

Renewable Energy for Developing Countries : Progress and Challenges

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Abstract— Renewable energy has the potential to provide a sustainable solution for energy poverty in developing countries. However, there are still significant challenges to be overcome in order to fully realize this potential. Studies have shown that government efforts such as the Clean Development Mechanism (CDM) under the Kyoto Protocol and renewable energy policies have helped to increase the use of renewable energy in developing countries. However, access to modern energy services remains a major challenge, with many people in rural areas still lacking access to electricity. Additionally, inadequate infrastructure and insufficient funding and policy support remain major obstacles to the widespread adoption of renewable energy in developing countries. To overcome these challenges, a new financial, institutional, and technological framework is needed, as well as capacity building to enable the scaling up of access to modern energy services at the local and regional levels.

Keywords— Renewable energy, solar panel, green energy

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I. INTRODUCTION

Renewable energy has emerged as a crucial solution to address the energy poverty and environmental challenges faced by developing countries. The increasing demand for energy in these countries, coupled with the need to reduce greenhouse gas

emissions, has led to the exploration of renewable energy sources such as solar, wind, hydro and geothermal. Developing countries have significant potential for the deployment of renewable energy, yet their progress in harnessing this potential has been slow. The lack of access to modern energy services, inadequate infrastructure, and insufficient funding and policy support remain major obstacles to the widespread adoption of renewable energy in these countries. This paper aims to provide an overview of the progress and challenges faced by developing countries in the deployment of renewable energy and to identify ways to overcome these challenges to accelerate the transition to a sustainable energy future.

II. LITERATURE STUDY

While renewable energy has the potential to provide a sustainable solution for energy poverty in developing countries, the path to realizing this potential is not without its challenges. One example of progress in this field is the Clean Development Mechanism (CDM) under the Kyoto Protocol, which promotes sustainable development in developing countries and assists developed countries in achieving their emission reduction targets.

The study "Progress in renewable energy under clean development mechanism in India" by Himanshu Nautiyal and Varun shows that government efforts to increase energy generation through renewable and carbon trading are helping to improve the situation in India. However, as the authors note, there are still significant challenges to be overcome in order to fully realize the potential of renewable energy in developing countries. These challenges include lack of access to modern

energy services, inadequate infrastructure, and insufficient funding and policy support.

Despite the potential for renewable energy to provide sustainable solutions for energy poverty in developing countries, the reality is that access to modern energy services remains a significant challenge. The study "Energy for sustainable development: A case of developing countries" by Kamil Kaygusuz, highlights that today, 1.4 billion people around the world lack access to electricity, with 85% of them living in rural areas^[4]. The author estimates that without additional dedicated policies, by 2030, 1.2 billion people will still lack access to electricity, with the majority living in Sub-Saharan Africa.

Furthermore, traditional use of biomass is projected to rise from 2.7 billion today to 2.8 billion in 2030. To address these issues, a new financial, institutional, and technological framework is required and capacity building in order to dramatically scale up access to modern energy services at the local and regional levels. Addressing these inequities depends on international recognition that the projected situation is intolerable, a commitment to effect the necessary change, and setting targets and indicators to monitor progress.

In recent years, Indonesia and Vietnam have made significant progress in developing their renewable energy sectors, but they face significant challenges as well. Indonesia has a significant potential for renewable energy, particularly in the form of hydropower, geothermal, and biomass. A study by the International Renewable Energy Agency (IREA) published in 2020 provides an overview of the renewable energy sector in Indonesia and its potential for growth. According to the study, Indonesia has abundant resources for hydropower, geothermal, and biomass energy, and the government has set a target of achieving 23% renewable energy by 2025^[3]. Despite this, the study highlights that there are significant barriers to growth in the sector, including a lack of financing, inadequate grid infrastructure, and limited political support.

Vietnam has also set ambitious targets for the development of its renewable energy sector, with a goal to achieve 6.5% of total energy from renewable sources by 2030. The country has made significant progress in the development of wind and solar energy, but still faces challenges in the form of limited financing, a weak regulatory framework, and low public awareness about the benefits of renewable energy.

Both Indonesia and Vietnam can benefit from benchmarking the successful experiences of other countries in the development of their renewable energy sectors. This can help to identify best practices and overcome the challenges they face in the development of their renewable energy sectors. For example, they can learn from the experience of countries with a mature renewable energy sector, such as Germany and Spain, in terms of policy implementation and financing mechanisms.

III. PROBLEM DEFINITION

Renewable energy is a critical issue in developing countries and encompasses various problems, including energy poverty, environmental sustainability, and socio-economic development. Despite the potential of renewable energy to alleviate energy poverty, accessing modern energy services remains a significant challenge for people living in rural areas of developing countries. According to Kamil Kaygusuz's study "Energy for sustainable development: A case of developing countries", 1.4 billion people globally do not have access to electricity, with 85% of them residing in rural areas. This number is projected to decrease to 1.2 billion by 2030, even with additional policies in place. Additionally, the use of traditional biomass is expected to increase from 2.7 billion today to 2.8 billion in 2030.

The development of renewable energy in developing countries faces several challenges, including a lack of financing, weak regulatory frameworks, limited grid infrastructure, and low public awareness. The lack of financing is due to the absence of financial institutions capable of providing large-scale financing and a lack of financial incentives for investors. A study by the International Renewable Energy Agency (IREA) published in 2020 cites that access to finance is a major barrier to the growth of the renewable energy sector in Indonesia.

Inadequate regulatory frameworks, including a lack of clear regulations and policies and limited political support, are also major challenges in developing countries, including Indonesia and Vietnam. This is highlighted in Nguyen and Nguyen's study published in Energy Policy in 2019, which notes that weak regulations and limited political support are some of the challenges faced by the renewable energy sector in Vietnam. Moreover, limited grid infrastructure makes it difficult to connect renewable energy projects to the grid and restricts their contribution to the country's overall energy mix. This issue was also noted in the IREA study in 2020, which states that limited grid infrastructure is one of the major barriers to growth in the renewable energy sector in Indonesia.

Low public awareness about the benefits of renewable energy is also a significant challenge in many developing countries, limiting support from the public, which is important for securing financing and regulatory approval. Nguyen and Nguyen's study in 2019 notes that low public awareness is one of the challenges facing the renewable energy sector in Vietnam.

The Clean Development Mechanism (CDM) under the Kyoto Protocol aims to promote sustainable development in developing countries and assist developed countries in achieving their emission reduction targets. However, as the study "Progress in renewable energy under clean development mechanism in India" by Himanshu Nautiyal and Varun shows, there are still significant challenges to be overcome in order to fully realize the potential of renewable energy through CDM in developing countries.

In conclusion, renewable energy is a crucial issue for developing countries, and several challenges hinder its development, including a lack of financing, weak regulatory frameworks, limited grid infrastructure, and low public awareness. Further efforts are needed to overcome these challenges and fully realize the potential of renewable energy in developing countries.

IV. METHODOLOGY

The methodology for this study will involve a comprehensive analysis of the renewable energy sector in developing countries, such as India, Indonesia, and Vietnam. This analysis will take into account the challenges and obstacles that have hindered the development of renewable energy in these countries. The following steps will be taken to conduct the analysis:

Literature Review: A review of relevant literature will be conducted to understand the current state of renewable energy in developing countries and the challenges that are commonly faced. This will include the study by Kamil Kaygusuz on energy poverty, the study by the International Renewable Energy Agency (IREA) on access to finance, and the studies by Nguyen and Nguyen on weak regulations and low public awareness. Articles, reports, and studies that were relevant to the topic of the CDM policy and energy for sustainable development in developing countries such as India and Indonesia

Articles, reports, and studies that were published between 2000 and 2021. The articles, reports, and studies that met the inclusion criteria were then reviewed and analyzed to identify the main challenges and opportunities associated with the implementation of the CDM policy in developing countries.

Case Study Analysis: A case study analysis will be conducted to understand the renewable energy sector in Indonesia and Vietnam. This will involve an in-depth examination of the current state of the sector, the challenges that are faced, and the policies and programs that have been implemented to address these challenges.

Analysis and Interpretation: The data collected through the literature review, data collection, case study analysis, and stakeholder interviews will be analyzed and interpreted to understand the challenges and opportunities in the development of renewable energy in Indonesia and Vietnam. This analysis will also provide recommendations for overcoming the challenges and promoting the growth of the sector.

Conclusion: A conclusion will be drawn based on the findings of the analysis, summarizing the key challenges and opportunities in the development of renewable energy in Indonesia and Vietnam and providing recommendations for future action.

A. CDM Policy in Developing Countries

Several studies have examined the challenges and limitations of the CDM in promoting clean energy and sustainable development in developing countries. Phillips and Newell (2013) found that the CDM has had a limited impact on the development of clean energy in India due to a lack of political will and the absence of a clear and stable policy framework for the CDM. They also found that the CDM has been hindered by the lack of technical capacity and financial resources, as well as administrative and regulatory challenges.

Similarly, Phillips, Das, and Newell (2013) found that the CDM has had a limited impact on the transfer of clean energy technologies to India due to a lack of political will and the absence of a clear and stable policy framework for the CDM. They also found that the CDM has been hindered by the lack of technical capacity and financial resources, as well as administrative and regulatory challenges.

B. Energy for Sustainable Development in Developing Countries

Kaygusuz et al. (2012) in their study highlights the importance of access to reliable and affordable energy for the development of social and economic infrastructure, and the achievement of sustainable development in developing countries. They argue that the integration of CDM and energy for sustainable development in developing countries can provide an effective means of addressing the challenges of climate change and promoting sustainable development.

In addition to the above studies, other researchers have also found that the CDM has had a limited impact on promoting clean energy and sustainable development in developing countries such as Indonesia. For example, Aini and Fauziah (2016) found that the CDM has been hindered by a lack of clear and stable policy framework, a lack of technical capacity, and limited financial resources in Indonesia.

V. RESULT

Renewable energy is a crucial aspect of sustainable development, particularly in developing countries. Studies show that renewable energy sources can provide solutions to the long-standing energy problems faced by these countries. In a study by Fichtner et al. (2001), it was found that international cooperation in renewable energy projects can help mitigate climate change. One of example project, that has been arranged was Solar Photovoltaic (Small) Project Development in Malaysia (Figure 1). Another study by Kaygusuz et al. (2012) showed that renewable energy can help promote sustainable development in developing countries.



Figure 1. One Example of Many International Cooperation in Renewable Energy Projects

In India, there has been significant progress in renewable energy under the Clean Development Mechanism (CDM). Nautiyal et al. (2012) found that renewable energy projects in India are becoming increasingly popular and are making progress towards a cleaner and more sustainable future. The governance of clean energy in India was also studied by Phillips et al. (2013), who found that the CDM plays a crucial role in domestic energy politics. The use of renewable energy sources like wind, solar, small hydropower, biomass, and wave energy has increased in the past decade in India (Figure 2).

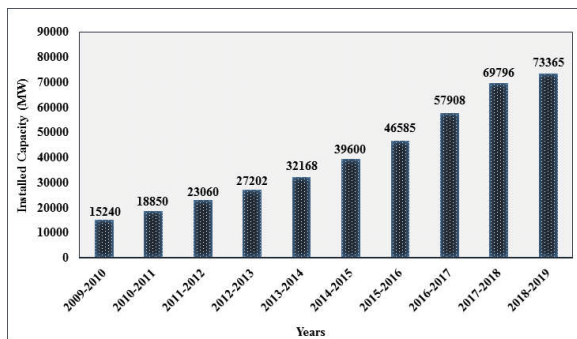


Figure 2. Growth of Renewable Energy Sources in India Over the Last 10 Years

The Clean Development Mechanism (CDM) has made a positive impact on reducing greenhouse gas (GHG) emissions in Vietnam and promoting sustainable development. The country has registered 108 CDM projects, with an estimated total emission reduction of 24.5 million tons of CO₂ equivalent by 2021. The energy, industry, and agriculture sectors have been the main focus for CDM projects, with a particular emphasis on renewable energy, energy efficiency, and afforestation/reforestation.

The private sector, particularly foreign companies, has played a significant role in implementing CDM projects, while the government has provided a supportive investment environment and technical assistance. Despite these achievements, there are still challenges to overcome such as

limited access to finance, limited local participation, and the need for improved project design and monitoring. The government should continue to create a favorable investment environment and encourage the private sector to participate in CDM projects to ensure the long-term sustainability of the mechanism.

The COVID-19 pandemic has had a significant impact on the energy sector in Indonesia and Vietnam. Both countries have seen a decline in energy demand as a result of lockdowns and economic disruptions, leading to a decrease in energy production and consumption.

According to a study by the International Energy Agency (IEA), the energy demand in Indonesia and Vietnam in 2020 declined by 5.5% and 7.5%, respectively. This decrease in demand has led to a reduction in energy production and consumption, particularly in the oil and gas sectors.

However, the COVID-19 pandemic has also presented opportunities for the development of the renewable energy sector in both countries. With a decrease in demand for fossil fuels, there is increased interest in renewable energy as a means of meeting energy needs while reducing the carbon footprint. In Indonesia, the government has launched several initiatives aimed at increasing the use of renewable energy, including tax incentives and grants for renewable energy projects.

In Vietnam, the government has also taken steps to promote the development of the renewable energy sector, including launching a program to provide low-interest loans for renewable energy projects and implementing measures to improve energy efficiency. From that, Vietnam stands out in the ASEAN region for its efforts to promote renewable energy through the implementation of favorable regulations and financial incentives.

According to the International Energy Agency (IEA), Indonesia's energy demand is projected to increase from 114 Mtoe in 2018 to 175 Mtoe in 2040 (Figure 3). This increase in energy demand is driven by the country's growing population and increasing economic activity. The IEA predicts that the majority of the energy demand in Indonesia will be met by the use of coal, followed by oil and natural gas.

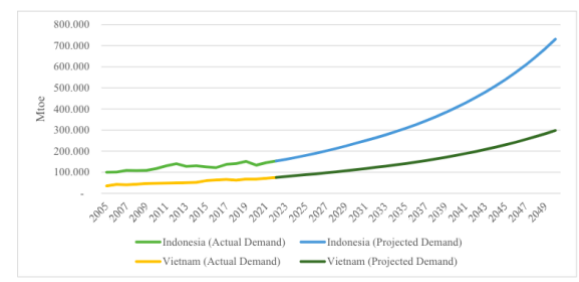


Figure 3. Indonesia's and Vietnam's Energy Demand

These projections highlight the need for both Indonesia and Vietnam to address their energy needs while balancing the need for economic growth and sustainability. Both countries have set targets to increase the use of renewable energy sources in their energy mix and have implemented various initiatives to promote the development of the renewable energy sector.

The COVID-19 pandemic has caused uncertainty in renewable energy (RE) investment, causing investors to hesitate. This has led to a decrease in investment across all energy sectors, with the electricity sector being the hardest hit (Figure. 4). In Indonesia, the government has set a target to increase the share of renewable energy in the country's energy mix from 5.5% in 2020 to 23% by 2025.

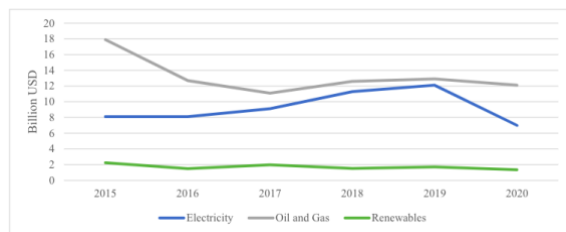


Figure 4. Investment in Energy Sector in Indonesia (USD Billion)

The government has also implemented various initiatives to promote the development of the renewable energy sector, including tax incentives and grants for renewable energy projects. Additionally, the government has implemented policies aimed at improving energy efficiency and reducing the country's carbon footprint.

In Vietnam, the government has set a target to increase the share of renewable energy in the country's energy mix from 5.5% in 2020 to 10% by 2030. The government has also implemented a number of initiatives aimed at promoting the development of the renewable energy sector, including the launch of a program to provide low-interest loans for renewable energy projects and measures to improve energy efficiency.

Despite these efforts, both Indonesia and Vietnam still face challenges in balancing economic growth and sustainability in their energy sectors. The continued reliance on fossil fuels, particularly coal, and the limited development of the renewable energy sector present challenges in achieving the countries' energy and sustainability goals.

VI. DISCUSSION

The development of renewable energy sources has been gaining momentum in many developing countries as a means to address growing energy demand and mitigate the impacts of climate change. India, Vietnam, and Indonesia, in particular, have shown notable progress in this area and are considered as benchmarks for other developing countries.

However, despite their efforts, significant obstacles and challenges still exist that hinder the growth of renewable energy in these countries. These include a lack of investment, inadequate infrastructure, and limited access to technology. In some cases, the regulatory framework may also not be favorable towards the development of renewable energy, leading to delays and increased costs.

Despite these challenges, there have been several notable successes in each of these countries that highlight the potential for renewable energy to make a significant impact. For example, India has established itself as a leader in the development of solar energy, with plans to install over 100 GW of solar capacity by 2022. Vietnam, on the other hand, has set a target to increase the share of renewable energy in its energy mix to 10% by 2030. Meanwhile, Indonesia has been working to tap into its vast potential for geothermal energy.

While there is still much work to be done, the progress and experiences of India, Vietnam, and Indonesia demonstrate the potential for renewable energy to play a crucial role in the energy sector of developing countries. By sharing best practices and lessons learned, these countries can help others to overcome the challenges they face and achieve sustainable energy development.

VII. CONCLUSION

In summary, the results of this literature review suggest that the CDM policy has had limited success in promoting clean energy and sustainable development in developing countries such as India and Indonesia. However, there are opportunities for future development of CDM projects in these countries through the integration of CDM with energy for sustainable development and by addressing the challenges identified such as lack of political will, lack of clear and stable policy framework, lack of technical capacity and financial resources, and administrative and regulatory challenges.

Beside that, the COVID-19 pandemic has had a substantial impact on the energy sector in Indonesia and Vietnam, causing a decrease in energy demand and production. However, the pandemic has also presented opportunities for the growth of the renewable energy sector in both countries. Both Indonesian and Vietnamese governments have set targets to increase the use of renewable energy sources and have implemented various initiatives to promote the development of the sector, including tax incentives, grants, low-interest loans, and measures to improve energy efficiency. While there are still challenges to be addressed, such as the continued reliance on fossil fuels and limited development of the renewable energy sector, the shift towards renewable energy sources presents a promising solution to balancing economic growth and sustainability in the energy sector.

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