“Dynamic impact of macroeconomic and financial stress factors on Clean Energy Index performance: Evidence from an ARDL analysis”

AUTHORS	Akshay Sahu Anup Kumar Avneesh Kumar

ARTICLE INFO	Akshay Sahu, Anup Kumar and Avneesh Kumar (2026). Dynamic impact of macroeconomic and financial stress factors on Clean Energy Index performance: Evidence from an ARDL analysis. *Investment Management and Financial Innovations*, *23*(1), 424-433. doi: 10.21511/imfi.23(1).2026.31
DOI	http://dx.doi.org/10.21511/imfi.23(1).2026.31
RELEASED ON	Wednesday, 18 March 2026
RECEIVED ON	Friday, 19 December 2025
ACCEPTED ON	Thursday, 05 March 2026
LICENSE	This work is licensed under a Creative Commons Attribution 4.0 International License
JOURNAL	"Investment Management and Financial Innovations"
ISSN PRINT	1810-4967
ISSN ONLINE	1812-9358
PUBLISHER	LLC “Consulting Publishing Company “Business Perspectives”
FOUNDER	LLC “Consulting Publishing Company “Business Perspectives”

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
30	2	8

BUSINESS PERSPECTIVES

LLC "CPC "Business Perspectives"
Hryhorii Skovoroda lane, 10,
Sumy, 40022, Ukraine

www.businessperspectives.org

Akshay Sahu (India), **Anup Kumar** (India), **Avneesh Kumar** (India)

DYNAMIC IMPACT OF MACROECONOMIC AND FINANCIAL STRESS FACTORS ON CLEAN ENERGY INDEX PERFORMANCE: EVIDENCE FROM AN ARDL ANALYSIS

Type of the article: Research Article

Received on: 19th of December, 2025
Accepted on: 5th of March, 2026
Published on: 18th of March, 2026

Akshay Sahu, Research Scholar, Commerce Faculty, Department of Commerce, Mahatma Gandhi Central University, India. (Corresponding author)

Anup Kumar, Research Scholar, Commerce Faculty, Department of Commerce, Mahatma Gandhi Central University, India.

Avneesh Kumar, Assistant Professor, Commerce Faculty, Department of Commerce, Mahatma Gandhi Central University, India.

Conflict of interest statement:
Author(s) reported no conflict of interest

Abstract

The growing importance of renewables in the global push towards low-carbon economies has led to rising investor interest in clean energy stocks; however, their performance remains sensitive to macroeconomic and financial conditions. This study aims to examine the dynamic short-run and long-run impacts of macroeconomic and financial stress factors on clean energy stock returns, proxied by the Clean Edge Green Energy Index. Monthly data covering the period from January 2008 to June 2025 are employed. An autoregressive distributed lag modeling framework is used to capture both short-run dynamics and long-run equilibrium relationships between clean energy stock returns, crude oil prices, exchange-rate, interest rate, and the volatility index. The results confirm the existence of a stable long-run relationship among the variables, as evidenced by the bounds testing approach. In the short run, increases in volatility, exchange-rate appreciation, and rising interest rates exert statistically significant negative effects on clean energy stock returns, while the adjustment toward long-run equilibrium is rapid, with approximately 74% of short-run deviations corrected within one month. In the long run, exchange-rate movements and interest rates continue to impose persistent and economically meaningful adverse effects, whereas crude oil price changes remain statistically insignificant. These findings underscore the importance of macro-financial conditions in shaping clean energy stock performance beyond commodity price dynamics and highlight the role of stable financial environments in supporting long-term investment in renewable energy markets.

Keywords clean energy, exchange rate, interest rate, volatility, financial stress, time series

JEL Classification Q42, G15, G12, C22

INTRODUCTION

The transition to clean energy technology is a major transformation with profound economic and technological implications. The impact that the transition has on energy extends not only to the energy sector but to all areas where capital flows and investment behavior occur. Different countries have set more aggressive decarbonization targets, resulting in a wider range of investments in clean and renewable energy technologies regionally and across various financial markets. Furthermore, clean energy assets are characterized as capital-intensive, reliant on long-term debt financing, and more sensitive to economic activity cycles than conventional corporate equities; thus, they are particularly vulnerable to deteriorating financing conditions and heightened financial volatility. Global investment in renewable energy has expanded rapidly in re-

http://dx.doi.org/10.21511/imfi.23(1).2026.31

cent years, driven by policy commitments, decarbonization targets, and rising capital flows into clean energy markets (IEA, 2024; IEA, 2025; OECD, 2024; Gniadkowska-Szymańska et al., 2025; Apergis & Payne, 2010; Gyimah et al., 2022).

Despite increasing research interest, the dynamic role of macroeconomic and financial stress factors in shaping clean energy stock performance remains insufficiently understood. Very few studies have examined how multiple macroeconomic variables jointly affect clean energy stocks across different time horizons. There are unanswered questions about how strong and persistent these relationships are during times of extreme global uncertainty (e.g., during a financial crisis, geopolitical tensions, and health shocks). It is important to understand how these macroeconomic relationships dynamically impact clean energy stock prices in both the short and long run.

1. LITERATURE REVIEW AND HYPOTHESES

The growing economic importance of renewable energy sectors has led to increased academic research on the performance of clean energy company stocks. In contrast to traditional industries, clean energy companies tend to operate under more capital-intensive, technologically uncertain, and policy- and financing-dependent conditions. As a result of these factors, the performance of clean energy stock returns can be significantly affected by macro-financial conditions, leading to interest in how general economic forces impact the stock performance of renewable energy companies (Lyócsa & Todorova, 2024; Pham et al., 2025).

A large body of literature has focused on the effect that energy, and especially crude oil prices, have on the returns earned by clean energy stocks. The early literature on this subject concentrated on the impact of pricing: as the price of fossil fuels rises, so too does the relative return produced by renewable energy investments via substitution and competition (Bondia et al., 2016; Ahmad, 2017). Nonetheless, evidence is heterogeneous from an empirical point of view. Several studies find that there are asymmetric, nonlinear, or weak relationships between oil prices and the returns on clean energy stocks, which suggests that oil price shocks could generate effects on investor sentiment in the short run without creating stable long-run effects (Dawar et al., 2021; Jiang et al., 2021; Niu, 2021; Ahmed et al., 2024; Aliakbari & Glebocki, 2025). More recent research suggests that as renewable energy markets mature, clean energy equities are gradually moving away from the traditional fossil fuel price dynamics (Pham et al., 2025). Related evidence also indicates that policy uncertainty may condition the response of clean energy stock returns to oil price shocks, further contributing to heterogeneous empirical findings in the literature (Zhao, 2020).

Macroeconomic and monetary conditions are another important channel through which the performance of clean energy stocks is affected. Exchange-rate fluctuations affect renewable energy companies by influencing international investment flows, export prices, and investment costs, especially for companies operating in globally integrated markets (e.g., Kocaarslan & Soytas, 2019; Gordo et al., 2024). Similarly, interest rate changes are particularly important in determining the valuation of clean energy stocks (i.e., the impact of discount rates and borrowing costs). Given the long project horizons and reliance of external finance that are typical of renewable energy-related investments, increases in interest rate are often accompanied by decreases in clean energy stock returns, particularly during periods of monetary tightening (Sadorsky, 2012; Ghosh, 2022; Pham et al., 2025; Chen & Lin, 2024).

The stress on the financial system and market uncertainty represents an additional mechanism for the transmission of the macro-financial environment to the clean energy equity markets. Market-wide volatility is commonly interpreted as a proxy for investor risk aversion and has been shown to have a strong negative impact on clean energy stock returns during periods of heightened uncertainty (Bouri et al., 2025; Zhang et al., 2024). During such episodes, investors rebalance portfolios away from high-risk and capital-intensive assets, disproportionately impacting clean energy equities (Ghosh, 2022). However, existing evidence suggests that the effects of volatility shocks tend to operate primarily through short-lived effects, which diminish as markets adjust to new information and evolving risk regimes (Pham et al., 2025). In addition, uncertainty related to climate and environmental policy has been shown to influence clean energy investment decisions and stock market behavior, reinforcing the role of uncertainty channels in renewable energy equity markets (Gavriilidis, 2021). Geopolitical risks and supply-side disruptions have also been found to interact with renewable energy markets through investment and financing channels (Islam et al., 2023).

New research suggests it is important to understand how quickly markets adjust when considering the financing of renewable energy. Price changes for clean energy stocks in the short-run will typically be caused by short-run constraints on liquidity, speculation, and sudden changes in investor sentiment; in contrast, price changes over longer time frames will tend to be based on macroeconomic fundamentals and financial factors (Lyócsa & Todorova, 2024; Wang et al., 2025). The majority of studies to date have either focused solely on individual macroeconomic and finance data or utilized econometric methods incapable of simultaneously modelling both short-run and longer-run dynamics within renewable energy finance, which limits the potential of understanding exactly how persistent the macro-financial relationships could be (Zaier et al., 2024).

Numerous econometric methods are often employed when assessing the performance of the renewable energy equity markets, including vector autoregressions (VAR), the use of volatility spillover models, and mixed frequency methods (Liu & Hamori, 2020; Zhang et al., 2024). Most existing approaches utilize short-run or restricted assumptions of stationarity, but time series analysis capturing the various integration orders (Pesaran et al., 2001; Yuen & Yuen, 2024) as well as a joint model of short-run adjustments and long-term equilibrium relationship offers a greater opportunity for understanding macro-financial transmission mechanisms within the energy equity market.

Based on current studies, the returns of clean energy stocks are influenced primarily by commodity prices, macroeconomic, and financial market conditions affecting clean energy stock returns. However, there is still a lack of comprehensive empirical evidence comparing how combinations of these various factors influence clean energy equity performance on a joint basis. The lack of clarity between the impact of dynamic short-run versus long-run factors on clean energy stock return performance is evident and introduces the need for a comprehensive empirical framework to account for both short-run and long-term influences.

The purpose of this study is to examine the dynamic short-run and long-run impacts of macroeconomic and financial stress factors on clean energy stock returns, proxied by the Clean Edge Green Energy Index.

Based on the above-mentioned theoretical arguments and empirical evidence, the following hypotheses are proposed:

H1: Increases in the volatility index are associated with a statistically significant decrease in clean energy stock returns in the short run.

H2: Exchange-rate appreciation and rising interest rates exert a persistent negative effect on clean energy stock returns in the long-run.

H3: Crude oil price movements do not exhibit a statistically significant long-run relationship with clean energy stock returns.

2. METHODS

This study uses monthly time-series data from January 2008 to June 2025. The proxy variable used to measure the performance of U.S. renewable energy stocks is the Clean Edge Green Energy Index (CELS), provided by NASDAQ. Other explanatory variables used in conjunction with this monthly index for data analysis are Brent crude oil prices, ten-year United States Treasury yield, volatility index (VIX), and BIS broad dollar index. All data used in this study are obtained from publicly available sources. Data on Brent crude oil prices, the ten-year United States Treasury yield, and the volatility index are obtained from the

http://dx.doi.org/10.21511/imfi.23(1).2026.31

Federal Reserve Bank of St. Louis. Data on the BIS broad dollar index are obtained from the Bank for International Settlements.

All financial price series are transformed into logarithmic returns where appropriate to ensure stationarity and comparability across variables, and to prevent the risk of spurious regression, which occurs with non-stationary prices.

To account for extraordinary events that may have had an effect on financial markets during the sample period, three dummy variables are introduced. These variables represent the implementation stage of the Paris Agreement, the first market disruption caused by the COVID-19 pandemic, and the start of the Russia-Ukraine conflict. Each dummy variable takes the value of one during the period of the concerned event and zero for other values. The inclusion of these controls makes it easier to separate the impact of macroeconomic and financial variables from temporary structural disturbances.

Prior to model estimation, standard unit root tests are applied to examine the time-series properties of all variables. The results indicate that the series are either stationary in levels or become stationary after first differencing, while none is integrated of order two or higher. These properties satisfy the necessary conditions for applying the autoregressive distributed lag modelling framework.

To examine both short-run dynamics and long-run relationships between clean energy stock returns and macroeconomic and financial stress factors, an autoregressive distributed lag modeling framework is employed. This approach allows the joint estimation of short-run adjustments and long-run equilibrium relationships within a single specification and is suitable when variables are integrated of mixed orders, provided none exceeds the first order of integration.

The estimated ARDL specification used in this study is as follows:

$$\begin{aligned} R\_CELS\_t = {} & \alpha_0 + \varphi_1 \cdot R\_CELS\_\{t-1\} \\ & + \beta_0 \cdot R\_OIL\_t + \gamma_0 \cdot R\_BIS\_t + \eta_0 \cdot VIX\_t \\ & + \eta_1 \cdot VIX\_\{t-1\} + \lambda_0 \cdot YIELD\_10Y\_t \\ & + \lambda_1 \cdot YIELD\_10Y\_\{t-1\} + \omega_1 \cdot D\_PARIS\_t \\ & + \omega_2 \cdot D\_COVID\_t + \omega_3 \cdot D\_UKR\_t + \varepsilon\_t, \end{aligned} \tag{1}$$

where *R_CELS* denotes clean energy stock returns; *R_OIL* represents crude oil price returns; *R_BIS* captures exchange-rate movements; *VIX* denotes the volatility index as a measure of financial market stress; and *YIELD_10Y* represents long-term interest rate. The dummy variables control for the Paris Agreement, the COVID-19 pandemic, and the Russia–Ukraine conflict, while the error term captures unexplained innovations.

The empirical investigation is carried out by a sequential estimation strategy. First of all, unit root tests are used to determine the order of integration of variables. Subsequently, the best configuration of the lag is determined using the Akaike Information Criterion, thus balancing model adequacy and model parsimony. Finally, the existence of a long-run relationship between the variables is analyzed through the bounds testing methodology. The test statistic exceeding the upper critical value provided statistically significant evidence for cointegration. Upon evidence of cointegration, both the short-run dynamics and the long-run coefficients are estimated in an error correction framework. The correction component measures the pace of correction in the process of correcting the disequilibria arising from long-run equilibrium after temporary disturbances. A statistically significant negative coefficient related to this component indicates a solid and stable adjustment mechanism.

Table 1. Unit root test

Variable	Level Stationary (ADF)?	Level Stationary (KPSS)?	First Difference Stationary (ADF)	First Difference Stationary (KPSS)
CELS	No	No	Yes	Yes
BIS	No	No	Yes	Yes
OIL	Yes	Yes	N/A	N/A
VIX	Yes	Yes	N/A	N/A
YIELD_10Y	No	No	Yes	Yes

To ensure the robustness of statistical inference, heteroskedasticity and autocorrelation consistent standard errors are used. Model adequacy is assessed using conventional diagnostic procedures, including tests for serial correlation, functional form misspecification, parameter stability, and residual behavior. The results of these diagnostics validate the temporal stability of the estimated relationships and that the model is appropriately specified.

3. RESULTS AND DISCUSSION

This section presents and discusses the empirical results obtained from the ARDL estimation, highlighting both the short-run dynamics and long-run relationships, along with diagnostic tests to ensure model robustness.

Table 2. Baseline ARDL estimation results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
R_CELS(–1)	0.2597	0.0447	5.814	0.000
R_OIL	0.0263	0.0335	0.785	0.434
R_BIS	–1.1502	0.3569	–3.222	0.002
VIX	–0.8956	0.1014	–8.828	0.000
VIX(–1)	0.8071	0.0904	8.929	0.000
YIELD_10Y	–1.2657	0.4944	–2.560	0.011
DUM_COVID	2.2352	2.4755	0.903	0.368
DUM_UKR	1.0736	1.5063	0.713	0.477
DUM_PARIS	0.2822	0.8876	0.318	0.751
C	5.1770	1.6077	3.220	0.002

Model statistics

- $R^2 = 0.5171$, Adj. $R^2 = 0.4952$;
- S.E. of regression = 5.9082;
- Durbin–Watson = 2.0899;
- F-statistic = 23.5619 ($p = 0.0000$).

Table 2 presents an overview of the findings from the baseline ARDL (1, 0, 0, 1, 0) model that explored how different factors may impact the performance of clean energy stocks, proxied by CELS. This ARDL included key macroeconomic indicators, measures of financial stress, and dummy variables to capture the introduction of the Paris Agreement, the period of COVID-19, and the Russia-Ukraine armed conflict. The coefficient of the lagged dependent variable, R_CELS(-1), is positive (0.2597) and statistically significant ($p < 0.01$). The Brent crude oil price (R_OIL) demonstrates a positive, however insignificant, coefficient with respect to its effect on the performance of the clean energy stock index. The U.S. Dollar Index (R_BIS) has a statistically significant negative coefficient. The same-period value of the volatility index is significantly and negatively related to clean energy returns, while its one-period lagged value is positive and statistically significant. The 10-year U.S. Treasury yield also exhibits a negative and statistically significant coefficient. None of the event dummies investigated (including those for the Paris Agreement, the global pandemic of COVID-19, and the Russia-Ukraine War) produced statistically significant impacts upon renewable energy stock return performance. The diagnostic statistics support the reliability of the model. The R-squared and adjusted R-squared indicate that roughly half of the variation in CELS returns is explained by the included variables, the F-statistic confirms overall significance, and the Durbin-Watson statistic points to the absence of serial correlation.

Table 3. F-bounds test

Test Statistic	Value	Significance	I(0) Bound	I(1) Bound
F-Statistic	31.00933	10%	2.20	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

Table 3 reports the results of the ARDL bounds testing procedure. The calculated F-statistic exceeds the upper critical bound at the one percent significance level, providing strong evidence of a long-run cointegrating relationship among clean energy stock returns and the selected macroeconomic and financial variables.

Table 4. ARDL short-run form

Variable	Coefficient	Std. Error	t-Statistics	Prob.
C	5.177011	1.846347	2.803921	0.0056
R_CELS(-1)	–0.740305	0.056690	–13.05891	0.0000
R_OIL	0.026284	0.046045	0.570844	0.5688
R_BIS	–1.150165	0.367951	–3.125865	0.0020
VIX(-1)	–0.088448	0.057957	–1.526103	0.1286
YIELD_10Y	–1.265745	0.446761	–2.833159	0.0051
D(VIX)	–0.895573	0.099515	–8.999370	0.0000
DUM_COVID	2.235218	3.892171	0.574286	0.5664
DUM_UKR	1.073562	2.825933	0.379897	0.7044
DUM_PARIS	0.282214	0.871078	0.323982	0.7463

http://dx.doi.org/10.21511/imfi.23(1).2026.31

Table 4 presents the short-run dynamics derived from the error-correction representation of the ARDL model. The error-correction term is negative and statistically significant, confirming the existence of a stable adjustment process toward long-run equilibrium. Approximately seventy-four percent of short-run deviations are corrected within one month.

In the short run, changes in the volatility index exert a strong and statistically significant negative effect on clean energy stock returns. Exchange-rate movements and changes in long-term interest rates are also statistically significant and negatively associated with returns. Crude oil price changes and the event dummy variables do not display statistically significant short-run effects.

Table 5. ARDL long-run form

Variable	Coefficient	Std. Error	t-Statistics	Prob.
R_OIL	0.035505	0.044575	0.796514	0.4267
R_BIS	–1.553636	0.507811	–3.059477	0.0025
VIX	–0.119476	0.074442	–1.604956	0.1101
YIELD_10Y	–1.709761	0.701578	–2.437021	0.0157
C	6.993078	2.185261	3.200112	0.0016

Error correction term (ECM)

$$EC = R\_CELS - (0.0355 \cdot R\_OIL - 1.5536 \cdot R\_BIS - 0.1195 \cdot VIX - 1.7098 \cdot YIELD\_10Y + 6.9931). \quad (2)$$

The long-run coefficients estimated by the ARDL specification are reported in Table 5. Exchange-rate appreciation and increases in long-term interest rates exhibit statistically significant negative effects on clean energy stock returns in the long-run. The coefficient on the volatility index is negative but not statistically significant at conventional levels, while crude oil prices also do not display a statistically significant long-run effect.

Table 6. Breusch-Godfrey LM test

Test Statistic	Value	Probability
F-statistic	1.8153	0.1655
Obs*R-squared	3.7828	0.1509

Table 6 reports the results of the Breusch - Godfrey LM test for serial correlation. The null hypothesis of no autocorrelation cannot be rejected at the conventional significance level, which suggests that the residuals are free from serial correlation and thus appropriate for the chosen ARDL dynamic specification.

Table 7. Ramsey RESET test

Statistic	Name	Value	p-value
t-statistic	Reset t-test	0.4600	0.6460
F-statistic	Reset F-test	0.2116	0.6460
Likelihood Ratio	Reset LR-test	0.2233	0.6365

The results of the Ramsey RESET test are given in Table 7. The test does not reject the null hypothesis of correct functional specification, meaning that there is no evidence of model misspecification.

The results of the CUSUM test are shown in Figure 1. The test statistics are not outside the 5 percent critical boundaries over the sample period, which denotes constant parameters of the estimated ARDL model.

The histogram of the residuals is shown in Figure 2. Although the Jarque-Bera test shows some deviation from normality, some deviations from normality are not unusual with financial return series, and those deviations do not significantly affect the validity of the ARDL estimates.

Table 8. Robustness check

Criterion	Criterion Selected Model	Interpretation
AIC	ARDL(1,0,0,1,0)	Baseline model
SIC / BIC	ARDL(1,0,0,1,0)	Confirms parsimonious structure
HQ	ARDL(1,0,0,1,0)	Confirms balanced lag selection

Table 8 presents the results of the robustness checks, based on alternative lag-selection criteria. All criteria point to the same ARDL (1,0,0,1,0) specification, with no qualitatively different results for the estimated coefficients, suggesting that the major results are robust to lag-length selection.

With respect to the proposed hypotheses, the empirical results provide clear evidence regarding their validity. The short-run estimates indicate that increases in financial market volatility exert a statistically significant negative effect on clean energy stock returns, thus supporting Hypothesis H1. The long-run coefficients reveal that exchange-rate appreciation and rising interest rates have persistent and statistically significant adverse effects

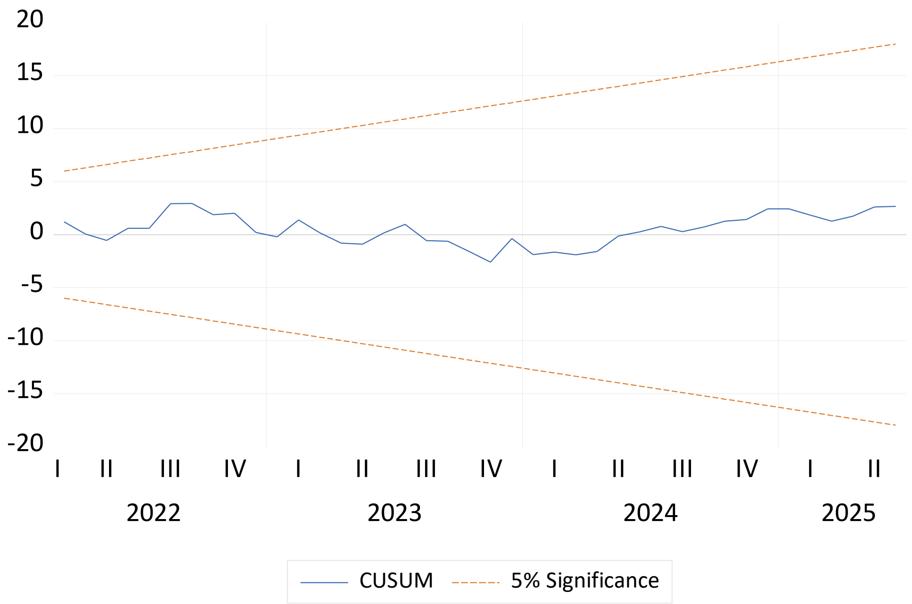

Figure 1. CUSUM test

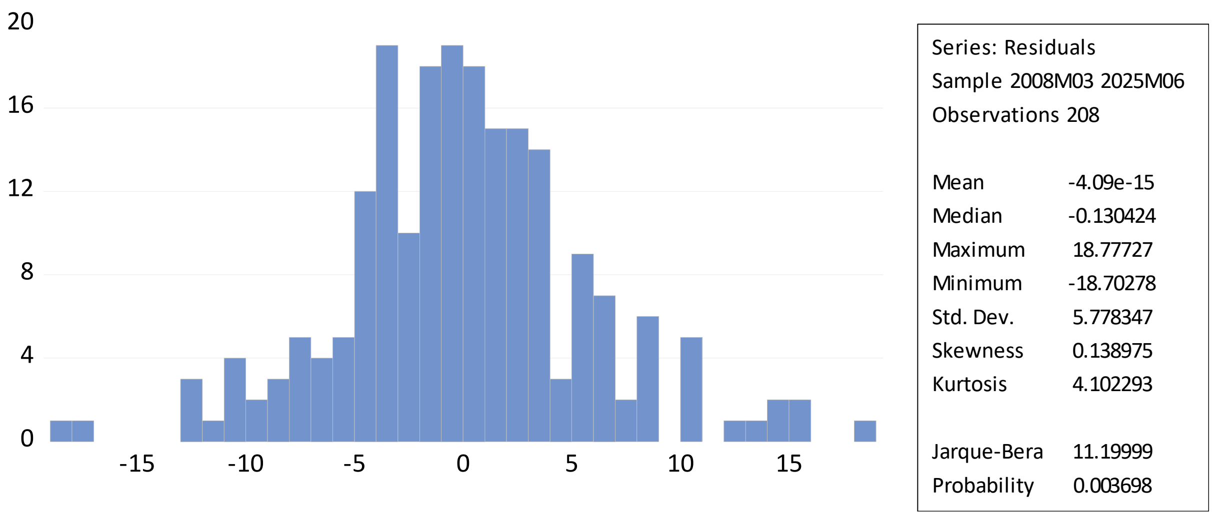

Figure 2. Normality of residuals

on clean energy stock returns, lending support to Hypothesis H2. In contrast, crude oil price movements do not exhibit a statistically significant long-run relationship with clean energy stock returns, indicating that Hypothesis H3 is not supported.

These empirical findings provide a basis for further interpretation of the underlying economic and financial mechanisms influencing clean energy stock performance. The empirical results reported in this paper provide clear evidence on how the macroeconomic and financial stress variables influence the performance of clean energy equities over different time horizons. A very important observation is the strong short-run responsiveness of clean energy returns to differences in financial market volatility, as evidenced by the short-run ARDL estimates. The negative short-run effect related to the volatility index, reported in Table 4, indicates that clean energy equities constitute a highly vulnerable sector during episodes of increased uncertainty, as investors tend to reduce investments in assets that are perceived as risky or speculative. This pattern is consistent with the prevailing characterization of renewable energy securities as being growth-oriented, capital-intensive securities that are generally among the first to suffer in periods of market stress.

http://dx.doi.org/10.21511/imfi.23(1).2026.31

The short-run effects of exchange-rate appreciation and rising long-term interest rates further highlight the impact of financial conditions on clean energy equity returns. Exchange-rate appreciation could reduce international capital flows into the economy and lower global risk-taking, while high interest rates increase financing costs and raise the discount rates that are placed on prospective cash flows. Renewable energy businesses are heavily dependent on external funding over long horizons, making their business operations extremely vulnerable to changes in the economy and financial markets, much more so than traditional industries.

The clean energy market's future development appears to depend more on fundamental macroeconomic conditions than on periodic and transient financial shocks. In other words, the long-run ARDL estimates indicate that an appreciating currency and rising interest rate will negatively impact the growth of renewable energy stock prices over time. Thus, the need for stable financing conditions to support investments in renewable energy markets is very important. These results are similar to earlier work that highlights the sensitivity of renewable-energy equities to monetary conditions and liquidity constraints (Sadorsky, 2012; Ghosh, 2022; Gordo et al., 2024), especially during periods of restrictive financial policy.

The absence of a statistically significant long-run relationship between crude oil prices and clean energy equity returns, as shown in Table 5, is empirical evidence for gradual decoupling in renewable energy markets from fossil fuel price dynamics. Although short-run fluctuations in oil prices may continue to affect how investors feel about energy stocks, they do not seem to have a stable influence on valuations of clean energy over long time frames. This result is consistent with the recent empirical literature suggesting that technological progress, policy, and structural changes in energy markets have made renewable-energy investments less dependent on the price fluctuations of fossil fuels.

Similarly, the lack of a substantial long-run effect of financial market volatility, in the long-run ARDL estimates, suggests that the transmission of uncertainty shocks is primarily through short-run mechanisms. While volatility creates sharp short-run adjustments, the effects of volatility gradually fade away as markets stabilize and market participants review fundamentals. The difference between short-run reactions and long-run equilibria reinforces the need to use empirical frameworks that allow explicit capture of dynamic behaviour across temporal horizons.

In addition to these findings, another important finding from the analysis is that the Paris Agreement, the COVID-19 pandemic, and the conflict between Russia and Ukraine do not exhibit statistically significant lasting effects on clean energy returns. This indicates that markets view temporary disruptions differently from long-run structural changes. Therefore, long-term asset allocations should not be overly influenced by short-run geopolitical or government policy events, but rather focus more on macroeconomic conditions and other financial factors that provide a longer-lasting impact.

Overall, the findings suggest that clean energy equity performance is determined by an interaction between short-run effects of financial stress and long-run macroeconomic circumstances. While fluctuations in the financial markets cause momentary movements, persistent movements in the exchange rate and interest rate have more permanent consequences. The findings from this study enhance our overall knowledge base on the subject of Renewable Energy Finance by identifying how macro-financial variables impact the performance of clean-energy equity markets through specific transmission channels and establishing the criticality of determining whether an event or occurrence has caused only a temporary effect versus having a permanent impact in relation to investment dynamics within the renewable energy investment markets.

CONCLUSION

This study examines the dynamic short-run and long-run impact of macroeconomic and financial stress factors on clean energy stock returns, proxied by the Clean Edge Green Energy Index. The empirical framework allows for a clear distinction between short-run adjustments and long-run equilibrium effects, allowing us to evaluate the relative contributions of financial stress and macroeconomic fundamentals.

The findings demonstrate that there is a considerable degree of short-run sensitivity of clean energy stocks to financial market volatility, consistent with heightened risk aversion and portfolio rebalancing during times of financial uncertainty. In contrast, appreciation in exchange rates and increases in interest rates have lasting negative effects, as they tend to increase the costs and risks associated with financing, which are critical to the long-run viability of capital-intensive renewable energy companies. On the other hand, crude oil price movements do not demonstrate any statistically significant relationship with clean energy stock returns in the long-run, suggesting a gradual decoupling from traditional fossil fuel market dynamics.

Overall, the evidence indicates that temporary financial stress can help explain short-run volatility in clean energy stocks and that macroeconomic and financial fundamentals are the primary determinants of longer-run valuation. The results, therefore, highlight the need for investors and asset managers to consider both interest rate risk and exchange-rate risk when making renewable energy equity investments, especially over a long investment horizon. Finally, the results underscore the significance of stable macro-financial conditions for continuing the growth of investment into clean energy markets and contribute to the empirical literature on the financial dynamics of the energy transition.

Future research may extend this framework by incorporating cross-country clean energy indices, higher-frequency data, or alternative measures of financial stress to further explore the transmission mechanisms between macro-financial conditions and renewable energy equity markets.

AUTHOR CONTRIBUTIONS

Conceptualization: Akshay Sahu, Anup Kumar, Avneesh Kumar.
Data curation: Akshay Sahu.
Formal analysis: Akshay Sahu, Anup Kumar.
Methodology: Akshay Sahu.
Project administration: Avneesh Kumar.
Resources: Avneesh Kumar.
Software: Anup Kumar
Supervision: Avneesh Kumar.
Validation: Anup Kumar, Avneesh Kumar.
Visualization: Akshay Sahu.
Writing – original draft: Akshay Sahu.
Writing – review & editing: Anup Kumar, Avneesh Kumar.

REFERENCES

1. Ahmad, W. (2017). On the dynamic dependence and investment performance of crude oil and clean energy stocks. *Research in International Business and Finance, 42,* 376-389. https://doi.org/10.1016/j.ribaf.2017.07.140
2. Ahmed, R., Chen, X. H., Kumpamool, C., & Nguyen, D. T. K. (2024). Inflation, oil prices, and economic activity in recent crises: Evidence from the UK. *Energy Economics, 126,* 106918. https://doi.org/10.1016/j.eneco.2023.106918
3. Aliakbari, T., & Glebocki, H. (2025). Financial development, disaggregated oil shocks, and renewable energy consumption. *International Economics, 183,* 100623. https://doi.org/10.1016/j.inteco.2025.100623
4. Apergis, N., & Payne, J. E. (2010). Renewable energy consumption and economic growth: Evidence from a panel of OECD countries. *Energy Policy, 38*(1), 656-660. https://doi.org/10.1016/j.enpol.2009.09.002
5. Bondia, R., Ghosh, S., & Kanjilal, K. (2016). International crude oil prices and the stock prices of clean energy and technology companies: Evidence from non-linear cointegration tests with unknown structural breaks. *Energy, 101,* 558-565. https://doi.org/10.1016/j.energy.2016.02.031
6. Bouri, E., Dudda, T. L., Rognone, L., & Walther, T. (2025). Climate risk and the nexus of clean energy and technology stocks. *Annals of Operations Research, 347*(1), 445-469. https://doi.org/10.1007/s10479-023-05487-z

http://dx.doi.org/10.21511/imfi.23(1).2026.31

7. Chen, S.-S., & Lin, T.-Y. (2024). Monetary policy and renewable energy production. *Energy Economics, 132,* 107495. https://doi.org/10.1016/j.eneco.2024.107495

8. Dawar, I., Dutta, A., Bouri, E., & Saeed, T. (2021). Crude oil prices and clean energy stock indices: Lagged and asymmetric effects with quantile regression. *Renewable Energy, 163,* 288-299. https://doi.org/10.1016/j.renene.2020.08.162

9. Gavriilidis, K. (2021). Measuring Climate Policy Uncertainty. *SSRN*. Retrieved from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3847388.

10. Ghosh, S. (2022). COVID-19, clean energy stock market, interest rate, oil prices, volatility index, geopolitical risk nexus: evidence from quantile regression. *Journal of Economics and Development, 24*(4), 329-344. https://doi.org/10.1108/JED-04-2022-0073

11. Gniadkowska-Szymańska, A., Keller, J., & Kowalska, M. (2025). Renewable Energy, Macroeconomic Stability and the Sustainable Development of the Logistics Sector: Evidence from the Visegrad Countries. *Energies, 18,* 5557. https://doi.org/10.3390/en18215557

12. Gordo, N., Hunt, A., & Morley, B. (2024). Alternative monetary policies and renewable energy stock returns. *Energy Economics, 136*. https://doi.org/10.1016/j.eneco.2024.107740

13. Gyimah, J., Yao, X., Tachega, M. A., Hayford, I. S., & Opoku-Mensah, E. (2022). Renewable energy consumption and economic growth: New evidence from Ghana. *Energy, 248,* 123559. https://doi.org/10.1016/j.energy.2022.123559

14. IEA. (2024). *World Energy Outlook 2024*. Paris: IEA. Retrieved from https://www.iea.org/reports/world-energy-outlook-2024

15. IEA. (2025). *Global Energy Review 2025*. Paris: IEA. Retrieved from https://www.iea.org/reports/global-energy-review-2025

16. Islam, M. M., Sohag, K., & Mariev, O. (2023). Geopolitical risks and mineral-driven renewable energy generation in China: A decomposed analysis. *Resources Policy, 80*. https://doi.org/10.1016/j.resourpol.2022.103229

17. Jiang, Y., Wang, J., Lie, J., & Mo, B. (2021). Dynamic dependence nexus and causality of the renewable energy stock markets on the fossil energy markets. *Energy, 233*. https://doi.org/10.1016/j.energy.2021.121191

18. Kocaarslan, B., & Soytas, U. (2019). Dynamic correlations between oil prices and the stock prices of clean energy and technology firms: The role of reserve currency (US dollar). *Energy Economics, 84*. https://doi.org/10.1016/j.eneco.2019.104502

19. Liu, T., & Hamori, S. (2020). Spillovers to renewable energy stocks in the US and Europe: Are they different? *Energies, 13*(12). https://doi.org/10.3390/en13123162

20. Lyócsa, Š., & Todorova, N. (2024). Forecasting of clean energy market volatility: The role of oil and the technology sector. *Energy Economics, 132*. https://doi.org/10.1016/j.eneco.2024.107451

21. Niu, H. (2021). Correlations between crude oil and stocks prices of renewable energy and technology companies: A multiscale time-dependent analysis. *Energy, 221*. https://doi.org/10.1016/j.energy.2021.119800

22. OECD. (2024). *OECD Economic Outlook, Volume 2024 Issue 1: An unfolding recovery*. Paris: OECD Publishing. https://doi.org/10.1787/69a0c310-en

23. Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16*(3), 289-326. Retrieved from https://onlinelibrary.wiley.com/doi/10.1002/jae.616

24. Pham, L., Pham, S., Do, H., Bissoondoyal-Bheenick, E., & Brooks, R. (2025). Common volatility in clean energy stocks. *Energy Economics, 148*. https://doi.org/10.1016/j.eneco.2025.108592

25. Sadorsky, P. (2012). Correlations and volatility spillovers between oil prices and the stock prices of clean energy and technology companies. *Energy Economics, 34*(1), 248-255. https://doi.org/10.1016/j.eneco.2011.03.006

26. Wang, M., Ouyang, K., & Jing, P. (2025). Dynamic interplay of energy uncertainty, supply chain disruption, and digital transformation on China's renewable energy stocks. *Energy Economics, 141*. https://doi.org/10.1016/j.eneco.2024.108127

27. Yuen, T. H. A., & Yuen, W. K. T. (2024). Public investment on renewable energy R&D Projects: The role of geopolitical risk, and economic and political uncertainties. *Energy Economics, 138*. https://doi.org/10.1016/j.eneco.2024.107837

28. Zaier, L. H., Mokni, K., & Ajmi, A. N. (2024). Causality relationships between climate policy uncertainty, renewable energy stocks, and oil prices: a mixed-frequency causality analysis. *Future Business Journal, 10*(1). https://doi.org/10.1186/s43093-024-00399-1

29. Zhang, L., Liang, C., Huynh, L. D. T., Wang, L., & Damette, O. (2024). Measuring the impact of climate risk on renewable energy stock volatility: A case study of G20 economies. *Journal of Economic Behavior and Organization, 223,* 168-184. https://doi.org/10.1016/j.jebo.2024.05.005

30. Zhao, X. (2020). Do the stock returns of clean energy corporations respond to oil price shocks and policy uncertainty? *Journal of Economic Structures, 9*(1). https://doi.org/10.1186/s40008-020-00229-x