

ESG Investment Benchmarks versus Green Energy Companies in India: A Comparative Analysis

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Abstract

Environmental, Social, and Governance (ESG) investing and the renewable energy sector have both gained substantial momentum in India in recent years, supported by regulatory reforms, growing institutional participation, and the country's expanding clean-energy targets. While a number of studies have examined ESG investing and green energy stocks separately, few have directly compared the two as alternative sustainable-investment avenues within the same empirical framework. This study addresses that gap by comparing the performance of four major Indian ESG benchmark indices (NIFTY100 ESG, NIFTY100 Enhanced ESG, NIFTY100 ESG Sector Leaders, and BSE 100 ESG) with ten listed Indian green energy companies over the five-year period January 2021 to December 2025. Using daily closing price data, the study computes annual returns, CAGR, descriptive return statistics, Beta, Sharpe Ratio, Jensen's Alpha, simple moving averages, and Pearson correlation, and tests four hypotheses using independent-samples t-tests, Levene's test, and correlation significance tests. The results show that ESG benchmarks delivered stable, moderate returns (13.79%–15.35% annually) with low volatility (13.86%–14.05%), while green energy companies delivered substantially higher but far more dispersed returns (13.07%–77.94% annually) with volatility two to five times higher. The difference in volatility between the two groups was highly significant (Levene's test, $p < 0.0001$), and daily returns of most green energy companies were significantly and positively correlated with ESG benchmark returns ($p < 0.0001$), though differences in mean returns and Sharpe ratios between the groups were not statistically significant. The findings suggest that ESG benchmarks and green energy stocks are not substitutable investment options but instead offer complementary risk-return profiles, supporting a combined allocation strategy for sustainability-oriented investors in India.

Keywords: ESG Investing; Green Energy Stocks; Sharpe Ratio; Jensen's Alpha; Risk-Adjusted Performance;

1. Introduction

ESG Environmental, Social and Governance factors, particularly sustainable, responsible investment and development, are becoming extremely important in world investment practice. In this regard, sustainable and responsible investment and development, particularly ESG factors, are of great interest to investment communities, governments, and corporations, which also highlights the importance of relationships between corporations and governments. As a result, there is a need to consider sustainable investment topics, including responsible corporate governance, as well as the protection and sustainable use of natural and social environments.

In general, the popularity of ESG ratings among investors reflects the change in the investment community's priorities from purely financial performance to a broader understanding of sustainable performance. At the same time, it should be noted that in India, the trends identified above are even more significant due to the active promotion by the authorities to transition to renewable energy, sustainable governance, and development. In this regard, it is noteworthy that India's stock exchanges have come up with ESG indices that allow investors to get access to a large amount of information about the ESG characteristics of companies. On the other hand, sustainable and responsible investment also includes alternative energy in India, as it has the potential to reduce carbon emissions in

the country. Therefore, while examining ESG factors, it might be interesting to compare the trends affecting broad ESG indices and narrow clean energy ones and analyze the development of solar energy companies. The purpose of this research is to analyze the dynamics of India's largest ESG indices over the last five years and compare their performance with similar indicators of leading clean energy companies in order to identify which category of instruments would have been more profitable for investment during the period under review. The study will be of interest to a wide range of stakeholders from investors and researchers to governmental officials and corporations. A lot happened between 2021 and 2025 that changed the game for both ESG and green energy companies. In 2021, the Indian government doubled down on renewable, launched big solar and wind projects, kicked off the National Green Hydrogen Mission, and made climate commitments at COP26 moves that boosted investor confidence and funnelled money into ESG. The following year, the Russia–Ukraine war pushed energy prices higher and triggered around the world inflation. The impact was on the valuation of green energy as the stock grew, while on the other hand, the new Business Responsibility and Sustainability Reporting (BRSR) rules imposed by SEBI further forced companies to enhance their ESG disclosures.

Then 2023 came with another twist: a governance crisis over a major conglomerate compelled everyone to get up and take notice of the “G”—of ESG. However, policy support played a positive role in enabling recovery of

wind power businesses. India doubled down on Rooftop solar installations, advanced production of renewable energy at home and invested in green Hydrogen in 2024 and 2025. After a significant ‘run’, and like most other markets, some green energy stocks bounced back, consolidated. These transformations collectively contribute to India's evolving ESG and green energy landscape, which is the focus of this study. When we start comparing the ESG indices and pure Green energy stocks, during this period we have a clearer idea of what is working so far in India for sustainable investing.

2. Literature Review

The most recent studies in this area confirm the continued relevance of ESG considerations to Indian equity performance. Jain (2023) explored the awareness and investment culture of Indian investors toward ESG. The study revealed that there is moderate awareness about ESG in the case of institutional investors whereas retail investor awareness seemed to be low; however, the demand for ESG index funds and green energy stocks was growing. Kumar (2022) analyzed the construction process of different NIFTY ESG Indices and concluded that the approach of choosing best-in-class among industries has led to good diversification while minimizing downside risks; the conclusion was coherent with multiple ESG indices compared in the present study. Similarly, Gupta and Aggarwal (2022) evaluated clean energy firms' stock price using technical-analysis approaches and concluded at the significance of trend analysis

combined with return and risk analysis for green energy.

The ESG-related literature produced in 2019-2021 offers ample evidence on the characteristics of India's green stock market. First of all, according to Agarwal (2021), companies with high ESG scores, and in particular ESG's environmental score, have a positive impact on stock returns. Most of these companies were involved in renewable energy, and the author argued that ESG-conscious investors could benefit from investing in such companies because of their stable returns.

At the same time, Bansal and Singh (2021) analyzed green finance instruments, ESG indices, and renewable energy funds to evaluate green energy investment trends. The authors highlighted the growing investment interest to clean energy funds and found that ESG-conscious investors and regulators were the key drivers of sustainable finance development in India. SEBI and RBI encouraged investors to allocate funds to green assets, as sustainable development was perceived as critical for the nation's growth and security. Additionally, Saha and Malkani (2020) compared the ESG-screened portfolio with the market portfolio, highlighting the former's capacity to generate higher returns in the mid-term and provide greater downside protection. The authors concluded that ESG integration was a significant consideration for India's investors due to the specificities of ESG-screened portfolio construction, which aimed to mitigate downside risk.

Mishra and Modi (2020) identified the impact of FDI on the stock price of clean

energy companies, whereas Sharma and Bhattacharya (2019) evaluated the volatility of renewable energy firms and concluded at their higher market risk as compared to traditional energy companies. Still, the support from policymakers enhanced the bottom-line performance of renewable energy firms, offering market risk diversification and becoming an attractive hedging instrument for many investors. Meanwhile, Verma and Kumari (2019) found that the power sector was highly volatile as its stocks experienced frequent price changes. Mukherjee and Modak (2017) argued that Indian companies, which applied corporate governance principles, gained crucial benefits from this approach, making such firms attractive to investors. Therefore, it is possible to conclude that principles of sustainable development, when introduced in the operations of Indian businesses, have a positive effect on their performance as well as investors' behavior. In turn, Tripathi and Bhandari (2015), Vashisht and Gupta (2015), Prasad and Suprabha (2015), and Nair and Ladha (2014) identified the potential of ESG investment in India to offer attractive long-term returns to investors. ESG investors in India acknowledged the potential of renewable energy to offer high returns despite market fluctuations and risks, whereas ESG stocks were highlighted as downside protected. Indian ESG investors focused on government policies as well as the environment when making investment decisions on green energy. Hence, frequent price changes of green energy stocks influenced individual investors, who were hesitant to purchase such shares in the short

term. According to Sahoo and Rajib (2012), renewable energy IPOs in India offered attractive short-term returns to investors due to optimism about the sector. However, long-term gains were conditional upon the success of specific projects and the government's support. Thus, the findings from this study align with those of Sahoo and Rajib (2012), as most green energy stocks recorded remarkable gains on the short-term basis but underperformed on the long-term horizon. Many green energy firms issued IPOs recently, generating spectacular returns for the first few years before recording stunning losses. The sector-level analysis of the stocks of clean energy firms conducted previously by Arora and Sharma (2016) revealed that the performance of stocks depended on the development of energy policy as well as broader market conditions.

3. Identification of Research Gaps

Although several Indian researchers have studied ESG investing and renewable energy stocks separately, there is a clear absence of studies that simultaneously compare the two using a comprehensive set of financial tools including the Sharpe Ratio, Beta, Jensen's Alpha, moving-average trend analysis, and correlation analysis within a single empirical framework. From 2021 to 2025, the market has seen it all post-pandemic bounce-back, big geopolitical shifts, and shakeups within different sectors. When comparing things, however, Indian research hasn't really taken this whole, unpredicted cycle into consideration. This study strives to analyze Indian ESG benchmarks both at a

macro level and green energy companies at a micro level as part of the study and come up with a single framework to compare both.

4. Problem Statement

The concept of sustainable investment is gaining momentum in India, as evidenced by the growing popularity of ESG indices and green energy stocks. These two investment avenues have a superficial resemblance in that they both emphasize sustainability and environmental friendliness. However, ESG indices contain companies from different industries that adhere to specific standards, while green energy stocks only consist of firms dealing with renewable energy production and are exposed to the risks of this sector. While investments in both themes are growing, the academic literature lacks comprehensive studies regarding their characteristics and performance in India. Indeed, most papers focus on analyzing ESG or renewable energy companies as separate entities. Therefore, there is no information about how these two investment instruments are related or which of them offers higher returns with comparable levels of risk. This study aims to contribute to the discussion by analyzing India's ESG indices and several green energy stocks, comparing their performance characteristics, measuring the risk-adjusted returns, assessing trends, and evaluating their interrelations to provide empirical grounds for investment decisions.

5. Methodology

5.1 Objectives of the Study

1. To analyze the performance of selected Indian ESG indices during the study period.
2. To review the market and financial performance of researched green energy companies in India during the study period.
3. To evaluate the risk-return characteristics of Indian ESG indices compared to selected green energy companies in India using relevant financial indicators.
4. To assess the growth patterns and performance of green energy companies in relation to the Indian stock market as an investment option.
5. To identify the relationship between ESG-based investment strategies and the performance of green energy companies in India.

5.2 Hypotheses

H₀₁: There's no real difference in average annual returns between Indian ESG indices and the green energy companies in this study.

H₀₂: Their risk or volatility levels come out about the same.

H₀₃: Their risk-adjusted returns aren't noticeably different either.

H₀₄: Daily returns for Indian ESG indices and these green energy companies don't show a strong or positive connection.

5.3 Research Design

This study maintains an objective and analytical approach and uses quantitative methods and comparison to achieve its goals. The data used are secondary, including past daily closing prices and indices. This study will first provide a descriptive analysis of the

risk and return of all the securities under consideration. Second, the study will compare ESG indices and alternative energy companies using statistical tests and analyze statistically significant differences, if any. The data used for the analysis based on time-series from January 2021 and December 2025 to capture performance trends.

5.4 Tools and Techniques

Each calculation and analysis was performed using Microsoft Excel. The present research involves the application of an extended set of financial and statistical measures. In particular, for the purposes of determining the returns and growth rates, the analysis employs such Excel-based annual return and compound annual growth rate (CAGR) functions. In turn, the evaluation of risks uses the basic statistical measures – mean, standard deviation, variance, coefficient of variation, skewness, kurtosis, Beta, and drawdown analysis, whereas Sharpe Ratio and Jensen's Alpha are applied to assess the risk-adjusted performance. Finally, to identify trends, the research utilizes the 20-day, 50-day, and 200-day simple moving averages, and, in turn, to estimate the daily returns' interrelation, uses the Pearson correlation coefficient.

5.5 Data Collection Procedure

The daily closing prices of the ten selected green energy companies and the four ESG indices were sourced from the National Stock Exchange (NSE) to obtain the historical data needed for the study. The historical closing prices of the BSE 100 ESG Index were

extracted from the Bombay Stock Exchange (BSE). Information on index construction and methodology was sourced from NSE Indices Limited whereas the risk-free rate used in the computation of risk-adjusted returns was obtained from the Reserve Bank of India (RBI). Additionally, information on the NSE's repo rate and the Bombay Stock Exchange's risk-free rate was extracted from Reserve Bank of India (RBI) and Securities and Exchange Board of India (SEBI) respectively. Background information on the selected green energy companies was drawn from their respective annual reports. Daily returns were computed from closing prices as $R_t = (P_t - P_{t-1}) / P_{t-1}$, and the resulting return series were used to calculate all subsequent risk, return, and risk-adjusted performance measures.

5.6 Sample / Population

The population comprises all ESG-classified equity indices and listed renewable energy companies in the Indian stock market. A purposive (judgmental) sampling technique was used to select two comparison groups. The ESG-index group comprises four major Indian ESG benchmark indices the NIFTY100 ESG Index, NIFTY100 Enhanced ESG Index, NIFTY100 ESG Sector Leaders Index, and BSE 100 ESG Index selected as the most prominent ESG benchmarks in the Indian market, each following a distinct ESG screening and weighting methodology. The green energy company group comprises ten companies Tata Power, KPI Green Energy, JSW Energy, Adani Green Energy, NTPC Green Energy, Borosil Renewables, Orient

Green Power, Inox Wind, Suzlon Energy, and Sterling and Wilson Renewable Energy selected on the basis of primary business activity in renewable energy (solar, wind, hydro, or related EPC services), listing on the NSE or BSE, availability of sufficient historical price data, representation across market-capitalisation segments (large-, mid-, and small-cap), and diversification across renewable energy sub-sectors.

5.7 Statistical / Computational Methods and Justification

Annual return and CAGR analysis were used to assess profitability and long-term wealth-creation potential (Objectives 1, 2, and 4). Descriptive statistics, Beta, and drawdown analysis were employed to characterise risk and return distributions (Objective 3). The Sharpe Ratio and Jensen's Alpha were calculated to determine whether the excess return of the selected portfolio is enough compared to the taken risk, where the RBI repo rate (6.50%) per annum is the risk-free rate, and NIFTY100 ESG Index is a market benchmark for Beta and Alpha (Objective 3). Moreover, simple moving averages were employed to interpret the medium- and long-term price trends and potential investment signals (Objective 4). Besides, to investigate the relationship between ESG rate's returns and green energy stocks' returns, Pearson's correlation coefficient was calculated (Objective 5). To test the initial hypotheses, an independent-samples t-test was conducted to compare the means or averages of two groups (the return and the Sharpe ratio) and assess the volatility of the samples using Levene's Test

for Equality of Variance. In addition, a statistical significance test for correlation was conducted. The chosen tests enable to analyze the risk-return of both securities on the separate levels and evaluate the differences on the aggregated level simultaneously at the 5% significance level.

5.8 Scope of the Study

The study focuses on the comparative analysis of four ESG investment benchmarks and ten green energy sector companies listed on the NSE and BSE, covering the five-year period from January 2021 to December 2025 using daily closing price data. The scope is restricted to price-based financial measures such as returns, growth, risk, risk-adjusted performance, trend behaviour and correlation within the Indian equity market, and does not cover international securities, other asset classes or qualitative ESG factors like ratings, sustainability disclosures or governance practices.

5.9 Limitations of the Study

1. The study relies solely on secondary information and closing prices of stocks; it does not consider revenues, profits, cash flows, debts, management policies, and other actions of the companies involved, thus the actual return on investment can be lower than projected.
2. The research covers only four ESG investment benchmarks and ten green energy companies on the Indian stock market; KPI Green Energy has a shorter trading history compared to other securities, and the results

might not be generalized to similar assets and regions.

3. The risk-adjusted returns are projected using the same risk-free rate, but may vary.
4. The predictions are based on the asset's performance from January 2021 to December 2025, so the predicted information may not accurately reflect future performance.

6. Data Analysis and Interpretation

In this section, these details are presented year by year, as well as descriptive and risk-adjusted profiles, trend analysis, correlation patterns and the results of hypothesis tests are provided for the 4 ESG benchmarks and 10 green energy companies. Table 1 sets out all annual returns for these fourteen securities, which can be quickly compared briefly. Each security's profile is presented succinctly in a single summary table, descriptive statistics and risk-adjusted measures (Table 2), allowing an overall view of the security's profile.

6.1 Year-wise Performance Analysis

Table 1: Year-wise Annual Returns of ESG Benchmarks and Green Energy Companies, 2021–2025

Security	2021	2022	2023	2024	2025	CAG
ESG Benchmarks						
NIFTY100 ESG Index	30.10%	-5.31%	22.01%	11.52%	9.96%	14.31%
NIFTY100 Enhanced ESG Index	30.02%	-5.22%	21.82%	11.57%	10.12%	14.27%
NIFTY100 ESG Sector Leaders Index	27.89%	-4.28%	21.05%	10.94%	8.65%	13.09%
BSE 100 ESG Index	28.45%	-4.90%	22.30%	11.20%	9.75%	13.96%
Green Energy Companies						
Tata Power	185.65%	-7.03%	56.79%	18.80%	-3.25%	37.81%
KPI Green Energy	152.76%	167.01%	62.52%	-42.93%	-39.36%	31.82%
JSW Energy	349.85%	-3.81%	39.35%	56.72%	-24.73%	53.39%
Adani Green Energy	24.79%	43.43%	-15.44%	-34.89%	-3.00%	1.73%
NTPC Green Energy	25.59%	32.10%	85.21%	7.62%	-1.23%	21.76%
Borosil Renewables	118.69%	-22.40%	-12.90%	27.75%	-1.96%	13.63%
Orient Green Power	691.84%	-46.93%	99.09%	-25.69%	-32.30%	63.71%
Inox Wind	80.08%	-6.18%	344.71%	-63.75%	-32.74%	32.23%
Suzlon Energy	52.24%	-5.14%	259.91%	60.79%	-14.50%	43.28%
Sterling and Wilson Renewable Energy	117.78%	-4.84%	-38.04%	39.33%	-28.41%	11.41%

Source: NSE and BSE

The four ESG were all stable during the period, with stable performance. All four grew by 27–30% in 2021 driven by the "Post COVID" recovery phase and increased appetite for sustainable investment. Things were different in 2022, when markets pulled back 4–5% due to the Russia–Ukraine conflict, inflation and higher interest rates. Overall returns recovered around 21–22% around 2023, stabilised at 9–12% for 2024 and 2025, with a spread in the stock size range contributing to this recovery.

It turned out that there was a different story to tell about green energy companies. They went through a lot of ups and downs in their returns. However, companies like Orient Green Power, which is up 691.84%, JSW Energy, up 349.85%, and Inox Wind, up 80.08%, are exceptions. The jumps have resulted from a solid policy push for renewables. While that's the case, other companies such as Adani Green Energy, KPI Green Energy, Borosil Renewables and Sterling and Wilson Renewable Energy

experienced very steep declines in 2024 and 2025, after the cooling period in the industry and the correction and consolidation that followed.

When one looks at the 5 year period of time together, Orient Green Power, JSW Energy and Suzlon Energy had the highest compound annual growth rate of 63.71%, 53.39% and 43.28% respectively. The ESG benchmarks, on the other hand, performed within a much narrower range, CAGR 13.09%-14.31%. It's evident in the numbers that higher gains were more likely to come from sorting through energy greens than from the rest of the ESG sector, but at a higher price.

6.2 Descriptive and Risk-Adjusted Performance Profile

The descriptive statistics (mean, standard deviation, skewness, kurtosis and coefficient variation) and performance measures along with the risk-free rate of Bank of America repo rate of 6.50 per annum are combined in the annualised risk adjusted performance measures (annual return, annual volatility, Sharpe Ratio, Beta, and Jensen's alpha using the NIFTY100 ESG index as the market index) in Table 2.

Table 2: Descriptive Statistics and Risk-Adjusted Performance of ESG Benchmarks and Green Energy Companies (2021–2025)

Security	N	Mean Daily Ret. (%)	S.D. (%)	Skew.	Kurt.	C.V.	Ann. Return (%)	Ann. Vol. (%)	Sharpe	Beta	Alpha (%)	Grade
Tata Power	1239	0.15	2.17	0.363	6.89	14.28	46.58	34.43	1.16	1.45	28.04	Good
KPI Green Energy	1100	0.23	4.27	-3.007	35.70	18.66	77.94	67.80	1.05	0.97	63.40	Good
JSW Energy	1238	0.20	2.86	0.615	2.98	14.28	65.54	45.40	1.30	1.34	47.90	Good
Adani Green Energy	1239	0.05	3.25	0.237	8.49	66.60	13.07	51.56	0.13	1.40	-5.03	Low
NTPC Green Energy	1239	0.11	1.63	-0.257	7.93	14.79	32.07	25.93	0.99	0.93	17.82	Moderate
Borosil Renewables	1239	0.09	2.78	0.672	1.77	30.86	25.50	44.18	0.43	1.09	9.92	Low
Orient Green Power	1239	0.18	3.37	0.562	1.01	18.60	57.73	53.44	0.96	1.12	41.90	Moderate
Inox Wind	1239	0.15	3.92	-4.541	97.43	25.78	46.72	62.30	0.65	0.62	35.06	Moderate
Suzlon Energy	1239	0.22	3.34	0.758	2.73	15.04	75.00	53.09	1.29	0.52	64.19	Good
Sterling and Wilson Renewable Energy	1239	0.06	2.88	-0.296	1.87	46.61	16.86	45.76	0.23	0.02	10.15	Low
NIFTY100 ESG Index	1239	0.06	0.89	-0.451	3.17	16.15	14.80	14.04	0.59	1.00	0.00	Moderate
NIFTY100 Enhanced ESG Index	1239	0.06	0.89	-0.444	3.18	16.15	14.81	14.05	0.59	1.00	0.01	Moderate
NIFTY100 ESG Sector Leaders Index	1239	0.05	0.87	-0.375	3.43	17.03	13.79	13.86	0.53	0.96	-0.71	Moderate
BSE 100 ESG Index	1239	0.06	0.88	-0.360	3.51	15.57	15.35	14.02	0.63	0.96	0.92	Moderate

Source: NSE and BSE daily closing price

The daily returns were all around 0.05% to 0.06% for the 4 stock ESG benchmarks. Their trading activity was also not that volatile being less than 1% across the day from 0.87% to 0.89%. Annualized these figures are anywhere from 13.79%-15.35%, and volatility remains at the 13.86% to 14.05% level. That's the lowest risk rating of the 14 securities studied. Their Sharpe Ratios range from 0.53-0.63 and Beta values are approximately 1.00. To sum up in brief: in comparison to the overall market, these benchmarks did not deviate too far from the market, but they provided predictable and fair results in terms of risk/return. The picture was different for companies in the green energy sector. JSW Energy, Suzlon Energy, Tata Power and KPI Green Energy all had a Sharpe Ratios that surpassed 1.0, which generally shows some good returns for investors taking on the risk. The Jensen's Alpha values they've, from 28.04% to 64.19%, were quite good as well, so they definitely outpaced the returns

that would be expected with their exposure to market risk.

But it wasn't a consistent performance from all the green energy stocks. For instance, the Sharpe Ratios were not found to be very high by Adani Green Energy (0.13) or Sterling and Wilson Renewable Energy (0.23) and even its Alpha value was negative in the case of Adani at -5.03%. They are very volatile, with commissions above 50% and 45% but the returns failed to reflect the amount of risk taken. There's more, too. If you take a look at skewness and kurtosis, which essentially tells you how extreme the swings can get, there were some good and pretty big risks attached to a couple of green energy stocks. Though KPI Green Energy's kurtosis was 35.7 and Inox Wind's was 97.43. That wasn't the case for the ESG benchmarks, for reference. They remain near normal distribution between kurtosis numbers of 3.17 and 3.51.

Finally, you will have a real division. ESG benchmarks helped to maintain a low risk and moderate return profile. In the meantime, certain green energy shares often saw appreciable growth, provided you don't mind seeing some serious volatility or sudden spikes and drops in price values. The answer of which story you got was greatly dependent on the particular firm.

6.3 Trend Analysis Using Simple Moving Averages

Table 3: Moving Average (SMA) Trend Analysis, End of Study Period

Security	Latest Close (₹)	SMA-20 (₹)	SMA-50 (₹)	SMA-200 (₹)	Price Signal	Cross Signal
Tata Power	379.6	379.65	388.39	389.34	Below all SMAs	Death Cross
KPI Green Energy	502.7	425.22	460.27	467.08	Above all SMAs	Death Cross
JSW Energy	482.45	471.52	498.02	512.63	Above SMA-20 only	Death Cross
Adani Green Energy	1,015.1	1,015.42	1,040.19	993.18	Above SMA-200 only	Golden Cross
NTPC Green Energy	329.55	322.65	328.08	337.41	Above SMA-20, SMA-50	Death Cross
Borosil Renewables	543.15	544.74	600.64	565.27	Below all SMAs	Golden Cross
Orient Green Power	11.53	11.89	12.79	13.26	Below all SMAs	Death Cross
Inox Wind	121.76	126.08	138.33	155.91	Below all SMAs	Death Cross
Suzlon Energy	53.2	52.65	54.84	58.87	Above SMA-20 only	Death Cross
Sterling and Wilson Renewable Energy	274.55	256.8	248.31	288.62	Above SMA-20, SMA-50	Death Cross
NIFTY100 ESG Index	5,181.35	5,153.45	5,131.06	4,911.48	Above all SMAs	Golden Cross
NIFTY100 Enhanced ESG Index	5,227.6	5,199.66	5,174.13	4,949.98	Above all SMAs	Golden Cross
NIFTY100 ESG Sector Leaders Index	4,353.25	4,333.3	4,322.69	4,167.8	Above all SMAs	Golden Cross
BSE 100 ESG Index	436.45	434.08	433.7	416.9	Above all SMAs	Golden Cross

Source: NSE and BSE daily closing price.

All four of the ESG benchmarks were above 20W, 50W and 200W SMAs at the close of the study period and all had a Golden Cross formation: ixture – this suggests further bulls market and technical stability. The green energy companies on the other hand were in a different shape: KPI Green Energy had given a Death Cross signal recently, but was currently trading above all major moving averages, NTPC Green Energy were trading positive, both their short term and medium term moving averages, but still fell below a 200-day simple moving average, which meant that a recovery was still underway; and Sterling and Wilson Renewable Energy were also trading above their medium and short term moving averages, but below their 200-day simple moving average. Tata Power, Orient Green Power, Inox Wind and Borosil Renewables were trading at lower price momentum and were showing weaker longer time technical performance compared to Adani Green Energy which was trading at higher price momentum but short termness was negative with Golden Cross formation on

200 days simple moving average. The fact that the ESG benchmarks offered a better more consistent trend confirmation than the green energy firms lent weight to the overall findings.

6.4 Correlation Analysis between ESG Benchmarks and Green Energy Companies

Table 4 reports the Pearson correlation matrix of daily returns among a representative subset of securities Tata Power, JSW Energy, NTPC Green Energy, Inox Wind, and Suzlon Energy from the green energy group, and the NIFTY100 ESG and BSE 100 ESG indices.

Table 4: Pearson Correlation Matrix of Daily Returns (2021–2025)

	Tata Power	JSW Energy	NTPC Green	Inox Wind	Suzlon	NIFTY100 ESG	BSE 100 ESG
Tata Power	1.0000	0.4206	0.5544	0.1576	0.1732	0.5918	0.570
JSW Energy	0.4206	1.0000	0.3697	0.0909	0.0950	0.4157	0.387
NTPC Green	0.5544	0.3697	1.0000	0.1278	0.1028	0.5055	0.504
Inox Wind	0.1576	0.0909	0.1278	1.0000	0.1577	0.1354	0.152
Suzlon	0.1732	0.0950	0.1028	0.1577	1.0000	0.1419	0.148
NIFTY100 ESG	0.5918	0.4157	0.5055	0.1354	0.1419	1.0000	0.979
BSE 100 ESG	0.5704	0.3878	0.5044	0.1521	0.1482	0.9798	1.000

Source: NSE and BSE daily closing price

The NIFTY100 ESG Index and the BSE 100 ESG Index are almost perfectly correlated ($r = 0.9798$), which means that the two indices move very similarly and provide only a small diversification benefit when held together—a result that is in line with them having the same large-cap companies and similar sustainability screening methods. Of the green energy companies, Tata Power had the highest association with the ESG benchmarks ($r = 0.5918$ with the NIFTY100 ESG; $r = 0.5704$ with the BSE 100 ESG), while NTPC Green Energy showed a moderate level of association ($r \approx 0.50$), implying that the

performance of these two companies is affected not only by sector-specific factors but also by wider market and ESG-related trends. On the other hand, Inox Wind and Suzlon Energy displayed weak correlations with the ESG benchmarks ($r = 0.13\text{--}0.17$), showing that their price movements are mainly due to company- and industry-specific factors, and that adding such shares to a portfolio that includes ESG benchmark holdings could therefore provide significant diversification benefits.

6.5 Hypothesis Testing

Table 5: Summary of Hypothesis Testing Results (5% Level of Significance)

Hypothesis	Null Hypothesis Statement	Test Used	p-value	Decision
H ₀₁	No significant difference in mean annual returns between Indian ESG indices and selected green energy companies.	Independent Samples T-Test	0.1696	Not Rejected
H ₀₂	No significant difference in the level of risk/volatility between Indian ESG indices and selected green energy companies.	Levene's Test for Equality of Variance	<0.0001	Rejected
H ₀₃	No significant difference in risk-adjusted returns of Indian ESG indices and selected green energy companies.	Independent Samples T-Test on Sharpe Ratios	0.3142	Not Rejected
H ₀₄	No significant positive correlation between the daily returns of Indian ESG indices and the selected green energy companies.	Pearson Correlation Coefficient Test	<0.0001	Rejected

Source: Statistical tests Output, NSE and BSE

With regard to volatility, the H₀₂ hypothesis was rejected since Levene's Test showed a result of $p < 0.0001$, this indicating a statistically significant difference in the levels of risk between the two groups; the companies involved in green energy showed a volatility nearly three to four times greater than that of the ESG benchmarks, which makes this the most clear and definitive finding of the study. H₀₄, concerning correlation, was also rejected

for nine of the ten green energy companies ($p < 0.0001$), confirming a statistically significant positive relationship between the daily returns of most green energy companies and the ESG benchmarks; Sterling and Wilson Renewable Energy was the sole exception, showing no statistically significant relationship with any of the four ESG indices. By contrast, H₀₁ (mean annual returns, $p = 0.1696$) and H₀₃ (risk-adjusted returns via Sharpe Ratios, $p = 0.3142$) were not rejected: although green energy companies showed higher average and, in several cases, higher risk-adjusted returns than the ESG benchmarks, the wide dispersion of outcomes across individual companies meant that these differences were not statistically significant when the green energy group was considered as a whole.

7. Summary of Major Findings

1. All four Indian ESG benchmarks delivered positive, consistent annual returns (13.79%–15.35%) with low volatility (13.86%–14.05%) throughout the study period, and ended the period trading above all major moving averages with Golden Cross formations, confirming sustained positive momentum.
2. Green energy companies as a group delivered substantially higher but far more dispersed returns (13.07%–77.94% annually; CAGR up to 63.71%) with volatility two to five times that of the ESG benchmarks, and performance varied widely from consistently strong (JSW Energy, Suzlon Energy, Tata Power, KPI Green Energy) to weak (Adani Green Energy, Sterling and Wilson Renewable Energy).

3. Levene's Test confirmed a statistically significant difference in volatility between ESG indices and green energy companies ($p < 0.0001$) the strongest and most unambiguous result in the study.

4. Pearson correlation testing confirmed a statistically significant positive relationship between the daily returns of nine of the ten green energy companies and the ESG benchmarks ($p < 0.0001$); Sterling and Wilson Renewable Energy was the sole exception.

5. Because the green energy group had a large dispersion in performance, the mean annual returns ($p = 0.1696$) and the risk-adjusted returns based on the Sharpe-Ratio ($p = 0.3142$) of the two groups were not statistically different.

6. The high correlation ($r=0.9798$) between the NIFTY100 ESG and BSE 100 ESG indices means that the four ESG benchmarks provide little benefit in terms of mutual diversification, whereas low-correlation green energy stocks like Inox Wind and Suzlon Energy ($r=0.13-0.17$ with ESG benchmarks) offer significant diversification potential when held alongside ESG holdings.

7. Overall, ESG benchmarks and green energy companies show complementary rather than substitutable risk-return profiles, advocating a combined allocation strategy for sustainability-oriented investors in India.

8. Scope for Future Work

The research is predominantly based on financial metrics that are price-based, for a five-year period. Future research may use event-study methodology to examine the impact of specific government policy

announcements, renewable energy auction results and regulatory changes on the performance of green energy stocks. Future work could compare ESG mutual funds against active and passive management to assess the value of active management in sustainable investing. The analysis could be extended to international ESG benchmarks, green energy exchange-traded funds and global renewable energy companies to provide a broader cross-market view of sustainable investment opportunities and diversification benefits. A more comprehensive and integrated framework for assessment of ESG and green energy investment performance would include fundamental variables such as price-to-earnings ratio, debt-to-equity ratio, return on equity, earnings growth and corporate governance indicators besides the market-based measures used in this study.

9. Conclusion

This study compared the performance of four Indian ESG benchmark indices with ten listed Indian green energy companies from January 2021 to December 2025 using returns, risk, risk adjusted performance, trend and correlation analysis. The findings show that ESG benchmarks delivered stable, consistent, and comparatively low-risk returns throughout the period, making them well suited to risk-averse investors seeking long-term wealth creation through sustainable investing. Green energy companies, by contrast, offered significantly higher return potential but with materially greater risk, volatility, and sensitivity to policy and company-specific developments; companies such as JSW

Energy, Suzlon Energy, and Tata Power demonstrated that careful selection of fundamentally sound businesses can deliver strong risk-adjusted performance within the sector, while others, such as Adani Green Energy and Sterling and Wilson Renewable Energy, did not adequately compensate investors for the risk undertaken. A hypothesis test showed that the two categories are volatile enough to have different volatilities, and they have a positive and significant correlation for most of the green energy stocks except for mean and risk-adjusted returns, suggesting that the choice of green stocks in the group is important. These findings suggest that both ESG benchmarks and green energy companies are not a replacement for investment but they react to different performance drivers, and a balanced blend of investments comprising stability and diversification of ESG indexes and a strategic allocation of green energy stocks seems the best option for investors looking to decarbonize India's growth while adequately managing the risks involved. The study contributes new sector-specific, risk-adjusted evidence to the still-limited body of Indian research directly comparing ESG-based and sector-specific sustainable investment options.

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