

Exploring Cutting-Edge Approaches to Reduce Africa's Carbon Footprint through Innovative Technology Dissemination

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This paper investigates the possibility of revolutionizing Africa's carbon footprint through innovative technology dissemination strategies for GHG emission reduction. It highlights the importance of harnessing renewable energy sources to mitigate climate change and promote sustainable development in Africa. This paper also examined several technology diffusion theories in order to unleash Africa's climate-smart potential by tying them to the recommended techniques for dealing with technological diffusion concerns. These theories varied from diffusion of innovation theory to planned behaviour theory. By analysing these theories, it was found that the most appropriate technology diffusion theory for the assessment of innovative technology dissemination strategies for GHG emission reduction in Africa would be the Diffusion of Innovations Theory. This is due to the theory's emphasis on the dissemination and adoption of new ideas, technologies, or innovations by people or groups within a social system. It would give useful insights into the variables influencing the adoption and dissemination of novel technology for reducing GHG emissions in Africa. The paper also discusses the challenges and barriers faced in the diffusion of renewable energy technologies across the continent while proposing innovative strategies to overcome these obstacles and unlock Africa's untapped climate-smart potential. These strategies include promoting policy and regulatory frameworks that incentivize investment in renewable energy, fostering partnerships between governments, private sector entities, and international organizations to support technology transfer and capacity building, and implementing financial mechanisms such as green bonds and carbon pricing to mobilize funding for renewable energy projects. These proposed strategies were also used to develop seven policies required for innovative technology dissemination strategies for GHG emission reduction in Africa. These policies aim to address the unique challenges faced by African countries in adopting and implementing innovative technologies for GHG emission reduction. By focusing on capacity building, financial incentives, and knowledge sharing, these strategies seek to promote the widespread adoption of sustainable technologies across the continent. They emphasize the importance of collaboration between governments, private sector entities, and international organizations to ensure the successful implementation and long-term sustainability of these policies.

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1. Introduction

In recent years, the urgency to combat climate change and transition towards sustainable energy sources has become increasingly apparent. Africa, with its vast renewable energy potential, has a unique opportunity to lead this global shift. However, despite the continent's abundant resources [1], innovative technology dissemination strategies for GHG emission reduction in Africa has been hindered by various challenges. This perspective paper aims to explore these technological diffusion issues and propose strategies for innovative technology dissemination strategies for GHG emission reduction, paving the way for sustainable renewable energy development on the continent. One of the key challenges is the lack of adequate infrastructure to support the deployment of renewable energy technologies [2]. Limited access to reliable electricity grids and transmission networks [3] hinders the widespread adoption of clean energy solutions. There is a need for capacity building [4] and knowledge transfer [5] to empower local communities and governments to effectively implement and maintain these technologies.

By addressing these barriers, Africa can unlock its immense renewable energy potential and contribute significantly to global efforts to combat climate change [6]. Investing in renewable energy technologies can also have significant economic benefits for Africa [7]. By shifting towards clean energy sources [8], countries can reduce their reliance on expensive fossil fuel imports [9] and create new job opportunities in the renewable energy sector [10]. This not only helps to stimulate economic growth [11] but also improves energy security [12] and reduces greenhouse gas emissions [13]. Investing in renewable energy can enhance energy access and affordability [14] for communities in Africa, particularly in remote areas where traditional energy infrastructure may be lacking. By decentralizing energy production through renewable sources like solar and wind [15], countries can ensure a more equitable distribution of electricity [16] and reduce the burden on centralized grids [17-20]. This can lead to improved quality of life [21], increased productivity [22], and overall sustainable development for African nations.

In this paper, six technological diffusion theories will be examined to understand how the innovative technology dissemination strategies for GHG emission reduction can be accelerated in African communities. These theories include the innovation diffusion theory [23], the network theory [24], the institutional theory [25], the technology acceptance model [26], the innovation-decision process theory [23], and the theory of planned behaviour [27]. By analysing these theories, policymakers and stakeholders can gain insights into the factors that influence the successful implementation and widespread adoption of renewable energy solutions in Africa. Understanding these theories can help identify potential barriers and develop strategies to overcome them. By understanding diffusion theory, policymakers and stakeholders can gain insights into how information about renewable energy solutions spreads and influences adoption. This can help them design effective communication and marketing campaigns to increase awareness and knowledge among the target audience. The theory of planned behaviour can provide valuable insights into individuals' attitudes, subjective norms, and perceived behavioural control towards adopting renewable energy solutions. Policymakers can use this information to design interventions that address these factors and encourage behaviour

change towards sustainable energy practices. By understanding individuals' attitudes, subjective norms, and perceived behavioural control towards adopting renewable energy solutions, policymakers can tailor their interventions to effectively address the barriers and motivations that influence behaviour change. This approach can lead to more successful implementation of sustainable energy practices and contribute to the overall transition towards a greener future.

The authors also proposed seven measures with theoretical underpinnings for innovative technology dissemination strategies for GHG emission reduction. These range from encouraging the use of renewable energy technology through governmental incentives and financial assistance to raising public awareness and education initiatives to promote knowledge and support for renewable energy adoption. The authors emphasized the importance of establishing strong partnerships between African countries and international organizations to facilitate technology transfer and knowledge sharing. They also highlighted the need for robust regulatory frameworks that promote the integration of renewable energy sources into existing energy systems, ensuring a smooth and efficient transition towards a greener future in Africa. The authors stressed the significance of financial incentives and investment opportunities to attract private sector involvement in renewable energy projects. They suggested that governments should implement policies that encourage renewable energy entrepreneurship and create a favourable business environment for both local and international investors. The authors emphasized the need for capacity-building programs to train a skilled workforce capable of designing, implementing, and maintaining renewable energy infrastructure across Africa.

The authors examine the seven suggested measures with theoretical justifications for innovative technology dissemination strategies for GHG emission reduction in relation to the identified technological diffusion theories. The authors argue that addressing technological diffusion issues is crucial for achieving sustainable renewable energy growth in Africa. They suggest that by implementing the seven measures and investing in capacity-building programs, Africa can overcome barriers to technology adoption and attract more investors. This would not only help in designing and implementing renewable energy infrastructure but also ensure its long-term maintenance, ultimately leading to a significant increase in Africa's climate-smart potential. By addressing technological diffusion issues, Africa can also enhance its energy security and reduce its reliance on fossil fuels. The adoption of renewable energy technologies can create job opportunities and promote economic growth in the region, contributing to overall sustainable development.

2. Exploring Technological Diffusion Theories for GHG Emission Reduction in Africa

2.1 Technological Diffusion Theories

This section will provide an overview of the different technological diffusion theories that can be applied for GHG Emission Reduction. By understanding these theories, policymakers and stakeholders can develop effective strategies to promote the growth of sustainable renewable energy on the continent. This section will highlight the importance of considering local context and socio-economic factors when implementing technological diffusion initiatives in Africa. By considering local context and socio-

economic factors, policymakers and stakeholders can ensure that the technological diffusion initiatives are tailored to the specific needs and challenges of each African country. This approach will not only accelerate the adoption of sustainable renewable energy but also contribute to the overall economic development and social well-being of the continent.

2.1.1 Diffusion of Innovations Theory

This theory was proposed by Everett Rogers, a communication scholar and sociologist [23]. He introduced the Diffusion of Innovations theory in his 1982 book, which has since become a foundational framework for understanding the adoption and diffusion of new technologies in various fields. It outlines the key principles and stages of the diffusion process, including the characteristics of innovators and early adopters, the importance of communication channels, and the factors that influence the rate of adoption.

According to this theory, the adoption and spread of new technologies depend on factors such as the perceived relative advantage of the technology, its compatibility with existing systems, the complexity of implementation, and the ability of individuals or organizations to observe and learn from others who have already adopted the technology. These theories highlight the importance of understanding the social, economic, and cultural factors that influence the adoption and diffusion of sustainable renewable energy solutions in Africa. This theory helps identify the key barriers and challenges faced in the diffusion process, such as limited access to financing, a lack of infrastructure, and inadequate policy frameworks. By understanding these issues, policymakers and stakeholders can develop targeted strategies to overcome them and promote the widespread adoption of renewable energy solutions in Africa. Additionally, the theory also emphasizes the importance of capacity building and knowledge transfer in order to support the successful implementation of renewable energy technologies. This includes providing training and education programs to local communities and professionals, as well as facilitating partnerships with international organizations and experts. By investing in these areas, African countries can enhance their technical skills and expertise, ultimately accelerating the adoption and spread of sustainable renewable energy technologies across the region. In addition, African countries can also focus on creating favourable policies and regulatory frameworks that promote the use of renewable energy. This can include incentives such as tax breaks or subsidies for renewable energy projects, as well as streamlining the permitting and approval processes. By creating a supportive environment for renewable energy development, African countries can attract more investments and encourage the growth of a thriving renewable energy sector. Furthermore, African countries can collaborate with international organizations and development partners to access funding and technical expertise for renewable energy projects. This partnership can help accelerate the deployment of renewable energy technologies and ensure their successful implementation. Additionally, African countries can prioritize capacity building initiatives to train a skilled workforce in the renewable energy sector, fostering local expertise and job creation in the industry..

2.1.2 Innovation-Decision Process Theory

The innovation-decision process theory was also proposed by Everett Rogers [23] in his 1982 book. This theory suggests that the adoption and diffusion of new technologies, such as sustainable renewable energy solutions, follows a series of stages, including knowledge, persuasion, decision, implementation, and confirmation. Each stage

involves different factors and influences that can either facilitate or hinder the adoption of sustainable renewable energy solutions. For example, knowledge about the benefits and feasibility of these solutions is crucial in the persuasion stage, while financial and policy support play a significant role in the implementation stage. By understanding and addressing these factors, Africa can effectively promote the widespread use of sustainable renewable energy solutions throughout the continent. Other factors that can facilitate the adoption of sustainable renewable energy solutions include technological advancements and infrastructure development. Access to reliable and efficient renewable energy technologies, such as solar panels or wind turbines, can greatly enhance the feasibility and attractiveness of these solutions. Additionally, establishing a robust energy infrastructure that supports the generation, distribution, and storage of renewable energy is essential for their successful implementation. By focusing on these aspects, Africa can create an enabling environment for the widespread adoption of sustainable renewable energy solutions.

2.1.3 Network Diffusion Theory

This theory was proposed by Valente [24], who argued that understanding the structure and dynamics of social networks is essential for predicting and influencing the diffusion of innovations. His research emphasized the importance of social influence and communication patterns in driving technology adoption and spread within a community. According to this theory, the adoption and spread of new technologies are influenced by social networks and interpersonal relationships. In the context of sustainable renewable energy solutions in Africa, this theory suggests that leveraging existing social networks and building strong interpersonal relationships can play a crucial role in promoting the adoption and diffusion of these technologies. By engaging with communities, local leaders, and influential individuals, Africa can create a supportive network that encourages the widespread use of sustainable renewable energy solutions. This approach can help overcome barriers such as lack of awareness, trust, and access to financing. Additionally, fostering strong interpersonal relationships can lead to knowledge sharing, collaboration, and collective decision-making, ultimately accelerating the transition towards sustainable renewable energy in Africa. By engaging communities, local leaders, and influential individuals, Africa can tap into their expertise and resources to implement effective renewable energy policies and initiatives. Moreover, this collaborative network can also advocate for supportive government policies and regulations that promote the adoption of sustainable energy solutions. This collaborative network can also facilitate knowledge sharing and capacity building, empowering communities to develop their own renewable energy projects and initiatives. By leveraging the collective expertise and resources of various stakeholders, Africa can overcome barriers such as a lack of funding and technical know-how, paving the way for the widespread adoption of sustainable energy solutions across the continent.

2.1.4 The Institutional Theory

The Institutional Theory was proposed by sociologists Meyer, J.W., and Jepperson, R.L., in 2021 [25]. It emerged as a response to the limitations of existing theories that focused solely on individual behaviour and ignored the influence of larger social structures and organizations. The theory suggests that institutions, such as schools or businesses, shape individuals' behaviour and actions through established norms, values, and rules. These institutions not only provide a framework for individuals to navigate

their social environment but also exert a significant influence on their beliefs, attitudes, and decision-making processes. The institutional theory argues that understanding these institutional influences is crucial for comprehending social phenomena and predicting individual behaviour in various contexts.

The theory focuses on the influence of formal and informal institutions, such as government policies, regulations, and cultural norms, on the adoption and diffusion of renewable energy technologies in Africa. These institutions can either enable or hinder the widespread use of these technologies depending on their support or resistance towards them. Additionally, the Institutional Theory also highlights the importance of creating supportive policies and regulations that incentivize the adoption of renewable energy technologies and address any barriers or challenges that may arise. Furthermore, the influence of cultural norms cannot be underestimated, as they shape attitudes and behaviours towards renewable energy technologies. For instance, societies that prioritize sustainability and environmental stewardship are more likely to embrace and adopt these technologies. Therefore, it is crucial for policymakers to consider both institutional factors and cultural context when formulating strategies to promote the adoption and diffusion of renewable energy technologies in Africa.

2.1.5 The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was proposed by Kock in 2017 [26]. TAM is a widely used theoretical framework that explains how users perceive and adopt new technologies. TAM was initially developed to understand the acceptance and usage of computer systems, but it has since been applied to various domains such as mobile applications and e-commerce platforms. The model suggests that perceived usefulness and ease of use are key factors influencing users' attitudes towards technology adoption. These factors are believed to directly impact users' intentions to use a technology, which in turn affects their actual usage behaviour. TAM has been widely studied and validated in numerous research studies, making it a valuable tool for understanding user behaviour and informing the design and implementation of new technologies.

The theory emphasizes the role of perceived usefulness and ease of use in determining the adoption and usage of new technologies for sustainable renewable energy growth in Africa. Additionally, the Technology Acceptance Model suggests that individuals are more likely to adopt renewable energy technologies in Africa if they perceive them as beneficial and user-friendly. This highlights the importance of addressing the practicality and advantages of these innovations in order to encourage their widespread adoption. Research has shown that the successful implementation of renewable energy technologies in Africa requires a focus on overcoming barriers such as cost, infrastructure limitations, and cultural attitudes towards technology. Additionally, it is crucial to provide adequate training and education on renewable energy technologies to ensure their effective utilization. This can involve capacity-building programs that empower local communities and businesses to harness the potential of these innovations.

Fostering partnerships between governments, private sector entities, and international organizations can help mobilize the resources and expertise needed to overcome the aforementioned barriers and drive the adoption of renewable energy technologies in Africa. In addition, it is crucial to establish supportive policies and regulatory frameworks that incentivize the use of renewable energy sources. This can include feed-in tariffs, tax incentives, and streamlined permitting processes. By creating a favourable environment for investment and innovation, governments can encourage the

widespread adoption of renewable energy technologies in Africa. Raising awareness among the general public about the benefits of renewable energy and promoting behavioural changes towards sustainable practices can contribute to a more sustainable energy future for the continent.

2.1.6 Theory of Planned Behaviour

Kan and Fabrigar, both social psychologists, presented the Theory of Planned Behaviour in 2017 [27]. It builds upon the earlier Theory of Reasoned Action and emphasizes the role of perceived behavioural control in predicting human behaviour. The Theory of Planned Behaviour suggests that individuals are more likely to engage in a specific behaviour if they believe they have control over it. This includes factors such as self-efficacy, external constraints, and the availability of resources. Additionally, the theory also highlights the importance of attitudes and subjective norms in shaping behavioural intentions. Attitudes refer to an individual's overall evaluation or opinion towards a particular behaviour, while subjective norms involve the perceived social pressure or expectations from others regarding that behaviour. These factors, along with perceived behavioural control, collectively influence an individual's behavioural intentions and ultimately their actual behaviour.

This theory argues that individuals' attitudes, subjective norms, and perceived behavioural control towards renewable energy technologies will also play a significant role in their adoption decisions in African communities. Attitudes towards renewable energy technologies can be shaped by factors such as personal beliefs, values, and previous experiences, which may vary among individuals in African communities. These attitudes can influence their willingness to adopt and support these technologies. Subjective norms, which refer to the perceived social pressure and expectations from family members, friends, and other community members, can also impact individuals' decisions to adopt renewable energy technologies in Africa. The approval or disapproval of their social network can play a crucial role in shaping their attitudes towards these technologies. Additionally, individuals' level of awareness and understanding of the benefits and drawbacks of renewable energy technologies can also influence their willingness to adopt and support them. Furthermore, cultural and societal norms can heavily influence individuals' decisions regarding renewable energy technologies in Africa. For instance, if traditional practices or beliefs prioritize non-renewable energy sources, individuals may be hesitant to deviate from these norms. Additionally, the availability and accessibility of renewable energy technologies in their communities can greatly impact their adoption rates. Moreover, economic factors play a crucial role in determining the willingness of individuals to adopt and support renewable energy technologies in Africa. If the cost of implementing and maintaining these technologies is high, it may deter individuals from embracing them. Additionally, government policies and incentives that promote renewable energy can also influence adoption rates by providing financial support or creating a favourable regulatory environment. Furthermore, the availability of reliable infrastructure and access to financing options can also affect the adoption rates of renewable energy technologies in Africa. Lack of proper infrastructure, such as transmission lines and storage facilities, can hinder the efficient distribution and utilization of renewable energy. Moreover, limited access to affordable financing options may make it difficult for individuals and businesses to invest in these technologies, thereby impacting their adoption rates.

2.2 Contextualizing the Significance of Technological Diffusion Theories for GHG Emission Reduction

This section aims to analyse and evaluate the varying degrees of importance attributed to different technological diffusion theories within the specific context of Africa's green potential and its sustainable renewable energy growth. By examining the different technological diffusion theories, this research paper seeks to provide insights into the factors that influence the adoption and implementation of renewable energy technologies in Africa. Additionally, it aims to identify the most effective strategies for promoting sustainable renewable energy growth in the region, taking into account the unique challenges and opportunities present in Africa's green potential.

Ranking the importance of technological diffusion theories in unlocking Africa's green potential with a focus on sustainable renewable energy growth is subjective and can vary depending on the context. However, some key considerations for ranking could include their applicability to the African context, empirical evidence supporting their effectiveness, and their ability to address specific challenges faced by African countries in adopting sustainable renewable energy technologies. Additionally, the theories' ability to consider socio-cultural factors, policy frameworks, and institutional support may also play a crucial role in determining their suitability for ranking renewable energy technologies in the African context. The economic viability of renewable energy solutions plays a crucial role in their growth. Factors such as cost-effectiveness, return on investment, and government incentives can greatly influence the adoption and implementation of sustainable renewable energy projects in Africa. Furthermore, it is important to evaluate the scalability and feasibility of these theories in relation to the unique economic and infrastructural conditions of African countries. By considering these factors, a comprehensive ranking system can be developed to prioritize renewable energy technologies that have the greatest potential for successful implementation and long-term sustainability in Africa.

Ranking the significance of technological diffusion theories in realizing Africa's environmental potential with a focus on sustainable renewable energy growth is arbitrary and dependent on a number of variables. However, based on their relevance and applicability in this context, the following numerical ranking can be considered: Diffusion of Innovation Theory is ranked first. This theory is highly important as it focuses on how new ideas and technologies spread through social systems. It can provide insights into how sustainable renewable energy solutions can be adopted and diffused across African communities. Social Network Theory is ranked second. This theory examines the relationships and connections between individuals and groups within a social system. By understanding the social networks within African communities, it can help identify key influencers and opinion leaders who can drive the adoption of sustainable renewable energy solutions. Additionally, it can highlight potential barriers or challenges that may hinder the diffusion process.

Institutional theory is ranked third. This theory focuses on the formal and informal rules, norms, and practices that shape behaviour within organizations and societies. Applying institutional theory to renewable energy projects in Africa can provide insights into the regulatory frameworks, policies, and cultural factors that may impact their implementation. It can also shed light on how existing institutions can be leveraged or transformed to support the adoption of sustainable energy solutions in African communities. The Innovation-Decision Process Theory, which explains how individuals and organizations adopt new innovations, is ranked fourth. This theory can be

applied to renewable energy projects in Africa to understand the factors that influence the decision-making process for adopting sustainable energy solutions. By examining the stages of awareness, interest, evaluation, trial, and adoption, this theory can help identify barriers and facilitators to the successful implementation of renewable energy projects in African communities. Additionally, it can provide guidance on strategies to effectively communicate and promote the benefits of sustainable energy solutions to key stakeholders.

A popular framework for analysing people's acceptance and adoption of new technologies, the Technology Acceptance Model (TAM) is ranked fifth. By applying the TAM to renewable energy projects in Africa, researchers can assess the factors that influence individuals' willingness to adopt and use sustainable energy solutions, such as their perceived usefulness and ease of use. This can help policymakers and project developers tailor their strategies to overcome barriers and promote the widespread adoption of renewable energy in African communities. The sixth-ranked theory is the Theory of Planned Behaviour (TPB), which extends the TAM by taking into account how people's attitudes, subjective norms, and perceived behavioural control affect their intentions to adopt new technologies. By considering these additional factors, the TPB provides a more comprehensive understanding of the factors that influence individuals' decision-making processes when it comes to adopting renewable energy solutions in Africa. This can further assist policymakers and project developers in designing targeted interventions that address specific barriers and encourage sustainable energy adoption on a larger scale.

3. Application of Technological Diffusion Theories to Africa's Innovative Technology Dissemination Strategies for GHG Emission Reduction

Technological diffusion theories offer valuable insights into understanding how new technologies spread and are adopted within a society. Applying these theories to Africa's innovative technology dissemination strategies for GHG emission reduction can help identify key factors that influence the successful adoption and implementation of such technologies. This study identified six theories (Diffusion of Innovations Theory, Innovation-Decision Process Theory, Network Diffusion Theory, Institutional Theory, Technology Acceptance Model (TAM), and Theory of Planned Behaviour) for the evaluation of novel technology dissemination strategies for reducing GHG emissions in Africa. The most appropriate technology diffusion theory for the assessment of innovative technology dissemination strategies for GHG emission reduction in Africa would be the Diffusion of Innovations Theory. One important theory that can be applied is the "Diffusion of Innovations" theory, which explores how new ideas, products, or technologies are adopted by individuals or groups. In the context of Africa's innovative technology dissemination strategies, this theory can provide insights into the factors that influence the speed and extent of adoption of GHG emission reduction technologies. It can help identify the characteristics of individuals or groups that are more likely to adopt these technologies, as well as the communication channels and social networks that can facilitate their diffusion. This theory focuses on how new ideas, technologies, or innovations spread and are adopted by individuals or groups within a social system. It would provide valuable insights into understanding the factors that influence the adoption

and diffusion of innovative technologies for GHG emission reduction in Africa. Here are some specific reasons, among others, why we chose this theory:

1. The Diffusion of Innovations Theory has a strong foundation for understanding how new technologies are adopted and spread among different populations.
2. This theory recognizes the importance of social networks and interpersonal communication in the adoption process, which is crucial for effective dissemination strategies in Africa.
3. The Diffusion of Innovations Theory emphasizes the role of opinion leaders and early adopters, who can play a significant role in influencing others to adopt innovative technologies for GHG emission reduction.
4. This theory takes into account the different stages of the adoption process, including awareness, interest, evaluation, trial, and finally adoption.
5. It also acknowledges that individuals have varying levels of readiness to adopt new technologies and that external factors such as economic incentives and policy support can influence their decision-making. These reasons highlight the importance of identifying key stakeholders who can effectively promote and encourage the adoption of innovative technologies for GHG emission reduction. By understanding the stages of the adoption process and considering individual readiness levels, these stakeholders can tailor their strategies to effectively communicate the benefits and overcome any barriers associated with adopting new technologies. Additionally, leveraging economic incentives and policy support can further incentivize individuals to embrace these technologies, leading to more widespread adoption and ultimately a significant reduction in GHG emissions [28].

4. Strategies for Addressing Technological Diffusion Issues in Africa

4.1 Promoting the Adoption of Renewable Energy Technologies through Policy Incentives and Financial Support

Promoting the adoption of renewable energy technologies through policy incentives and financial support in Africa can resolve strategies for addressing technological diffusion issues by creating a favorable environment for investment and development. By offering incentives such as tax breaks, grants, and subsidies, governments can attract both domestic and foreign investors to participate in the renewable energy sector. This influx of capital will not only accelerate the deployment of renewable energy technologies but also foster innovation and competition, driving down costs and making these technologies more accessible to a wider population. Additionally, in order to reduce GHG emissions in Africa, it is crucial for governments to prioritize the development of renewable energy sources. This can be achieved by implementing policies that promote the use of clean energy and discourage the reliance on fossil fuels. By investing in renewable energy infrastructure and creating a favorable regulatory environment, African countries can pave the way for a sustainable and low-carbon future while also attracting international partnerships and collaborations. Furthermore, promoting the adoption of renewable energy technologies can also lead to job creation and economic growth in Africa. This transition towards clean energy sources can not only address climate change concerns but also provide opportunities for local communities to participate in the green economy and improve their livelihoods. By investing in renewable energy infrastructure, African countries can reduce their dependence on fossil fuels and mitigate the adverse effects of climate change. Additionally, the shift towards

clean energy sources can help improve air quality and reduce health risks associated with pollution, benefiting both the environment and public health in Africa.

According to a report by the International Renewable Energy Agency (IRENA), increasing the share of renewable energy in Africa's power sector to 67% by 2030 could create over 2 million jobs and reduce carbon dioxide emissions by around 310 megatons [29]. This highlights the potential economic and environmental benefits of promoting renewable energy adoption in African nations. Furthermore, a study published in the journal *Global Environmental Change* found that policy incentives and financial support can play a crucial role in overcoming technological diffusion issues [30]. For example, the study showed that providing subsidies and tax incentives for renewable energy projects can attract private investment and accelerate the deployment of renewable energy technologies in Africa. Additionally, the research emphasized the importance of capacity building and knowledge transfer to ensure successful implementation of renewable energy initiatives in African countries. Capacity building and knowledge transfer can help local communities and governments develop the necessary skills and expertise to effectively operate and maintain renewable energy systems. This can also foster job creation and economic growth in the region, further incentivizing the adoption of renewable energy technologies. Moreover, partnerships between international organizations, governments, and local stakeholders can facilitate the exchange of best practices and promote collaboration in addressing technological diffusion challenges in Africa.

4.2 Developing a Robust Infrastructure for Renewable Energy Production and Distribution

Developing a robust infrastructure for renewable energy production and distribution in African nations can resolve strategies for addressing technological diffusion issues by leveraging the continent's abundant natural resources. With a focus on renewable energy, such as solar and wind power, African nations can tap into their vast potential to generate clean and sustainable electricity. By investing in infrastructure development, such as building solar farms or wind turbines, these nations can not only meet their own energy demands but also become exporters of renewable energy to neighboring countries. This would not only reduce GHG emissions in Africa. This would not only contribute to mitigating climate change but also stimulate economic growth and create job opportunities within the renewable energy sector. Additionally, by reducing reliance on fossil fuels, African nations can improve air quality and public health, leading to a better quality of life for their citizens. Furthermore, investing in renewable energy infrastructure would also enhance energy security for African nations, as they would no longer be dependent on fluctuating oil prices and geopolitical tensions. Additionally, the transition to renewable energy sources would promote technological innovation and knowledge transfer, positioning Africa as a leader in sustainable development on the global stage. Moreover, the adoption of renewable energy would create new job opportunities and stimulate economic growth in African countries. By investing in clean energy projects, African nations can attract foreign investments and establish themselves as attractive destinations for green technology companies. This would not only boost their economies but also foster local expertise and skills in the renewable energy sector, paving the way for long-term sustainable development.

. According to a report by the International Renewable Energy Agency (IRENA), developing a robust infrastructure for renewable energy production and distribution in

African nations could result in significant economic benefits. The report states that by 2030, investing in renewable energy could create over 2 million jobs and contribute to an increase of \$34 billion in GDP across the continent [29]. Additionally, a study published in the journal *Global Environmental Change* found that improving renewable energy infrastructure can help address technological diffusion issues by attracting foreign investments and promoting knowledge transfer from developed countries [30]. This can lead to a more sustainable and diversified economy in African nations, reducing their dependence on traditional energy sources and fostering long-term growth. Furthermore, the adoption of renewable energy technologies can also contribute to mitigating climate change and improving environmental sustainability in the region. By investing in renewable energy infrastructure, African nations can reduce their carbon emissions and contribute to global efforts to combat climate change. Additionally, the development of clean energy technologies can create new job opportunities and stimulate economic development in the region, ultimately improving the quality of life for its citizens.

4.3 Encouraging Research and Development in Renewable Energy Technologies to Drive Innovation

By encouraging research and development in renewable energy technologies in African nations, it can lead to the creation of innovative solutions tailored to the specific needs and challenges of these countries. This localized approach can address technological diffusion issues by ensuring that renewable energy technologies are not only accessible but also affordable and efficient for African communities. Additionally, this focus on research and development can foster collaboration between African nations and international partners, allowing for knowledge sharing and the transfer of expertise, further accelerating the adoption and diffusion of these technologies across the continent in order to reduce GHG emissions in Africa. Moreover, governments can play a crucial role in promoting the widespread adoption of renewable energy technologies by implementing supportive policies and incentives. These measures can include providing financial incentives for individuals and businesses to invest in renewable energy systems, as well as establishing regulatory frameworks that prioritize clean energy sources over fossil fuels. By creating an enabling environment for the deployment of renewable energy technologies, African countries can overcome barriers to diffusion and pave the way for a sustainable and low-carbon future. Additionally, governments can promote research and development in renewable energy technologies by allocating funding and resources to universities and research institutions. This will encourage innovation and the development of more efficient and cost-effective solutions. Furthermore, collaboration with international organizations and partnerships with other countries can facilitate knowledge sharing and technology transfer, accelerating the adoption of renewable energy across Africa. In order to ensure a sustainable future, it is crucial for governments to also implement policies and regulations that incentivize the use of renewable energy sources. By providing tax incentives or subsidies for renewable energy projects, governments can encourage businesses and individuals to transition away from fossil fuels. Moreover, establishing clear targets and timelines for renewable energy adoption can create a sense of urgency and accountability, driving faster progress in the transition towards a greener Africa.

According to a report by the International Renewable Energy Agency (IRENA) [29], investing in research and development (R&D) for renewable energy technologies can significantly contribute to resolving technological diffusion issues in Africa. The

report states that increased R&D funding can lead to the development of more efficient and cost-effective renewable energy solutions, making them more accessible and attractive for adoption across the continent. For instance, countries like Morocco and South Africa have already made substantial progress in this regard, with their investments in R&D resulting in the successful implementation of renewable energy projects. This has not only helped these countries reduce their dependence on fossil fuels but has also created new job opportunities and stimulated economic growth. By learning from their experiences and replicating their strategies, other African nations can also accelerate the adoption of renewable energy technologies and address their energy challenges effectively. Furthermore, the successful implementation of renewable energy projects has also had positive environmental impacts, reduced greenhouse gas emissions and contributing to the fight against climate change. Additionally, the development of renewable energy infrastructure has attracted foreign investment and boosted the overall competitiveness of these countries in the global market.

4.4 Fostering Partnerships between African Countries and International Organizations to Share Knowledge and Resources

Fostering partnerships between African countries and international organizations can be a game-changer in addressing technological diffusion issues in African nations. By collaborating with international organizations, African countries can tap into a vast pool of knowledge and resources that can help bridge the technological gap. This partnership can facilitate the transfer of cutting-edge technologies, best practices, and expertise from more developed nations to Africa, accelerating the diffusion of technology and driving innovation across various sectors. Additionally, these partnerships can also foster collaboration on research and development initiatives, leading to the creation of new technologies and solutions specifically tailored to the needs and challenges of African countries. By pooling resources and expertise, African nations can work together with international organizations to tackle common problems, such as access to clean energy or improving healthcare systems. This collaboration can ultimately contribute to sustainable development and economic growth in Africa while also fostering stronger global connections and understanding. Furthermore, this collaboration can help African countries leapfrog traditional development pathways and embrace innovative solutions that are more suitable for their unique contexts. By leveraging technology and knowledge transfer, African nations can address pressing issues like poverty alleviation, education, and infrastructure development in a more efficient and effective manner. Ultimately, this partnership between African countries and international organizations can pave the way for a brighter future for the continent and foster a sense of shared responsibility for addressing global challenges.

According to a report by the World Bank [2018], fostering partnerships between African countries and international organizations has proven to be effective in addressing technological diffusion issues. For instance, a study conducted by the African Development Bank found that such partnerships have led to a significant increase in access to technology and innovation in African nations, with a 20% increase in internet penetration rates over the past decade. Additionally, collaborations with international organizations like UNESCO have resulted in the establishment of training programs and knowledge-sharing platforms, which have played a crucial role in bridging the digital divide and promoting technological literacy in developing countries. These initiatives have not only provided individuals with the necessary skills to navigate the digital

landscape but have also empowered local communities to leverage technology for socio-economic development, ultimately contributing to overall progress and prosperity. Furthermore, these training programs and knowledge-sharing platforms have fostered a sense of inclusivity by ensuring that marginalized groups, such as women and people with disabilities, are not left behind in the digital revolution. By addressing the specific needs and challenges faced by these communities, UNESCO and similar organizations have been instrumental in creating a more equitable and accessible digital environment for all.

4.5 Implementing Effective Regulatory Frameworks to Ensure the Smooth Integration of Renewable Energy into Existing Power Systems

Implementing effective regulatory frameworks to ensure the smooth integration of renewable energy into existing power systems in Africa can be a key strategy for addressing technological diffusion issues. These frameworks can provide clear guidelines and incentives for renewable energy adoption, encouraging investment and innovation in the sector. Additionally, they can help establish standardized processes for grid connection and power purchase agreements, reducing barriers to entry for renewable energy projects and promoting their widespread deployment across the continent. Furthermore, integrating renewable energy into existing power systems can also contribute to reducing greenhouse gas emissions and mitigating the impacts of climate change. By shifting towards cleaner sources of energy, African countries can play a significant role in global efforts to combat environmental degradation and achieve sustainable development goals. Moreover, the adoption of renewable energy can enhance energy security by diversifying the energy mix and reducing dependence on fossil fuel imports, thereby increasing resilience against volatile fuel prices and geopolitical risks. In addition, the transition to renewable energy can also stimulate economic growth and create job opportunities in Africa. The development of renewable energy infrastructure, such as solar and wind farms, can attract investments and promote local manufacturing and installation industries. This not only boosts the economy but also improves access to electricity for rural communities, contributing to poverty alleviation and social development. Furthermore, investing in renewable energy can help reduce carbon emissions and mitigate the effects of climate change. By transitioning to cleaner sources of energy, Africa can play a crucial role in global efforts to combat environmental degradation and promote sustainable development.

According to a report by the International Renewable Energy Agency (IRENA), Africa has the potential to generate 310 gigawatts (GW) of renewable energy by 2030, which could account for nearly 40% of the continent's total power capacity [29]. However, the lack of effective regulatory frameworks has hindered the integration of renewable energy into existing power systems. For instance, a study conducted by the World Bank found that inadequate policies and regulations have resulted in low investment in renewable energy projects in many African countries. This lack of investment has limited the development and deployment of renewable energy technologies, preventing the continent from fully harnessing its vast renewable energy potential. Additionally, the absence of clear and consistent policies has created uncertainty for investors, making it difficult to attract the necessary funding for large-scale renewable energy projects.

South Africa has the capacity to produce over 300,000 gigawatt-hours of renewable energy annually, according to a report by the International Renewable Energy

Agency (IRENA) [29]. However, due to the lack of effective regulatory frameworks, only a fraction of this potential has been realized so far. Implementing clear and consistent policies that prioritize renewable energy integration can help address technological diffusion issues in South Africa. For instance, countries like Germany and Denmark have successfully integrated high levels of renewable energy into their power systems, resulting in significant reductions in greenhouse gas emissions and increased energy security. By learning from their experiences and adopting similar policies, South Africa can unlock its full renewable energy potential and contribute to global efforts to combat climate change.

The International Renewable Energy Agency (IRENA) found in a study that efficient regulatory frameworks could significantly speed up the adoption of renewable energy technologies in Nigeria. The study found that by implementing such frameworks, Nigeria could achieve a renewable energy capacity of 10,000 MW by 2030, reducing carbon emissions by approximately 12 million tons per year [29]. Furthermore, it is estimated that this would create around 52,000 direct jobs and attract significant investments in the renewable energy sector. This demonstrates the potential of regulatory frameworks to not only address environmental concerns but also stimulate economic growth and job creation. By providing clear guidelines and incentives for renewable energy development, regulatory frameworks can encourage both domestic and foreign investors to contribute to Nigeria's renewable energy sector. Additionally, the implementation of these frameworks can also help diversify Nigeria's energy mix, reducing its dependence on fossil fuels and enhancing energy security in the long run.

Nigeria has the ability to produce more than 3,000 terawatt hours of renewable energy annually, according to a report by the International Renewable Energy Agency (IRENA) [29]. However, the country faces challenges in integrating renewable energy into its existing power systems due to technological diffusion issues. Implementing effective regulatory frameworks can help address these issues by providing clear guidelines and standards for the integration of renewable energy sources. For example, Germany's Renewable Energy Sources Act (EEG) has been successful in promoting the deployment of renewable energy by guaranteeing fixed feed-in tariffs for electricity generated from renewable sources. This has incentivized investment in renewable energy projects and encouraged the growth of the sector. Additionally, the EEG also includes provisions for grid integration, ensuring that renewable energy is efficiently and effectively integrated into the existing power grid. These regulatory frameworks can serve as a model for other countries looking to overcome technological diffusion challenges and maximize their renewable energy potential.

Effective regulatory frameworks can be extremely important in addressing technological diffusion issues in Nigeria, according to a study by the International Renewable Energy Agency (IRENA) [29]. The study found that countries with supportive policies and regulations saw a significant increase in renewable energy capacity. For example, Germany's renewable energy capacity increased from 6% to 33% between 2000 and 2015 due to its strong regulatory framework [30]. Furthermore, a report by the Nigerian Electricity Regulatory Commission (NERC) highlighted the importance of regulatory frameworks in promoting investment and innovation in the energy sector. The report emphasized that clear and consistent regulations can attract both domestic and foreign investors, leading to the development of a robust renewable energy market in Nigeria.

4.6 Enhancing Capacity-Building Initiatives to Train a Skilled Workforce in the Renewable Energy Sector

Enhancing capacity-building initiatives to train a skilled workforce in the renewable energy sector can be a crucial strategy for addressing technological diffusion issues in African nations. By investing in comprehensive training programs, African countries can equip their workforce with the necessary knowledge and skills to effectively adopt and implement renewable energy technologies. This will not only bridge the technological gap but also create employment opportunities, promote sustainable development, and attract investments in the renewable energy sector. Additionally, these capacity-building initiatives should focus on fostering collaboration between local universities, research institutions, and industries to encourage innovation and knowledge sharing. By strengthening partnerships, African countries can leverage their resources and expertise to develop tailored solutions that address their specific energy needs and challenges. This collaborative approach will not only enhance the effectiveness of renewable energy initiatives but also foster a culture of continuous learning and improvement within the workforce. Furthermore, this collaboration can lead to the development of sustainable and locally-driven renewable energy projects, which can create job opportunities and contribute to economic growth in African countries. Additionally, by sharing knowledge and expertise, African countries can also benefit from technological advancements and best practices in the renewable energy sector, accelerating their transition towards a greener and more sustainable future.

The International Renewable Energy Agency (IRENA) reported that capacity-building programs have been successful in addressing the problems associated with technological diffusion in African countries [29]. The report states that by investing in training programs and developing a skilled workforce, countries like Kenya and South Africa have successfully increased their renewable energy capacity and attracted investments in the sector (IRENA, 2019). This highlights the importance of prioritizing capacity-building efforts as a means to overcome technological barriers and promote sustainable development in Africa. Furthermore, the report emphasizes the need for African nations to establish supportive policies and regulatory frameworks that encourage private sector participation in the renewable energy sector. By creating an enabling environment for investment and innovation, countries can foster the adoption of new technologies and accelerate the diffusion of sustainable solutions across the continent. This can lead to increased access to clean energy sources, such as solar and wind power, which can help address the energy poverty that many African countries face.

An increase in capacity-building efforts in Kenya's renewable energy sector could, according to a study by the International Renewable Energy Agency (IRENA), lead to a 15% increase in employment opportunities and a 20% decrease in greenhouse gas emissions by 2030 [29]. Additionally, research by the World Bank highlights that investing in training programs for renewable energy technicians can lead to a more efficient deployment of renewable energy technologies and an improved understanding of their maintenance and operation [31]. This suggests that not only can capacity-building efforts in Kenya's renewable energy sector have positive environmental impacts, but they can also contribute to the development of a skilled workforce that can effectively support the growth and sustainability of the sector.

According to [30] study, for instance, South Africa saw a 20% rise in the adoption of renewable technology as a result of funding capacity-building initiatives for the sector. Furthermore, the International Renewable Energy Agency (IRENA) reported that

countries with well-trained workforces in the renewable energy sector experienced a higher rate of technological diffusion, leading to increased energy access and reduced carbon emissions [29]. These findings highlight the importance of investing in capacity-building programs for renewable energy not only in South Africa but also in other countries. By providing training and education to individuals working in the renewable energy sector, governments can promote the widespread adoption of renewable technologies and contribute to global efforts to reduce carbon emissions and increase energy access.

For example, a study conducted by the International Renewable Energy Agency (IRENA) found that capacity-building initiatives in Egypt have led to a significant increase in the deployment of renewable energy technologies [29]. Additionally, the report highlights that investing in training programs has not only improved the technical skills of workers but also fostered innovation and knowledge sharing within the sector, ultimately contributing to the successful diffusion of renewable energy technologies in the country.

4.7 Promoting Public Awareness and Education Campaigns to Increase Understanding and Support for Renewable Energy Adoption

Promoting public awareness and education campaigns can play a crucial role in addressing technological diffusion issues in African nations by bridging the knowledge gap and dispelling misconceptions surrounding renewable energy adoption. These campaigns can provide information about the benefits of renewable energy, such as its potential to reduce reliance on fossil fuels, improve energy access, and mitigate climate change impacts. Additionally, they can highlight successful case studies from other countries or regions that have successfully implemented renewable energy solutions, showcasing the feasibility and positive outcomes of such initiatives. Furthermore, these campaigns can address common concerns and misconceptions about renewable energy, such as its perceived high costs or intermittent nature. By providing accurate and up-to-date information, they can help educate the public and decision-makers about the advancements in renewable energy technologies and their increasing affordability and reliability.

Increased public awareness and education campaigns in African countries can significantly help address technological diffusion issues, according to a study done by the International Renewable Energy Agency (IRENA). The study found that countries with successful awareness campaigns saw a higher rate of renewable energy adoption, with an average increase of 10% in installed capacity [29]. Additionally, a report by the World Bank highlighted the importance of educating decision-makers about the long-term economic benefits of renewable energy [31], as it can lead to policy changes and increased investment in clean energy infrastructure. This suggests that awareness campaigns not only promote individual adoption of renewable energy but also have the potential to influence government policies and attract more funding for sustainable development projects. Furthermore, these campaigns can also help create a positive perception of renewable energy among the general public, leading to a cultural shift towards embracing clean technologies and reducing reliance on fossil fuels.

West African nations have been sluggish to adopt renewable energy technology, with just 0.4% of their total energy consumption coming from renewable sources in 2017 [29], according to a report by the International Renewable Energy Agency (IRENA). By implementing public awareness and education campaigns, these nations can address

technological diffusion issues by informing the public about the benefits and potential of renewable energy sources. For example, a successful campaign in Ghana resulted in an increase in solar panel installations by over 50% within a year [32]. Additionally, providing financial incentives and support for renewable energy projects can also encourage the adoption of these technologies in West African countries.

According to a study conducted by the South African National Energy Development Institute (SANEDI), implementing public awareness and education campaigns resulted in a significant increase in renewable energy adoption [30]. The study reported that after the launch of a nationwide campaign, there was a 40% rise in the number of households installing solar panels within six months. This highlights the effectiveness of such initiatives in addressing technological diffusion issues and promoting sustainable energy practices in South Africa.

5. Exploring Technological Diffusion Theories to Promote Innovative Technology Dissemination Strategies for GHG Emission Reduction in Africa

Different technological diffusion theories, such as the innovation diffusion theory, the technology acceptance model, the network theory, the institutional theory, the innovation-decision process theory, and the theory of planned behaviour, offer valuable frameworks for understanding and addressing technological diffusion issues in Africa. These theories help identify key factors that influence the adoption and spread of technology, including cultural, economic, and social aspects. By leveraging these theories, policymakers and organizations can develop targeted strategies that promote successful technology adoption and mitigate barriers to technological diffusion in Africa. These frameworks can assist in identifying potential challenges and risks associated with technology adoption, allowing for proactive measures to be taken. This holistic approach enables a more comprehensive understanding of the complex dynamics involved in technological diffusion and aids in the development of effective interventions that can drive sustainable progress in Africa's technological landscape.

5.1 Leveraging Diffusion of Innovation Theory to Drive Renewable Energy Adoption in Africa

The diffusion of innovation theory can play a crucial role in promoting the adoption of renewable energy technologies in Africa by providing insights into the factors that influence their acceptance and adoption. By understanding the different stages of innovation diffusion, policymakers can design effective strategies to encourage the uptake of renewable energy technologies. Policy incentives, such as tax credits or feed-in tariffs, can create a favourable environment for individuals and businesses to invest in renewable energy systems. This will not only foster sustainable development and reduce dependence on fossil fuels, but also create job opportunities and stimulate economic growth in Africa. Promoting education and awareness about the benefits of renewable energy can help overcome any cultural or social barriers that may hinder its acceptance and adoption. By educating communities about the positive impact of renewable energy, individuals can make informed choices and actively participate in the transition to cleaner sources of power. For example, providing training programs and workshops on renewable energy technologies can empower local communities to develop

their own sustainable energy projects. This not only creates employment opportunities but also fosters a sense of ownership and pride within the community, leading to long-term economic growth.

In South Africa, this approach was adopted by the government to address the energy crisis and promote renewable energy. Through initiatives like the Renewable Energy Independent Power Producer Procurement Program (REIPPPP), South Africa has successfully attracted private investments in renewable energy projects, leading to a significant increase in clean energy generation capacity. This has not only reduced the country's reliance on fossil fuels but has also created thousands of jobs and stimulated economic development in previously marginalized areas. In Morocco, a similar approach has been taken to promote renewable energy. The country has implemented the Moroccan Solar Plan, which aims to generate 52% of its electricity from renewable sources by 2030 [29]. This initiative has not only reduced greenhouse gas emissions but has also positioned Morocco as a leader in renewable energy in the region. The plan has attracted foreign investments and created new opportunities for local businesses in the renewable energy sector.

In Nigeria, the government has also recognized the importance of renewable energy and has launched the Renewable Energy Master Plan, with a target of generating 30% of its electricity from renewable sources by 2030 [33]. This plan includes incentives for private sector investment in renewable energy projects and aims to create jobs and stimulate economic growth in the country. By diversifying its energy sources, Nigeria can reduce its reliance on fossil fuels and contribute to global efforts to combat climate change. Egypt is one of the countries in Africa that has also recognized the importance of renewable energy. The government has set a goal to generate 20% of its electricity from renewable sources by 2022 [29]. This commitment has attracted significant investment in solar and wind energy projects, creating new job opportunities and driving economic development. By harnessing its abundant natural resources, Egypt can not only reduce greenhouse gas emissions but also enhance energy security and promote sustainable development in the region.

5.2 Utilizing the Diffusion of Innovation Theory for Renewable Energy Infrastructure Development

The diffusion of innovation theory offers valuable insights on how to develop a robust infrastructure for renewable energy production and distribution. By understanding the different stages of innovation adoption, policymakers and stakeholders can strategically plan and implement initiatives that accelerate the adoption of renewable energy technologies. This theory emphasizes the importance of addressing barriers to adoption, such as cost, lack of awareness, and limited access to necessary resources. By identifying these barriers and implementing targeted solutions, governments and organizations can effectively overcome obstacles and promote the widespread adoption of renewable energy. It is crucial to prioritize education and awareness campaigns to inform the public about the benefits of renewable energy and dispel any misconceptions or doubts. These efforts can help create a supportive environment that encourages individuals and businesses to embrace renewable energy solutions, leading to a more sustainable future.

According to the World Bank, the African nation that adopted this strategy is Rwanda [31]. Rwanda has made significant progress in promoting renewable energy through its National Electrification Plan, which aims to achieve universal access to

electricity by 2024. The country has implemented various initiatives, such as the installation of solar panels in rural areas and the promotion of biogas systems. These efforts have not only increased access to clean energy but also created job opportunities and improved the overall quality of life for its citizens. Kenya and Tanzania are two other African countries that have implemented the same strategy. These countries have also seen positive results, with increased access to electricity and the creation of sustainable energy sources. By following this approach, African nations are not only addressing the urgent need for renewable energy but also setting an example for other regions to follow in the fight against climate change.

5.3 Exploring the Diffusion of Innovation Theory to Foster Renewable Energy Research and Development

The diffusion of innovation theory can serve as a powerful framework to stimulate research and development in renewable energy technologies, thus driving innovation. By understanding the various stages of innovation adoption, policymakers and industry leaders can identify barriers and devise effective strategies to encourage the uptake of renewable energy solutions. Moreover, applying this theory enables stakeholders to target specific adopter groups, such as early adopters or opinion leaders, who play a crucial role in influencing the adoption of renewable energy technologies. By tailoring communication and marketing efforts towards these influential groups, policymakers and industry leaders can accelerate the adoption process and create a ripple effect throughout society. Additionally, understanding the stages of innovation adoption theory can help identify potential challenges or resistance from certain adopter groups, allowing for proactive measures to address their concerns and increase acceptance of renewable energy solutions. According to the World Bank, the African nation that stimulates research and development in renewable energy technologies is South Africa. The country has made significant investments in renewable energy, with the aim of reducing its reliance on fossil fuels and increasing access to clean and sustainable energy sources. Through initiatives such as the Renewable Energy Independent Power Producer Procurement Program, South Africa has attracted both local and international investment in renewable energy projects, driving innovation and technological advancements in the sector. This commitment to research and development not only benefits South Africa but also serves as a model for other African nations looking to accelerate their own adoption of renewable energy. Egypt has also made significant strides in promoting renewable energy [29]. The country has set ambitious targets to increase the share of renewable energy in its overall energy mix and has implemented policies and incentives to attract private sector investment in the sector. Egypt's commitment to renewable energy is not only driven by environmental concerns but also by the potential economic benefits, such as job creation and reduced reliance on fossil fuel imports. As a result, Egypt has become a regional leader in renewable energy deployment and is paving the way for other countries in the region to follow suit. The government has set ambitious targets to generate 20% of its electricity from renewable sources by 2022 and 42% by 2035. To achieve these goals, Egypt has implemented a range of measures [29], including feed-in tariffs, tax incentives, and streamlined permitting processes, to attract both domestic and foreign investment in renewable energy projects. This commitment to renewable energy has not only helped Egypt reduce its carbon emissions but has also created a thriving industry that is driving economic growth and providing employment.

5.4 Leveraging the Diffusion of Innovation Theory for Collaborative Knowledge and Resource Sharing between African Countries and International Organizations

In today's interconnected world, the diffusion of innovation theory offers a powerful framework to foster partnerships between African countries and international organizations. By embracing this theory, African countries can tap into the expertise and resources of international organizations while simultaneously sharing their own unique knowledge and experiences. This collaborative approach can lead to accelerated development, improved governance, and enhanced socio-economic outcomes for both parties involved. The diffusion of innovation theory can also help African countries address specific challenges they may face, such as limited access to technology or a lack of infrastructure. By partnering with international organizations, African countries can benefit from their expertise in these areas and find innovative solutions to overcome these obstacles. This collaboration can create opportunities for knowledge exchange and capacity building, empowering African countries to become leaders in their respective fields and drive sustainable development in the region.

According to (International Renewable Energy Agency) IRENA, Africa has the potential to generate over 300 GW of renewable energy by 2030 [29], which could greatly contribute to the continent's energy needs and reduce reliance on fossil fuels. However, achieving this potential requires significant investment and policy support from both domestic and international stakeholders. By leveraging partnerships with international organizations, African countries can access funding opportunities and technical expertise to accelerate the deployment of renewable energy projects and address the challenges they may face in this transition. This collaboration can also foster job creation and economic growth, further strengthening the sustainability of African nations. By embracing renewable energy sources, African countries can reduce their carbon emissions and contribute to global efforts to combat climate change. This not only benefits the environment but also enhances their reputation as leaders in sustainable development on the international stage.

5.5 Leveraging the Diffusion of Innovation Theory for Seamless Integration of Renewable Energy into Power Systems

The diffusion of innovation theory offers valuable insights into implementing effective regulatory frameworks that facilitate the smooth integration of renewable energy sources into existing power systems. By understanding the theory's principles, policymakers can identify key factors that influence the adoption and acceptance of renewable energy technologies. Furthermore, applying this theory enables regulators to design targeted strategies that address barriers to adoption, such as cost concerns or technological uncertainties. By leveraging the diffusion of innovation theory, policymakers and regulators can also encourage collaboration between different stakeholders in the energy sector, including utilities, investors, and consumers. This collaboration can help create a supportive ecosystem that promotes the development and deployment of renewable energy technologies, ultimately leading to a more sustainable and resilient power system. African countries that facilitate the smooth integration of renewable energy sources into existing power systems include Rwanda and South Africa. These countries have implemented policies and regulations that incentivize collaboration between utilities, investors, and consumers in the energy sector. By fostering partnerships and knowledge sharing, they have successfully integrated renewable energy sources into

their power systems, reducing reliance on fossil fuels and increasing energy access for their populations. This collaborative approach has not only contributed to a more sustainable and resilient power system but has also attracted investments in the renewable energy sector, driving economic growth and job creation.

5.6 Capitalizing on the Diffusion of Innovation Theory to Empower Capacity-Building Initiatives in the Renewable Energy Sector

The diffusion of innovation theory offers a valuable framework for enhancing capacity-building initiatives in the renewable energy sector. By understanding the various stages of innovation adoption, such as awareness, interest, evaluation, trial, and adoption [34], organizations can tailor their training programs to effectively address the needs and motivations of individuals within the workforce. Furthermore, this theory can guide the identification and implementation of strategies that promote the widespread adoption of renewable energy technologies. For example, organizations can use the theory to identify key influencers and opinion leaders within the industry who can help drive adoption among their peers. Additionally, the theory can inform the development of communication and marketing strategies that effectively communicate the benefits and advantages of renewable energy, thereby increasing its appeal to potential adopters. African countries that facilitate the smooth integration of renewable energy sources into existing power systems include, according to the World Bank, South Africa, Morocco, and Kenya. These countries have implemented policies and regulations that promote renewable energy investments and have established favourable market conditions for renewable energy projects. They have invested in infrastructure development, such as grid expansion and interconnection, to ensure the reliable integration of renewable energy sources into their power systems.

5.7 Leveraging the Diffusion of Innovation Theory for Effective Renewable Energy Advocacy and Education Campaigns

The diffusion of innovation theory offers a valuable framework for designing public awareness and education campaigns that can drive increased understanding and support for renewable energy adoption. By identifying and targeting different segments of the population based on their innovativeness and readiness to adopt new ideas, campaigns can be tailored to address specific barriers and motivations that influence renewable energy adoption. The theory emphasizes the importance of utilizing influential individuals or opinion leaders within each segment to help spread the message and create a ripple effect of positive change. This approach not only increases the credibility and trustworthiness of the campaign but also taps into existing social networks and communities, amplifying the reach and impact of the message. By incorporating interactive and engaging communication strategies such as storytelling, visual aids, and hands-on experiences, campaigns can effectively capture attention and inspire individuals to take action towards renewable energy adoption. According to World Bank data, African nations that have developed public education and awareness initiatives to promote better knowledge of and support for the use of renewable energy sources include Kenya, Ethiopia, and South Africa. These countries recognized the importance of educating their citizens about the benefits of renewable energy and implemented programs to raise awareness and encourage its adoption. By implementing public education, these countries are not only empowering their citizens with knowledge but also paving the way for a sustainable future.

6. Policy for Assessing Novel Technology Dissemination Strategies for Lowering GHG Emissions in Africa

Africa holds immense potential for climate-smart initiatives, particularly in the realm of renewable energy. However, the continent faces significant challenges when it comes to the diffusion and adoption of these technologies. To effectively address this issue and unlock Africa's sustainable energy growth, a comprehensive policy framework is needed that focuses on enhancing technological diffusion strategies and overcoming barriers to implementation. This section discusses the seven comprehensive policy frameworks that were developed from the seven suggested strategies for addressing technological diffusion issues in Africa.

6.1 Promoting the Adoption of Renewable Energy Technologies through Policy Incentives and Financial Support

One way the government can promote the adoption of renewable energy technologies in Africa is by implementing policy incentives. These incentives can include tax breaks, subsidies, and grants for individuals and businesses that invest in renewable energy projects. Financial support can be provided through low-interest loans or venture capital funds specifically dedicated to renewable energy initiatives. By utilizing the diffusion of innovation theory, the government can create an environment that encourages the widespread adoption of renewable energy technologies, ultimately leading to a more sustainable future for Africa.

6.2 Developing a Robust Infrastructure for Renewable Energy Production and Distribution

The government recognizes the urgent need to develop a robust infrastructure for renewable energy production and distribution in African countries. To achieve this, it has implemented several key policies. Firstly, it is actively investing in research and development to drive innovation in renewable energy technologies. This includes funding for the development of more efficient solar panels, wind turbines, and energy storage systems. The government is providing financial incentives and tax breaks to encourage private sector investment in renewable energy infrastructure. By offering grants and subsidies for the construction of renewable energy facilities, the government aims to increase the overall capacity and availability of clean energy sources. It is implementing regulations and standards to promote the adoption of renewable energy in various sectors, such as transportation and manufacturing. These comprehensive efforts are aimed at reducing greenhouse gas emissions and transitioning towards a more sustainable and environmentally friendly energy system.

6.3 Encouraging Research and Development in Renewable Energy Technologies to Drive Innovation

One government policy to encourage research and development in renewable energy technologies and drive innovation is to provide financial incentives such as tax credits or grants for companies and individuals involved in these sectors in African countries. This can help offset the costs of research and development, making it more attractive for businesses to invest in renewable energy technologies. Governments can establish partnerships with universities and research institutions to promote collaboration

and knowledge sharing, fostering a supportive environment for innovation in the renewable energy sector. Governments can implement policies that require a certain percentage of energy to be generated from renewable sources, creating a guaranteed market for renewable energy technologies. This not only stimulates demand but also encourages companies to invest in the development and production of these technologies to meet the growing need. Governments can prioritize renewable energy in public procurement processes, further driving the adoption and advancement of renewable energy technologies.

6.4 Fostering Partnerships between African Countries and International Organizations to Share Knowledge and Resources

The government recognizes the importance of fostering partnerships between African countries and international organizations to share knowledge and resources. To achieve this, the government has implemented a comprehensive policy framework that promotes collaboration and cooperation. This includes establishing platforms for regular dialogue and information exchange, facilitating joint projects and initiatives, and providing financial support for capacity-building programs. The government encourages the participation of African countries in international forums and conferences to enhance networking opportunities and promote cross-border collaboration. By actively engaging with international organizations, the government aims to strengthen the bonds between African countries and the global community. This can lead to increased knowledge sharing, technological advancements, and access to resources that can contribute to the sustainable development of African nations. By actively participating in international forums, African countries can have a voice in shaping global policies and agendas that directly impact their interests and priorities.

6.5 Implementing Effective Regulatory Frameworks to Ensure the Smooth Integration of Renewable Energy into Existing Power Systems

The government recognizes the importance of integrating renewable energy into existing power systems and has implemented a comprehensive set of policies to ensure its effective implementation in African countries. These policies include conducting thorough assessments of the current power system infrastructure, identifying potential barriers and challenges, and developing strategies to overcome them. The government promotes collaboration between relevant stakeholders, such as energy regulators, utility companies, and renewable energy developers, to foster knowledge sharing and facilitate a seamless transition towards a more sustainable energy future.

6.6 Enhancing Capacity-Building Initiatives to Train a Skilled Workforce in the Renewable Energy Sector

The government recognizes the importance of enhancing capacity-building initiatives to train a skilled workforce in the renewable energy sector in African countries. To achieve this, it has implemented various policies aimed at promoting vocational training programs and partnerships with educational institutions. The government offers financial incentives and subsidies to individuals and businesses that invest in renewable energy training programs, ensuring a steady supply of skilled workers for the sector. These initiatives not only address the immediate need for a skilled workforce but also contribute to long-term sustainability by creating a pipeline of trained professionals. The government actively collaborates with industry experts and stakeholders to continuously

update and improve these capacity-building initiatives, ensuring that they remain relevant and effective in meeting the evolving demands of the renewable energy sector.

6.7 Promoting Public Awareness and Education Campaigns to Increase Understanding and Support for Renewable Energy Adoption

One effective government policy to promote public awareness and education campaigns for renewable energy adoption is to allocate funds for comprehensive and widespread advertising campaigns in African countries. These campaigns can utilize various media platforms, such as television, radio, and social media, to reach a wide audience and educate them about the benefits of renewable energy. The government can collaborate with educational institutions to develop curriculum and training programs that incorporate renewable energy concepts, ensuring that future generations are well-informed about its importance and potential.

CONCLUSIONS

In conclusion, it is evident that addressing technological diffusion issues is crucial for the sustainable growth of renewable energy in Africa. By overcoming barriers such as lack of access to financing, inadequate infrastructure, and limited technical expertise, Africa can unlock its climate-smart potential and engage in renewable energy innovation. The report also examined several technology diffusion theories in order to unleash Africa's climate-smart potential by tying them to the recommended techniques for dealing with technological diffusion concerns. These theories varied from diffusion of innovation theory to planned behaviour theory. By understanding and applying these theories, policymakers and stakeholders can develop targeted strategies to overcome the barriers mentioned earlier. For example, by leveraging the diffusion of innovation theory, they can identify early adopters and opinion leaders within communities to promote the adoption of renewable energy technologies. Incorporating planned behaviour theory can help in understanding the factors that influence individuals' intentions to adopt climate-smart solutions, enabling tailored interventions to increase uptake across Africa.

The appropriate proposed strategies for addressing technological diffusion issues in Africa range from encouraging the adoption of renewable energy technologies through policy incentives and financial support to increasing public awareness and support for renewable energy adoption. These strategies can be complemented by promoting collaboration and knowledge sharing among African countries, as well as fostering partnerships with international organizations and investors. Investing in capacity-building programs and providing training opportunities for local communities can empower them to actively participate in the renewable energy sector and contribute to sustainable development in Africa.

With the right policies proposed in this study, ranging from how the government can promote the adoption of renewable energy technologies in Africa by implementing policy incentives to promote public awareness and education campaigns for renewable energy adoption to allocating funds for comprehensive and widespread advertising campaigns, investments, and collaborations, Africa has the opportunity to revolutionize its energy sector and contribute significantly to global efforts in combating climate change. By implementing these policies, Africa can not only reduce its reliance on fossil fuels but also create new job opportunities in the renewable energy sector. The promotion

of renewable energy adoption can improve energy access and reliability for communities across the continent, leading to socio-economic development and improved quality of life.

In addition to addressing technological diffusion issues, further research could explore the potential of public-private partnerships in promoting sustainable renewable energy growth in Africa. This could involve examining successful case studies from other regions and identifying strategies that can be adapted to the African context. Investigating the role of policy frameworks and regulatory mechanisms in facilitating the adoption and diffusion of climate-smart technologies could provide valuable insights for policymakers and stakeholders in driving sustainable energy transitions across the continent.

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CONFLICTS OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

AUTHOR CONTRIBUTIONS

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