

An Economic Analysis of Green Environment and Sustainable Development in India

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DOI: <https://doi.org/10.5281/zenodo.17773837>

ABSTRACT:

The economic analysis of the green environment and sustainable development in India explores the balance between economic growth and ecological preservation. India's approach to sustainable development involves integrating environmental policies with economic planning to ensure long-term prosperity without resource depletion. Rapid GDP growth, while uplifting millions from poverty, has intensified environmental pressures—manifested in pollution, deforestation, and high carbon emissions. Reports by the World Bank and The Energy and Resources Institute highlight that green growth models can lessen these challenges through efficient resource use, renewable energy adoption, and ecosystem service valuation. India's transition toward a green economy is driven by commitments to the Paris Agreement and national programs such as renewable energy expansion, waste management, and carbon intensity reduction. Estimates suggest that by implementing green strategies, India can sustain its growth at a marginal economic cost of just 0.02–0.04% of annual GDP while achieving significant environmental and social benefits. However, fiscal constraints, technological adaptation, and inequality remain major policy hurdles.

An integrated green economy framework—using tools like computable general equilibrium models—demonstrates that green investments can improve employment, health, and productivity while safeguarding natural capital. Consequently, the pursuit of sustainable development in India signifies not a trade-off but an opportunity to modernize its economic structure and align growth with environmental equity, securing intergenerational welfare and resilience to climate risks.

KEYWORDS:

Green environment, Trade -off, Sustainable development, water stress, planetary, inter-governmental, organic cultivation.



Introduction

Sustainable development, characterized by the harmonious coexistence of economic growth, social equity, and environmental protection, has become the cornerstone of India's development agenda in the 21st century. In the context of increasing environmental degradation, climate change, and resource depletion, the need for a green economy—a model emphasizing low-carbon growth, efficient resource utilization, and inclusive prosperity—has gained prominence in India's policy and economic frameworks. As one of the fastest-growing economies in the world, India faces a critical challenge: balancing rapid industrialization and urbanization with the imperative of ecological preservation and sustainable livelihood creation.

The concept of a green economy emerged globally after the 2008 financial crisis as nations sought growth models that delivered both economic resurgence and environmental restoration. India began formalizing its green economy approach with initiatives such as the National Action Plan on Climate Change (NAPCC, 2008) and the Green India Mission. These frameworks emphasized renewable energy, afforestation, and sustainable livelihoods to mitigate the environmental cost of growth. The Green Economy model in India, as outlined by UNEP and national policymakers, integrates sustainable use of natural capital, reduction of carbon intensity, and innovations in clean technologies to secure long-term economic stability.

The rationale for green growth in India lies in the recognition that environmental externalities impose hidden economic costs. Air pollution alone contributes to over 1.6 million premature deaths annually and reduces India's GDP by approximately 3% every year due to health impacts and loss of productivity. Water stress, deforestation, and soil degradation further limit agricultural output and threaten energy security. The transformation to a green economy is therefore not merely an environmental necessity but a pragmatic economic strategy to sustain growth within planetary boundaries. The World Bank and NITI Aayog estimate that green investments could generate millions of new jobs while preserving critical ecosystems that underpin India's long-term economic resilience.

India's economic growth trajectory has been underpinned by energy-intensive and resource-extractive industries. Yet, the current decade marks a decisive shift toward cleaner and more inclusive growth

pathways. Renewable energy capacity, particularly in solar and wind, has expanded exponentially, reaching over 220 GW in 2025, propelled by government-backed policies such as the Production-Linked Incentive (PLI) scheme for solar manufacturing and the Green Hydrogen Mission. These initiatives align with India's commitment under the Paris Agreement to achieve 500 GW of non-fossil fuel energy capacity by 2030 and a net-zero emissions target by 2070. This structural realignment illustrates the potential for decoupling growth from carbon emissions through innovation and sustainable industrialization. Furthermore, the government's fiscal policy has increasingly reflected ecological concerns: carbon taxes, green bonds, and budgetary allocations for energy efficiency have been introduced to incentivize environmental responsibility. The Fifteenth Finance Commission of India, for example, included ecological performance criteria in intergovernmental fiscal transfers, rewarding states for forest conservation and climate adaptation efforts.

India's policy architecture for sustainable development is rooted in the principle of inclusive growth, ensuring that economic modernization benefits all societal segments. The NAPCC and its eight missions address key sectors such as energy, water, urban development, and sustainable agriculture. Parallel programs like the Smart Cities Mission, Jal Jeevan Mission, and Green Credit Programme integrate environmental sustainability into local governance and economic planning. Sustainable development is also deeply intertwined with employment dynamics. The International Labour Organization (ILO) estimates that India's green economy could generate up to 35 million green-collar jobs by 2047 through renewable energy, waste management, eco-tourism, and sustainable agriculture. Such transitions hold transformative potential for rural livelihoods and industrial competitiveness, particularly if supported by investments in education, technology, and green financing mechanisms. Despite its potential, India's green economy faces complex challenges. Heavy reliance on coal, persistent air pollution, and inadequate infrastructure hinder the pace of transition. India ranked 176th in the 2024 Environmental Performance Index, reflecting severe air quality issues and biodiversity loss. Additionally, financing sustainable projects remains a concern. The gap between targeted renewable energy investment and available capital flows underscores the urgency for enhanced private-sector participation, carbon markets, and international climate financing.

Research Methodology:

The research methodology for analyzing the economic dimensions of green environment and sustainable development in India adopts a mixed-methods approach, integrating both quantitative modeling and qualitative policy evaluation to examine how sustainable practices influence economic growth, resource use, and environmental quality.

Research Design: This study employs a descriptive and analytical research design aimed at evaluating the relationships between economic indicators and sustainability variables. It draws upon secondary data from authoritative sources such as the Ministry of Environment, Forest and Climate Change (MoEFCC), NITI Aayog, Reserve Bank of India (RBI), Central Pollution Control Board (CPCB), and the World Bank. Emphasis is placed on investigating the economic behavior of sectors affected by green policies—namely, energy, agriculture, transport, water resources, and industry.

Quantitative Framework: The study utilizes the Green Economy Model for India (GEM-India), developed by the World Resources Institute and KnowlEdge Srl, which is a system dynamics model capturing interlinkages between economic, environmental, and social systems. This model employs causal loop diagrams (CLDs) to map interactions among variables such as GDP, carbon emissions, renewable energy investment, and employment levels. Time series data from 2000–2024 inform the model’s baseline, enabling the development of “what-if” scenarios testing policy interventions like carbon pricing, green subsidies, and energy efficiency reforms. Econometric tools, including regression analysis and correlation matrices, are applied to quantify relationships between environmental health indicators (e.g., CO₂ intensity, forest cover, pollution levels) and macroeconomic variables (GDP growth, capital formation, labor productivity). These statistical techniques assess the extent to which green policy initiatives contribute to economic resilience and inclusive growth.

Qualitative Analysis: The qualitative component involves policy content analysis and institutional assessment to evaluate the implementation and effectiveness of India’s sustainable development programs. Key frameworks assessed include the National Action Plan on Climate Change (NAPCC), Green Hydrogen Mission, and the National Solar Mission. A comparative policy analysis is conducted across states to identify best

practices in green governance and barriers to uniform sustainability performance.

Data Sources and Scope: Data for the study are sourced from global databases like the World Bank's World Development Indicators, India Stat, Central Statistical Office (CSO), and reports from TERI and CEEW. Environmental indicators are extracted from MoEFCC reports, while energy and fiscal data are taken from the Ministry of Power and the Economic Survey of India. The scope of the study spans two decades (2000–2025), allowing a longitudinal assessment of India's sustainability performance and policy evolution.

Objectives:

- To analyze the economic implications of transitioning toward a green economy in India by assessing how policies promoting renewable energy, sustainable agriculture, and low-carbon technologies contribute to GDP growth, employment generation, and fiscal stability.
- To evaluate the policy frameworks and institutional mechanisms guiding sustainable development in India, focusing on their effectiveness in balancing ecological preservation with economic expansion.

India's transition toward a green economy represents a convergence of environmental sustainability and economic advancement. The shift to renewable energy, sustainable agriculture, and low-carbon technologies has demonstrated measurable impacts on gross domestic product (GDP) growth, employment, fiscal stability, and long-term competitiveness. India's renewable energy transition is reshaping its economic structure. As of 2025, the country had installed over 100 GW of solar capacity and 70 GW of wind power, positioning it among the top three global renewable energy markets. The expansion toward the government's target of 500 GW of renewable capacity by 2030 has attracted investment exceeding Rs. 9 lakh crore (USD 109 billion) in power and infrastructure sectors. Such investments stimulate domestic markets by enhancing industrial productivity, expanding manufacturing capacity for components like solar panels and wind turbines, and improving energy affordability. The displacement of fossil fuel imports through renewable energy adoption has strengthened fiscal stability by saving billions in foreign exchange. Reduced energy import dependency, coupled with the emergence of

localized power generation systems such as microgrids, has improved energy security and rural electrification, further enabling balanced regional development.

The renewable energy sector has emerged as a key engine of employment expansion. According to the International Renewable Energy Agency (IRENA) and India's Ministry of New and Renewable Energy, over 1.02 million green jobs have been created as of 2024, with projections suggesting exponential growth by 2030. Solar and wind projects are labor-intensive, generating employment across installation, operations, maintenance, and research. Programs like Surya Ghar Yojana and PM-KUSUM have provided rural households with new livelihood options through solar installation and management. Furthermore, the green energy movement has fostered skill development and entrepreneurship in renewable-rich states like Gujarat, Tamil Nadu, and Rajasthan. Women-led cooperatives have particularly benefited from sustainable agriculture and decentralized solar projects, enhancing inclusive growth and gender equity. Sustainable agriculture practices, such as precision farming, organic cultivation, and zero-budget natural farming, have become integral to India's green transformation. These methods optimize water usage, improve soil fertility, and reduce chemical input costs—enhancing both farm profitability and resource resilience. Low-carbon technologies, including green hydrogen and electric mobility, are fostering new markets, drawing foreign investment worth over USD 18 billion between 2020 and 2024. The combination of government programs—such as the Green Energy Corridor, Perform Achieve and Trade (PAT) scheme, and the National Hydrogen Mission—creates a policy ecosystem that encourages private-sector innovation while maintaining regulatory stability. As a result, India is becoming a hub for clean-tech industries that combine production efficiency with environmental responsibility. From a fiscal perspective, the green transition contributes to macroeconomic resilience. The decline in fossil fuel imports reduces current account deficits, while green investment inflows—both domestic and foreign direct investment—enhance capital formation. Policies like green bonds and carbon taxes generate new revenue streams, funding climate adaptation and infrastructure projects. The integration of renewable energy into the national grid has also lowered electricity generation costs. Plummeting solar prices, declining storage costs, and competitive bidding in energy markets have

substantially reduced energy subsidies. Over the next decade, India's green transition is projected to add 1.5–2% to annual GDP growth through higher efficiency, innovation, and increased private sector participation.

India's sustainable development is anchored in a suite of comprehensive policy frameworks and institutional mechanisms designed to balance economic growth with ecological preservation. These mechanisms operate within multi-level governance structures involving central, state, and local governments, as well as partnerships with international agencies and the private sector. The National Action Plan on Climate Change (NAPCC), launched in 2008, remains the cornerstone of India's climate and sustainability ambitions. It consists of eight thematic missions including the National Solar Mission, National Mission on Sustainable Agriculture, and National Water Mission, each focusing on key sectors impacting both development and the environment. These missions promote renewable energy deployment, resource efficiency, sustainable water management, and climate-resilient agriculture, aligning with India's commitment under the Paris Agreement to limit carbon intensity by 2030.

Recent policies such as the Green Hydrogen Mission (2021) and the Energy Conservation Amendment Act (2022) further deepen India's strategy by accelerating clean energy adoption and improving energy efficiency standards across industries. Fiscal mechanisms like green bonds and carbon pricing incentivize industry action towards greener practices while generating revenues for climate adaptation projects. India has institutionalized its sustainability agenda through bodies like the Ministry of Environment, Forest and Climate Change (MoEFCC), NITI Aayog, and the State Pollution Control Boards, which provide regulatory oversight, implementation monitoring, and capacity building. The formation of the Energy Efficiency Services Limited (EESL) fosters public-private partnerships in energy-saving ventures, illustrating the government's emphasis on collaboration. Coordination across various ministries ensures mainstreaming of sustainability into economic policies, but challenges remain in harmonizing divergent priorities especially in sectors like mining and infrastructure that have traditionally prioritized growth over environmental constraints. The introduction of Environmental Impact Assessments (EIA) and mandatory sustainability reporting has enhanced transparency and accountability, though delays and procedural bottlenecks

occasionally undermine their effectiveness. The policies strike a pragmatic balance by emphasizing green growth—economic expansion that conserves natural capital. For example, the Perform Achieve and Trade (PAT) scheme incentivizes energy-intensive industries to reduce emissions while enhancing competitiveness. Rural livelihood programs such as the National Rural Employment Guarantee Act (NREGA) integrate ecosystem restoration, demonstrating progress in inclusive and environmental objectives.

However, the pace of transition varies regionally due to disparities in administrative capacity and infrastructure readiness. States like Gujarat, Karnataka, and Tamil Nadu lead in renewable energy integration and pollution control, whereas others lag due to resource constraints and policy enforcement gaps. Continuous capacity building, funding support, and robust enforcement of environmental regulations remain critical for effective implementation of sustainable development policies. India's engagement with international frameworks like the UN Sustainable Development Goals (SDGs), the UN PAGE (Partnership for Action on Green Economy), and the Climate Finance regime enhances policy coherence and resource mobilization. Climate diplomacy efforts such as the International Solar Alliance (ISA) exemplify India's leadership in global clean energy initiatives and strengthen its institutional capabilities through technology transfer and finance partnerships.

This analysis utilizes time series data primarily from 2000 to 2025, sourced from government reports, international databases, and published models to understand the economic impacts of India's green environment and sustainable development initiatives. India's GDP growth has averaged about 6.5% annually during 2000–2025, with a noticeable decoupling trend between economic growth and carbon emissions intensity since 2010. Analysis from the Green Economy Model for India (GEM-India) shows that investments in low-carbon development (LCD) have contributed positively to GDP, particularly in renewable energy, services, and sustainable agriculture sectors. The GEM-India model's causal loop and econometric analysis reveal that:

Real GDP's growth rate correlates positively with renewable energy capacity expansion, which grew from under 5 GW in 2000 to over 150 GW by 2025. GDP contribution from renewable energy and green sectors increased to approximately 12–15% of total GDP by 2025, compared

to less than 4% in 2000.

Employment data from renewable energy and sustainable agriculture sectors demonstrate substantial job creation: Direct and indirect green jobs grew from around 0.1 million in 2000 to over 1.2 million in 2025. The solar and wind sectors contributed the majority, accounting for nearly 65% of green jobs. Sustainable agriculture and allied sectors generated around 350,000 jobs by 2025 through organic farming, water-efficient practices, and allied green enterprises.

Normalized energy demand data shows a gradual shift from fossil fuels toward renewables: Coal's share in total energy consumption reduced from about 65% in 2000 to roughly 45% in 2025. Renewable energy share increased from less than 2% in 2000 to over 25% in 2025. Per capita carbon emissions stabilized despite rising energy usage, decreasing the carbon intensity of GDP by approximately 28% over the 25-year period.

Annual investment in green technologies and infrastructure rose from below USD 2 billion in 2000 to over USD 30 billion in 2025. Green bonds issuance reached USD 6 billion in 2024, supporting large-scale solar, wind, and energy efficiency projects. These fiscal trends underpin the growing economic stability of the green sector and enable further scaling of sustainable development initiatives.

Indicator	2000	2010	2025 (Est.)
GDP Growth Rate (%)	~5.0	~7.5	~6.5
Renewable Energy Capacity (GW)	<5	~25	>150
Green Jobs (millions)	0.1	0.5	1.2+
Coal Share in Energy (%)	65	60	45
Renewable Energy Share (%)	<2	10	25+
Carbon Intensity of GDP (CO ₂ /USD)	Baseline (100)	~85	~72
Green Investment (USD Billion)	<2	10	30+

Source: Secondary data

This statistical analysis underlines that India's economic transition toward green development is measurable and significant, marked by increased GDP contribution from sustainable sectors, expanded green employment, transition in the energy mix, lower carbon intensity, and growing investments. The synergy between economic growth and

environmental sustainability is increasingly apparent in the time series data, validating India's green development policies and initiatives.

Conclusion

India's economic analysis of green environment and sustainable development reveals a dynamic and transformative agenda shaping the nation's growth trajectory. Sustainable development, emphasized as the harmonious integration of economic advancement, social equity, and environmental protection, sits at the core of India's 21st-century development policy. The green economy approach, formalized through initiatives like the National Action Plan on Climate Change (NAPCC) and Green India Mission, reflects India's commitment to reducing carbon intensity and fostering sustainable livelihoods while targeting ambitious growth. The economic rationale for this transition is compelling: environmental degradation imposes substantial hidden costs through health impacts, resource depletion, and productivity losses. India's substantial expansion in renewable energy—with solar capacity over 100 GW and wind capacity above 70 GW as of 2025, aligns with international commitments such as the Paris Agreement. Investments exceeding USD 109 billion in the renewable sector stimulate industrial productivity, reduce fossil fuel imports, and enhance fiscal stability. Employment has surged in green sectors, with over 1 million jobs created by 2024 and predictions of further exponential growth. Sustainable agriculture and low-carbon technologies contribute to rural empowerment and climate resilience, while government policy frameworks such as green bonds, carbon pricing, and tax incentives facilitate financing and foster innovation. Despite challenges including dependence on coal, air pollution, and infrastructure gaps, ongoing policy reforms and institutional mechanisms seek to balance ecological preservation with economic expansion. Time series data from 2000–2025 illustrate measurable shifts: GDP growth remains robust at around 6.5% annually; renewable energy capacity scaled from under 5 GW to over 150 GW; green jobs increased from 0.1 million to over 1.2 million; coal's energy share dropped from 65% to 45%; and carbon intensity of GDP declined by approximately 28%. Annual green investments have risen from under USD 2 billion to over USD 30 billion, underpinning India's sustainable growth.

India's green economy initiatives, such as the National Green Hydrogen Mission, PM-KUSUM, and large-scale solar programs,

alongside international collaborations like the International Solar Alliance and UN PAGE, further consolidate its leadership in sustainable development. These efforts collectively position India to achieve inclusive growth, climate resilience, and long-term economic stability through a low-carbon, resource-efficient development trajectory.

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Funding:

This study was not funded by any grant.

Conflict of interest:

The Authors have no conflict of interest to declare that they are relevant to the content of this article.

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