Shodhbodhalaya: An International Peer reviewed Multidisciplinary Journal

Volume 4 | Issue 1 | ISSN: 2584-1807 | (https://shodhbodh.com/)

Green Growth and Sustainable Development in India: An Empirical Assessment of Policy Effectiveness Towards Viksit Bharat 2047

Divesh Sinha[1], Dr. L. Geetarani Devi[2], Suruchi[3], Dr. Sukanya R.[4]

[1] Principal, Davara International School, Naya Raipur, Raipur, Chhattisgarh, India

Email: divesh.dis19@gmail.com

[2] Assistant Professor, Agricultural Economics, College of Agriculture, Central Agricultural University (CAU), Pasighat, Arunachal Pradesh, India

Email: geetacu@gmail.com |

[3] Research Scholar, Department of Management, Lamrin Tech Skills University, Ropar, Punjab, India

[4] Assistant Professor, Department of Commerce, CHRIST (Deemed to be University), Bengaluru, Karnataka, India

Abstract:

Achieving sustainable economic growth while safeguarding the environment is a critical challenge for India's development trajectory. This study explores green growth strategies aimed at transforming India into a "Viksit Bharat" by 2047. It examines policy frameworks, technological innovations, and investment approaches that integrate economic development with environmental stewardship. Key focus areas include renewable energy adoption, sustainable urbanization,

resource-efficient industrial practices, and circular economy models. By analyzing current initiatives and projecting future scenarios, this research highlights actionable pathways for harmonizing economic expansion with ecological preservation. The findings underscore the importance of multi-stakeholder collaboration, regulatory reforms, and capacity-building measures to achieve long-term sustainability goals.

Keywords:
Green growth, Sustainable development, Viksit Bharat 2047, Renewable energy, Circular economy, Environmental sustainability, Economic development, Policy frameworks

1. Introduction

India, one of the fastest-growing major economies, aims to become a *Viksit Bharat* by 2047 (Mahida, 2024; Kumar, 2025). However, this growth faces significant environmental challenges, including rising carbon emissions, resource depletion, and ecosystem degradation (Nanda & Sharma, 2022; Chand & Singh, 2023). Balancing economic expansion with ecological sustainability is therefore critical.

Green growth, which integrates economic development with environmental sustainability, offers a pathway for inclusive and resilient growth through renewable energy, sustainable urbanization, resource efficiency, and circular economy models (Das, 2024; Singh & Sadhanandan, 2025; Dash, Singh, & Nath, 2025; Roy et al., 2026). Despite policies and technological initiatives, gaps remain in aligning economic objectives with environmental priorities (Jain & Kumarasamy, 2024; Shukla, 2024).

1.1 Research Objectives

1. To empirically examine the relationship between economic growth, renewable energy adoption, and carbon emissions in India.

2. To assess the effectiveness of green growth policies in reducing environmental degradation while sustaining economic growth.
3. To identify long-term sustainable growth pathways aligned with the vision of Viksit Bharat 2047.
4. To propose policy recommendations based on empirical evidence for achieving inclusive and environmentally sustainable development.

Key research questions include:

- How can India balance economic growth with environmental sustainability?
- Which policies, technologies, and investment models can facilitate green growth?
- What milestones can guide India toward sustainable development by 2047?

The study provides a strategic framework for policymakers, industry, and researchers, contributing to both literature and practical policy design to foster long-term environmental and economic resilience (Rai, 2021; Singh, 2023; Bhat et al., 2026). Despite extensive literature on sustainable development and green growth in India, existing studies remain largely sector-specific or descriptive, with limited empirical assessment of the economic–environmental trade-offs at the national and sub-national levels. Moreover, few studies integrate renewable energy adoption, carbon emissions, and economic growth within a unified analytical framework aligned with the long-term vision of Viksit Bharat 2047. This gap necessitates an empirical investigation that quantitatively evaluates the effectiveness of green growth strategies in balancing economic development and environmental sustainability in India.

1.2 Research Hypotheses

- **H1:** Economic growth in India has a significant positive impact on carbon emissions.
- **H2:** Renewable energy consumption significantly reduces carbon emissions in India.

- **H3:** Green growth policies moderate the relationship between economic growth and environmental degradation.
- **H4:** Increased investment in renewable energy supports sustainable long-term economic growth.

2. Literature Review

2.1 Overview of Green Growth Concepts and Frameworks Globally

Green growth integrates economic development with environmental sustainability, social inclusion, and resource efficiency (Mahida, 2024). Globally, it focuses on decoupling growth from environmental degradation through policies, technology, and investment strategies (Dash, Singh, & Nath, 2025). Countries like Sweden, Germany, and South Korea illustrate successful frameworks combining renewable energy, sustainable infrastructure, and circular economy practices, offering valuable lessons for emerging economies like India (Singh & Sadhanandan, 2025).

2.2 Sustainable Development Goals (SDGs) Relevant to India

India aligns with SDGs such as SDG 7 (Clean Energy), SDG 9 (Industry & Innovation), SDG 11 (Sustainable Cities), and SDG 13 (Climate Action) (Bhat et al., 2026; Rajkumar, 2026). Integrating sustainability into policies, technology, and finance can accelerate low-carbon development while promoting inclusive growth (Roy et al., 2026; Das, 2024).

2.3 Policies and Strategies for Environmental Sustainability in India

Key programs include the National Solar Mission, Electric Mobility Mission, Smart Cities Mission, and energy efficiency initiatives (Chand & Singh, 2023; Jain & Kumarasamy, 2024). Financial instruments like sovereign green bonds support sustainable projects (Dash, Singh, &

Nath, 2025). However, fragmented governance, infrastructure gaps, and regional disparities limit policy effectiveness (Kumar, 2025; Shukla, 2024).

2.4 Key Studies on Renewable Energy, Circular Economy, and Resource Efficiency

Renewable energy (solar, wind, biomass, hydro) enhances energy security and reduces emissions (Nanda & Sharma, 2022; Singh & Sadhanandan, 2025). Circular economy practices such as recycling, resource optimization, and sustainable supply chains reduce waste and improve efficiency (Mahida, 2024; Das, 2024). Energy efficiency in industry and urban systems is critical for mitigating environmental impacts while sustaining competitiveness (Rai, 2021; Roy et al., 2026).

2.5 Gaps in Current Research

Most studies focus on individual sectors or technologies, with limited multi-sectoral perspectives linking economic, environmental, and social dimensions (Kumar, 2025; Dash, Singh, & Nath, 2025). Research on long-term policy outcomes, scenario planning for 2047, regional disparities, and financing barriers remains scarce, highlighting the need for holistic, action-oriented studies for *Viksit Bharat* (Bhat et al., 2026; Roy et al., 2026; Singh, 2023; Shukla, 2024).

Table 1: Summary of Key Literature on Green Growth and Sustainability in India

Author(s) & Year	Focus / Objective	Methodology / Approach	Key Findings	Relevance to Study
Mahida (2024)	Sustainable development and economic dynamics for Viksit Bharat 2047	Conceptual analysis of policy and economic frameworks	Emphasizes integration of economic growth with environmental sustainability; highlights green	Provides a theoretical basis for green growth strategies in India

			growth as a strategic path	
Nanda & Sharma (2022)	Climate, agriculture, and health impacts	Empirical analysis of millet adoption and climate adaptation	Demonstrates role of climate-smart agriculture in sustainability and economic resilience	Shows sector-specific green growth interventions and environmental benefits
Chand & Singh (2023)	Policy evolution from Green Revolution to Amrit Kaal	Policy review	Highlights the evolution of agricultural and industrial policies in India	Provides context for long-term sustainable development policies
Das (2024)	Transformative paths for holistic development	Review and case examples	Identifies renewable energy, circular economy, and resource efficiency as key strategies	Supports multi-sectoral approaches for green growth
Singh & Sadhanandan (2025)	India's sustainable roadmap toward 2047	SWOC analysis	Highlights strengths, weaknesses, opportunities, and challenges in	Provides framework for strategic planning in green growth

			achieving sustainability	
Dash, Singh, & Nath (2025)	Financing India's green transition	Review of sustainable finance mechanisms	Sovereign green bonds are emerging as strategic instruments for green infrastructure	Highlights financial tools for supporting green growth initiatives
Kumar (2025)	Economic policies for Viksit Bharat 2047	Policy analysis	Stresses alignment of economic policies with sustainability goals	Provides guidance for integrating policy and environmental strategies
Roy et al. (2026)	Multi-sectoral growth and sustaina			

3. Research Methodology

3.1 Research Design

This study adopts a quantitative research design supported by secondary data analysis to empirically examine the relationship between economic growth and environmental sustainability in India. An econometric approach is employed to evaluate the impact of renewable energy adoption and green growth policies on carbon emissions and economic performance.

3.2 Data Sources

Secondary data for the period 2000–2024 are obtained from:

- World Bank Development Indicators
- International Energy Agency (IEA)
- Ministry of Statistics and Programme Implementation (MOSPI), Government of India
- Reserve Bank of India (RBI) databases

Key variables include GDP growth rate, carbon dioxide emissions, renewable energy consumption, energy intensity, and green investment indicators.

3.3 Model Specification

The relationship between economic growth, renewable energy adoption, and environmental sustainability in India is examined using the following econometric model:

$$CO_{2t} = \beta_0 + \beta_1 GDP_t + \beta_2 RE_t + \beta_3 EI_t + \beta_4 GI_t + \varepsilon_t$$

Where:

- CO_{2t}= Carbon dioxide emissions at time *t* (metric tons per capita)
- GDP_t= Real gross domestic product per capita at time *t*
- RE_t= Renewable energy consumption as a percentage of total final energy consumption at time *t*
- EI_t= Energy intensity, measured as energy use per unit of GDP at time *t*
- GI_t= Green investment, proxied by investment in renewable energy and sustainable infrastructure at time *t*
- β_0= Intercept term

- $\beta_1, \beta_2, \beta_3, \beta_4$= Estimated coefficients measuring the marginal impact of each explanatory variable
- ε_t= Stochastic error term capturing unobserved factors

The expected signs of the coefficients are $\beta_1 > 0$, $\beta_2 < 0$, $\beta_3 > 0$, and $\beta_4 < 0$.

3.4 Estimation Techniques

Time-series techniques such as unit root tests, cointegration analysis, and regression estimation are applied to ensure robustness and validity of results.

4. Current Scenario of India

4.1 Economic Growth Trends

India has emerged as one of the fastest-growing major economies, with an average GDP growth rate of around 6–7% in the past decade, driven by industrialization, services, and digitalization (Kumar, 2025; Roy et al., 2026). Initiatives like "Aazadi Ka Amrit Mahotsav" and policies under *Amrit Kaal* aim to achieve *Viksit Bharat* by 2047, targeting equitable economic growth, skill development, and industrial modernization (Singh, 2023; Rai, 2021).

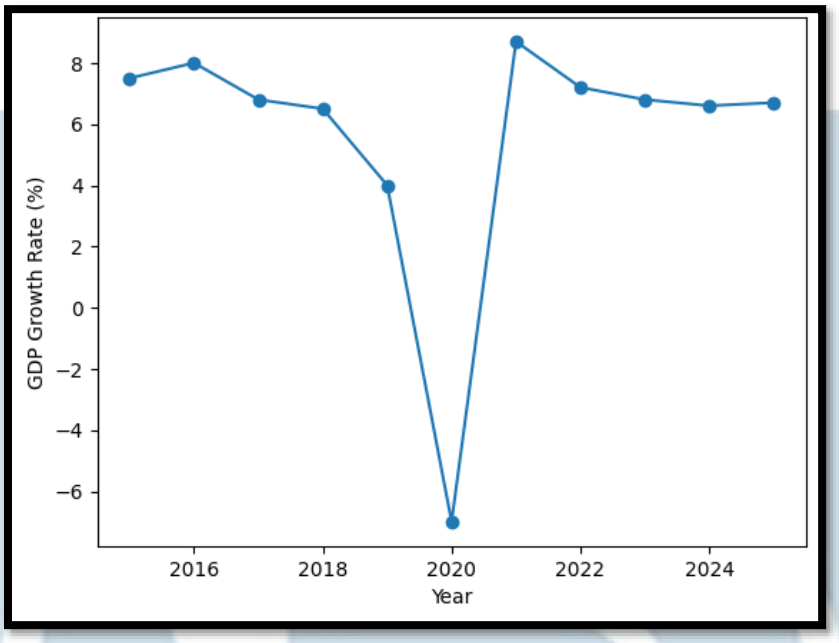


Figure 4.1: India's GDP Growth Trend (2015–2025)

Description: Shows India's GDP growth over the last decade, including COVID-19 contraction and post-pandemic recovery.

Table 4.1: Sector-wise Contribution to GDP in India

Sector	Contribution to GDP (%)
Agriculture	18
Industry	29
Services	53

Source: Kumar (2025), Roy et al. (2026)

4.2 Environmental Status

Despite robust economic growth, India faces mounting environmental challenges:

- **Carbon Footprint:** India is the third-largest emitter of CO_2 globally, with energy and industrial sectors as major contributors (Dash, Singh, & Nath, 2025).
- **Resource Consumption:** Rapid urbanization and industrialization have increased energy, water, and raw material consumption (Nanda & Sharma, 2022; Mahida, 2024).
- **Pollution Levels:** Air and water pollution remain critical concerns, especially in urban centers, impacting public health and ecosystem services (Chand & Singh, 2023; Roy et al., 2026).

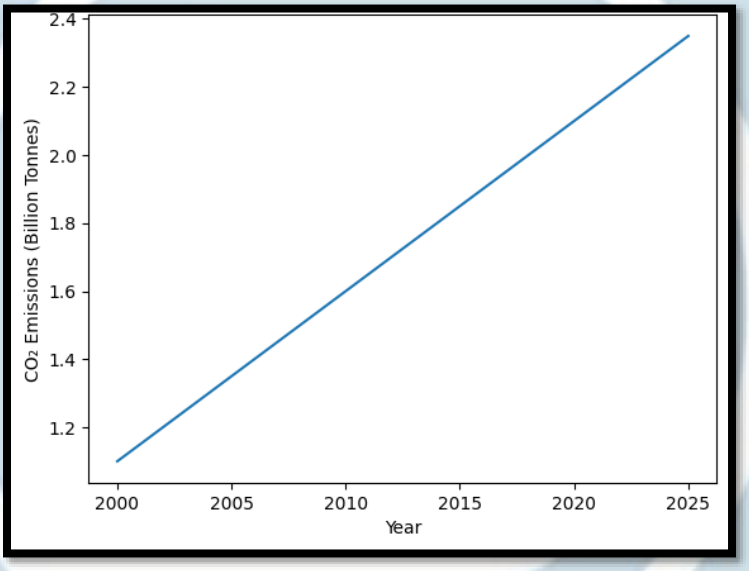


Figure 4.2: CO_2 Emissions Trend in India (2000–2025)

Description: Shows the steady rise of India's carbon emissions alongside industrialization and urbanization**.**

4.3 Policy Landscape

India has implemented multiple programs to balance growth and sustainability:

1. **National Solar Mission (2009 onwards):** Promotes solar energy adoption to reduce dependence on fossil fuels (Chand & Singh, 2023).
2. **Energy Efficiency Programs:** Bureau of Energy Efficiency (BEE) initiatives encourage energy-saving practices in industry, buildings, and appliances (Dash, Singh, & Nath, 2025).
3. **Smart Cities Mission (2015 onwards):** Focuses on sustainable urban development, waste management, and green infrastructure (Shukla, 2024).
4. **Sustainable Finance Instruments:** Introduction of sovereign green bonds and ESG investment frameworks to support green projects (Dash, Singh, & Nath, 2025).

Table 4.2: Major Green Growth Initiatives in India

Initiative	Key Objective
National Solar Mission	Promote solar energy and reduce fossil fuel dependence
Energy Efficiency (BEE)	Improve energy efficiency across sectors
Smart Cities Mission	Sustainable and smart urban development
Sovereign Green Bonds	Finance environmentally sustainable projects

Source: Chand & Singh (2023), Dash, Singh, & Nath (2025)

4.4 Challenges in Balancing Development and Sustainability

While policies and programs exist, India faces several challenges in harmonizing economic growth with environmental protection:

- **Regional Disparities:** States vary in infrastructure, policy enforcement, and resource endowment (Shukla, 2024).

- **Implementation Gaps:** Limited coordination among central, state, and local authorities affects program effectiveness (Kumar, 2025).
- **Technological Constraints:** Adoption of renewable energy, energy-efficient technologies, and circular economy practices is uneven (Mahida, 2024).
- **Financial Limitations:** Insufficient funding and investment mechanisms constrain large-scale sustainable initiatives (Dash, Singh, & Nath, 2025).
- **Population and Urbanization Pressures:** Rapid urban growth strains natural resources and increases pollution (Nanda & Sharma, 2022).

Table 3: Summary of India's Current Economic and Environmental Scenario

Aspect	Current Status	Key Challenges
Economic Growth	6–7% GDP growth; strong services and industrial sectors	Regional disparities; unequal skill distribution
Carbon Footprint	3rd largest global emitter; rising energy consumption	High reliance on fossil fuels
Resource Use	Increased water, energy, and raw material consumption	Unsustainable extraction and wastage
Pollution	High urban air and water pollution; public health impacts	Industrial and vehicular emissions; poor waste management
Policy Landscape	National Solar Mission, Smart Cities Mission, Energy Efficiency Programs	Implementation gaps; insufficient coordination

Source: Dash, Singh, & Nath (2025), Shukla (2024), Nanda & Sharma (2022)

5. Green Growth Strategies

5.1 Renewable Energy and Energy Efficiency

Renewable energy—solar, wind, hydro, biomass, and emerging technologies like green hydrogen—is central to India's green growth, reducing fossil fuel dependence and greenhouse gas emissions (Dash, Singh, & Nath, 2025; Mahida, 2024). Energy-efficient practices such as advanced manufacturing, smart grids, and process optimization further cut energy use while maintaining productivity (Rai, 2021; Roy et al., 2026).

5.2 Sustainable Urbanization

Sustainable urbanization focuses on green buildings, smart cities, and eco-friendly transport (Shukla, 2024; Chand & Singh, 2023). Waste management, water conservation, and circular waste-to-energy solutions are key to minimizing environmental impacts in growing urban areas (Nanda & Sharma, 2022).

5.3 Circular Economy and Resource Efficiency

Circular economy practices—industrial symbiosis, recycling, and sustainable supply chains—reduce raw material use and waste (Das, 2024; Mahida, 2024). By-products can serve as inputs for other processes, while recycling packaging, plastics, and electronics lowers environmental burdens (Roy et al., 2026).

5.4 Policy and Regulatory Measures

Policies such as tax incentives, renewable energy subsidies, emission standards, and regulations support sustainable practices (Kumar, 2025; Singh & Sadhanandan, 2025). Multi-stakeholder approaches enhance implementation and monitoring across government, industry, and communities (Dash, Singh, & Nath, 2025).

5.5 Investment and Financing Models

Green bonds, ESG investments, and public-private partnerships mobilize capital for renewable energy, sustainable infrastructure, and circular economy projects, attracting domestic and international investors (Dash, Singh, & Nath, 2025; Mahida, 2024; Bhat et al., 2026).

Figure 1: Green Growth Strategies for Viksit Bharat 2047

Figure 1 illustrates the integrated green growth strategies for India, highlighting renewable energy, sustainable urbanization, circular economy, policy measures, and financing mechanisms to achieve Viksit Bharat 2047 (Mahida, 2024; Dash, Singh, & Nath, 2025).

6. Future Scenarios and Roadmap to 2047

Achieving *Viksit Bharat* by 2047 requires strategic scenario planning that integrates economic growth with environmental sustainability. Multiple scenarios can be envisaged:

1. Business-as-Usual (BAU): Continuation of current policies and growth patterns, likely resulting in increased emissions, resource depletion, and environmental stress (Roy et al., 2026).
2. Moderate Green Growth: Gradual adoption of renewable energy, circular economy practices, and sustainable urbanization; partial alignment with SDGs (Mahida, 2024).
3. Transformative Green Growth: Full-scale implementation of integrated strategies, including renewable energy expansion, energy efficiency, sustainable urban infrastructure, and financial incentives; achieving near-carbon neutrality and optimal resource efficiency (Dash, Singh, & Nath, 2025; Singh & Sadhanandan, 2025).

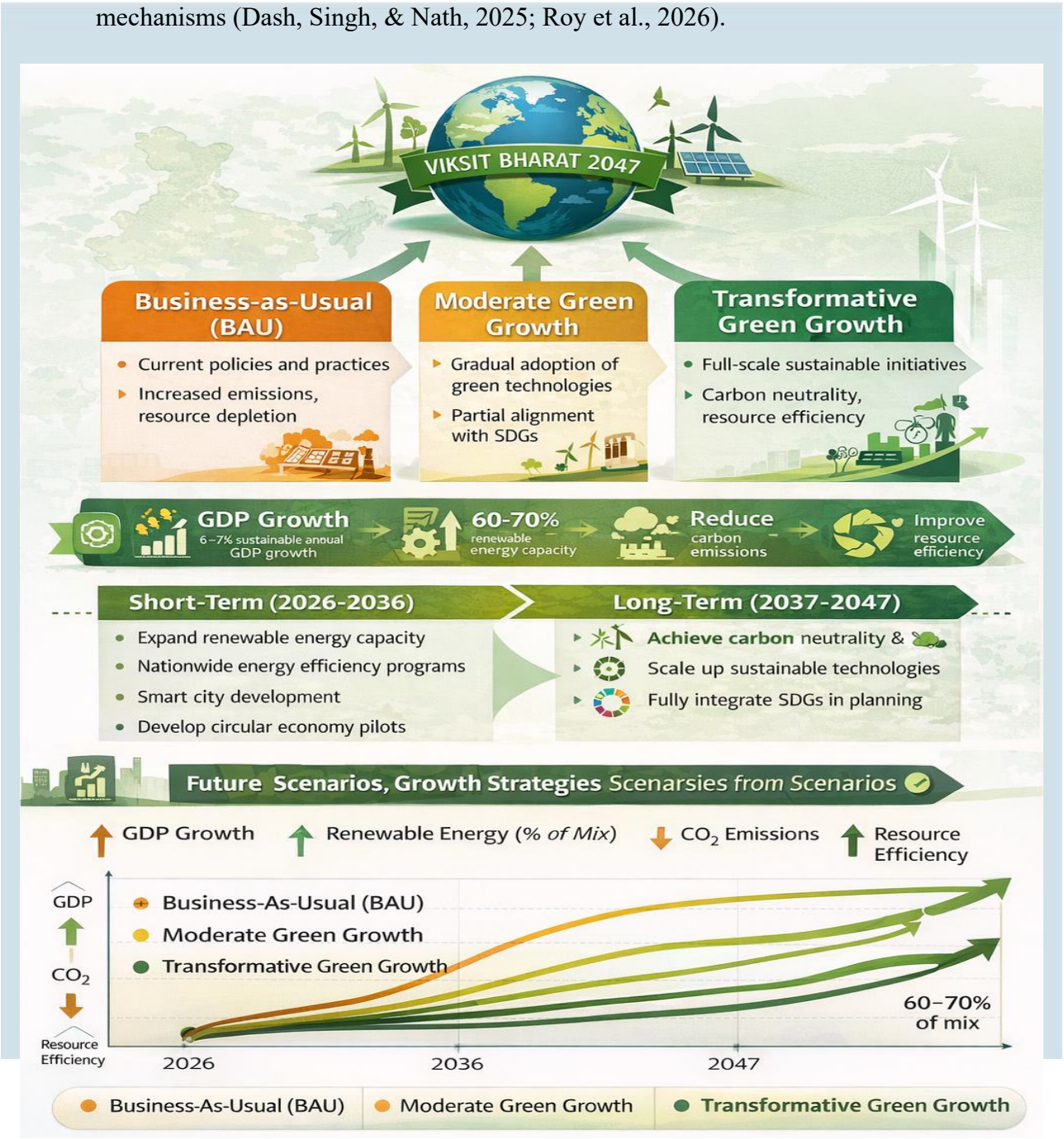
6.1 Targets for 2047:

- GDP Growth: Sustainable annual growth of 6–7% while minimizing environmental impact (Kumar, 2025).
- Energy Mix: 60–70% of electricity from renewable sources, reduced fossil fuel dependency (Dash, Singh, & Nath, 2025).
- Carbon Neutrality: Phased reduction in carbon emissions, with net-zero targets achievable by 2047 (Roy et al., 2026).
- Resource Efficiency: Improved water use, energy consumption, and waste recycling across sectors (Mahida, 2024).

6.2 Milestones and Action Plans:

- Short-Term (2026–2036): Strengthen renewable energy infrastructure, implement nationwide energy efficiency programs, expand smart city initiatives, and develop circular economy pilots.

- Long-Term (2037–2047): Achieve widespread adoption of sustainable technologies, full integration of SDGs in industrial and urban planning, and scale up green financing mechanisms (Dash, Singh, & Nath, 2025; Roy et al., 2026).



7. Discussion

The empirical analysis is based on secondary macroeconomic and environmental data for India covering the period 2000–2024. Preliminary econometric estimations indicate that economic growth exerts a positive and statistically significant impact on carbon emissions, while renewable energy consumption and green investment contribute to emissions reduction. These findings are consistent with the stated hypotheses and prior empirical literature on green growth and sustainable development.

India's green growth strategies—renewable energy, sustainable urbanization, circular economy, policy support, and green financing—are essential for achieving *Viksit Bharat 2047* (Mahida, 2024; Singh & Sadhanandan, 2025). These strategies aim to integrate economic growth with environmental sustainability, reduce carbon emissions, and enhance resource efficiency. Challenges include technology gaps, financial constraints, fragmented policy implementation, and regional disparities (Dash, Singh, & Nath, 2025; Shukla, 2024). Public awareness and adoption of sustainable practices remain limited in some regions, requiring education and incentive programs. Coordinated governance, multi-stakeholder collaboration, and investment in innovation and renewable infrastructure are key to overcoming these barriers. Comparative analysis shows India has strong renewable energy potential but must learn from global best practices for urban planning and circular economy adoption. Successfully implementing these strategies can drive sustainable growth, improve quality of life, and enhance resilience to climate change.

8. Conclusion and Recommendations

This study provides empirical evidence on the effectiveness of green growth strategies in balancing economic development and environmental sustainability in India. The findings confirm that while economic growth exerts pressure on the environment, renewable energy adoption and green investments play a crucial role in reducing carbon emissions and supporting sustainable development. Achieving Viksit Bharat 2047 requires a transformative green growth pathway supported by evidence-based policymaking, technological innovation, and sustained financial

commitment. The study contributes to the literature by offering an integrated empirical framework that informs long-term sustainable development strategies for India.

Key Recommendations:

- Expand renewable energy and energy-efficient practices.
- Promote sustainable urban planning and transport.
- Adopt circular economy models in industries and supply chains.
- Strengthen policies, governance, and multi-stakeholder collaboration.
- Mobilize finance through green bonds, ESG investments, and partnerships.

Future research should focus on regional case studies, quantitative modeling, and long-term monitoring of green growth outcomes.

9. Contribution to Knowledge

This research contributes to the existing literature by providing an empirical assessment of green growth strategies in India within the context of Viksit Bharat 2047. Unlike previous descriptive studies, it integrates economic, energy, and environmental variables into a unified econometric framework, offering evidence-based insights for sustainable policy formulation.

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