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Climate Finance and Renewable Energy Transition in India: Evaluating Policy Effectiveness and Investment Challenges in the Post-Paris Era (2015-2025)

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Abstract— *This paper critically analyses how climate finance and renewable-energy investment can enable India to transition to low-carbon in the post-paris Agreement period between 2015- 2025. The research design embraced in the study is a qualitative and descriptive study design, which is solely based on secondary data that has been sourced through government reports, policy documents, international climate-finance data bases, and academic sources. The article has examined the country-level climate-financing approaches including the green bonds, renewable-energy initiatives, government-corporate initiatives, and international climate-finance instruments like the Green Climate Fund. The study identifies that India has achieved a lot in the growth of renewable-energy and other sustainable-finance processes; nonetheless, the structural issues such as financing gaps, technological dependence, unpredictable regulations, and perpetual reliance on fossil fuels remain to limit the decarbonization over time. The paper concludes with the finding that the most important issue of the realization of the climate-commitments of India in the Paris Agreement should be the improvement of the institutional coordination, climate-finance governance and technological innovations.*

Keywords— ***Climate Finance, Renewable Energy, Paris Agreement, Green Investment, India, Climate Governance.***

I. INTRODUCTION

The framework of global climate governance has been changed by the Paris Agreement adopted at the events on the Twenty-First Conference of Parties (COP-21) in 2015; it has introduced a decentralized model structured on Nationally Determined Contributions (NDCs) and long-term decarbonization pathways (Falkner, 2016). The Paris Agreement in contrast to the Kyoto agreement was more inclusive, with climate finance, technological co-operation, domestic policy integration; it did not incur legal binding obligations as chiefly the developed countries under the Kyoto agreement. In the case of developing economies like India, the Agreement presented both opportunities and challenges due to the fact that climate governance would have to be incorporated into the economic development, industrial growth, energy security, and alleviation of poverty.

The strategy of India on climatic policy post-Paris has placed much stress on the transformation of energy into renewable sources, energy efficiency, climate resilience and sustainable infrastructure. It has become one of the biggest markets in the world with its orientations towards renewable-energy ventures like the National Solar Mission, the National Green Hydrogen Mission and the electric-

mobility schemes. Meanwhile, India is still struggling with a considerable amount of financial and technological obstacles to large-scale decarbonization policies. The IEA, 2023 stated that to realize India renewable-energy objectives and net-zero promise by 2070, the nation will need to invest in massively large amounts. Climate finance consequently finds itself in the core of the climate-governance system of India. Increasing prominence has been given to domestic financing institutions, green bonds, multilateral climate funds, and public-private partnerships as a means of mobilizing investment into renewable energy and low-carbon infrastructure. Nevertheless, the lack of financial commitment to global climate, regulatory insecurity, reliance on data technologies and fossil-fuel supremacy still limit the efficiency of the Indian energy transition.

This paper provides a critical review of the climate-finance structure and India's renewables – transition in the post Paris era (2015-2025). The paper contrasts financing schemes, institutional matters and governance of renewable energy and the overall incompatibilities between economic growth and decarbonisation.

II. REVIEW OF LITERATURE

Existing literature on climate finance and India's renewable energy transition highlights the need for strengthening financial governance, institutional coordination and technological innovation for the objectives of the Paris Agreement in India.

Bhattacharya et al. (2022) raise the argument that climate finance is necessary to developing countries since low-carbon transitions would necessitate massive construction of infrastructure, technological innovation and adaptation funding. Their work highlights that poorer countries like India cannot fulfill the promises of the Paris Agreements without better financial assistance and institutional changes at home.

Falkner (2016), the Paris Agreement implied a new system of governance with a country-specific set of climate commitments and decentralization of the policymaking process. The author states that climate finance and technological cooperation are two substantial pillars of the post-Paris regime of governance.

Dubash and Rajamani (2018) focus on the history of climate-policy in India and suggest that the country tries to reconcile the priorities of developmental with international climate-related commitments. Their study points out that India has seen growth of renewable-energy not because of environmental concerns, but also because of energy security and industrial competitiveness.

Despite an increase in investment, both public and private, in the transition of renewable-energy in India, there still exists significant financing gap (Climate Policy Initiative, 2023). Transmission infrastructure, storage systems and adaptation financing are among the other critical areas that will need increased investments due to climate, the report states.

Ghosh (2019) restates the political economy of India's energy transition and why it is that the fossil fuel dependency has still not been weaned enough in the Indian system of industry and development. The paper outlines some of the paradoxes fuelled by dependence on coal and a push for renewable energy.

According to the report by the International Renewable Energy Agency (IRENA, 2023) India has become one of the fastest-growing renewable-energy markets in the world. Nonetheless, technological reliance on solar modules and battery systems that are imported still poses vulnerabilities to the clean-energy transition process.

In general, the literature shows that although India has already reached relatively high growth in renewable-energy following the Paris Agreement, climate-finance sufficiency, institutional coordination and technological capacities are quite significant governance issues. The current research is thus a contribution to the existing literature as it critically assesses climate-finance governance and renewable-energy transformation of India during 2015-2025.

Objectives

1. To examine the role of climate finance and renewable-energy investment in supporting India’s low-carbon transition during the post-Paris Agreement period (2015–2025).
2. To evaluate the institutional, financial, and technological challenges affecting the effectiveness of India’s climate-governance and renewable-energy transition framework.

Hypotheses

H1: “Climate finance and renewable-energy investments significantly contribute to India’s low-carbon transition and climate-governance objectives in the post-Paris era.”

H2: “Financial constraints, technological dependency, and institutional fragmentation negatively affect the effectiveness of India’s renewable-energy transition and climate-governance framework.”

III. RESEARCH METHODOLOGY

The research methodology will be qualitative and descriptive, targeting the period after the Paris Climate Agreement in India from 2015 – 2025 focusing only on the

climate-finance governance and the renewable-energy transformation in India. The study has an exclusive reliance on secondary data, which have been compiled through reports of the government, data on renewable-energy sources, international databases on climate-finance, documents of policies, and a literature search of scholarly research materials. The sources of data include, but are not limited to, reports coming out of "Ministry of New and Renewable Energy (MNRE)", "Ministry of Environment, Forest and Climate Change (MoEFCC)", "Reserve bank of India (RBI)", the "International Energy Agency (IEA)", the "International renewable energy agency (IRENA)", "Climate policy initiative (CPI)", World bank and "United Nations Framework Convention on climate change (UNFCCC)". It uses thematic content analysis to assess the governance of renewable-energy, green-finance strategies, institutional coordination and climate-policy implementation, in the Indian post-paris climate framework.

Theoretical Framework

The analysis rests on the Ecological Modernization Theory (EMT) that opinionates that the environmental sustainability and economic development can be reconciled via technological innovation, institutional transformation as well as market-driven governance and sustainable industrial transformation. However, contrary to conventional ecological models which consider economic growth and environmental protection to be contradictory, EMT proposes that cleaner production and renewable-energy development and sustainable governance frameworks can be achieved through modernization processes.

Applying to the Indian context, the Ecological Modernization Theory will be a valuable tool in explaining how climate governance is rising in integrating transition to renewable energy, green investment, sustainable infrastructure, and industrial competitiveness. The following three concerns, namely renewable energy, green hydrogen, electric mobility and climate-finance mechanisms conducted by India after the Paris Agreement, can be explained with the help of the theory.

The structure also enables one to analyze the role of the market-based environmental regulation, technological modernization and the role of a public- private partnership in the climate-governance structure of India. As a result, EMT offers an analytical foundation upon which one can explore the question of whether India has the systems and policies in climate-finance and renewable-energy able to provide the long-term low-carbon development with a sustainable level of economic growth and energy security.

IV. RESULTS AND DISCUSSION

Renewable-Energy Growth and Climate-Finance Growth.

The study has indicated the remarkable rise in deployment rate of renewable-energy in the post-Paris Agreement year of 2015-2025 in India. Governance of renewable energy has been one of the most salient elements of the Indian climate-policy landscape as increased focus on the government is shifting toward renewable energy sources as a means to both realize energy security and industrial modernization, as well as emissions reduction. According to Ministry of New and Renewable Energy (MNRE, 2024), India is now one of the most prominent producers of renewable-energy among the world which includes solar and wind energy. Solar parks, rooftop solar systems, wind-energy corridors and decentralized solar-energy systems are a sign of institutional prioritization of clean-energy transition.

The analysis also reveals that climate finance has been at the forefront in promoting growth of renewable-energy. Examples of government subsidies and concessional lending, viability-gap funds, green bonds, and multilateral funding mechanisms have also played a central role on the investment in renewable energy. According to the IEA, 2023 after the Paris Agreement, more and more investment was directed to renewable-energy infrastructure in India, both domestically and internationally, especially in utility-scale solar power plants and grid modernization. This confirms Hypothesis H1 which postulates climate finance augers well in low-carbon transition in India.

Simultaneously, the paper concludes a growth of renewable-energy sources is not a climate-only phenomenon. There is an increasing linkage of renewable energy to the larger developmental goals, including creating jobs, making industries more competitive in world markets, decreasing fossil fuel purchases, and lighting up rural villages. As a result, the governance of renewable-energy in India indicates a synthesis of the developmental paradigm incorporating both the ecological and economic interests.

Domestic Climate-Financing Mechanisms

The results show that domestic financing institutions are an important element in the climate-governance system in India. Investment in renewable-energy and sustainable financing of infrastructure has been progressively financed by public-sector financial institutions, including the Indian Renewable Energy Development Agency (IREDA) , Power Finance Corporation (PFC) and by public-sector banks. Moreover, the sovereign green bonds launched by the Government of India are becoming significant tools of drawing in sustainable finance.

This analysis reveals that green bonds have increased and diversified considerably the investment opportunities in climate-related issues by bringing the institutional investors into the renewable-energy and infrastructural projects. The Climate Bonds Initiative (2024) suggests that India has emerged as one of the largest green-bond markets among the emerging economies. The involvement of the private-sector in financing renewable-energy has also risen significantly especially in the development of solar-energy, electric mobility and battery.

Nevertheless, the work reveals crucial structural flaws in the system of domestic climate-finance governance. Electricity-distribution companies are constantly in financial distress, which continues to destabilize investments for renewable energy due to non-timely payments that are uncertain to the private developers. Also, the financing of adaptation is still unsatisfactory, since financing of commercial profitable mitigation initiatives is usually preferred by private investors to long-term climate resilience programs. This partly favors Hypothesis H2 on institutional and financial constraints of the climate-governance system in India.

International Climate Finance and Technological Dependency

The results also show that climate finance at the international level still remains significant yet inadequate in the climate transition in India. Renewable-energy and adaptation projects in India have received financial support of the Green Climate Fund (GCF) and the World Bank , Asian Development Bank (ADB) , and Asian Infrastructure Investment Bank (AIIB) . Nonetheless, the analysis indicates that implementations of climate-finance flows continue to be far below the whoop necessary to meet the targets of the Nationally Determined Contributions (NDCs) and long-term net-zero targets of India. Technological dependency is another primary area of concern in governance that is identified in the analysis. In spite of the massive growth in renewable-energy sources, India is still a reliant spot on imported solar modules, post-battery-storage technologies and the more crucial minerals required in clean-energy systems. The International Renewable Energy Agency (IRENA, 2023) notes that this reliance poses strategic risks to India in its energy-transition plan and restricts its technological autonomy on the national level.

Public-Private Partnerships and Green Investment Governance

The findings reveal that the notion of public-private partnerships (PPP) has become more and more relevant in the climate-governance architecture of India. In India, the growth of renewable energy is strongly reliant on the role of the private sector, especially in the area of solar parks, wind-energy, electric-mobility, and sustainable urban infrastructure. The government has thus provided policy incentives, production based incentive schemes, and regulatory reforms to attract the private investment in the low carbon sectors.

The research concludes that PPPs have enabled technological modernization and speedy implementation of renewable-energy. International investors and domestic conglomerates have also ventured into the clean-energy industry in India and turned renewable energy into a large segment of economic investment. Nevertheless, the analysis shows that regulatory uncertainty, land-acquisition struggles, bottlenecks in transmission, and ineffective policy enforcement remain to diminish investor confidence.

V. CONCLUSION

The paper concludes that climate finance and renewable-energy governance are currently the main elements in the Indian climate-policy regime over the period between 2015 and 2025 between the post-Paris Agreement. India has made impressive development in the renewable-energy sector by using solar-energy solutions, green-investment solutions, the government-corporate collaborations, and sustainable-finance solutions. Climate finance has been significant in enhancing the low carbon transition and information infrastructures modernization.

The results however show that the climate-governance framework in India is also plagued by significant structural problems. Limitations to long-term decarbonization initiatives are financial, technological dependency, institutional fragmentation, lopsided investment in each region, and sustained dependence on fossil fuels. The international climate-finance commitments are still insufficient and domestic financing of adaptation and technological self-sufficiency are to be reinforced heavily.

The next generation policy initiative must thus focus on mobilizing green investments in the long term, increasing domestic clean-energy production, deepening global technological collaboration and better global climate-governance institutions that can bring environmental sustainability to hand in hand with inclusive economic growth.

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