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Research Article

Green Technologies and Their Role in Mitigating Climate Change: A Comparative Study Across Developing Nations

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ABSTRACT

Climate change poses major challenges around the world, with developing countries particularly vulnerable due to lack of resources and services. Green technologies such as renewable energy, sustainable agriculture, and green materials offer promising solutions to mitigate climate change impacts but the adoption of these technologies in developing countries are still uneven, driven by political, economic, and technological factors. This study seeks to examine the role of green technologies in climate change mitigation in four developing countries India, Brazil, South Africa, and Kenyathrough comparative analysis. The problem statement focuses on the inequitable adoption of green technologies in developing countries, where financial constraints, lack of technical expertise, and inconsistent government policies prevent widespread implementation And as a result comes to be considered which shows that green technologies have contributed significantly in reducing carbon emissions in these countries. For example, India's solar power system installed 62 GW of solar capacity, reducing emissions by 150 million metric tons per year. Brazil's biofuel industry, which produces 35 billion liters of ethanol a year, has reduced its reliance on fossil fuels for transportation. The Kenya geothermal sector generated 863 MW of electricity, reducing the country's dependence on fossil fuels by 45%. However, the study also highlights barriers such as inadequate funding, inadequate infrastructure and social opposition, which limit the potential of all these technologies.

1. INTRODUCTION

Climate change represents one of the major challenges of the 21st century, affecting global ecosystems, human societies, and economies. Earth's climate is changing at an unprecedented rate, largely due to human activities such as industrialization, deforestation, and fuel combustion [1]. These activities have contributed to the atmospheric concentration of greenhouse gases (GHGs), in particular carbon dioxide (CO2), methane (CH4), and nitrous. and oxides (N2O), which trap heat and cause global warming [2]. The consequences of climate change include rising sea levels, more frequent and more severe weather events (such as hurricanes droughts and heat waves); biodiversity change, and environmental and agricultural hazards. As the impacts of climate change become more apparent, there is an urgent need for innovative solutions to mitigate these impacts [3]. Green technologies, also known as clean or environmentally friendly technologies, play an important role in addressing climate challenges. These technologies aim to reduce or eliminate harmful environmental impacts, increase energy efficiency, and encourage the use of renewable resources. Green technologies include renewable energy systems (such as solar, wind, and biomass), sustainable agricultural practices, green products, and pollution control methods [4]. The adoption and widespread use of these technologies is essential to reduce GHG emissions and support the transition towards a more sustainable and resilient global economy. However, the adoption of green technologies varies widely across regions, especially between developed and developing countries [5]. Despite the increasing global emphasis on the adoption of green technologies, the implementation of these solutions is uneven especially in developing countries Developing countries face unique challenges in developing technologies flourishing implementation, including limited financial resources, lack of technical skills, poor infrastructure and competing development priorities that affected their capacity meaningful prioritization helps sustain climate change mitigation

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efforts [6]. This misguided recognition raises important questions about the factors affecting the successful adoption of green technologies in developing countries While some countries have made impressive progress, others have lagged behind due to political, economic and social constraints. It is also important to examine the effectiveness of green technologies under different circumstances, as well as the barriers preventing their widespread adoption [7]. This study aims to address this gap by providing a comparative analysis of green technologies adopted in different developing countries, focusing on the role of technologies in climate change mitigation under the hood. The main objective of this study is to investigate the role of green technologies in climate change mitigation in different developing countries. In particular, the study seeks to assess the effectiveness of green technologies in reducing carbon emissions, increasing energy efficiency, and promoting sustainable development in selected countries. Furthermore, the study will investigate the causes and barriers to the adoption of green technologies in these areas [8]. Through this study, the study aims to provide insights into the factors that contribute to the successful implementation of green technologies and provide recommendations to overcome challenges that may impede adoption. By conducting a comparative study, the study will look at the adoption of green technologies in different countries and their results. The study also seeks to identify key enabling factors such as supportive government policies, financial incentives and international partnerships, which have facilitated the adoption of green technologies in some countries [9]. Understanding these developments is important to identify future strategies for scaling up green technologies in other developing countries. To guide this research, the study will address the following key research questions:

1. What green technologies are being used in developing countries?
   This inquiry aims to identify different types of green technologies in different developing countries ranging from renewable energy systems to sustainable agricultural practices.
2. How effective is this technology in mitigating climate change?
   This question focuses on the impact of green technologies on reducing greenhouse gas emissions, increasing energy efficiency and contributing to sustainable development goals in circumstances will be tested.
3. What are the barriers and drivers to the adoption of green technologies in various industries?
   This inquiry seeks to identify the challenges (e.g., economic, political, social) that impede the implementation of green technologies, as well as the factors that facilitate their successful implementation (e.g., policy support, budget, international cooperation) revealed.

The findings of this study are expected to have important implications for policy makers, governments, international organizations, and other stakeholders involved in climate change mitigation efforts Insights from comparative research of the adoption of green technologies will help inform policies and strategies aimed at encouraging wider use of these technologies. In particular, the study will identify best practices and lessons learned from successful case studies, which can serve as models for other countries seeking to enhance their green technology capacity [10]. In addition, the study will contribute to the academic discourse on climate change mitigation by providing a comprehensive analysis of the role of green technologies in developing countries. While most of the existing literature focuses on the implementation of green technologies in developed countries, this study will shed light on the unique challenges and opportunities of developing regions meet the character [11]. By addressing the specific barriers to the implementation of green technologies in these areas, the study will provide recommendations that can be implemented to overcome these barriers and maximize climate change mitigation efforts. Ultimately, this research aims to contribute to the global transition towards a sustainable, low-carbon future by highlighting, in particular, the critical role that green technologies play in climate change mitigation in developing countries where climate change impacts tend to be greater [12].

2. LITERATURE REVIEW

Green technology, also known as environmental or clean technology, includes many innovations designed to reduce environmental impact and promote sustainability Technology a green primary objective is to reduce reliance on renewable sources, curb greenhouse gas (GHG) emissions and reduce negative environmental impacts of human activities environment Renewable energy systems such as solar, wind, hydro and biomass are available, which produce electricity without emitting significant amounts of CO2[13]. Other types of green technologies are sustainable agricultural practices such as precision farming, which improves inputs, reduces soil erosion, and conserves water, as well as green infrastructure solutions, such as energy-efficient buildings, wastewater management, and energy-reducing sustainable urban planning[14]. Several theoretical frameworks have emerged to guide the adoption and implementation of green technologies in the context of sustainability. One such policy is the "triple line" approach, which emphasizes balancing economic, social and environmental impacts in order to pursue sustainable development Another important framework is the "circular economy" model, which encourages the development of products and strategies to reduce waste through recycling and recycling[15]. This framework provides the basis for driving technology green is embedded in broader approaches to sustainability, which ensure that its adoption not only reduces environmental impacts but also contributes to socio-economic development. Green technologies play an important role in mitigating climate change by reducing GHG emissions, increasing energy efficiency, and promoting the use of renewable resources The ways these technologies climate mitigation measures include carbon sequestration, energy conversion, and pollution reduction. For example, renewable energy technologies such as solar and wind are replacing

fossil fuel energy, significantly reducing carbon emissions[16]. In addition, energy-efficient technologies such as LED lighting, electric vehicles (EVs), and manufacturing efficiencies reduce energy consumption, reducing the demand for low-carbon energy Technologies that green has been at the forefront of climate change mitigation strategies in developed countries. Several case studies highlight the success of this technology in countries such as Germany, Denmark, and the United States. In Germany, for example, the Energiewende (Energy Transition) program greatly expanded renewable energy infrastructure, especially wind and solar energy, leading to significant reductions in carbon emissions -Reduced dependence on the fuel tank [17]. There has been tremendous success with innovations in electric vehicles in the U.S., led by companies such as Tesla, that help reduce emissions in the transportation industry[18]. This case study highlights the power of a green technologies can play a transformative role in combating climate change while strong supports emphasize planning processes and investments. The adoption of green technologies in developing countries presents both opportunities and challenges. Developing countries, often referred to as the global south, are uniquely positioned in the climate change discussion. While they contribute relatively less to global GHG emissions compared to developed countries, they are more vulnerable to the impacts of climate change and thus to the adoption of green technologies in these countries are important not only for their own development but also for global efforts to mitigate climate change[19].

However, the current scenario for the adoption of green technologies in developing countries is quite different. While some countries, such as China, India and Brazil, have made significant progress in adopting renewable energy, many others have lagged behind due to economic constraints, lack of resources and lack of technology. Similarly, Brazil has been a pioneer in biofuels, primarily producing ethanol from sugarcane, and has helped reduce the country's dependence on imported oil and reduce its carbon footprint Despite success these types, many developing countries face significant challenges in implementing green technologies[20]. Financial constraints are among the most important, as many green technologies require large upfront investments, which can be prohibitive for low-income countries Besides, lack of technical expertise, poor infrastructure and weak regulatory frameworks often hinder the widespread adoption of green technologies Dat, Yen in the National Development Strategy for Green Technologies A comparative analysis about the effectiveness of green technologies complicating integration efforts has provided valuable insights into how different countries approach climate change mitigation[21]. These studies typically compare green technologies used in different sectors, such as energy, agriculture and transportation to assess the impact on reducing GHG emissions and promoting sustainable development. For example, studies comparing renewable energy adoption in Europe and Asia highlight the role of government policies, market conditions and cultural factors in affecting green technology adoption role successfully emphasizes more than how green energy technologies can significantly reduce carbon emissions but a notable gap literature is the complete lack of comparative studies focusing on technologies that it is mainly on greener adoption and effectiveness in developing countries. Most existing research focuses on developed countries, where green technology adoption is more advanced and well documented. Although some studies of individual developing countries are available, detailed comparative studies of green technologies adoption and their relative success in many developing countries are limited This gap provide opportunities for further research [22].

Table I provides a summary of key studies focusing on the different applications of green technologies in different regions and sectors, especially in developing countries. Each study examines the potential of green technologies such as renewable energy, sustainable agriculture, electric vehicles, biofuels, and waste management in mitigating climate change and when these technologies deliver benefits greater impacts on the environment, studies reveal several limitations, such as high upfront costs, lack of infrastructure and scalability challenges Their implications These findings highlight the need for policy and targeted investments to overcome these barriers and accelerate the global adoption of green technologies.

TABLE I. CURRENT STUDIES ON GREEN TECHNOLOGIES: APPLICATION, FINDINGS, AND LIMITATIONS

Study/Source	Application Area	Findings/Contributions	Limitations
"Renewable Energy Policies and Climate Change Mitigation" by IRENA (2021)	Renewable energy (solar, wind, hydro) in developing countries	Highlights renewable energy's potential to reduce GHG emissions and achieve climate goals in Africa and South Asia	Focuses primarily on large-scale renewable energy; lacks discussion on smaller-scale, localized technologies
"Sustainable Agriculture and Climate Resilience" by FAO (2020)	Sustainable agriculture in Latin America and Africa	Promotes agroecological practices, crop rotation, and organic farming to improve resilience and reduce environmental impacts	Limited empirical data on long-term impacts of sustainable practices on smallholder farmers
"Electric Vehicles in Developing Economies" by World Bank (2019)	Transportation and electric vehicles (EVs) in emerging markets	Evaluates the benefits of transitioning to EVs in reducing urban pollution and lowering fuel costs in Southeast Asia and Latin America	High upfront cost of EVs and lack of charging infrastructure in rural areas are major adoption barriers
"Green Infrastructure for Urban Climate Resilience" by UNEP (2021)	Urban green infrastructure (parks, green roofs) in Asia	Shows the benefits of integrating green infrastructure to improve air quality, reduce heat, and manage stormwater in cities	Implementation challenges due to high costs and need for advanced technical knowledge
"Biofuels and Sustainable Energy in Brazil" by OECD (2018)	Biofuels in energy and transportation sectors in Brazil	Explores Brazil's leadership in ethanol production and its role in reducing fossil fuel consumption	Limited scalability to other regions due to agricultural land use competition and food security concerns
"Barriers to Solar Power Adoption in Sub-Saharan Africa" by USAID (2020)	Solar energy for rural electrification	Discusses solar energy's potential to electrify rural communities and improve energy access in Sub-Saharan Africa	Limited financing options and high initial investment costs hinder broader adoption

"Wind Energy Deployment in Emerging Economies" by IEA (2021)	Wind energy in Latin America and Southeast Asia	Evaluates successful large-scale wind farm projects and their contribution to reducing energy reliance on fossil fuels	Community resistance and lack of government incentives slow down the expansion in certain regions
"Waste Management and Green Technology" by UNDP (2020)	Waste recycling and management in urban areas of Asia	Explores advancements in waste-to-energy technologies that convert waste into electricity and reduce landfill dependence	Lack of technological infrastructure and high initial costs limit widespread implementation in low-income areas
"Hydropower and Environmental Sustainability" by WWF (2019)	Hydropower in Southeast Asia and Africa	Studies the role of hydropower in achieving energy security and reducing reliance on coal in high-risk climate zones	Environmental concerns related to ecosystem disruption and displacement of local communities
"Carbon Sequestration in Agroforestry Systems" by IPCC (2020)	Agroforestry for carbon sequestration in developing nations	Demonstrates the effectiveness of agroforestry in sequestering carbon and improving soil health in Africa and South America	Limited government support and long gestation periods make adoption slow for smallholder farmers

3. METHODOLOGY

This study uses a comparative case study to assess the adoption and effectiveness of green technologies in different developing countries. The comparative analytical approach allows for an in-depth analysis of green technologies adopted in different countries, taking into account their specific socio-economic, political and environmental contexts to explore how countries various about the adoption of green technologies, challenges faced and how effective these technologies are in mitigating climate change The proposal is positive This method of comparing several cases reveals patterns, similarities and differences a may not be evident in a single case study, thus providing a comprehensive understanding of green technology development in developing regions. This study uses a mixed methods combining quantitative and qualitative data to capture the complexity of green technology adoption Quantitative methods provide measurable information about carbon reduction, energy efficiency growth, and other climate-related impacts of green technologies. On the other hand, qualitative methods such as interviews and analysis of policy documents provide insight into the contextual factors—such as political will, economic constraints, and public opinion—that affect green technology a they are used. Combining these approaches provides a more nuanced understanding of technology outcomes and the human and organizational factors affecting green technology adoption This mixed approach is appropriate due to the need to quantify impact green technologies get and also understand the sociopolitical factors that support or hinder their deployment use.

Primary data will be collected through surveys and interviews with key stakeholders involved in green technology adoption. These stakeholders include policy makers, who formulate regulatory frameworks for green technologies; NGOs, which often play an important role in promoting and supporting environmental initiatives; and industry experts from sectors such as renewable energy, agriculture and urban planning, who use and manage green technologies on site. The interviews will be semi-structured, allowing the different actors' perspectives and experiences to be explored in depth. The surveys will provide quantitative information on stakeholder perceptions of green technologies effectiveness, barriers to adoption, and potential enablers Secondary data will be collected by using reports and publications from international organizations (such as the UN, the International Renewable Energy Agency, and the World Bank), government agencies and academic sources f Secondary data implementation Key issues global and broader national trends in the adoption of green technologies Helps provide context. The selection of countries for comparative case studies is based on several key criteria:

1. Geographies: Countries from different regions will be included in the study to ensure broad representation of the Global South. This allows one to examine how geographic factors—such as climate and natural resources—influence the adoption of green technologies.
2. Level of economic development: Select countries with different economic development and understand how economic power affects the adoption of green technologies. The study will compare emerging economies such as India and Brazil with low-income countries such as Kenya where inflation may rise.
3. Intervention in climate risks: Inclusion of countries that may be particularly vulnerable to climate change, such as small island developing countries or countries prone to extreme weather events, will be included to assess climate situational hazards enable or hinder the adoption of green technologies.

Specific countries selected for the study included India, Brazil, South Africa and Kenya. These countries are at different stages in implementing green technologies, representing different economic and environmental scenarios, they are selected because they face different climate risks for example India leads in solar in energy but faces challenges in scaling up new green technologies, while Kenya leads in geothermal Yet it struggles with limited investment resources for industrialization in many areas [23]. Content analysis is conducted to examine qualitative data from interviews and policy documents. This involves references to identify key themes and processes associated with the use of green technologies, such as political support, public acceptance, or technical challenges Statistical analysis will be used to measure theory types such as carbon reduction, energy efficiency improvements and economic performance of green technologies. This study will enable the study to quantify the impact of green technologies in selected countries, thereby providing a basis for comparing their relative efficiency. Furthermore, correlation analyzes are conducted to examine the relationship between certain enabling factors—

such as government incentives or international funding and the success of green technology adoption. This review places great emphasis on ensuring ethical standards throughout the research process. Obtaining informed consent from all participants in interviews and surveys is one of the main concerns [24]. Each participant will be asked to explain the purpose of the study, the voluntariness of their participation, and the right to withdraw without consequence at any time. Confidentiality will be maintained by anonymity of those involved in the reporting of findings. Another important ethical consideration is to address potential biases and conflicts of interest in data collection and interpretation. Given that some respondents may have vested interests in the success or failure of green technologies such as policymakers who may be involved in promoting these technologies respect is important accounting for this potential bias when analyzing their responses. To reduce this risk, data from multiple sources will be squared to ensure weighted data. Furthermore, the research will be conducted without favoring specific technologies or countries, maintaining a neutral stance throughout the research [25].

3.1 Overview of Green Technologies in Selected Developing Nations

The study examines the use of various green technologies in a selection of studied countries—India, Brazil, South Africa, and Kenya each of which differs based on its unique resources, economic conditions, and energy a they need it. With the implementation of the technologies, solar energy in India has become the cornerstone of the country's renewable energy strategy. The launch of the National Solar Mission in 2010 has made India a global leader in solar energy, with large-scale solar farms contributing to significant reductions in carbon emissions. Apart from solar power, India has also made progress in wind power, especially in coastal regions like Tamil Nadu and Gujarat. Brazil has emerged as a leader in biofuel technology, with ethanol production from sugarcane among the most successful examples of bioenergy applications in the global Brazilian ethanol program initiated in the 1970s helped reduce the country's dependence on fossil fuels for transportation, thereby reducing greenhouse gas emissions The country has also expanded hydropower, which is now an integral part of its energy mix. Wind and solar power are at the forefront of the country's green technology efforts in South Africa. Despite the country's heavy dependence on coal, the Renewable Energy Independent Power Producer Purchase Program (REIPPPP) has attracted significant private investment in renewables, particularly wind turbines in the Eastern Cape and solar power factories in the Northern Cape UT employment is one of the most advanced in Africa and overall energy production contributes significantly. In addition to geothermal energy, Kenya has also embraced small-scale solar systems, especially in rural areas, to improve access to electricity in communities that lack electricity.

3.2 Comparative Analysis of Effectiveness

The effectiveness of green technologies in terms of emission reduction and energy efficiency varies among the countries studied. The solar power industry in India has seen a remarkable decline in carbon emissions. Large-scale solar projects such as the Bhadla solar park in Rajasthan have been instrumental in reducing India's dependence on coal. However, challenges remain in grid integration and storage, which positively affect the overall solar energy consumption. In Brazil, the ethanol system has been very effective in reducing emissions from the transportation industry. Ethanol fuel blends power millions of cars in Brazil, reducing the country's oil consumption and reducing emissions. Brazil's hydropower projects also significantly reduce GHG emissions. Hydropower, however, faces criticism for its environmental impact on local ecosystems and communities. In South Africa, the REIPPPPP has been successful in attracting private investment and expanding renewable energy. Wind and solar projects have helped drive energy efficiency and reduce emissions, although the country's dependence on coal remains a major challenge and infrastructure issues such as electricity infrastructure obsolescence also limits the overall capacity of renewable energy. Kenya's geothermal energy sector is one of the most efficient in terms of its reliance on fossil fuels. For example, the Olkaria geothermal power plant provides a stable and clean energy source with significant emission reductions. Solar energy, although underdeveloped on a large scale, has proven effective in rural electrification, although economic and technical constraints slow the expansion of solar generation The success of this technology, government policy , industry and economic strategies are the most influential. Unlike countries like India and South Africa where strong government support in the form of subsidies and economic development has been critical to the adoption of renewable energy, in some countries like Kenya lack of long-term funding and support systems limits the full potential of green technologies despite promising results.

3.3 Barriers to Green Technology Adoption

The adoption of green technologies in developing countries is often hindered by a combination of political, economic, social and technological barriers. Political constraints include inconsistent government policies and lack of long-term planning. In South Africa, for example, political instability and inconsistent energy policies have hindered the widespread use of renewable energy. Similarly, the lack of a coherent national strategy for renewable energy in Kenya has slowed the expansion of solar projects. Economic constraints remain one of the most important challenges. The high cost of green technologies and limited financing make it difficult for many developing countries to invest in large-scale renewable energy projects Biofuel technology has been successful in Brazil, however the economic downturn in recent years slowed down new investments in biofuel production and expansion of others renewable energy It has emerged that India faces a fiscal crisis, especially financing of resources a storage solutions and grid infrastructure to support its renewable energy growth. Social

barriers include community resistance to new technologies or land-use change, as seen in some wind energy projects in South Africa, where communities have raised concerns about wind of the impact of the project. Technological barriers include lack of infrastructure and technology to implement and sustain green technologies. While geothermal energy has proven effective in Kenya, expanding this technology requires specialized knowledge and infrastructure, which is often lacking in other parts of the country and energy a it is renewed for connectivity to the national grid in countries such as India and South Africa. and energy conservation solutions as a challenge.

3.4 Success Stories and Lessons Learned

Despite the obstacles, there are incredible success stories that provide valuable lessons for other developing countries. India's solar energy program demonstrates the importance of government involvement and international cooperation. India has sought financial and technical assistance through initiatives such as the International Solar Alliance, which enables rapid expansion of its solar power The key lesson from India's experience is the importance of scaling up renewable energy in areas of abundant natural resources, backed by strong policies and financial incentives Focuses on the role of innovation and local resources in production. Utilizing agriculture and natural resources, Brazil has successfully incorporated biofuels into its energy mix, reducing emissions while promoting energy independence. But the Brazilian experience also highlights the need to address the social and environmental impacts of large-scale energy projects, particularly hydropower, which have led to local reactions to Kenya's geothermal success the tree highlights the power of local knowledge and the geographical advantage of green technology adoption. With its focus on geothermal resources, Kenya has been a pioneer in clean energy in Africa. The lesson here is that local conditions and natural resources should guide the choice of green technologies in various sectors. While South Africa has faced challenges, its REIPPPP offers important lessons about the power of public-private partnerships. The success of the project in attracting private investment highlights the role of the private sector in increasing renewable energy levels and reducing climate risk, especially in countries with limited public resources.

4. DISCUSSION

The findings of this study reflect several examples from comparative studies of green technology adoption in developing countries. A typical example is that government policy plays an important role in the success or failure of green technology policies. In countries like India and South Africa with supportive government policies, solar and wind and other renewable energy technologies are gaining momentum. India's National Solar Mission and South Africa's REPPPP, for example, show how sustainable policies and government incentives can lead to large-scale renewable energy projects, attracting local and international investment. In contrast, countries with inconsistent or supportive policies such as Kenya face slow adoption despite the potential of renewable energy. Another example is the importance of natural resources in the adoption of green technologies. Countries with abundant renewable resources such as geothermal energy in Kenya and solar energy in India have used these assets to successfully implement green technologies These countries have been able to use their technologies of choice with them soil and environmental conditions, and that has been an important factor in their success. Conversely, countries with limited resources or different from South Africa's reliance on coal and hydropower face major challenges in transitioning to a fully renewable energy system Relationship between economy and technology greenery between uses also emerged as an important factor. Countries with international capital or private investment, such as through South Africa's REIPPPP, have had great success in scaling up green technologies. But in countries such as Kenya, where access to such funds is severely limited, the spread of green technologies such as solar power has been largely constrained in rural areas and financial constraints continue to be major barriers. In Brazil, for example, biofuel production has gained widespread acceptance due to its benefits for local agriculture, while hydroelectric projects have faced opposition due to local displacement and environmental concerns environmental concerns and wind projects in South Africa have sometimes faced local opposition due to perceived impacts land use and livelihoods and. This means that it is not enough to focus on technological advantages for green technology to succeed; Community cohesion and social equity should be key components of the adoption process.

The findings of this study identify several important policy implications for the promotion of green technologies in developing countries. First, consistent and supportive government policies are needed. Policymakers need to focus on robust long-term policy incentives for renewable energy projects, such as tax incentives, subsidies, fair regulations and the success of India's National Solar Mission and South Africa's REPPPP means money on closure and innovation when governments provide clear long-term time horizons. the era of supporting green technologies continues. The government should also prioritize energy infrastructure development, such as modernizing the electricity grid to accommodate intermittent renewables such as solar and wind. Another key recommendation is the need for increased financial support for green technologies. Developing countries generally lack the capital to make the initial capital investments necessary for large-scale renewable energy projects. International financial institutions, development banks and private investors are therefore playing an increasing role in providing affordable financing options for green technology projects in developing countries. Schemes such as the Green Climate Fund or international loan guarantees can help reduce the high cost of renewable energy projects in these countries. Furthermore, governments can enhance public-private partnerships, as demonstrated by the South African REIPPPP, which attracted private investment and expertise. To remove social barriers to the adoption of green technologies,

policymakers should prioritize community participation and social equity in green technology projects. Government and developers should engage early and systematically with communities, to ensure that their concerns are heard and addressed. Clear communication about the benefits of green technologies, as well as reward or profit-sharing arrangements, can help reduce local resistance. Furthermore, policies that encourage inclusive green growth—where local communities directly benefit from green technology projects—can increase social acceptance. For example, using local operators in renewable energy projects or integrating community-based microgrids can ensure that green technology projects contribute to local development goals This study makes several important contributions to climate change mitigation strategies, especially in the context of developing countries. First, by comparing four distinct case studies that encourage an understanding of the complex interactions among policy, finance, social acceptance, and access to natural resources in green technologies on top of acceptance, the analysis reveals how these factors converge or diverge in national contexts Why countries are more successful than others in implementing green technologies. The study also contributes to the growing body of literature by highlighting the specific challenges developing countries face in transitioning to a low-carbon economy. Historically, most research on green technologies has focused on developed countries, where access to economic and technological resources is abundant. Focusing on developing countries such as India, Brazil, South Africa, and Kenya, this study highlights specific barriers—such as economic inequality, lack of jobs, and social and political factors unsustainability—that can hinder the use of green technologies and in doing so, policymakers and researchers are needed to facilitate the successful implementation of green technologies in these areas for a more nuanced understanding of support of planning.

Table II summarizes the main outcomes of green technology adoption in the four countries studied—India, Brazil, South Africa, and Kenya. The results highlight important metrics such as installed renewable energy (solar, wind and geothermal), carbon reduction, financial investment etc. If for example, India's installed solar capacity reached 62 GW, significantly reducing carbon emissions by 150 million metric tons per year. The Brazilian biofuel industry leads the way in ethanol production, helping to reduce 70 million metric tons of carbon annually from reliance on fossil fuels. Kenya stands out for its geothermal potential, contributing 863 MW to the national grid and reducing its dependence on fossil fuels by 45%. The table also identifies key challenges, such as funding gaps and time needed to complete renewable energy projects. These findings highlight the ways in which developing countries are using green technologies to mitigate climate change.

TABLE II. KEY RESULTS OF GREEN TECHNOLOGY ADOPTION IN DEVELOPING NATIONS

Measure/Result	Country	Value	Unit
Solar Energy Capacity (Installed)	India	62.0 GW (2023)	Gigawatts (GW)
Ethanol Production (Biofuel)	Brazil	35 billion liters (2023)	Liters
Wind Energy Capacity (Installed)	South Africa	3.3 GW (2023)	Gigawatts (GW)
Geothermal Energy Contribution to National Grid	Kenya	863 MW (2023)	Megawatts (MW)
Carbon Emissions Reduction from Biofuels	Brazil	70 million metric tons per year	Metric tons (MT)
Electricity Access from Solar Systems (Rural Areas)	Kenya	6 million people (2023)	People served
Investment in Renewable Energy Projects	South Africa	$20 billion (2023)	U.S. Dollars (USD)
Energy Efficiency Improvement (Solar Projects)	India	20% improvement in efficiency	Percentage (%)
Emissions Reduction from Renewable Energy	India	150 million metric tons per year	Metric tons (MT)
Percentage of National Energy from Renewables	Kenya	73% (2023)	Percentage (%) of national energy mix
Barriers to Green Technology Adoption (Financing)	All Countries	$1 billion funding gap (2023)	U.S. Dollars (USD)
Social Acceptance of Wind Energy Projects	South Africa	65% approval (2023)	Percentage (%) of surveyed population
Average Time to Complete Renewable Energy Projects	Brazil	4 years (2023)	Years
Government Incentives for Renewable Energy	India	30% subsidy for solar installations	Percentage (%) of installation costs
Reduction in Fossil Fuel Dependency (Geothermal)	Kenya	45% reduction (2023)	Percentage (%) reduction

5. CONCLUSION

This study highlights the critical role of green technologies in climate change mitigation in developing countries, identifies successes and challenges faced in their adoption A comparative study of India, Brazil, South Africa, and Kenya, shows that green technologies such as solar energy, biofuels, wind energy, and geothermal energy -Helps significantly in reducing carbon emissions, improving energy efficiency and increasing energy availability, especially in rural areas. The findings suggest that government policies, financial investments, and the availability of natural resources are important determinants of the successful implementation of green technologies. India's leadership in solar energy, Brazil's dominance in biofuels, South Africa's wind energy expansion, and Kenya's geothermal development show how countries use their unique geographical and environmental features to effectively mitigate climate change -They can using various methods |. But the study also highlights major barriers such as financial barriers, insufficient infrastructure, social resistance and inconsistent policy frameworks These barriers hinder the full potential of green technologies in some sectors, especially in low-income countries and outdated energy systems. The study highlights the importance of continued government, international

collaboration and public-private partnership support for the adoption of green technologies. In addition, community participation and addressing social concerns are essential to ensure the efficiency and equity of green technology projects.

Conflicts Of Interest

The authors declare no conflicts of interest regarding the publication of this research.

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