial setting that produces less electricity whilst there exists an industrial setting with fewer human capacity that can produce abundant electrical power.

4.2 Lack of Systemic Investigation and Development

In Nigeria as a case study, no comprehensive systemic investigation related to the impediments of full adoption of renewable energy transition has been performed and most fact-finding (research)centres seem to be deviating their effort from that. In addition, there is no highest level of systemic investigation on technological development associated with renewable power in the country, thereby decelerating adoption of the clean-tech due to lack of funds. It is quintessential to point out that Nigeria has inadequate human capability and applicable coaching in renewable energy improvement and this has made the clean tech yet to be available widely (Muhammed et al., 2017)

4.3 Technical Challenge

Technology has generally been recognized as what suppresses willingness to make investments in renewable energy. This is genuine particularly in sub-Saharan Africa where core clean-technologies are faintly furnished or sustained nicely. Because of lack of skilled personnel to train, exhibit and keep strength structures,

humans are unwilling to espouse the technological approach for concern of unsuccessful outcome. Currently, in most African countries, renewable and clean technologies are fee-deprived in contrast to the greatly used fossil fuel technologies. This however may be subjected to the reality that most renewable clean-tech are imported (Sambo, 2009a). The immoderate costs of the clean-tech suggest that some nations across the world particularly the developing regions have strong affinity to clinch to fossil fuels generated electrical energy due to its ease of accessibility, availability, reliability and affordability unlike renewable energy.

Lack of machineries needed for transmission and distribution grid coupled with equipment and services that are indispensable for clean-tech is indeed a significant infrastructural hindrance for full adoption of renewable electricity transition in most developing countries. Most of this equipment cannot be found locally in African countries particularly in Nigeria and are subsequently imported from the industrialized nations. It is this importation that makes the equipment to be highly priced and this in flip makes production of renewable energy to emerge costly and unaffordable (Sambo, 2009a).

Inadequate connectivity to the grid is another technical or infrastructural challenge. In the wind electricity arena for instance, high levels of transmission loss are being witnessed in the route of the transportation of electrical or mechanical power from the manufacturing points to the consumption point (Sambo,2009a). Due to this, many buyers have lost self-assurance in renewable clean-tech and are not inclined with high degree of reluctance to make investments in them for fear of losing.

Inadequate servicing and upkeep of machineries in a state of good repair coupled with low reliability in clean-tech lowers consumers' self-trust in some renewable energy techniques and these have indeed hindered their full adoption (Oyedepo, 2012b). This is due to the fact that most renewable clean-tech equipment are imported and therefore, lack of spare or component parts coupled with inadequate skills to restore the equipment leads to failure of equipment and this in effect is directly proportional to lack of energy supply. Many customers therefore decide to depend on fossil fuels for supply of electrical energy due to its reliability and availability. In the vicinity of fabrication technology, Nigeria has a low-level rating. As it was stated earlier, NASENI is recognized as the only indigenous business enterprise owned by the federal government of Nigeria saddled with the mandate of fabricating or manufacturing industrial and technological equipment such as photo voltaic even though, many of its component components are imported (NASENI, 2011).

4.4 Lack of Grasp and Awareness

Households' unwillingness, huge public disinterest and disengagements to adopt renewable electrical energy transition for fear of unreliability are recognized as socio-cultural challenges hindering renewable power improvement in African countries, Nigeria in particular. All of these are as a result of lack of attention and knowledge collectively in rural and urban communities. Majority of individuals in Sub-Saharan Africa are uneducated to expand their horizon on what renewable clean-tech is all about (Giwa et al., 2017; Muhammed et al., 2017). They are additionally hardly oriented on the technical and environmental influences associated with over-reliance on combustible non-renewables and all of these have decelerated the adoption rate, circulation and usage of renewables.

4.5 Lack of Strategy Firmness, Insurance Steadiness and Implementation by Policy Makers

Lack of insurance plan, insurance policies and strategy firmness for renewable energy enhancement is in reality a huge challenge limiting full adoption of renewable clean-tech in most nations of the African continent particularly in Nigeria. The nature of renewable strength construction requires clear insurance diagram, insurance plan and insurance policies to expand the self-belief and enthusiasm of capitalists. Enabling insurance policies create impenetrable and predictable environment for investment. Furthermore, regulatory measures such as codes and acceptable levels of quality have been identified to heighten the adoption of renewable energy transition through minimization of technological and regulatory dangers associated with business investment. In Sub-Saharan Africa, Nigeria in particular, there exists distinctive renewable clean-tech insurance policies whereas regional insurance policies are not entirely formed due to unpalatable implementation approach. What this simply indicates is that, in spite of several policies developed on renewable energy in the country, their implementation has proven to be difficultdue to immaturity (Ikem et al., 2016; Muhammed et al., 2017 and Giwa et al., 2017).

Furthermore, participation of private ownership in renewable and clean energy initiatives in Nigeria is hindered via the lack of well-defined insurance policies on personal investment and delays in the authorization of free enterprise projects. It has been proved that commercial renewable clean-tech initiatives require huge amount of money to run. So, failure of policy makers to put effective measures that will entice capitalists and venture capitalists in place slows down the adoption of renewable clean-tech transition in the country (Yusuf, Flossie, Aritra, Senthilarasu and Tapas, 2022).

4.5 Geographical and Ecological Challenge

The geographical site and the state of the environment prior to anthropogenic pollution in a region can lead to a decline in renewable clean-tech adoption. For instance, the incidence of solar radiation as well as the strength of wind energy on the earth is totally based on geographical location. These two renewable energies are sporadic in nature and this could causetheir usage by individuals to be circumscribed because their reliability will be inconsequential(Sambo, 2009a).

Additionally, increased human population has proven to be directly proportional to shortage of eco-friendly and renewable resources and this hinders full adoption of renewable clean-tech in Nigeria. As human population rises, production of renewable energy becomes steeply-priced and this will in turn be uneconomical and exorbitant to be afforded by consumers.

4.6 Lack of Market Competitiveness

The steep nature of startup funds associated with renewable clean-tech science is substantially mirrored in their market values when to be disposed of to purchasers. Market prices for these systems are high and unaffordable by many prospective consumers and this is attributed to the truth that total cost of production is distinctly immoderate compared to fossil fuels. Since human beings in general often opt for cost effective technological grasp in most cases, renewable clean-tech therefore, experiences unfair market rivalry from fossil fuel technology whose operational charges are often subsidized.

Other elements that make replenished energy generated from natural processes to experience low rivalry and unavailable in the market encompass lack of rewarding and replicable renewable clean-tech enterprise modelsto help in altering small-scale initiatives to commercial enterprise; inconsistent biomass supply, lack of market for renewable power coupled with excessive and fluctuating prices of renewable energy. Hence, it is evident that majority do not have the money to opt for renewable clean-technologies due to their increased cost of installations and operations that raise their market charges and restrict their marketability. Since the market for renewable electricity sources is limited, its improvement is moreover restrained and as a result, individuals are demotivated in the acquisition and amplification of such technologies because it will be ironical to pump money into the development of a technology that is rendered unmarketable (Giwa et al., 2017; Muhammed et al., 2017).

4.7 Financial and Economic Downturn

Factors that determine the degree of full adoption of renewable clean-tech transition in relation to financial and economic perspectives are preliminary capital costs, transaction costs, economic status, availability of incentives and subsidies. Startup funds for renewables are exorbitant when in contrast to traditional sources of energy, and this in turn raises the price of energy generation through renewable clean technologies. In any profitable business, preference is given to keeping startup funds low while maximizing profits. Hence, high value of startup funds is a huge hindrance towards full adoption of renewable energy transition. Many developing countries, Nigeria in particular lacks ample renewable energy technologies and therefore relies on their importation from industrialized nations. This importation successively raises preliminary investment costs of the technologies and for this reason, prospective capitalists are discouraged due to the luxurious nature of the imported technologies as against the ones made domestically (Ikem et al., 2016).

Many transaction costs are moreover involved in the generation of renewable and clean energy which in turn raises the entire manufacturing costs. The concept of transaction costs entails the required timeand costs of resources to establish and to recognize difficulties that the establishment focuses at solving. Naturally, formation of renewable power technologies are multi-faceted when compared to the construction of a non-renewable power plant. What this implies is that greater transaction quotations are required in renewable clean-tech projects. Regardless of the project size, the activities, methodologies and commodities or by-products involved are the same. For instance, an agreement has to reached by many parties, numerous products of interest and/or by-products stimulate or exacerbate the projects coupled with the truth that most of these projects are in conjunction withdistinct socio-economic views as well as affairs of the development. Hence, all of these have positioned renewable technologies to be steeply-priced to producers as well as consumers (Giwa et al., 2017; Oji et al., 2012).

Furthermore, the economic conditions of most African countries, Nigeria in particular is poor and this extremely results into great distortions of the strength of renewable market. For instance, prices of solar systems have proven to be exorbitant and unaffordable to most households in rural communities where low income earners are in abundance. Despite the utilization of low levels of technology by some renewable energy, they are still less commercially competitive when they are compared with fossil fuels. It is therefore, smart on the on the part of the governmentto aid committed investment in renewable and clean energy development to pace up the commercialization of the technologies (Giwa et al., 2017).

Lack of credit facilities coupled with high interest rate on credit facilities is moreover an impediment to the full adoption of renewable energy particularly in Nigeria. It is set up that most traditional electricity plants had been constructed with huge subsidies coupled with their capital costs being covered. However, very few monetary institutions (both public and private) are inclined to furnish significant loans for execution of renewable and clean energy projects. Also, the excessive tiers of subsidies on fossil fuels bring up unfair opposition to renewable power utilized sciences thereby rendering the technologies to be economically weak to compete in the markets. Due to the reality that there are many incentives to acquire fossil fuels than renewable and clean energy, many individuals decide to adhere to the use of what favours them which is fossil fuels (Giwa et al., 2017; Muhammed et al, 2017).

4.8 Theft and Vandalism

Standalone structures such as photovoltaic solar energy technologies are susceptible to stealing and destruction. This undesirable act is a huge challenge facing full adoption of renewable and clean energy transition in Nigeria (Giwa et al., 2017). Areas that are high in power demand in the country are susceptible to stealing and disfigurement of solar energy technology as a result of insecurity and insurgency ravaging the country (Ohunakin et al., 2014). What these vandals do is to dispose of or cut some transmissions in protest towards established policies by policy makers or for the purpose of stealing and this in turn has brought about a serious decline in the regular living of Nigerians (Ibukun and Adebayo, 2021).

4.9 Lack of Protection Stability

Stabilized security is crucial for full adoption of renewable energy in African countries, particularly in Nigeria. With the ongoing engagement of terrorists, kidnappers, insurgents, bandits and militants throughout the country, it will turn out to be challenging for an enabling surroundings to thrive for full adoption of renewable energy technologies in all aspects in spite of the sizeable practicable market due to human populace and demand gap. The insecurity is seen to affect all aspects that would possibly enhance full adoption of renewable energy. Investors would require a secured area to establish. Also, hooked up infrastructures require full protection over a prolonged duration for its return investment. Furthermore, local research and development on renewable and clean energy technologieswould in addition require a consistent and secured environment. It is also established that killings and kidnapping particularly in the northern part of the countryhave impeded the development of some energy plant existence and unique infrastructures that ought to embellish the adoption of renewable and clean energy technologyin the country thereby exposing the region to vulnerability and a high level of danger that affects all kinds of business establishments (Ohunakin et al., 2014; Miftau and Oruonye, 2020).

V. Solutions to the Challenges of Renewable Energyin Nigeria

In order to overcome the earlier established challenges facing full adoption of renewable energy in Africa, particularly in Nigeria, the government and concerned stakeholders are called upon to take immediate action in the following ways:

a. Nigeria is endued with abundant undepletable and inexhaustible resources meant for tapping and coalescing to supply mix with a more promising future in solar PV, wind and biomass. Hence, the government should speedily expedite action on full adoption of these renewable energy technologies across the nooks and cranny of the country.

b. Government and concerned private companies should escalate their efforts in the establishment of more research and development centres while strengthening the existing ones through adequate funding. This will make it possible for technology transfer and home-based commercialization of renewable energy technologies to be achieved. It is also pertinent to add that government should assess, observe and check the progress and performance of all the research centres in terms of excellent research output from the centres.

c. Government should espouse or design standards that will check the inundation of inferior quality renewables into the country. This will discourage some potential consumers from purchasing substandard renewable energy products such as solar panels, inverters and other energy conserving systems.

d. The need for human capacity building cannot be compromised hence, numerous technical personnel across the country should be well trained in the area of proper installations and maintenance procedures of renewable energy technologies.

e. It is established that the price of renewable energy technology such as solar photovoltaic (PV) is declining and as a result, related component parts should also be subsidized to assist low-income earners in affording the technology. Tax incentives policy should also be implemented to reduce the cost price of any renewable energy technology. Provision of incentives such as subsidies, taxation waivers and investment loans in the sector should be highly practised by the government to help reduce the initial high cost of renewable energy technologies in the country.

f. Policy instability must be shunned and continuous development should be welcomed for full realization of renewable energy projects before year 2030.
g. The Nigerian government must comply with the documented Nigerian Renewal Energy and Energy Efficiency Policy (NREEEP) as this will help in blending renewable and clean energy in the supply mix as well as diversifying and increasing the supply.
h. More awareness should be raised and strategic campaigns should be designed and amplified at federal, state and local levels by both private and government sectors in the dissemination of information through seminars, workshops, and media adverts to the public on the need to embrace and adopt renewable energy technology.
i. Appropriate measures as well as continuous surveillance improvement to prevent theft, vandalization and insecurity related to renewable and clean energy establishment should be employed.
j. Establish a renewable and clean energy funding/financing agency in the country.
k. Carry out a resource examination and evaluation to determine the entire renewable and clean energy potential in the country as well as identify the local conditions and local precedencies in numerous ecological zones.

VI. Conclusion

Full adoption of renewable energy transition in Nigeria is essentialto achieve SDG-7. Hence, it becomes imperative that policy makers, stakeholders and the general public take immediate and sustained actions to halt the earlier stated challenges facing full adoption of the technology in Africa particularly in Nigeria. The solutions in this paper offer a unique strategy to address those challenges and it is hoped that this paper can serve as a guide and offer usefulness to renewable energy researchers, science communities, potential inventors, the government and the general public on the need to pursue sustainable green energy for economic sustainability as well as climate change neutrality.

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