

Managerial approaches to navigating renewable energy investment globally

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Abstract—In an era marked by dynamic global transformations, our study delves into the emerging trends at the nexus of economic growth, renewable energy consumption and production, sustainable development and innovation, infrastructure environment, market size, and the allure of investing in renewable energy. These trends have become focal points in multidisciplinary discussions, driving the imperative for nuanced understanding among multinational corporations adapting to the modern challenges of sustainable development. Drawing from data spanning 2021 to 2023 and encompassing 29 countries, our research meticulously explores these relationships. Our empirical findings reveal positive correlations between economic growth, renewable energy dynamics, sustainable development indicators, and investment appeal, illuminating their interconnectedness. These results formed the basis for a matrix that identifies optimal investment strategies for companies in the renewable energy sector, considering the relative strengths and weaknesses of both the companies and the host countries. These insights offer invaluable guidance for corporations in crafting effective strategies and policies to navigate the evolving landscape of global energy transition and sustainable development.

Keywords—renewable energy, energy investment, sustainability, innovation, strategy, internationalization

I. INTRODUCTION

Global energy corporations are increasingly compelled by societal and governmental pressures to transition towards sustainability. This shift entails a move away from traditional fossil fuel-based energy sources toward renewable alternatives, such as solar, wind, and hydroelectric power, as well as investments in energy efficiency measures, grid modernization, and the adoption of smart technologies to optimize energy consumption and reduce environmental impact [1]–[10].

This transition necessitates a deep understanding of not only internal resources and capabilities but also the institutional landscape of the countries in which they operate. While existing literature acknowledges the importance of considering the political, economic, social, and technological factors in decision-making processes regarding renewable energy transitions [1], [10]–[13] there remains a research gap in understanding how specific country indicators influence the attractiveness of these transitions for multinational corporations (MNCs).

II. THEORY AND PURPOSE

Our study aims to bridge the identified gap by examining existing literature and selecting a comprehensive set of country indicators that capture the multifaceted aspects influencing the appeal of renewable energy transitions in the corporate sector. By analyzing the dependencies among these indicators in both developed and developing countries, we seek to uncover insights crucial for guiding managerial decision-making for global energy MNCs. By leveraging insights from prior studies and their practical application in corporate strategy, our research aims to deepen understanding of how economic, social, and environmental factors collectively shape the attractiveness of renewable energy transitions across diverse national contexts. Ultimately, our findings are poised to provide actionable insights tailored to MNCs navigating the complex landscape of global energy transition towards sustainability.

Existing literature underscores a variety of factors impacting the relationship between economic growth and renewable energy adoption. Studies by Bibi and Li [1], Sebr and Ben Salha [2], Hieu and Mai [3], Kasperowicz et al. [4], Salehin and Kiss [8] highlight nuanced effects across different countries, underscoring the significance of local conditions in shaping the efficacy of renewable energy utilization. Conversely, Dissanayake et al. [14] reveal a bidirectional relationship between GDP and renewable energy consumption solely within transition economies, challenging the universality of this correlation.

Pan et al. [5] and Vostriakova [6] both contribute to the domain of investigating the interdependence between sustainable development and renewable energy. Pan et al. [5] offers insights into the adoption of sustainable practices in energy generation and consumption. Similarly, Vostriakova [6] sheds light on the implications of renewable energy for economic growth and sustainability.

Jamshidi and Meybodi [10] propose a two-stage methodology for evaluating renewable energy source efficiency in Europe, emphasizing the pivotal role of GDP, energy prices, renewable energy consumption, development of information and communication technologies, and industrial value added in achieving heightened renewable energy efficiency. Similarly, Chen Yang et al. [11] develop an index system to assess the impact of diverse factors on renewable energy development efficiency, facilitating clearer identification of success determinants in this realm.

Hou, Wang and Zhang [15] demonstrate how green finance fosters renewable energy development through an analysis of 53 countries, underscoring the imperative of integrating financial instruments into renewable energy development strategies. Moreover, the well-documented link between foreign direct investment (FDI) and economic growth, elucidated in studies by Batóg and Pluskota [7], Hou, Wang, and Zhang [15], and Hoa et al. [12], underscores the pivotal role of FDI in stimulating development, particularly in developing countries reliant on FDI for financing renewable energy projects.

Emphasizing the positive impact of renewable energy sources on economic growth, studies by Hoa et al. [12] and Mahendru et al. [16] underscore the creation of new employment opportunities and increased workers' incomes. However, this positive impact hinges upon a favorable political and economic environment, suggesting that the nexus between FDI, renewable energy, and economic growth is contingent upon conducive conditions.

In synthesizing existing literature, it becomes evident that no study has comprehensively examined the relationship between holistic indicators of economic growth, renewable energy production and consumption, and the attractiveness of investment in this sector (RECAI). Additionally, there remains a dearth of strategies guiding the internationalization of companies operating in the renewable energy sector to ensure robust returns on investment.

Considering the crucial importance of these tasks for guiding policy interventions, attracting investment, and accelerating the transition to a more sustainable energy, we aim to explore contemporary management approaches to navigating investments in renewable energy development globally. To achieve this goal, we have formulated the following primary hypotheses for examination:

Hypothesis 1: There is a correlation between countries' economic growth indicators and investments in their renewable energy sectors.

This hypothesis is grounded in existing literature that identifies various economic growth metrics as influential factors in fostering renewable energy transitions and enhancing the attractiveness of renewable energy investments (RECAI). This attractiveness is determined by a complex set of criteria, conditions, and factors that drive investor interest in committing capital to renewable energy.

Hypothesis 2: The impact of economic growth indicators on the attractiveness of renewable energy investments differs between developed and developing countries, influencing the strategic behavior of companies in the renewable energy sector.

This hypothesis is based on the premise that developed and developing countries have different economic levels. Living standards, access to education, and healthcare differ significantly between these groups, leading to varying amounts of investment in their economies in general and in the renewable energy segment in particular.

Hypothesis 3: The company's strategic behavior in the global renewable energy sector depends on how well its capabilities align with the host country's attractiveness for renewable energy investments.

By analyzing the relationships between a company's capabilities and the host country's attractiveness for renewable energy investments (RECAI) in both developed and

developing countries, we aim to identify information that can serve as the basis for managerial decision-making by global energy MNCs.

Thus, our study not only complements existing knowledge in the field of the relationship between economic growth and renewable energy but also proposes new perspectives for analysis and investment that can contribute to the effective development of renewable energy sources on a global scale.

III. METHODOLOGY

Given the significance of our research objectives, we carefully selected a methodology that allows for a comprehensive analysis of the factors influencing renewable energy investments. Our research focuses on two main tasks:

1) identifying the relationships between indicators that reflect the development of countries and the implementation of renewable energy programs and projects, and

2) providing recommendations for companies on formulating investment strategies for renewable energy development in different countries.

To address the first task, we analyzed a panel data set of national economies included in the RECAI ranking [17]. Using data from these countries ensures the objectivity of our results concerning investment attractiveness in the renewable energy sector.

The data for the study were formed based on indicators that reflect the general and specific characteristics of countries regarding their attractiveness for implementing renewable energy programs and projects. In this work, we investigate the relationship between indicators of attractiveness for investment in the renewable energy sector, countries' economic growth indicators (Group 1), the growth of renewable energy production, and the growth of renewable energy consumption (Group 2). Thus, the dataset includes annual data on the following variables:

Group 1 – General Indicators:

- Renewable Energy Country Attractiveness Index (RECAI) [17];
- Economic Development (Gross Domestic Product (GDP) per capita) [19];
- Human Development Index (HDI);
- Sustainability and Innovation (SI);
- Infrastructure Environment (IE);
- Private Participation (PP);
- Market Size (MS).

Group 2 – Specific Indicators:

- Renewable Energy Consumption, as a percentage of total final energy consumption (REC);
- Renewable Energy Production, Terawatt-hours (RE).

The selected indicators for the study are based on existing publications regarding the modeling of relationships between the development of economic systems and renewable energy, specifically in the works of [11], [12], [14], [15], [16].

Regarding the country sample, it is noteworthy that not all of the countries included in the RECAI ranking [17] have complete information for all the selected indicators, particularly for the Infrastructure Environment (IE) Sustainability and Innovation (SI), Private Participation (PP) and Market Size (MS). Therefore, after summarizing the availability of general and specific indicators related to the

attractiveness of investment in renewable energy, out of the 40 countries included in the RECAI ranking [17], 29 countries were included in the sample.

Following World Bank recommendations for categorizing countries by economic development level, we divided the sample into two subgroups: developed countries (16 countries) and developing countries (13 countries). Information for the countries was compiled from publicly available data sources [17]–[22]. The study period covers the years 2021–2023.

Given that a substantial portion of the initial data for countries is presented in rank form, Spearman's rank correlation method [23] was deemed appropriate for analyzing the relationship between the studied indicators. This method is particularly well-suited for data that do not meet the assumptions of normal distribution or require ordinal ranking, as it assesses the strength and direction of association between variables based on their ranks rather than their exact values.

To further interpret the results and establish actionable insights, we apply a matrix method that aligns with the formation of investment strategies in the renewable energy sector. Specifically, this method accounts for the alignment of a company's strategy with the positions of both the company and the host country regarding renewable energy investment. This approach draws upon the work outlined by [24], which emphasizes the utility of matrix methods in identifying a multinational company's strategic behavior.

IV. FINDINGS AND IMPLICATIONS

To investigate the hypothesis concerning the influence and interdependence of economic development indicators and the characteristics of renewable energy market development across the entire sample, we computed Spearman's correlation coefficients (Table 1).

The analysis revealed a direct relationship between economic growth and the RECAI, supporting Hypothesis 1. The strongest correlations were between RECAI (X1) and Market Size (X7) at 0.70, and RECAI (X1) and Private Participation (X6), with moderate correlations not exceeding 0.42.

The results also indicate that renewable energy projects are relevant for both developed and developing countries, with positive correlation coefficients between RECAI and national economic development indicators. However, the strength of these correlations varies between developed and developing countries, confirming Hypothesis 2. In developed countries, renewable energy investments are more strongly dependent on economic development, as shown by higher correlation coefficients between RECAI (X1) and GDP per capita (X2), HDI (X3), sustainability and innovation (X4), infrastructure environment (X5), private participation (X6), and market size (X7), compared to developing countries.

In developing countries, there is a notable relationship between the production and consumption of renewable energy and the activity of private companies. The correlation coefficients between private participation (X6) and renewable energy consumption (X8) is 0.63, and between private participation (X6) and renewable energy production (X9) is 0.58, significantly higher than those for developed countries and the overall study population.

TABLE I. SPEARMAN'S CORRELATION BETWEEN ECONOMIC INDICATORS AND RENEWABLE ENERGY MARKET DYNAMICS

Indicator Pairs*	Overall Sample	Developed Countries	Developing Countries	Summary (based on the scale of Dancy & Reidy [25])
<i>General indicators influencing the attractiveness of renewable investment</i>				
X ₂ & X ₁	0,38	0,35	0,28	Weak correlation in all settings
X ₃ & X ₁	0,31	0,17	0,14	
X ₄ & X ₁	0,33	0,27	0,15	
X ₅ & X ₁	0,48	0,56	0,11	Moderate correlation overall and in developed countries; weak in developing countries
X ₆ & X ₁	0,65	0,83	0,45	Strong correlation overall and in developing countries; very strong in developed countries
X ₇ & X ₁	0,70	0,86	0,50	Very strong correlation overall and in developed countries; moderate in developing countries
X ₈ & X ₁	0,40	0,19	0,51	Moderate correlation overall and in developed countries; strong in developing countries
X ₉ & X ₁	0,42	0,21	0,55	
<i>Impact on renewable energy consumption</i>				
X ₂ & X ₈	0,36	0,40	0,42	Moderate correlation in developed and developing countries; weak overall;
X ₃ & X ₈	0,37	0,37	0,34	Weak correlation in all settings
X ₄ & X ₈	0,33	0,45	0,23	Moderate correlation in developed countries; weak overall and in developing countries;
X ₅ & X ₈	0,30	0,09	0,35	Weak correlation overall and in developing countries; very weak in developed countries
X ₆ & X ₈	0,30	-0,06	0,63	Strong in developing countries; weak overall; negligible in developed countries
X ₇ & X ₈	0,17	0,06	0,34	Weak correlation in all settings
<i>Impact on renewable energy production</i>				
X ₂ & X ₉	0,32	0,36	0,46	Moderate correlation in developing countries; weak overall and in developed countries
X ₃ & X ₉	0,33	0,34	0,40	
X ₄ & X ₉	0,26	0,35	0,31	Weak correlation in all settings
X ₅ & X ₉	0,24	0,09	0,38	
X ₆ & X ₉	0,27	-0,03	0,58	Strong in developing countries; weak overall; negligible in developed countries
X ₇ & X ₉	0,20	0,11	0,36	Weak correlation in all settings

Source: Compiled by the authors

NOTES: X1 – RECAI; X2 - GDP per capita; X3 - Human Development Index (HDI); X4 - Sustainability and Innovation; X5 - Infrastructure Environment; X6 - Private participation; X7– Market size; X8 - Renewable Energy Consumption; X9- Renewable Energy Production.

Further, we used these findings to create indicator chains for renewable energy investment decisions. The chains were formulated based on the correlations between economic growth rates and RECAI from strongest to weakest. This ranking guides decision-makers on which factors to prioritize.

For developed countries, the chain of indicators is:

$$MS \rightarrow PP \rightarrow IE \rightarrow GDP \rightarrow SI \rightarrow RE \rightarrow REC \rightarrow HDI \quad (1)$$

For developing countries, the chain of indicators is:

$$RE \rightarrow REC \rightarrow MS \rightarrow PP \rightarrow GDP \rightarrow SI \rightarrow HDI \rightarrow IE \quad (2)$$

The next part of the study is related to testing the Hypothesis 3. To understand and justify companies' behavior in renewable energy investments, we employed a matrix method, elaborating on 'global strategic CSR matrix' for MNCs [24] and constructing a 2x2 matrix with the following dimensions:

Y-axis: A country's 'strong-weak' position in renewable energy attractiveness index, determined by factors revealed in the indicator chains for developed and developing countries.

X-axis: A company's 'strong-weak' position within the renewable energy sector, gauged by its capability to execute such projects, measured by inclusion in indexes like the S&P Global Clean Energy Index [26], NASDAQ Clean Edge Green Energy [27], Solactive Clean Energy Index [28], or similar. Presence in these indexes indicates a strong position.

By formalizing the positions of both the company and the state in terms of 'strong-weak', we can define strategies for renewable energy investment as strategies of constructive interaction, control, and submission. These strategies are informed by relevant indicators identified for monitoring during their implementation (Fig.1).

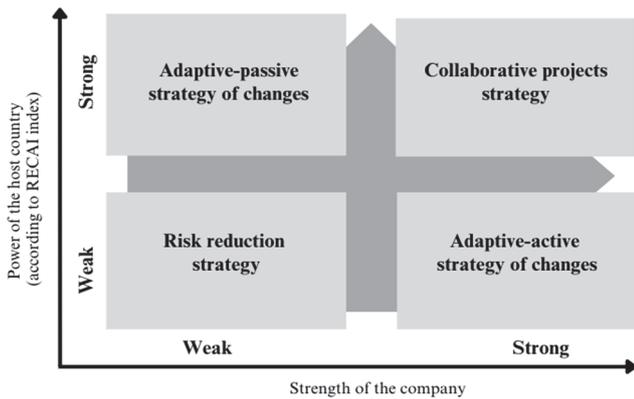


Fig.1. Matrix of the MNC's strategies for investing in renewable energy in the context of business internationalization

1. Collaborative projects strategy:

This quadrant corresponds to a situation where the company has a high attractiveness rating for investment in renewable energy (RECAI), indicating significant experience, technical knowledge, and relative financial stability. In turn, the country selected for internationalization is developed with a high level of economic development and infrastructure environment (GDP, IE). In such conditions, the best strategy is to implement collaborative projects, maximizing the benefits of interaction. For example, Iberdrola (Spain, S&P Global Clean Energy Index) actively collaborates with the USA in wind energy.

2. Adaptive-active strategy of changes:

Recommended for energy companies with significant experience and resources planning to invest in countries with average or low levels of economic development and weak infrastructure. Here, companies must actively adapt and stimulate changes, utilizing their strengths to develop local infrastructure. For example, Enel Green Power (Italy, S&P

Global Clean Energy Index) invests in projects in Kenya, where infrastructure development and the implementation of new technologies are needed.

3. Adaptive-passive strategy of changes:

Corresponds to a situation where the company has a lower attractiveness rating for investment (RECAI), possibly due to lack of experience or resources, while the host country is developed. In such a case, the company should gradually adapt to market conditions, utilizing existing infrastructure and country support. For example, Neoenergia (Brazil) invests in projects in Germany, utilizing local resources and support to enhance its experience and competencies.

4. Risk reduction strategy:

This strategy is recommended for companies with a low attractiveness rating for investment but with intentions to expand into countries with low levels of economic development and weak infrastructure. Under such conditions, the company should limit investments to the least risky projects and carefully analyze the situation. For example, Azure Power (India) invests in projects in Bangladesh, focusing on minimal-risk initiatives and gradually increasing investments.

Drawing from potential strategies that companies can adopt as part of their internationalization endeavors, coupled with the analysis of indicator results for both developed and developing countries, we outline various scenarios for the 'strong-weak' relationship between a company's position and that of the host country. Additionally, we provide recommendations regarding the indicators that necessitate monitoring for timely adjustments to the company's strategic behavior (Table 2).

TABLE II. BASIC TYPES OF STRATEGIC BEHAVIOR FOR BUSINESS INTERNATIONALIZATION IN RENEWABLE ENERGY INVESTMENT

Host Country Position	Description	Company Position	Description	Recommendations
Strong	S=f(Dd; RECAIa)	Strong	S=f(CEIa)	Collaborative projects strategy and Monitoring of performance indicators chain: MS→PP→IE→GDP→SI→RE→REC→HDI
Moderate	S=f(Dd; RECAIa)	Strong	S=f(CEIa)	
Moderate	S=f(Dn; RECAIb)	Strong	S=f(CEIa)	Collaborative projects strategy and Monitoring of performance indicators chain: RE→REC→MS→PP→GDP→SI→HDI→IE
Weak	S=f(Dn; RECAIb)	Strong	S=f(CEIa)	Adaptive-active strategy of changes and Monitoring of the indicators chain: RE→REC→MS→PP→GDP→SI→HDI→IE
Strong	S=f(Dd; RECAIa)	Weak	S=f(CEIb)	Adaptive-passive strategy of changes: MS→PP→IE→GDP→SI→RE→REC→HDI
Moderate	S=f(Dd; RECAIa)	Weak	S=f(CEIb)	
Moderate	S=f(Dn; RECAIb)	Weak	S=f(CEIb)	Risk reduction strategy and Monitoring of the indicators chain: RE→REC→MS→PP→GDP→SI→HDI→IE
Weak	S=f(Dn; RECAIb)	Weak	S=f(CEIb)	

Source: Compiled by the authors based on [24].
 NOTES: S - position; Dd - developed country; Dn - developing country; RECAIa - the country's position in the RECAI is above average; RECAIb - the country's position in the RECAI is below average; CEIa - the company's position in the clean energy indexes is above average; CEIb - the company's position in the clean energy indexes is below average.

The strategies outlined in the matrix—collaborative projects, adaptive-active changes, adaptive-passive changes, and risk reduction—are tailored to the relative strengths and weaknesses of both the company and the host country. These strategies, along with the recommended indicator chains, offer a roadmap for companies to optimize their investment decisions and adapt to varying market conditions. By monitoring key indicators, companies can make timely adjustments to their strategies, enhancing the potential for successful internationalization in the renewable energy sector.

V. CONCLUSIONS AND LIMITATIONS

Our study provides empirical evidence of the interplay between economic development indicators and renewable energy market dynamics, advancing our understanding of factors influencing investment attractiveness in this sector. The findings contribute to the studies of Pan et al. [5] and Vostriakova [6] by examining a wide set of general and specific indicators such as RECAI, GDP per capita, Infrastructure Environment, Sustainability and Innovation, Market Size, and renewable energy production and consumption, proving a connection between economic development and renewable energy investment attractiveness. Specifically, hypothesis 1 was supported, demonstrating a clear correlation between economic growth and renewable energy investments. Hypothesis 2 was partially supported, highlighting differing impacts in developed versus developing countries. Hypothesis 3 was confirmed, indicating that a company's strategic behavior is indeed influenced by the alignment of its capabilities with the host country's investment attractiveness.

For policymakers, our findings offer valuable insights into fostering a more attractive investment climate for renewable energy. By understanding the key economic indicators that correlate with renewable energy investment attractiveness, policymakers in both developed and developing countries can tailor their strategies to improve these metrics. Specific actions could include enhancing infrastructure, increasing support for sustainable innovation, and creating favorable economic conditions to attract foreign direct investment in renewable energy projects.

For multinational corporations, our study provides actionable recommendations based on observed trends. Companies should consider collaborative projects in high-performance countries where both economic development and infrastructure are strong. In low-performance countries, corporations might adopt adaptive-active strategies to stimulate local infrastructure development or risk reduction strategies to minimize exposure. By aligning their strategic behavior with the host country's investment attractiveness, companies can optimize their internationalization efforts in the renewable energy sector. Our research also forms the basis for a strategic matrix that defines optimal investment strategies, considering the strengths and weaknesses of both companies and host countries, building on the matrix approach presented in [24]. This matrix offers guidance for MNCs in navigating the global energy market. The findings highlight the importance of prioritizing renewable energy investment and consumption in policy development to ensure sustainable economic growth and environmental resilience.

While our study presents valuable insights, it has certain limitations. We did not include a sensitivity analysis to test the robustness of our results, which could strengthen the findings

by showing how stable the correlations are under different assumptions or parameters. Additionally, a more detailed regression analysis could provide deeper insights into the relationships between the variables. Future research could explore these areas, along with the impact of emerging technologies and policy changes on these relationships, deepening the understanding of how renewable energy innovations influence economic development and investment attractiveness.

Overall, our study enhances the understanding of the interrelationship between economic growth, renewable energy dynamics, sustainability indicators, and investment attractiveness, providing a foundation for future research in global renewable energy investment management.

REFERENCES

- [1] A. Bibi and X.-M. Li, "The Asymmetric Dilemma of Renewable Energy, Financial Development, and Economic Growth: Fresh Evidence from Pakistan". *Environ. Sci. Pollut. Res.*, vol. 29, pp. 31797–31806, 2022. doi: 10.1007/s11356-021-17914-4.
- [2] M. Seabri and O. Ben Salha, "On the Causal Dynamics between Economic Growth, Renewable Energy Consumption, CO2 Emissions and Trade Openness: Fresh Evidence from BRICS Countries", 2019. Available: <https://mpira.uni-muenchen.de/52535/>.
- [3] V.M. Hieu and N.H. Mai, "Impact of Renewable Energy on Economic Growth? Novel Evidence from Developing Countries through MMQR". *Estimations. Environ. Sci. Pollut. Res.*, vol. 30, pp.578–593, 2023. doi: 10.1007/s11356-022-21956-7.
- [4] R. Kasperowicz, Y. Bilan and D. Štreimikienė, "The Renewable Energy and Economic Growth Nexus in European Countries". *Sustain. Dev.*, vol. 28, pp.1086–1093, 2020. doi: 10.1002/sd.2060.
- [5] X. Pan, T. Shao, X. Y. Zheng, X. Ma Zhang and Q. Zhang, "Energy and Sustainable Development Nexus: A Review". *Energy Strategy Rev.*, vol. 47, p. 101078, 2023.
- [6] V. Vostriakova, "The Impact of Renewable Energy on Economic Growth and Sustainable Development". *Conf. Qual. Prod. Improv. CQPI*, vol. 3 pp.28–40, 2021. doi: <https://doi.org/10.2478/cqpi-2021-0004>.
- [7] J. Batóg and P. Pluskota, "Renewable Energy and Energy Efficiency: European Regional Policy and the Role of Financial Instruments". *Energies*, vol. 16(24), p. 8029, 2023. Available: <https://doi.org/10.3390/en16248029>.
- [8] M. Salehin and J. T. Kiss, "Testing the Causal Relationship between Economic Growth and Renewable Energy Consumption: Evidence from a Panel of EAGLE Countries". *International Journal of Energy Economics and Policy*, vol. 12(1), pp. 281–288, 2022. doi: <https://doi.org/10.32479/ijee.11851>.
- [9] N. Jamshidi and M. E. Meybodi, "Dynamic spillover effects of renewable energy efficiency in the European countries", *Environmental Science and Pollution Research*, 2024. pp. 11698–11715. doi: 10.1007/s11356-023-31815-8.
- [10] S. Owjimehr, M. E. Meybodi and N. Jamshidi, "Can geopolitical risk improve energy efficiency in European countries?", *Energy Strategy Reviews*. vol.49, p. 101145, September 2023, doi: 10.1016/j.esr.2023.101145.
- [11] C. Yang, A. Farhan, O. Lyulyov and S. Huishui, "Renewable energy development efficiency: Spatial dynamic evolution and influencing factors". November 2023, *Natural Resources Forum*. doi: 10.1111/1477-8947.12368.
- [12] P. X. Hoa, V. N. Xuan, N. T. Phuong Thu and L. M. Huong, "Nexus of innovation, foreign direct investment, economic growth and renewable energy: New insights from 60 countries". Available: <https://doi.org/10.1016/j.egy.2024.01.050>.
- [13] N. Mironova, H. Koptieva, I. Liganenko, A. Sakun and D. Chernyak, "Modeling the Selection of Innovative Strategy for Development of Industrial Enterprises". *WSEAS Transactions on Business and Economics*, vol. 19, pp. 278–291, 2022. doi: 10.37394/23207.2022.19.26.
- [14] H. Dissanayake, N. Perera, S. Abeykoon, D. Samson, R. Jayathilaka, M. Jayasinghe and S. Yapa, "Nexus between carbon emissions, energy consumption, and economic growth: Evidence from global economies". *PLoS One*. 2023 Jun 23, vol. 18(6) e0287579. doi:

- 10.1371/journal.pone.0287579.
- [15] H. Hou, Y. Wang and M. Zhang. "Green finance drives renewable energy development: empirical evidence from 53 countries worldwide". *Environmental Science and Pollution Research*, 2023, vol. 30(33), pp.1-18. doi: 10.1007/s11356-023-28111-w.
- [16] M. Mahendru, A. K. Tiwari, G. D. Sharma, S. Nathaniel and M. Gupta. "Energy-growth nexus for 'Renewable Energy Country Attractiveness Index' countries: Evidence from new econometric methods". vol. 15, no. 3, 2024. Available: <https://doi.org/10.1016/j.gsf.2023.101704>.
- [17] Renewable Energy Country. Index (RECAI). Attractiveness Index. Available: https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/power-and-utilities/ey-recal-58th-edition-top-40-ranking-october-2021.pdf.
- [18] Ja. Hudakova, "Relationship Between Gross Domestic Product and Human Development Index". 4th International Multidisciplinary Scientific Conference on Social Sciences and Arts SGEM, vol. 4. pp. 665-672, 2017. doi: 10.5593/sgemsocial2017/14/S04.087.
- [19] Gross Domestic Product (GDP), Available: <https://data.oecd.org/gdp/gross-domestic-product-gdp.htm>.
- [20] Human Development Index. Available: <https://hdr.undp.org/data-center/country-insights#/ranks>.
- [21] The 2023 Infrastructure Index. Available: <https://cms.law/en/int/publication/cms-infrastructure-index-2023/the-2023-infrastructure-index-ranking>.
- [22] Renewable Energy and Jobs Annual Review 2022 IRENA. Available: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2022/Sep/IRENA_Renewable_energy_and_jobs_2022.pdf.
- [23] K.A. Abd Al-Hameed, "Spearman's Correlation Coefficient in Statistical Analysis". *International Journal of Nonlinear Analysis and Applications*, vol. 13(1), pp. 3249-3255, 2022.
- [24] N. Krasnokutskaja and T. Danko, "Corporate Social Responsibility and Countries' Reputation: A Study from a Global Strategic Management Perspective." In *Comparative CSR and sustainability*, pp. 364-379. Routledge, 2022.
- [25] C.P. Dancey and J. Reidy, "Statistics Without Maths for Psychology". Pearson education, 2007.
- [26] S&P Global Clean Energy Index. Available: <https://www.spglobal.com/spdji/en/indices/sustainability/sp-global-clean-energy-index/#data>.
- [27] NASDAQ Clean Edge Green Energy. Available: <https://indexes.nasdaqomx.com/Index/Overview/CELS>.
- [28] Solactive Clean Energy Index. Available: <https://www.solactive.com/Indices/?index=DE000SL0AVM5>.