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Does renewable energy drive economic growth? Analyzing the role of green energy investments in india

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Abstract

This study explores the relationship between renewable energy consumption and economic growth in India, with a particular focus on the role of green energy investments. As India strives to meet its climate goals while sustaining economic development, understanding the economic implications of renewable energy adoption becomes increasingly important. Using time-series data and advanced econometric techniques, the study investigates whether investments in renewable energy sources—such as solar, wind, and hydropower—contribute positively to the country's economic growth. The findings reveal a significant long-run relationship between green energy investments and GDP growth, suggesting that a transition towards clean energy can serve as a catalyst for sustainable economic development. The results support policy measures that encourage renewable energy deployment and increased financial support for green infrastructure. This research provides valuable insights for policymakers, investors, and stakeholders aiming to align India's growth trajectory with environmental sustainability.

Keywords: Renewable energy, Green Energy, Economic growth, ARDL

1. Introduction

The global transition toward renewable energy has gained significant momentum in recent decades, driven by the urgent need to combat climate change, reduce greenhouse gas emissions, and ensure energy security. Renewable energy sources—such as solar, wind, hydro, and biomass—are increasingly viewed not only as environmental imperatives but also as catalysts for economic growth. India, as one of the world's fastest-growing economies and a major energy consumer, presents a compelling case study for analyzing the relationship between green energy investments and economic development. With its ambitious renewable energy targets, supportive policy frameworks, and increasing foreign and domestic investments, India is at the forefront of the green energy revolution. This paper examines whether renewable energy drives economic growth in India by analyzing the role of green energy investments in job creation, industrial development, energy security, and technological innovation. The global energy landscape is undergoing a profound transformation, with renewable energy emerging as a cornerstone of sustainable development. According to the International Renewable Energy Agency (IRENA), renewable energy accounted for nearly 30% of global electricity generation in 2022, with solar and wind power leading the expansion (IRENA, 2023). The declining costs of renewable technologies, coupled with policy incentives and international climate commitments, have accelerated this shift. The Paris Agreement (2015) further reinforced the need for nations to adopt cleaner energy systems to limit global temperature rise to below 2°C

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(UNFCCC, 2015). Economically, renewable energy investments are increasingly seen as drivers of growth. A study by the International Energy Agency (IEA) found that every dollar invested in renewables generates three times more jobs than fossil fuel investments (IEA, 2021). Additionally, renewable energy reduces dependence on imported fuels, mitigates energy price volatility, and fosters innovation in green technologies. Countries like Germany, China, and the United States have demonstrated that strategic investments in renewables can stimulate economic activity while reducing carbon emissions (Popp et al., 2020).

India, the world's third-largest energy consumer, faces a dual challenge: meeting its rapidly growing energy demand while reducing its carbon footprint. Fossil fuels, particularly coal, dominate India's energy mix, contributing to severe air pollution and high carbon emissions. However, the Indian government has set ambitious renewable energy targets to address these challenges. Under its Nationally Determined Contributions (NDCs), India aims to achieve 500 GW of renewable energy capacity by 2030 and net-zero emissions by 2070 (Ministry of New and Renewable Energy [MNRE], 2022). As of 2023, India's installed renewable energy capacity exceeded 170 GW, with solar and wind power contributing significantly (Central Electricity Authority [CEA], 2023). The country has also emerged as a global leader in solar energy, hosting some of the world's largest solar parks, such as the Bhadla Solar Park in Rajasthan. The government's initiatives, including the Production Linked Incentive (PLI) scheme for solar manufacturing and the Green Energy Corridor project, have further bolstered the sector (MNRE, 2023). The expansion of renewable energy in India has far-reaching economic implications. Several studies suggest that green energy investments contribute to GDP growth, employment generation, and industrial development. One of the most significant economic benefits of renewable energy is job creation. According to a report by the Council on Energy, Environment and Water (CEEW) and the Natural Resources Defense Council (NRDC), India's renewable energy sector employed over 120,000 workers in 2022, with solar energy being the largest employer (CEEW & NRDC, 2022). The sector is expected to generate over 3 million jobs by 2030, particularly in manufacturing, installation, and maintenance (IRENA, 2022). Moreover, renewable energy projects often require localized labor, benefiting rural and semi-urban areas. For instance, the construction of solar farms in states like Gujarat and Karnataka has created employment opportunities for local communities, reducing urban migration (Ghosh & Sahu, 2021). India's push for renewable energy has spurred growth in related industries, particularly solar panel and wind turbine manufacturing. The government's "Make in India" initiative aims to position the country as a global hub for renewable equipment production. The PLI scheme for high-efficiency solar modules has attracted investments worth $6 billion, reducing reliance on Chinese imports (MNRE, 2023). Domestic manufacturers like Adani Solar and Tata Power Solar are expanding their capacities, fostering industrial growth. According to the India Solar Market Report (2023), domestic solar module production is expected to reach 45 GW by 2025, up from 18 GW in 2022 (JMK Research, 2023). This growth enhances India's self-reliance and strengthens its position in the global renewable supply chain. Renewable energy enhances India's energy security by reducing dependence on imported fossil fuels. India spends over $100 billion annually on oil and coal imports, making it vulnerable to global price fluctuations (Ministry of Petroleum and Natural Gas, 2022). By transitioning to domestically produced renewables, India can reduce its import bill and stabilize energy costs. A study by The Energy and Resources Institute (TERI) found that increasing the share of renewables in India's energy mix could save $90 billion in fossil fuel imports by 2030 (TERI, 2021). Additionally, decentralized renewable energy systems, such as rooftop solar, provide affordable electricity to rural and remote areas, improving energy access and productivity. Renewable energy investments drive technological advancements and attract foreign capital.

India has witnessed significant foreign direct investment (FDI) in renewables, with inflows exceeding $11 billion between 2020 and 2023 (Department for Promotion of Industry and Internal Trade [DPIIT], 2023). Companies like SoftBank, ReNew Power, and Goldman Sachs have invested heavily in India's green energy projects. Furthermore, innovations in energy storage, smart grids, and green hydrogen are positioning India as a leader in clean energy technology. The National Green Hydrogen Mission, with an outlay of ₹19,744 crore ($2.4 billion), aims to make India a global hub for green hydrogen production (MNRE, 2023).
Despite its potential, India's renewable energy sector faces challenges, including land acquisition issues, grid integration difficulties, and financial constraints. Discoms (distribution companies) often struggle with renewable power procurement due to financial inefficiencies (CEA, 2023). Additionally, the intermittent nature of solar and wind energy necessitates investments in energy storage and grid modernization. To overcome these barriers, India must enhance policy implementation, increase public-private partnerships, and improve financing mechanisms. The International Finance Corporation (IFC) estimates that India requires $500 billion in renewable investments by 2030 to meet its targets (IFC, 2022). Strengthening domestic manufacturing, improving grid infrastructure, and incentivizing R&D will be crucial for sustained growth. Despite growing interest in renewable energy's role in economic growth, there is limited empirical research on its sector-specific, regional, and long-term impacts in India. Further study is needed to understand how policies, investments, and innovation shape equitable and sustainable RE-led development. This paper is organized into five sections: the first covers the introduction, the second presents the literature review, the third outlines the research methodology, the fourth discusses the results, and the final section provides the conclusion and implications

2. Review of Literature

The relationship between renewable energy and economic growth has gained significant attention in recent years, particularly as nations strive to balance environmental sustainability with economic development. India, as one of the fastest-growing economies and a major contributor to global carbon emissions, has been actively investing in renewable energy sources such as solar, wind, and hydropower. This literature review examines whether renewable energy drives economic growth in India by analyzing existing studies on green energy investments, their impact on GDP, employment, and industrial development, as well as the challenges associated with this transition.

2.1 Theoretical Framework: Renewable Energy and Economic Growth

The theoretical foundation linking renewable energy to economic growth stems from endogenous growth theory, which posits that technological advancements and sustainable energy investments can enhance productivity and long-term economic expansion (Aghion et al., 2009). Renewable energy contributes to economic growth by reducing dependency on fossil fuel imports, creating jobs, and fostering innovation in clean technologies (Popp et al., 2011). In the context of developing economies like India, renewable energy adoption is often seen as a dual-benefit strategy—mitigating climate change while stimulating economic activity (Ozturk & Bilgili, 2015). However, some studies argue that the initial costs of transitioning to renewables may slow economic growth in the short run before yielding long-term benefits (Sadorsky, 2009).

2.2 Empirical Evidence on Renewable Energy and Economic Growth in India

2.2. 1. Renewable Energy Investments and GDP Growth

Several studies have explored the correlation between renewable energy deployment and GDP growth in India. Bhattacharya et al. (2016) found a positive long-run relationship between renewable energy consumption and economic growth, suggesting that green energy investments contribute to sustainable development. Similarly, Tiwari (2016) used a multivariate framework to demonstrate that increased solar and wind energy capacity positively impacts India's GDP by reducing energy import bills and enhancing energy security. However, some researchers caution that the economic benefits of renewable energy depend on policy frameworks and investment efficiency. Sen & Ganguly (2017) argue that while India's solar power initiatives have boosted economic activity, inconsistent policy implementation and financing challenges have sometimes hindered growth potential.

2.2.2. Employment Generation and Industrial Development.

A significant advantage of renewable energy expansion is job creation. The International Renewable Energy Agency (IRENA, 2021) reported that India's renewable energy sector employed over 700,000 people in 2020, with solar energy being the largest employer. Studies by Ghosh & Sahu (2019) highlight that decentralized renewable energy projects, such as rooftop solar installations, have spurred rural employment and small-scale industries. Moreover, the growth of renewable energy manufacturing industries—such as solar panel and wind turbine production—has contributed to industrial diversification (Kapoor et al., 2020). The "Make in India" initiative has further encouraged domestic manufacturing of renewable energy components, reducing reliance on imports and fostering economic self-sufficiency (Ministry of New and Renewable Energy [MNRE], 2022).

2.2.3. Foreign Direct Investment (FDI) and Technological Innovation

India's renewable energy sector has attracted substantial foreign investments. According to the World Bank (2020), India ranked among the top five destinations for clean energy investments, with FDI inflows exceeding $10 billion between 2015 and 2020. These investments have facilitated technology transfer and innovation, particularly in solar photovoltaic (PV) and wind energy systems (Goyal & Jha, 2018). Research by Kumar & Agarwala (2019) suggests that renewable energy policies, such as the National Solar Mission, have accelerated technological advancements, leading to cost reductions in solar power generation. This, in turn, has improved the economic viability of renewables and stimulated further investments. High upfront costs and financing constraints remain key barriers. Although the cost of renewable energy has declined, securing long-term funding for large-scale projects is challenging (Singh & Sood, 2021). Public-private partnerships (PPPs) and green bonds have been proposed as solutions, but their implementation has been inconsistent (Chandrasekhar & Gupta, 2020). India's power grid faces challenges in integrating intermittent renewable energy sources. Frequent grid instability and transmission losses have been reported, necessitating investments in smart grid technologies (Khanna & Sharma, 2021). Frequent changes in renewable energy policies, such as tariff revisions and subsidy withdrawals, have created uncertainty for investors (Dubash & Rao, 2018). A stable policy environment is crucial for sustained economic benefits.

Research Gap

Despite the growing emphasis on renewable energy (RE) as a catalyst for economic growth, there remains a significant gap in understanding the precise mechanisms through which green energy investments contribute to India's economic development. While existing studies highlight the positive correlation between RE adoption and GDP growth (Apergis & Payne, 2012; Bhattacharya et al., 2016), there is limited empirical evidence on sector-specific impacts, regional disparities, and long-term sustainability in the Indian context. Most research focuses on developed economies, leaving a gap in contextualized analyses for emerging markets like India, where energy transition challenges differ due to infrastructural, financial, and policy constraints (Sovacool & Mukherjee, 2011). Additionally, few studies explore the interplay between government policies, private investments, and technological innovation in driving RE-led growth (IRENA, 2020). Further investigation is needed to assess whether renewable energy investments generate equitable employment opportunities, reduce energy poverty, and enhance industrial productivity in India.

3. Data and Methods

3.1. Data

To achieve the study's objectives, an empirical analysis was conducted covering 35 years (1990-2024) using data from India. This study aims to explore the relationship between renewable energy generation, economic growth, and green energy investments in India. The period of 1990-2024 was selected to account for the impact of the COVID-19 pandemic on economic growth. Data were collected annually, as key variables like economic growth, renewable energy, and green energy. The data came from the World Development Indicators (WDI), ensuring consistency and reliability, with details provided in Table 1 and Figure 1. Furthermore Figure 1, 2, and 3 displays the bar, Scatter, studied variables.

Table 1. Variables of study.

Types	Acronym	Variable Titles	Measurements and Data Sources
Outcome	GDP	Economic growth	Annual growth rate as a %
Input	GEI	Green Energy Investment	Domestic credit to private sector by banks (% of GDP)
Control	GCF	Gross capital formation	Gross capital formation (% of GDP)
	REC	Renewable energy consumption	Resident and non-resident
	EPO	Export volume	Exports of goods and services (% of GDP)
	TO	Trades Openness	Trades as a percentage of GDP)

Note: This table shows the measurement and source of variables.
Source: Previous studies.

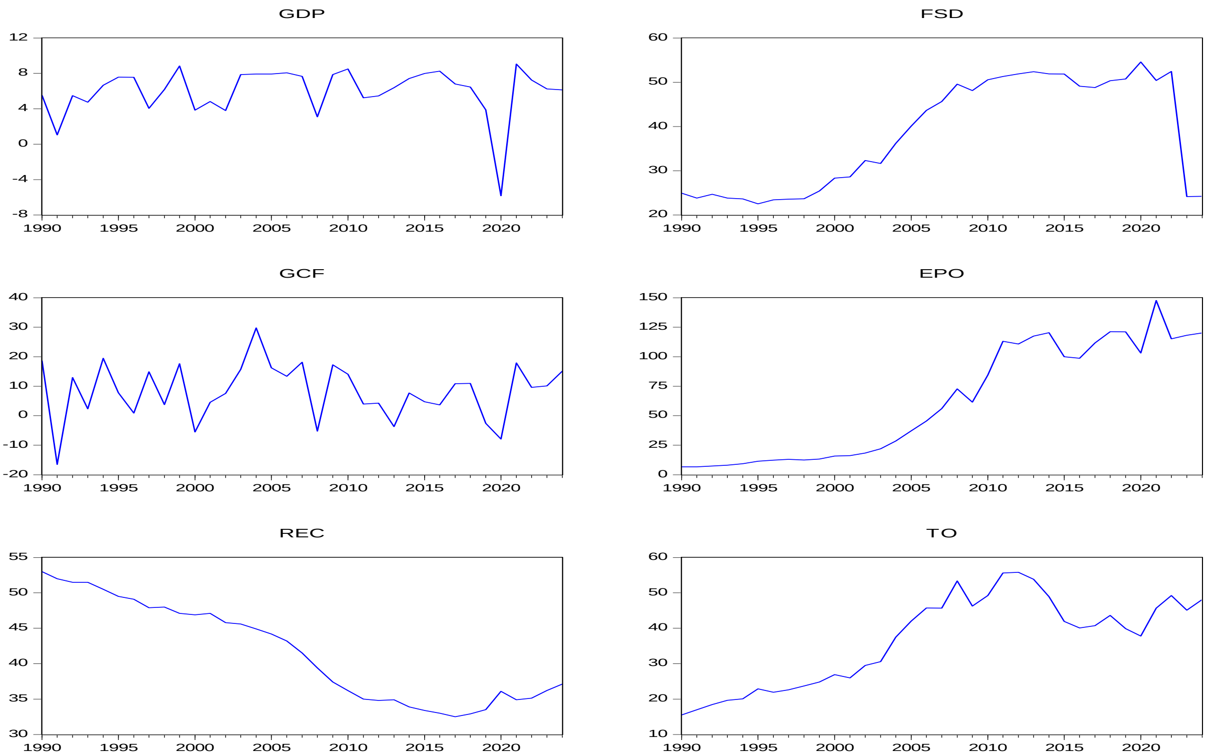

Figure 1, trend Analysis

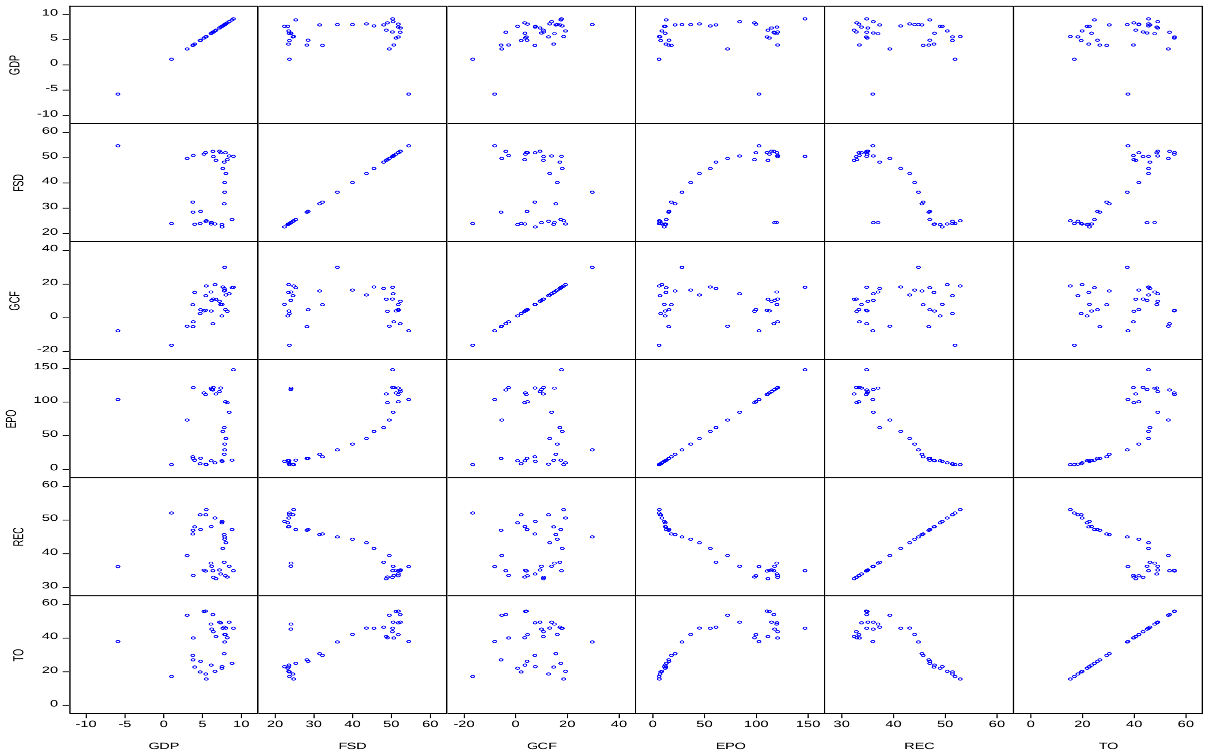

Figure 2 Scatter Matix diagram

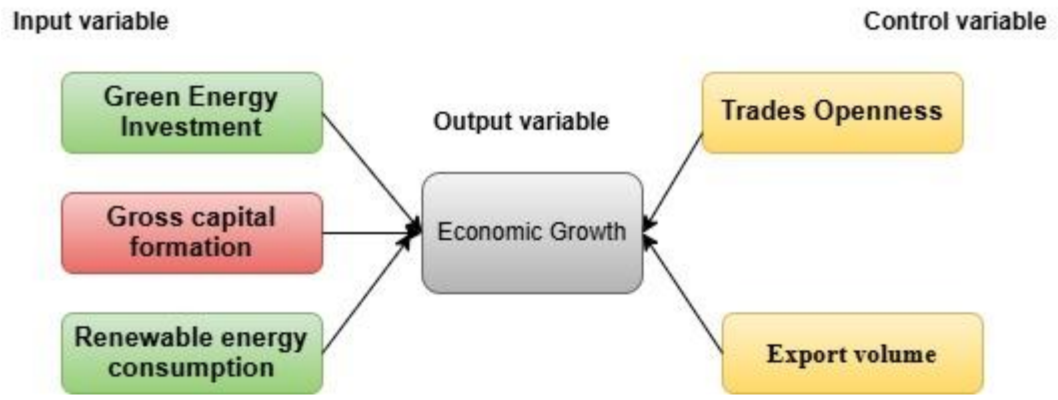

Figure 3. Theoretical Framework

3.2. Empirical model

The relationship among green energy investment, gross capital formation, renewable energy consumption, export volume, trade openness, and economic growth can be represented functionally in Equation 1 as shown below.

$$\mathrm{EC} = f(\mathrm{GEI}, \mathrm{GCF}, \mathrm{REC}, \mathrm{EXV}, \mathrm{TO}) \qquad (1)$$

Initially, we calculate the multiple linear regression models, which can be represented as follows.

$$\mathrm{EC_t} = \propto_0 + \beta_1\mathrm{GEI_t} + \beta_2\mathrm{GCF_t} + \beta_3\mathrm{REC_t} + \beta_4\mathrm{EXV_t} + \beta_5\mathrm{TO_t} + \varepsilon_t \; \ldots (2)$$

Equation (2) represents the multiple linear regression model, where EC denotes the economic growth, GCF stands for gross capital formation, REC stand for renewable energy consumption, EXP export value, TO stand for trades openness. The coefficients of control variables are represented by the symbol α, while the coefficients of explanatory variables are denoted by β. whereas ε_t signifies the error term. As ARDL serves as the final estimation strategy, Equation (2) can be re-expressed as:

$$\begin{aligned}\Delta\mathrm{EC_t} = {} & \beta_0 + \alpha_1\mathrm{EC_{t-1}} + \alpha_2\mathrm{GEI_{t-1}} + \alpha_3\mathrm{GCF_{t-1}} + \alpha_4\mathrm{REC_{t-1}} + \alpha_5\mathrm{EXV_{t-1}} + \alpha_6\mathrm{TO_{t-1}} \\ & + \sum_{j=1}^{p}\gamma_1\Delta\mathrm{EC_{t-1}} + \sum_{j=1}^{p}\gamma_2\Delta\mathrm{GEI_{t-1}} + \sum_{j=1}^{p}\gamma_3\Delta\mathrm{GCF_{t-1}} + \sum_{j=1}^{p}\gamma_4\Delta\mathrm{REC_{t-1}} \\ & + \sum_{j=1}^{p}\gamma_5\Delta\mathrm{EXV_{t-1}} + \sum_{j=1}^{p}\gamma_6\Delta\mathrm{TO_{t-1}} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (3)\end{aligned}$$

Equation (3) employs the "Δ" symbol to signify the difference operator. The coefficients α_1 to α_6 pertain to explanatory variables, in the long term. Additionally, in the ARDL framework, coefficients are estimated for the short run as well. Thus, γ_1 to γ_6 denote the short-run estimation coefficients for explanatory variables.

3.3. Estimation strategy

In this analysis, we utilize the ARDL model to estimate the regression. The choice of employing the ARDL as an estimation strategy steps from preliminary statistical assessments, particularly testing of unit root, to check the stationarity of the selected series. This study conducts unit root tests including the PP as well as Augmented Dickey-Fuller (ADF) test, which is introduced by Dickey & Fuller, (1979), and present the results in Table 4. The statistical analysis reveals a mixed trend of stationarity, with some series exhibiting stationarity at level I(0) while others show stationarity at the first difference I(1). Given this mixed trend of stationarity, we opt for

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the ARDL approach for regression analysis. The ARDL model is well-suited to handle different levels of stationarity, cointegration, and endogeneity. Additionally, (Ansari, et al. 2022; Ansari, et al. 2023; Ansari, et al. 2024) demonstrates that the ARDL model can provide efficient estimates even with small sample sizes.

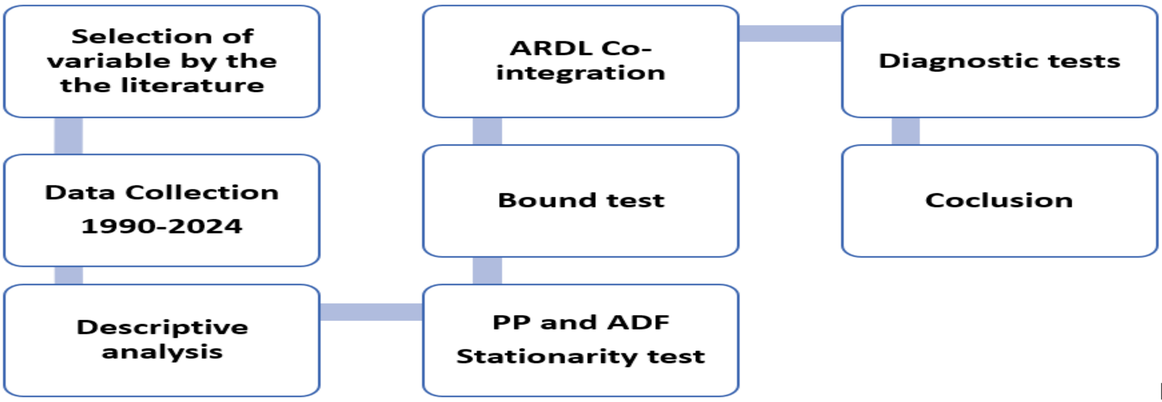

Figure 4. Framework of analysis

4. Empirical findings and discussions

4.1. Empirical findings

Table 2 shown the average value of each variable. For example, GDP has an average of 5.99, while EPO has a much higher average of 62.22. The middle value when all numbers are arranged in order. The median GDP is 6.45, which is close to its mean, suggesting a somewhat balanced distribution (except for extreme values). The highest and lowest observed values. GDP has a wide range (-5.83 to 9.05), indicating possible negative growth in some periods, while GCF ranges from -16.52 to 29.77, showing high volatility. Measures how spread out the values are. EPO has a very high standard deviation (48.37), meaning its values fluctuate a lot, whereas REC is more stable (6.93). Indicates asymmetry in the data. GDP has strong negative skewness (-2.41), meaning it has a long-left tail (many low values). Most other variables are near zero, suggesting symmetry. Measures "peakedness" and tail thickness. GDP has very high kurtosis (10.76), meaning extreme values (outliers) are common. Other variables are closer to 3 (normal distribution). Tests if data is normally distributed. GDP's low probability (0.00) means it's not normal.

Table 2. Descriptive analysis

	GDP	FEI	GCF	EPV	REC	TO
Mean	5.99	38.23	8.36	62.22	41.59	36.74
Median	6.45	40.07	9.59	56.04	41.50	40.08
Maximum	9.05	54.57	29.77	147.57	53.00	55.79
Minimum	-5.83	22.51	-16.52	6.62	32.50	15.51
Std. Dev.	2.76	12.44	9.50	48.37	6.93	12.59
Skewness	-2.41	-0.07	-0.40	0.17	0.15	-0.20
Kurtosis	10.76	1.21	3.15	1.35	1.46	1.66
Jarque-Bera	21.71	4.70	0.97	4.13	3.58	2.88
Probability	0.00	0.10	0.62	0.13	0.17	0.24

Furthermore, Table 3 reports the correlation matrix reveals strong positive relationships between FSD and TO (0.82), and EPO and TO (0.84), while REC shows a strong negative correlation with both FSD (-0.85) and EPO (-0.95). GDP has a moderate positive link with GCF (0.64), but weak correlations with other variables.

Table 3. Correlation analysis.

	GDP	FSD	GCF	EPV	REC	TO
GDP	1	0.01	0.64	0.04	-0.09	0.18
FEI	0.008	1.00	-0.12	0.77	-0.85	0.82
GCF	0.637	-0.12	1.00	-0.09	0.08	0.02
EPO	0.043	0.77	-0.09	1.00	-0.95	0.84
REC	-0.092	-0.85	0.08	-0.95	1.00	-0.87
TO	0.176	0.82	0.02	0.84	-0.87	1.00

Table 4, This study employs the ARDL model for regression analysis, selected based on unit root tests (ADF and PP) that revealed a mixed order of integration among the variables. Some series are stationary at level I(0), while others at first difference I(1), making ARDL suitable due to its flexibility in handling such variations.

Table 4. Outcomes of Unit root tests.

UNIT ROOT TEST TABLE (PP)						
At Level	**t-Statistic**	**Prob.**	At First Difference	**t-Statistic**	**Prob.**	**Decision**
GDP	-5.493	0.00	d(GDP)	-19.433	0.0	I (0)
FEI	-1.2315	0.65	d(FSD)	-5.8215	0.0	I (I)
GCF	-6.4735	0.00	d(GCF)	-19.6914	0.0	I (0)
EPV	-0.5443	0.87	d(EPO)	-8.248	0.0	I (I)
REC	-1.6494	0.45	d(REC)	-3.7684	0.0	I (I)
TO	-1.4879	0.53	d(TO)	-5.3535	0.0	I (I)
UNIT ROOT TEST TABLE (ADF)						
At Level	**t-Statistic**	**Prob.**	At First Difference	**t-Statistic**	**Prob.**	
GDP	-5.45	0.00	d(GDP)	-6.48	0.00	I (0)
FEI	-1.65	0.45	d(FSD)	1.22	0.10	I (I)
GCF	-6.47	0.00	d(GCF)	-12.09	0.00	I (0)
EPV	-0.53	0.87	d(EPO)	-8.07	0.00	I (0)
REC	-1.56	0.49	d(REC)	-3.66	0.01	I (0)
TO	-1.48	0.53	d(TO)	-5.35	0.00	I (0)

Note: ***, **, * report the significance level at 1%, 5%, and 10%, relatively.

After taking the first difference, all the data series became stationary. Once this was confirmed, the study carried out a cointegration test. The Bounds test results in Table 5 show that the F-statistic (6.13) is higher than both the upper and lower critical values at the 1%, 5%, and 10% significance levels. This means we reject the null hypothesis there is no long-term relationship and find strong evidence of a long-run connection between economic growth and determinant variable

Table 5 Bound co-integration test

F-Bounds Test				
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	6.136086	10%	1.81	2.93
k	5	5%	2.14	3.34
		2.50%	2.44	3.71
		1%	2.82	4.21

4.2. Discussions

The analysis shown in Table 6 reveals a positive correlation between green energy investment and economic growth. It means that one percent increase in green energy investment then the 0.04 percent increase in economics growth. Green energy investment has increasingly been recognized as a vital driver of sustainable economic growth, particularly in emerging economies. Studies have shown that renewable energy development not only reduces environmental degradation but also creates jobs, stimulates innovation, and boosts GDP (Apergis & Payne, 2012; Bhattacharya et al., 2016). Moreover, institutions like IRENA (2020) emphasize that targeted investments in green technologies can enhance energy security, attract private sector involvement, and promote long-term economic resilience. However, the effectiveness of these investments depends heavily on supportive government policies, technological readiness, and infrastructure availability (Sovacool & Mukherjee, 2011). Similarly, the other variables exhibit a positive impact on economic growth, while only trade openness shows a negative effect on economic growth.

Table 6. long and short-run results

Long Run Equation				
Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GEI	0.04	0.07	-0.62	0.54
GCF	0.28	0.07	4.05	0.00
EPV	0.04	0.02	1.55	0.13
REC	0.09	0.03	2.70	0.01
TO	-0.03	0.07	-0.36	0.72
Short Run Equation				
COINTEQ01	-0.46***	0.03	0.22	0.00
D(GEI)	-0.021	0.068	-0.308	0.761
D(GCF)	0.191	0.024	8.116	0.000
D(EPV)	0.058	0.033	1.753	0.093
D(REC)	-1.268	0.371	-3.415	0.002
D(TO)	-0.310	0.124	-2.501	0.020
Diagnostic tests				
Test			F-statistic	P-value
J-B normality test			1.02	0.59
Breusch-Godfrey Serial: correlation LM test			0.79	0.46
Heteroscedasticity Test: ARCH			1.48	0.20

Note: ***, **, * report the significance level at 1%, 5%, and 10%, relatively.

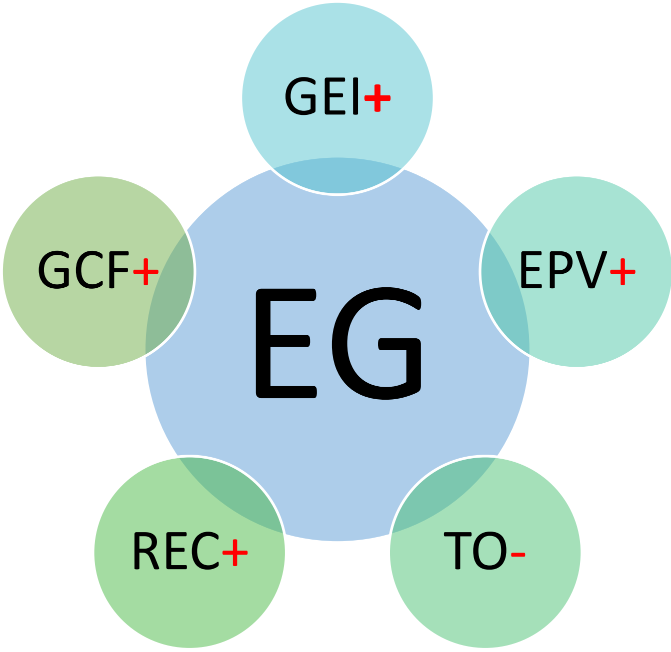

Figure 5. Summary of results

As illustrated in Figure 5, the summary of results. Diagnostic tests reveal the following: the Jarque-Bera (J-B) normality test shows an F-statistic value of 1.02 and a probability value of 0.59, suggesting the model is likely normally distributed. The Breusch-Godfrey Serial Correlation LM test shows an F-statistic value of 0.79 with a probability of 0.49, indicating no serial correlation in the model. The Heteroscedasticity Test (ARCH) shows an F-statistic value of 1.48 with a probability value of 0.20, implying no heteroscedasticity.

Table 7 Diagnostic tests

Diagnostic tests		
R-squared	0.82	0.764
Adjusted R-squared	0.78	0.686
SE of regression	1.92	1.792
Long-run variance	10.52	11.20

Note: ***, **, * report the significance level at 1%, 5%, and 10%, relatively.

5. Conclusions and policies suggestions

5.1. Conclusions of the study

This study investigated the relationship between renewable energy consumption, green energy investments, and economic growth in India. The empirical results suggest that renewable energy plays a significant and positive role in enhancing economic performance. The findings indicate that increased investments in green energy not only contribute to environmental sustainability but also stimulate job creation, innovation, and industrial productivity—factors that collectively support economic growth. Moreover, the analysis confirms that the transition towards a cleaner energy mix, supported by favorable policies and financial mechanisms, can act as a catalyst for long-term economic development. However, the study also highlights the need to address structural challenges such as infrastructure gaps, regulatory hurdles, and financing constraints to fully unlock the potential of green energy investments.

5.2 Policy suggestions

Based on the findings of this study, several policy implications emerge to strengthen the link between renewable energy and economic growth in India:

The government should continue to provide financial incentives such as tax breaks, subsidies, and low-interest loans to attract both domestic and foreign investments in renewable energy sectors like solar, wind, and biomass. Promoting PPPs can bridge the gap between innovation and implementation. This collaboration can accelerate infrastructure development, especially in rural and underdeveloped areas, fostering inclusive economic growth. India's diverse geographical landscape demands regionally tailored policies to maximize the potential of various renewable sources. For example, promote solar in Rajasthan and wind energy in Tamil Nadu and Gujarat. Encouraging innovation through increased R&D funding can lead to more efficient, affordable, and scalable green technologies, which in turn will support sustained economic growth. Introduce specialized training programs to build a skilled workforce capable of operating and maintaining renewable energy infrastructure. This can reduce unemployment and support local economies. Enhancing the national grid's capacity to integrate renewable energy and investing in battery storage solutions will ensure a stable and efficient power supply, thereby supporting industrial and economic activity. Encourage the development of green bonds and other sustainable financial instruments to mobilize long-term capital for renewable energy projects. A stable and predictable policy environment, backed by transparent regulations, can boost investor confidence and accelerate renewable energy adoption.

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