

RENEWABLE ENERGY TRANSITION AND MANUFACTURING COMPETITIVENESS: SUSTAINABLE INDUSTRIAL TRANSFORMATION AND EMERGING GLOBAL PERSPECTIVES

Dr. Ahmed M. El-Farsi^{1*}, Dr. Mariam A. Al-Misrati², Dr. Khaled S. Al-Werfalli²

^{1*}Department of Business Administration, Faculty of Economics and Political Science, University of Tripoli, Tripoli, Libya. ahmed.elfarsi@uot.edu.ly

²Department of Business Administration, Faculty of Economics and Political Science, University of Tripoli, Tripoli, Libya.

Corresponding Author: Dr. Ahmed M. El-Farsi

ABSTRACT

The transition toward renewable energy has become increasingly important for sustainable industrial development, energy security, and long-term economic competitiveness. This study examined the relationship between renewable energy transition and manufacturing competitiveness across 25 European economies over the period 2004-2024 using 525 country-year observations. Secondary data were obtained from Mendeley/Eurostat sources and the World Bank, with manufacturing value added as a percentage of GDP used as the principal proxy for manufacturing competitiveness. The analysis included descriptive statistics, temporal trend analysis, country-level comparison, Pearson correlation, and multiple linear regression. The findings showed a clear increase in renewable energy share over time, while manufacturing value added followed a more uneven and generally declining pattern. Manufacturing performance showed only a weak bivariate relationship with renewable energy share but stronger associations with investment and energy import dependency. Regression results indicated that investment and real GDP were positively associated with manufacturing value added, whereas renewable energy share, energy import dependency, inflation, and trade openness showed negative adjusted associations. These findings suggest that renewable-energy expansion alone does not determine manufacturing competitiveness and that broader structural and macroeconomic conditions play an important role. Coordinated policies linking renewable energy, industrial investment, energy security, and economic development are therefore essential for supporting sustainable industrial transformation.

Keyword: Renewable energy transition; Manufacturing competitiveness; Manufacturing value added; Sustainable industrial transformation; European economies

Article History:

Article Type: **Research**

Received Date: **31/03/2026** | Revised Date: **22/05/2026** | Accepted Date: **07/08/2026** | Published Date: **29/08/2026**

1. Introduction

Decarbonization, energy security and sustainable economic development have made the transition to renewable energies from fossil fuels the focus of global efforts. This shift is closely related to the manufacturing sector, which is energy-intensive and highly sensitive to energy prices and costs, environmental policies and international competitiveness. The use of renewable energy can help in the achievement of cleaner production and mitigate the risk of fossil fuel volatility, however, it requires large investment and technological adjustment (Usman et al., 2024). The evidence from emerging economies also reveals that the development of green energy can help in the transformation of industries and enhance the performance of these industries (Rasheed et al., 2026). An economy's ability to bring together energy transition, productive capacity, innovation, and policy support is becoming a crucial element of competitiveness in industry (Ahuja & Hausmann, 2025). Investments in green energy can enhance environmental competitiveness and contribute to sustainable economic development (Mia et al., 2025). Meanwhile, Industry 4.0 has become even more critical with respect to the technological modernization and flexible production in manufacturing competitiveness (Hughes et al., 2022). Renewable energy is consequently increasingly a part of a broader economic and industrial transition at the global level (Gielen et al., 2019). Such shifts are also deepening the competition in the markets of renewable energies and shaping the industrial policies of different countries (Jamil & Arif, 2023).

As renewable energy research has increased, much of the literature has focused on energy transformation, emissions reductions, technology or general sustainability results and not the competitiveness of manufacturing. While renewable energy is acknowledged as a key factor in global energy transition, its direct linkages with manufacturing performance are not well established (Hassan et al., 2024). Areas of focus within sector-specific studies include electric-vehicle battery value chains, which focus on supply chains, technology, life cycles and policy, instead of economy-wide manufacturing effects (Yang et al., 2022). Green hydrogen research has also largely focused on political economy and deployment conditions (Sadik-Zada, 2021). Research on biomass and biofuels has focused on technical potential and transition issues, rather than competitiveness of the industry. Similarly, strategies for renewable energy technologies are often given attention instead of integrated manufacturing indicators (Su'ait et al., 2025). So, there is still limited evidence at the multi-country level from the recent past that combines renewable-energy share, manufacturing value added, investment, energy dependency, inflation and trade openness.

It is important to understand the renewable energy–manufacturing relationship as the competitiveness of manufacturing in relation to renewable-electricity costs could affect investment and production configurations and long-term competitiveness (Bogdanov et al., 2021). Renewable-energy policies can also drive firm sustainability and investment incentives in the green transition (Zhang & Kong, 2022). While technological progress has been and will continue to be the platform for developing new sustainable energy systems, their impacts on industry are influenced by broader economic and structural

factors (Soni et al., 2024). In recent years, global events have made it even more important to transition to low-carbon, resilient systems that can help ensure energy security and economic recovery (Tian et al., 2022). Therefore, the present study analyzes 25 European economies during the period 2004-2024 in order to evaluate the situation of renewable-energy transition, manufacturing value added and related economic conditions.

Study Objectives

To examine temporal and cross-country patterns in renewable energy transition and manufacturing value added across European economies from 2004 to 2024.

To assess the relationship between renewable energy share and manufacturing competitiveness, using manufacturing value added as the principal proxy.

To determine the associations of energy import dependency, investment, economic conditions, and trade openness with manufacturing competitiveness in the context of sustainable industrial transformation.

2. Methodology

2.1 Study Design

The present study adopted a quantitative secondary data design for understanding the association between the transition to renewable energy and competitiveness of manufacturing industries in European economies. The approach undertaken was a longitudinal, country-level one with annual observations from 25 countries (2004–2024), giving rise to 525 country-year observations. This design enabled the study to evaluate the changes in the use of renewable energies, energy dependency, manufacturing performance, investments and macroeconomic conditions across the countries and over time.

2.2 Data Sources

Data sources for the study were two publicly available secondary data sources. Energy and macroeconomic indicators have been extracted from the dataset on Energy Security and Economic Growth in the European Union: The Moderating Role of Industrial Structure from the Mendeley Data platform (Török, 2026), based on Eurostat data. The World Bank indicator Manufacturing, value added (% of GDP) (World Bank, 2026) was used to obtain manufacturing performance. The two data sources were combined using a common identifier of country and year, and the combined data source was used as the final analytical data source.

2.3 Study Variables

Manufacturing value added (% of GDP) was taken as the key indicator of manufacturing competitiveness as the dependent variable. The main independent variable was renewable energy share

(%), representing the renewable energy transition. Other explanatory variables were energy import dependency (%), gross fixed capital formation (% of GDP), GDP at current prices, real GDP index, inflation (%), exports (% of GDP), imports (% of GDP), and trade openness (% of GDP). Trade openness has been determined by adding the export and import shares of GDP.

2.4 Data Preparation and Cleaning

The datasets were checked and cleaned before analysis. A common study period (2004 through 2024) was used, country names and codes were harmonized, and both data sources were consolidated by country and year. Missing values for all variables retained were also explored, and no duplicate country-year observations were found. Original values are missing for the trade openness variable, so it was computed from exports and imports. After cleaning, 25 countries and 525 full country-years of data remained.

2.5 Statistical Analysis

Descriptive statistics such as mean, standard deviation, minimum and maximum were computed for the primary study variables. The annual change in renewable energy share and renewable energy manufacturing value added were analyzed using temporal trend analysis, and country-level averages were used for comparative analysis. Pearson correlation analysis was used to analyze the correlation between renewable energy, manufacturing, energy dependency, investment, real GDP, inflation, and trade openness. Manufacturing value added was then used as the dependent variable, and multiple linear regression was carried out. A p-value of < 0.05 was considered significant.

2.6 Ethical Considerations

No confidential information, individual identifiers or human subjects were involved in the study, and only publicly available data at the country level were used. Thus, informed consent and formal ethical approval were not needed. Data sources were properly credited, and none of the data was manipulated to affect the results of the analysis.

3. Results

3.1 Overall Profile of Renewable Energy and Manufacturing Indicators

A total of 525 country-year observations for 25 European countries were analysed for the period 2004-2024. The overall share of renewable energy was 20.00% on average, but significant differences were found between countries and years. Manufacturing value added was on average 14.46% of GDP, thus reflecting significant variations in the relative weight of manufacturing in national economies. There was also considerable variation in energy import dependency, reflecting differences in the availability of energy domestically and dependence on outside sources. Average inflation was relatively low, and

investment averaged 22.07% of GDP. The macroeconomic indicators showed the highest spread of values, with trade openness. The general description of the characteristics is given in Table 1.

Table 1. Descriptive Statistics of the Main Study Variables

Variable	Mean	SD	Minimum	Maximum
Renewable energy share (%)	20.00	12.42	0.10	66.39
Manufacturing value added (% GDP)	14.46	5.31	3.88	37.10
Energy import dependency (%)	56.97	25.88	-50.62	104.14
GDP at current prices (million EUR)	485,038.85	771,680.95	4,915.60	4,328,970.00
Real GDP index (2010 = 100)	111.31	21.86	73.17	237.89
Investment (% GDP)	22.07	4.27	11.00	53.20
Inflation (%)	2.74	2.98	-1.70	19.40
Trade openness (% GDP)	123.08	62.89	45.20	412.20

3.2 Temporal Pattern of Renewable Energy Transition

There was a strong long-term positive trend throughout the study period for the renewable energy series. The proportion of renewable energy averaged around 12.8% in 2004 and rose to almost 28.8% in 2024. The rise was a gradual process in the first few years, but took a turn for the worse in the late 2010s. The trend suggests a continued shift towards renewable energy consumption by the European economies included. The average renewable energy share over the years is shown in Figure 1.

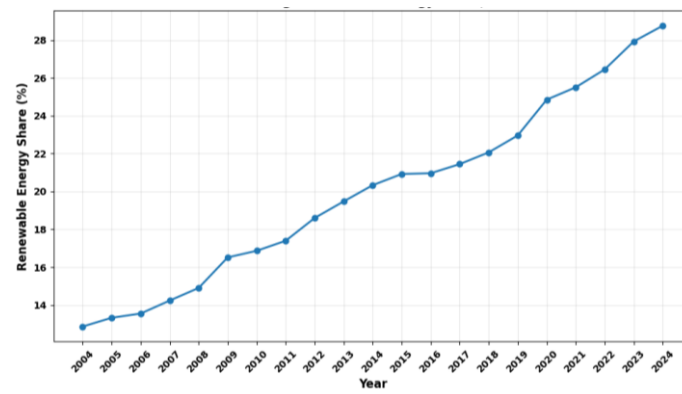


Figure 1. Trend in Average Renewable Energy Share, 2004–2024

The renewable-energy share grew faster after about 2018, when the growth was relatively strong after a relatively modest growth during the first decade. The highest growth was observed in the last few years of the study, with the average surpassing 24% since 2020 and keeping growing in 2024. In contrast to the manufacturing indicator, the series for renewables showed relatively few downward trends, reflecting the relatively stable path of the energy transition over time.

3.3 Temporal Pattern of Manufacturing Value Added

The performance of manufacturing value added was less stable during the 2004–2024 period. The contribution of manufacturing to GDP was around 15.9% on average at the outset of the study and decreased on average over the period, though with some temporary rebounds. There was a significant decline around 2008–2009, after which there was some recovery in the following years. A second rise took place around 2015, followed by a slow decline in the indicator. The entire yearly fluctuation can be seen in Figure 2.

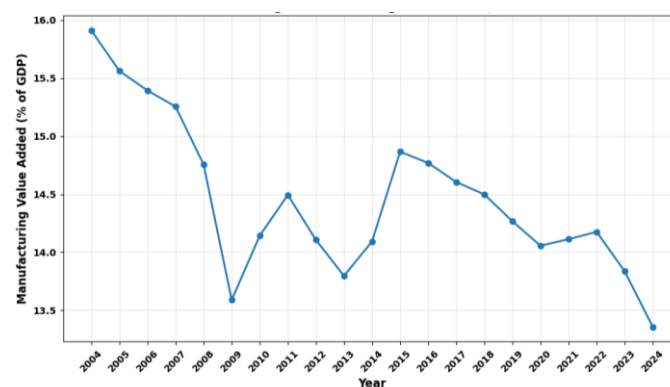


Figure 2. Trend in Average Manufacturing Value Added, 2004–2024

The value added in manufacturing slowly declined from around 14.9% in 2015 to around 13.4% in 2024 after the mid-period recovery. There was a short-term improvement, around 2021–2022, which was not maintained until the end of the period. Overall, the series demonstrates that the relative size of

manufacturing's contribution to GDP decreased over time despite the ongoing growth of renewables. This contrastive temporal pattern helps inform the following correlation and regression analyses.

3.4 Cross-Country Differences in Renewable Energy and Manufacturing Performance

Significant variations were noted in the penetration of renewable energy as well as in the contribution of the manufacturing industry to GDP across countries. The highest mean renewable energy share was achieved by Sweden (51.66%), Finland and Latvia. By contrast, Malta's and Luxembourg's shares of renewable energy were much lower. The trend for manufacturing performance was different. The highest values of manufacturing value added in relation to GDP were found in Ireland (25.83%), Czechia and Slovenia. High renewable-energy penetration did not necessarily result in high manufacturing shares, however. This variation suggests that manufacturing competitiveness is linked to more than just energy transition and to general structural and economic conditions. Table 2 provides an overview of country-level averages.

Table 2. Country-Level Mean Renewable Energy and Manufacturing Indicators

Country	Renewable Energy (%)	Manufacturing Value Added (% GDP)	Energy Dependency (%)	Investment (% GDP)	Trade Openness (% GDP)
Austria	32.39	17.19	64.82	23.66	103.95
Croatia	26.50	12.88	51.78	22.33	89.87
Czechia	13.24	21.84	32.33	26.51	135.55
Denmark	28.77	12.66	4.72	21.20	105.33
Finland	37.83	16.66	46.94	23.30	78.52
Germany	14.33	19.48	62.87	20.09	76.10
Ireland	8.65	25.83	81.94	26.36	204.73
Latvia	36.98	11.26	50.22	25.47	121.24
Romania	22.59	19.47	25.36	25.70	76.41
Slovenia	21.90	19.70	49.73	21.98	144.97
Sweden	51.66	14.30	32.33	23.44	89.09

Note: Selected countries are displayed to highlight major cross-country patterns.

3.5 Correlation Between Manufacturing and Energy-Economic Indicators

Pearson correlation analysis was employed to analyze the correlation between renewable energy, manufacturing value added, energy dependency, investment, real GDP, inflation and trade openness. There were positive and negative relationships among the variables, suggesting ties between manufacturing and energy-transition patterns and broader economic conditions. Investment and energy dependency were shown to be the most related to manufacturing, with energy dependency displaying a greater association with manufacturing value added than renewable energy. The complete correlation structure is presented in Figure 3.

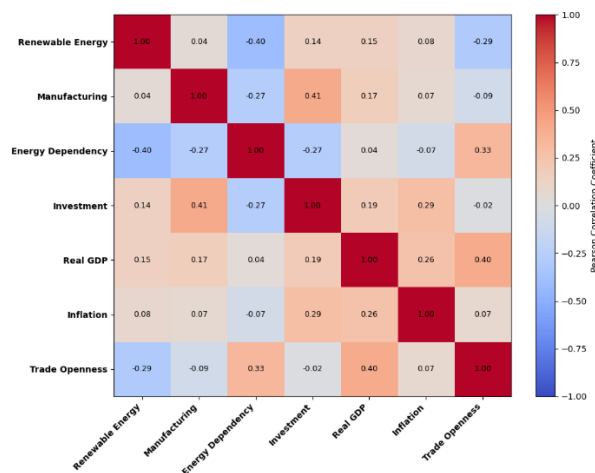


Figure 3. Correlation Matrix of Major Study Variables

Renewable energy had a moderate negative relation to energy dependency as revealed in the matrix, and energy dependency had a negative relation with manufacturing and investment. Positive relationships with real GDP were observed in trade openness, investment and manufacturing value added. With most variables, inflation possessed comparatively weak correlations. The overall trend indicates that the manufacturing performance had been more affected by investment, economic activity and dependence on energy sources than by the share of renewable sources.

3.6 Determinants of Manufacturing Value Added

There were several factors which had a statistically significant relationship with manufacturing value added, as identified by multiple linear regression. The overall model was significant and accounted for 23.55% of the variance in manufacturing performance. Investment had the highest positive correlation, and real GDP had a positive correlation with manufacturing value added. The adjusted coefficient for renewable energy share was significantly negative when the macroeconomic factors in the model were taken into account. The negative coefficients were also obtained for energy import dependency, inflation, and trade openness. The results suggest that the energy situation in combination with investment, economic activity and external economic exposure, and not renewable-energy transition

alone, had an impact on manufacturing performance. Results of the regression estimates are presented in Table 4.

Table 4. Multiple Linear Regression Predicting Manufacturing Value Added

Predictor	B	SE	t	p-value	95% CI
Renewable energy share (%)	-0.0664	0.0190	-3.490	<0.001	-0.1037 to -0.0290
Energy import dependency (%)	-0.0407	0.0092	-4.437	<0.001	-0.0587 to -0.0227
Investment (% GDP)	0.4448	0.0523	8.505	<0.001	0.3420 to 0.5475
Real GDP index	0.0511	0.0111	4.620	<0.001	0.0294 to 0.0729
Inflation (%)	-0.1464	0.0733	-1.997	0.046	-0.2904 to -0.0023
Trade openness (% GDP)	-0.0122	0.0039	-3.090	0.002	-0.0199 to -0.0044

Model statistics: $R^2 = 0.2355$; adjusted $R^2 = 0.2266$; $F = 26.59$; $p < 0.001$; $n = 525$.

4. Discussion

The results show that the manufacturing value added of the economies included in the sample broadly declined between 2004 and 2024, and the renewable energy transition occurred more steadily across the sample. This dichotomy implies that higher shares of renewables in the energy supply will not necessarily boost manufacturing's contribution to GDP. The bivariate correlation between renewable energy share and manufacturing value added further underscores this idea, as the link between renewable energy and manufacturing competitiveness is indirect and depends on overall economic conditions. The regression also revealed that investment and real GDP had a positive relationship with manufacturing value added, while energy import dependency, inflation and trade openness had a negative relationship with manufacturing value added. The results indicate that capital formation, economic activity, energy security and external market conditions are more important than the mere expansion of renewable energy for the competitiveness of manufacturing. The adjusted coefficient of the renewable energy share should thus be viewed as an association in the multivariable model and not as evidence that renewable energy hurts manufacturing performance.

The results of the present study are largely consistent with the previous studies that highlight the need for the development of renewable energy with the right policy, infrastructure and economic conditions. Renewable transition alone is not enough to produce general industrial gains, as highlighted by Elavarasan et al. (2020) that the process of renewable-energy expansion is significantly influenced by regulatory frameworks, infrastructure capacity, financing and regional conditions. In the same vein, Lin et al. (2017) demonstrated that coordinated innovation policy and technological upgrading are crucial

for sustainability-oriented industrial transformation, with investment found to have a positive effect in the current study. The findings are also consistent with those of Allan et al. (2021), which suggested that green industrial policy could help to reframe industrial competitiveness by combining climate goals with productive and technological approaches. Ghobakhloo et al. (2023) also noted that digitalization, resource efficiency, innovation, and organizational adaptation are all essential for a sustainable transition of the industry, again supporting the view that the competitiveness of the manufacturing industry is a multi-faceted phenomenon. Furthermore, the study found that higher capital formation is closely correlated with manufacturing performance, which is similar to the concept of green industrial policy from Altenburg and Rodrik (2017), which proposed that green industrial policy should encourage structural change through investment, innovation and capability development.

The results have important implications for energy and industrial policy. Expansion of renewable energy should be coupled with measures to boost industrial investment, technological capability, infrastructure, and energy security. The investment value added correlation with manufacturing value added is strong, indicating capital formation is a key factor in sustaining competitiveness in industry in the energy transition. Policies to decrease overreliance on imported energy may also increase resilience by reducing exposure to external shocks in the form of energy prices and supply disruptions. Meanwhile, the negative relationship between trade openness and manufacturing value added indicates that while the opening up of trade can have positive or negative effects, depending on the level of manufacturing activity in the country. As such, renewable-energy policy should be integrated with other policy areas such as industrial, trade, investment and innovation.

There are some caveats to keep in mind when interpreting the results. First, manufacturing value added as a percentage of GDP was used as a proxy for manufacturing competitiveness, but it is not a comprehensive indicator of manufacturing competitiveness as it does not measure all aspects, including productivity, export quality, technological intensity or production costs. Second, the study was based on European economies (25), and the results are not directly applicable to other regions of the world. Third, there are likely to be key distinctions between manufacturing subsectors that are not captured when using country-level secondary data. Lastly, the observational design only points to statistical relationships and cannot determine causal relationships between the renewable-energy transition and manufacturing performance.

Future studies should broaden the analysis to cover more countries and add developing and emerging economies with varying industrial and energy characteristics. Other more nuanced competitiveness indicators, such as labour productivity, manufacturing exports, energy costs, innovation intensity, and high-tech production, should also be added. These studies might also be done at the sector level to determine if renewable-energy transition impacts energy-intensive industries and less energy-intensive manufacturing industries differently. Future studies may also adopt a more sophisticated longitudinal

or causal approach and investigate the lagged effect of renewable-energy transition on manufacturing to see if there is any gradual effect.

5. Conclusion

This study investigated the link between renewable energy transition and manufacturing competitiveness for 25 European economies in 2004-2024. The results revealed a distinct positive trend in the share of renewables and an overall downward trend in manufacturing value added, with some fluctuations over the period under study. There were also significant variations in the manufacturing performance in countries with higher and lower shares of renewable energy, suggesting that countries with higher shares of renewables were not necessarily doing better in manufacturing. Results of the correlation analysis indicated that manufacturing value added was correlated more with investment and dependency on energy than with share of renewable energy. The results of the regression confirmed that investment and real GDP were positively significant in relation to manufacturing performance, while the association of energy import dependency, inflation, trade openness, and renewable energy share were negatively significant in the adjusted association. The results indicate that the transition to renewables alone is not enough to improve competitiveness in manufacturing industries and needs to be considered in the more general context of economic, investment, trade and energy-security conditions. The study shows the need for the marriage between renewable-energy policy and industrial development strategies as a whole. Sustainable industrial transformation requires strengthening capital investment, decreasing excessive dependence on energy, technological modernization and decent economic conditions. The findings offer valuable data to inform policy decisions that prioritize decarbonization objectives while ensuring the resilience and competitiveness of manufacturing.

References

1. Ahuja, K., & Hausmann, R. (2025). Industrial policy for competitiveness in the energy transition. *Green Intersections. The Global Embedding of Climate Change in Policy*. Brussels: Bruegel, 53-74.
2. Allan, B., Lewis, J. I., & Oatley, T. (2021). Green industrial policy and the global transformation of climate politics. *Global environmental politics*, 21(4), 1-19.
3. Altenburg, T., & Rodrik, D. (2017). Green industrial policy: Accelerating structural change towards wealthy green economies. *Green Industrial Policy*, 1, 2-20.
4. Bogdanov, D., Ram, M., Aghahosseini, A., Gulagi, A., Oyewo, A. S., Child, M., ... & Breyer, C. (2021). Low-cost renewable electricity as the key driver of the global energy transition towards sustainability. *Energy*, 227, 120467.
5. Elavarasan, R. M., Shafiullah, G. M., Padmanaban, S., Kumar, N. M., Annam, A., Vetrichelvan, A. M., ... & Holm-Nielsen, J. B. (2020). A comprehensive review on renewable energy development, challenges, and policies of leading Indian states with an international perspective. *Ieee Access*, 8, 74432-74457.
6. Ghobakhloo, M., Iranmanesh, M., Morales, M. E., Nilashi, M., & Amran, A. (2023). Actions and approaches for enabling Industry 5.0-driven sustainable industrial transformation: A strategy roadmap. *Corporate social responsibility and environmental management*, 30(3), 1473-1494.
7. Gielen, D., Boshell, F., Saygin, D., Bazilian, M. D., Wagner, N., & Gorini, R. (2019). The role of renewable energy in the global energy transformation. *Energy strategy reviews*, 24, 38-50.

8. Hassan, Q., Viktor, P., Al-Musawi, T. J., Ali, B. M., Algburi, S., Alzoubi, H. M., ... & Jaszczur, M. (2024). The renewable energy role in the global energy Transformations. *Renewable Energy Focus*, 48, 100545.
9. Hughes, L., Dwivedi, Y. K., Rana, N. P., Williams, M. D., & Raghavan, V. (2022). Perspectives on the future of manufacturing within the Industry 4.0 era. *Production Planning & Control*, 33(2-3), 138-158.
10. Jamil, M., & Arif, F. (2023). Competitive dynamics in the renewable energy sector: a global perspective. *Competitive Research Journal Archive*, 1(01), 130-138.
11. Lin, K. C., Shyu, J. Z., & Ding, K. (2017). A cross-strait comparison of innovation policy under industry 4.0 and sustainability development transition. *Sustainability*, 9(5), 786.
12. Mia, M. J., Hossain, M. S., Biswas, R. N., & Akon, M. S. (2025). Environmental Competitiveness, green energy, and global sustainability. In *Green Energy Investments and Economic Development* (pp. 147-169). Singapore: Springer Nature Singapore.
13. Mignogna, D., Szabó, M., Ceci, P., & Avino, P. (2024). Biomass energy and biofuels: perspective, potentials, and challenges in the energy transition. *Sustainability*, 16(16), 7036.
14. Rasheed, M. Q., Yuhuan, Z., Haseeb, A., Ahmed, Z., & Saud, S. (2026). Assessing green energy production and industrial excellence in Asian emerging economies in the context of industrial transformation and sustainable development. *Environment, Development and Sustainability*, 28(2), 3035-3060.
15. Sadik-Zada, E. L. K. H. A. N. (2021). Political economy of green hydrogen rollout: A global perspective. *Sustainability*, 13(23).
16. Soni, N., Singh, P. K., Mallick, S., Pandey, Y., Tiwari, S., Mishra, A., & Tiwari, A. (2024). Advancing sustainable energy: Exploring new frontiers and opportunities in the green transition. *Advanced Sustainable Systems*, 8(10), 2400160.
17. Su'ait, M. S., Ludin, N. A., & Sopian, K. (2025). Introduction to renewable energy technologies and energy transition strategies. In *Renewable Energy Technologies and Strategies in the Global Energy Transition* (pp. 1-14). American Chemical Society.
18. Tian, J., Yu, L., Xue, R., Zhuang, S., & Shan, Y. (2022). Global low-carbon energy transition in the post-COVID-19 era. *Applied energy*, 307, 118205.
19. Török, L. (2026). Energy security and economic growth in the European Union: The moderating role of industrial structure (Version 2) [Data set]. Mendeley Data. <https://doi.org/10.17632/7r7nnsqb9m.2>
20. Usman, F. O., Ani, E. C., Ebirim, W., Montero, D. J. P., Olu-lawal, K. A., & Ninduwezuor-Ehiobu, N. (2024). Integrating renewable energy solutions in the manufacturing industry: challenges and opportunities: a review. *Engineering Science & Technology Journal*, 5(3), 674-703.
21. World Bank. (2026). Manufacturing, value added (% of GDP) (NV.IND.MANF.ZS) [Data set]. World Development Indicators. World Bank dataset
22. Yang, Z., Huang, H., & Lin, F. (2022). Sustainable electric vehicle batteries for a sustainable world: perspectives on battery cathodes, environment, supply chain, manufacturing, life cycle, and policy. *Advanced Energy Materials*, 12(26), 2200383.
23. Zhang, D., & Kong, Q. (2022). Green energy transition and sustainable development of energy firms: An assessment of renewable energy policy. *Energy Economics*, 111, 106060.

This article is licensed under a [Creative Commons Attribution 4.0 International \(CC BY 4.0\)](https://creativecommons.org/licenses/by/4.0/)

License; copyright remains with the author(s).