



doi:10.5281/zenodo.18811693

The Effects of Transition to Renewable Energy on Climate Change Mitigation and Economic Development in Developing Nations

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ABSTRACT

This study examines the effects of transition to renewable energy on climate change mitigation and economic development in developing nations. This article takes into consideration the current progress, hindrances, and prospects in the renewable industry, referencing concepts like Ecological Modernisation and Energy Transition Theory. The statistics reveal an increasing use of renewable energy technology throughout Sub-Saharan Africa and South Asia. Progress is not even—capital investment, infrastructure growth, and enabling policies are considerably different. In spite of these shortcomings, renewable energy interventions have made carbon emissions reduction, enhanced jobs, and increased energy access in a range of contexts possible. Country case studies of Kenya, Bangladesh, and Nigeria provide different adoption approaches, each shaped by different government, fiscal, and institutional incentives. This report urges a concerted approach in the face of trends and challenges that have been brought onto the center stage. The principal priorities are strengthening national energy policies, broadening access to climate finance, ensuring technology transfer, enhancing cross-border energy cooperation, and assuring transition plans are equitable and equitable. Ensuring the right planning and unflinching commitment, renewable energy could be a source of sustainable development and environmental resilience for the developing world.

Keywords: Transition, Renewable Energy, Climate Change, Mitigation, Economic, Development, Developing Nations

INTRODUCTION

In the last few decades, the transition to renewable energy has become the priority of development agendas as much as a global climate imperative. The two imperatives that confront most developing economies - the urgent need to mitigate carbon emissions and the need to ensure access to secure energy for marginalized groups - are what drive the transition to renewable energy. Conventional energy sources such as coal, oil, and natural gas remain dominant in the generation of energy in most of these countries and contribute significantly to their greenhouse gas emissions and air pollution (IEA, 2022).

Meanwhile, renewable technologies such as solar, wind, and hydroelectric power are increasingly available and affordable. It presents the developing economies with a chance to decarbonize their energy supply and promote inclusive and sustainable growth. As the pace of climate change steps up and the need to implement global commitments such as the Paris Accord grows, adoption of renewable energy as national energy strategy has become increasingly important (IRENA, 2023).

The shift to renewable energy in middle- and low-income nations has many challenges, such as limited infrastructure, insufficient funds, and poor legislative systems. This study seeks to outline how the shift to renewable energy can best enhance climate action and initiate sustainable economic development in these nations.

Statement of the Problem

Developing nations are particularly vulnerable to climate change impacts, yet they often lack access to clean, reliable, and affordable energy. The shift to renewable energy can help reduce greenhouse gas emissions, improve energy security, and promote economic growth. While the environmental benefits of renewable power are well established, its economic effects on the developing world are more ambiguous. There is debate about whether investing in renewable energy stimulates economic growth and job creation or if it represents up-front costs, which some economies may not be capable of absorbing.

Aims and Objectives

The main aim of this study is to explore the effects of transition to renewable energy on climate change mitigation and economic development in developing Nations. The specific objectives of the study include:

1. It seeks to evaluate the extent to which the transition to renewable energy reduces the output of greenhouse gases in targeted developing nations.
2. To examine the economic consequences of this transition, such as its impact on growth, employment creation, and social development.

3. To identify the policy instruments, institutional arrangements, and fiscal measures that affect the effectiveness or ineffectiveness of renewable energy programs.

Research Questions

This study addresses the following key problems:

1. How has the utilization of renewable energy impacted carbon emissions in the developing world?
2. How will this change affect major economic indicators like GDP growth, employment, and availability of energy?
3. What institutional, financial, and policy conditions are facilitating or limiting the deployment of renewable energy projects in these settings?

Significance of the Study

The outcomes of this research have numerous significant practical benefits, highlighting that policymakers must prioritize the establishment of stable and favorable regulatory frameworks to attract investment and stimulate innovation. The study also seeks to contribute to scholarly literature and policy debate on sustainable energy development.

Scope and Limitations of the Study

Scope

This research is concerned with renewable energy trends and strategies for the developing world, with a specific emphasis on Africa and South Asia. Case studies from nations such as Kenya, Nigeria, and Bangladesh are provided with an eye towards outlining various stages of development and particular challenges encountered in all these countries.

Limitations

Limitations of research include varied availability of data by sector and nation, and quantifying long-term economic effects within restricted research timeframes. Furthermore, while the research covers social and economic effects of renewable energy, it does not cover energy efficiency and demand-side management exhaustively. Stating these limitations permits a targeted and attainable area of research.

Literature Review

Theoretical and Conceptual Framework

Theoretical Underpinnings

Ecological Modernization and Energy Transition Theories

This study is grounded in two primary theoretical frameworks that clarify the mechanisms of energy transitions and their broader implications:

1. **Ecological Modernisation Theory (EMT):** Ecological Modernisation Theory posits that environmental protection and economic growth are not intrinsically opposed. Technological developments, institutional reforms, and market methods can promote environmental enhancements in conjunction with economic development. This viewpoint contends that ecological damage need not be an inevitable consequence of industrial advancement if societies adopt cleaner technologies and improve environmental governance (Mol & Sonnenfeld, 2000). EMT advocates that investments in solar, wind, and other sustainable technologies may generate employment, improve efficiency, and modernise the economy, simultaneously reducing emissions.
2. **Energy Transition Theory (ETT):** Energy Transition Theory analyses the progression of society from one predominant energy source, such as coal or oil, to an alternative, such as renewable energy. This transition includes technology advancements as well as changes in infrastructure, social behaviour, institutions, and cultural norms.

ETT delineates three dimensions of change:

- ✓ Specialised inventions (e.g., nascent solar enterprises),
- ✓ Socio-technical frameworks (e.g., national energy regulations and utility providers),
- ✓ Environmental pressures (e.g., climate change, international policies, and economic shifts).

This theory aids in comprehending the complex and incremental characteristics of energy transitions, along with the barriers and enablers that influence their pace and direction (Geels, 2005).

Conceptual Framework

Concept of Renewable Energy

Renewable energy refers to power obtained from sources that are naturally replenished within short time intervals. These encompass solar energy, wind energy, hydrodynamic energy, geothermal energy, and biomass. In contrast to fossil fuels, these resources produce energy or heat with negligible carbon emissions, rendering them vital instruments in combating climate change and diminishing reliance on limited, polluting resources (IEA, 2022).

Concept of Climate Change Mitigation

Climate change mitigation entails reducing the sources of greenhouse gas emissions or enhancing their sinks. It emphasises measures that inhibit or mitigate the buildup of greenhouse gases in the atmosphere, chiefly through alterations in energy generation, land use, and consumption behaviours.

International overview of Climate Action and Renewable Energy

At the global level, renewable energy has transitioned from the periphery to the center of climate policy and sustainable development agendas. Initiatives like the Paris Agreement and the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy), have played key roles in putting renewables at the center of addressing environmental and socio-economic challenges.

It is the developed world that has predominantly spearheaded the shift toward renewable energy through government subsidies, innovations in technology, and massive capital outlays. Developing nations are increasingly joining this shift in energy, motivated by the common goals of boosting energy access and mitigating greenhouse gas emissions (IEA, 2023).

Competitive renewable energy schemes have been initiated by nations like India, Brazil, and South Africa, and global institutions like IRENA and the World Bank have stepped up efforts to accelerate clean energy in developing nations. Nevertheless, there continue to be gaps, most notably in access to finance and technical capability that can act as a hurdle in some areas.

Transition Pathways in Developing Economies

Developing nations exhibit an uneven adoption of renewable energy, depending on characteristics like endowment with resources, institutional characteristics, and national development agendas. While certain nations have managed to integrate clean energy into their overall development approach, others still rely on fossil fuels for political and economic reasons.

Kenya has tapped its geothermal resource, making the region a leader in renewable energy with more than 40% of electricity from it. Bangladesh, on the other hand, has made important strides with the solar home system, effectively electrifying millions of rural homes beyond the reach of the national grid. Nigeria, despite being potentially rich in solar energy, has been constrained by unreliable policy support and a feeble grid infrastructure, which has slowed its pace in renewable energy transition (World Bank, 2022).

These instances account for the lack of a one-size-fits-all model regarding renewable energy transitions. It becomes imperative for the creation of context-specific policies that consider local variables, governance frameworks, and fiscal systems in efforts to create smooth transitions in the renewable energy sector.

Challenges and Opportunities in Renewable Energy Adoption

Although there are potential gains from renewable energy technologies, developing countries face several very real challenges to surmount as they attempt to expand use of the technologies. Among the most important are financial barriers, as several countries lack access to low-cost long-term finance and are faced with high interest rates or currency risks that deter the private sector.

Institutional barriers in the shape of unclear regulations, fractured agency responsibilities, and weak enforcement of current energy legislation, are obstacles to growth in this industry. Technical barriers in the shape of aging grid infrastructure, low storage capacity, and absence of trained manpower are factors that make it tough to implement renewable energy projects.

Nonetheless, these are not unbridgeable challenges. Decreasing costs of solar and wind technologies have increasingly made renewable energy sources competitive with conventional energy sources. Additionally, technological innovation in decentralised energy systems, such as mini-grids and solar home systems, is enabling leapfrogging of conventional infrastructural barriers. Overall, global support through climate finance as well as knowledge exchange networks is enhancing opportunities for growth.

The countries that formulate energy policies aimed at clear, long-term goals, invest and build their human capital, and create conducive regulatory frameworks will be better placed to capture the full opportunities of the energy transition.

Trends in the Application of Renewable Energy in Developing Countries

The renewable energy capacity of developing countries has experienced significant growth due to decreasing technology costs and a desire for sustainable options. Countries in Africa, Asia, and Latin America are increasingly using solar, wind, hydro, or geothermal energy sources to meet their energy needs. This trend is evident in the recent past.

The likes of India, Kenya, and Bangladesh have experienced significant advancements, utilizing both grid-connected major projects and decentralized alternatives, such as solar household systems and mini-grids. While Kenya depends on renewable sources of electricity for more than 70% of its electricity, the majority of solar projects in Bangladesh provide reliable electricity to millions of off-Grid rural residents (IRENA, 2021). Nevertheless, significant gaps remain. Impaired financial resources, unstable laws, and infrastructure challenges continue to hinder progress in many countries. Some areas, particularly in Sub-Saharan Africa, have not fully exploited their renewable energy potential due to insufficient enabling policies and limited private sector involvement.

In spite of this, the general trend shows a consistent increase in the use of renewable energy and suggests that clean technology has become more important to national energy policies than being viewed as an optional option.

The outcomes of controlling the emission of greenhouse gases.

The use of renewable energy has helped developing countries reduce their dependence on fossil fuels. As renewable sources replace coal, oil, and diesel in energy generation, many nations have seen a decrease in greenhouse gas emissions over time. This is particularly significant.

The use of geothermal energy in Kenya and solar power in India has led to significant reductions in CO₂ emissions. Furthermore, decentralized energy systems like off-grid solar installations can replace kerosene and diesel while also enhancing interior air quality and improving public health outcomes.

Nevertheless, the rate of carbon emission reduction differs across countries. In regions with substantial fossil fuel subsidies or limited integration of renewables into the energy grid, environmental benefits typically decrease. To reap maximum benefits from renewable energy, it is necessary to implement additional measures, such as carbon pricing, energy efficiency plans, and the gradual elimination of fossil fuels.

Final analysis suggests that even though renewable energy helps reduce emissions, its effectiveness is heavily influenced by its inclusion in national electricity and water systems.

The Interconnection between Renewable Energy and Economic Growth

The nexus between economic growth and renewable energy use has been extensively studied in the literature in many empirical studies. Studies have shown that, investment in renewable energy technologies can stimulate economic activity through the creation of jobs, enhanced infrastructure, and lower energy expenses.

In their study, Apergis and Payne (2010), highlight the long-term relationship between renewable energy consumption and economic growth in OECD and non-OECD countries. Anser et al. (2020) demonstrated that renewable energy usage had a strong impact on the economic outcomes of several developing nations. These results are supported by the ecological modernisation theoretical framework, which asserts that green technology can lead to industrial innovation while supporting sustainability simultaneously.

Alternatively, other researchers contend that the potential for economic development in renewable energy can be made dependent upon the quality of governance, availability of capital, and preparedness of the market. In

some cases, the capital costs of pioneering investment or policy uncertainty can deter potential gains, especially in economically vulnerable

Effects of Renewable Energy on the Economy

Renewable energy plays a significant role in the economy development of developing countries. Some of the benefits include:

- 1. Job and Economic Prospects:** Renewable energy is now an important source of employment. The processes involved in installing, maintaining, and manufacturing wind turbines and other solar panels have created new job opportunities, particularly for skilled labourers in developing countries where the technology has not yet been developed.
Over 13 million individuals worldwide are employed in the renewable energy industry, with a significant proportion located in developing nations (IRENA, 2023). Off-grid solar companies have created numerous jobs and encouraged entrepreneurial ventures in rural areas, such as those in Kenya and Nigeria.
- 2. Energy Accessibility and Efficiency:** The social and economic benefits of energy access have been achieved through the implementation of decentralised renewable systems. In numerous off-grid regions, reliable electrical connectivity has facilitated students' study longer, increased productivity for small businesses, and decreased reliance on polluting fuels.
The solar home system effort in Bangladesh is a prime illustration of how this technology has helped millions of homes and economic activity in the rural areas. Mini-grid initiatives in Nigeria have also contributed to the extension of operational hours for small firms, while also reducing energy costs.
- 3. Economic Growth and Capital Investment:** There is empirical evidence that investments in renewable energy can accelerate GDP development, particularly with strong legislative frameworks and infrastructure. Countries that attract renewable power tend to draw foreign direct investment, encourage industrial growth, and promote innovation. However, in circumstances where government instability or high financing costs are prevalent, the realization of full economic benefits may be delayed or mishandled.

Case Studies of the Transition to Renewable Energy in Developing Nations.

Case One: Kenya

In Kenya, renewable energy is a well-developed area that has been developed to reduce the country's dependence on fossil fuels by using geothermal, hydro, and wind energy. Government-led initiatives, supported by international investors, have increased energy access and stimulated job creation in the renewable sector.

However, challenges still exist, particularly with regards to grid reliability and the need to provide energy services to underprivileged areas. Kenya's experience highlights the importance of stable policy frameworks and institutional cooperation in achieving an efficient energy transition.

Case Two: Bangladesh

Decentralized renewable energy solutions have been successful in improving access to energy in rural Bangladesh, as demonstrated by the installation of solar house systems in millions of homes with government and donor support. This effort has also improved living conditions and impacted educational and economic outcomes. As other countries follow suit or adopt these approaches, the success of these decentralization solutions offers an ideal model for others who face similar challenges.

Case Three: Nigeria

Nevertheless, while Nigeria is moving more slowly towards renewable energy, the country has experienced significant infrastructural failures and inconsistent policy implementation; however, adoption rates have been limited despite having a high level of solar potential (although recent research from the University College of Advanced Study suggested that many rural African countries had good infrastructure at their disposal), and off-grid energy projects are being started by some private sector players as small examples. Nigeria's situation

underscores the need for institutional reform, innovative funding strategies, and cooperative participation among stakeholders to move forward in renewable electricity projects.

Challenges to Effective Transition and Policy Gap.

The implementation of renewable energy in emerging economies is hindered by various persistent problems, despite growing momentum.

1. **Economic Limitations:** Numerous countries face considerable obstacles in securing reasonable long-term funding. High interest rates, currency fluctuations, and restricted creditworthiness hinder the attraction of investment for renewable energy projects.
2. **Regulatory and Policy Ambiguity:** Inconsistent and vague regulatory frameworks dissuade both domestic and international investment. The absence of long-term strategic planning and ineffective enforcement mechanisms hinders the execution of renewable energy projects.
3. **Infrastructural Deficiencies:** Obsolete transmission infrastructure, inadequate energy storage capacities, and grid instability often impede the comprehensive integration of renewable energy sources, especially intermittent ones like solar and wind.
4. **Social and Political Influences:** In specific contexts, conflicts regarding land rights, community resistance, and political instability hinder the progress of renewable energy initiatives.
5. **Institutional Constraints:** Insufficient technical proficiency and disjointed governance frameworks hinder effective coordination and the successful implementation of energy initiatives.

To surmount these obstacles, it is imperative to execute a holistic plan that includes financial innovation, institutional capacity building, community engagement, and enduring dedication from political leaders.

Policy Instruments, Institutional Arrangements, and Fiscal Measures

1. Creating Policy Plans that Accelerate Energy Transition.

The adoption of a comprehensive strategy that incorporates supportive policy instruments is crucial for developing countries to transition to renewable energy. It is necessary for governments to devise comprehensive, long-term energy plans that establish explicit measurable targets for the utilization of renewable energy alternatives. It is necessary to provide legal and institutional mechanisms that promote accountability and transparency for these initiatives....

A practical policy option is to introduce financial incentives, such as feed-in tariffs, tax incentives, and auctions for renewable energy. These actions decrease market entry challenges and enhance the project's viability for private investors. Kenya's energy auction system and Bangladesh's introductory concessional credit schemes for solar energy serve as good examples of how these policies can help accelerate the deployment of renewable technology.

In addition, the inclusion of renewable energy considerations in national development plans ensures alignment with wider economic and social objectives. The integrated planning scheme enables the allocation of resources to areas such as rural electrification, climate adaptation, and employment. Moreover, developing public-private partnerships can leverage crucial funds and technical expertise, which will lead to innovation and efficiency in the sector. Finally, improving the capabilities of regulatory agencies and energy ministries is necessary. A sufficiently skilled workforce and independent regulatory bodies are crucial for upholding standards, promoting fair competition in the market at large, while also ensuring long-term stability in markets.

2. Funding Models and Technological Transfer.

Finding affordable financial resources is still a major issue for many low- and middle-income nations. Why? The development of innovative financing models is necessary for the expansion of renewable energy solutions. Hence,

Institutional investors are more likely to be interested in renewable energy projects if they can tap into the potential of public and private support, which may reduce investment risks. Concessional loans, green bonds, and partial risk assurances are among the instruments that have helped to expand the clean energy sector.

A key role that multilateral financial institutions like the World Bank, the Green Climate Fund, and the African Development Bank will play is to provide tailored technical support and co-financing deals tailored to the needs of developing countries.

In addition to money, the transfer of technology and the development of local capacities are also important. By establishing connections with international developers, equipment manufacturers, and research institutes, information exchange can be improved while also supporting local value chains in the development of sustainable energy technology.

In addition, advancing domestic innovation through clean energy incubators or collaborations between academic institutions and industry can enable countries to adapt technologies to their own conditions and reduce the need for imported systems.

3. Localized and Globalized Support Systems.

The interdependence of energy systems is not a one-way street. One key benefit of regional cooperation is that it strengthens the chance to increase renewable energy across borders and make the systems stronger. The West African Power Pool and the South Asian Association for Regional Cooperation Energy Centre (SAARC) are two examples of integrated power markets that can reduce costs, make generation more efficient, and make energy more secure. Cross-border transmission lines and collaborative hydropower projects are two examples of collaborative infrastructure projects that can use economies of scale to cut down on redundancy.

In addition to their work in their own regions, they are also key providers of foreign aid. Just Energy Transition Partnerships (JETPs) have been set up in countries like South Africa and Indonesia to help reduce reliance on coal. They provide the financial and technical support needed to generate renewable energy.

The implementation of similar programs in other impoverished nations could significantly expedite global climate action.'

Grants, concessional loans and technical assistance are provided by donor countries, international organisations or charitable institutions which are also important. However, such aid must also serve the national interest of the recipient country and be provided in a way that strengthens local institutions while respecting national sovereignty.'".

4. A strategy for a just and equitable transition.

While countries work to develop cleaner energy systems, it's important that this transition is done with equity and inclusivity. To achieve a fair energy transition, we must prioritize not just emission reduction but also the creation of new opportunities, protecting those at risk, and allocating benefits to clean energy initiatives.

Planning this change must include job training and skills development. Employees from fossil fuel industries must have the necessary resources to transition into green emerging companies. Why? Such aid must include technical training schemes, career advice and comprehensive social safety nets.'

Community participation is also crucial in this process. A significant portion of initiatives in rural or historically underdeveloped areas must be influenced by local people. Why? By utilizing ownership structures like cooperatives or benefit-sharing arrangements, trust can be established and communities can receive direct rewards from renewable energy investments.

One of the key aspects of this change is gender inclusion. Women should play an active role in policy formulation and occupy different project-level roles, including engineering and entrepreneurial.' The implementation of gender-sensitive energy policies can enhance developmental outcomes and resilience.

It's imperative to establish transparent monitoring and evaluation mechanisms that can evaluate achievement, ensure accountability, and guide planning decisions. Some important metrics may include employment generation data, carbon reduction stats, energy accessibility improvements, and evaluation of equitable outcomes.

Summary of the Findings

This study investigated the effect of transitioning to renewable energy on climate change mitigation and economic development in developing nations. It also provided some key findings.

1. The study observed that, in several emerging economies, particularly those in Sub-Saharan Africa and South Asia, renewable energy technology has made significant strides. Despite challenges related to infrastructure and finances, countries like Kenya, Bangladesh, and India have made notable progress in the implementation of solar, wind, or geothermal energy technologies.
2. Similarly, the study found out that renewable energy sources are now playing an active role in decreasing greenhouse gas emissions and improving indoor air quality, particularly in areas that have reduced their dependence on diesel and coal-based generation.
3. Conversely, the study found out that renewable energy projects are positively influencing socio-economic conditions by creating jobs, improving access to energy, and increasing productivity in rural areas. The extent and allocation of these benefits vary depending on the country's characteristics, such as its institutions and policymakers.

CONCLUSION

The research revealed that although renewable energy has significant benefits, the transition faces systemic challenges such as high capital expenditures, diverse legislative frameworks and technical shortcomings, or varying levels of citizen participation.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made:

1. Build institutions with capacity for achieving effective policy implementation, particularly at the local and sub-national levels.
2. Promote inclusive planning approaches such as community participation, women's empowerment, and workforce preparation for green jobs which can boost public support and yield better outcomes.
3. Align energy programs with national development goals to ensure that renewable energy promotes environmental sustainability and economic inclusion while also alleviating poverty.

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