*Available Online at www.e-iph.co.uk*
*Indexed in Clarivate Analytics WoS, and ScienceOPEN*

E-B Environment - Behaviour Proceedings Journal

*AicQoL2025Pangkor*

https://www.amerabra.org/
**13th AMER International Conference on Quality of Life,**
Puteri Bayu Beach Resort, Pangkor Island, Malaysia.

e-IPH e-International Publishing House Ltd., United Kingdom

# Economic Impact of Supply Chain and Renewable Energy Adoption in ASEAN

**Norashida Othman[1,2*], Khairunnisa Itqan Khairul Anuar[3], Siti Norida Wahab[2,4], Nosica Rizkalla[5]**
**Corresponding Author*

[1] Department of Economics and Financial Studies Faculty of Business and Management, Universiti Teknologi MARA (UiTM), 42300 Puncak Alam, Selangor, Malaysia.
[2] Sustainable Supply Chain Logistics Management Research Initiative Group, Universiti Teknologi MARA, 42300 Puncak Alam, Selangor, Malaysia.
[3] Department of Group Strategy and Business Development, KPJ Healthcare Group, Menara KPJ, Jln Tun Razak, 50400 Kuala Lumpur, Malaysia.
[4] Department of Technology and Supply Chain Management Studies, Faculty of Business and Management, Universiti Teknologi MARA (UiTM), 42300 Puncak Alam, Selangor, Malaysia
[5] Department of Management, Faculty of Business, Universitas Multimedia Nusantara, Kabupaten Tangerang, Banten 15810, Indonesia.

shidaothman@uitm.edu.my; khairunnisaitqan.khairulanuar@gmail.com; sitinorida23@uitm.edu.my; nosica.rizkalla@umn.ac.id
Tel: +60102451335

**Abstract**
This study examines the impact of renewable energy consumption on economic growth in ASEAN-6 countries (Malaysia, Indonesia, Vietnam, Singapore, Thailand, and Japan) from 2000 to 2020 using a pooled mean group (PMG) approach for panel data analysis. The findings reveal a positive correlation between renewable energy usage and economic development, emphasizing reduced reliance on fossil fuels. Key factors analyzed include renewable energy consumption, logistic performance, and electricity production from renewables. The results demonstrate these variables significantly foster economic growth, advocating investments in renewables as a strategic priority for sustainable development.

Keywords: Renewable Energy Consumption; Economic Growth; Logistic Performance; ASEAN


DOI: https://doi.org/10.21834/e-bpj.v10i31.6402

## 1.0 Introduction

The global shift toward renewable energy is accelerating as nations strive to achieve climate goals and sustainable development. This transition highlights the critical need to understand the complex dynamics of renewable energy consumption (REC), electricity production from renewable resources (EPR), and economic growth. These interdependencies are particularly significant in ASEAN countries, where diverse energy policies, infrastructure capacities, and economic structures create unique opportunities and challenges (IEA, 2020; REN21, 2021). Renewable energy consumption plays a pivotal role in mitigating environmental challenges while simultaneously serving as a driver of economic development. However, the degree to which it contributes to economic growth depends on key factors such as logistic performance (LP), which enables the efficient generation, distribution, and utilization of renewable resources. An efficient renewable energy supply chain is essential for reducing reliance on non-renewable sources and fostering long-term economic sustainability (Jelti et al., 2021).

*eISSN: 2398-4287 © 2025. The Authors. Published for AMER by e-International Publishing House, Ltd., UK. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/). Peer–review under responsibility of AMER (Association of Malaysian Environment-Behaviour Researchers).*
DOI: https://doi.org/10.21834/e-bpj.v10i31.6402

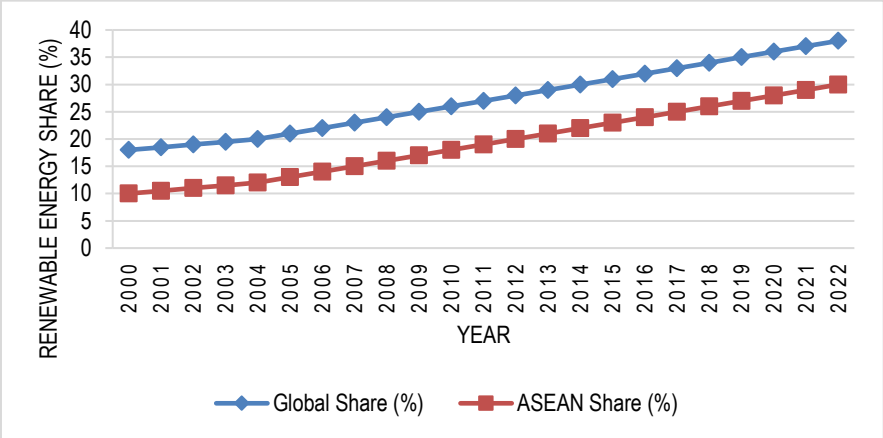


Fig 1. Renewable Energy's Share in Global and ASEAN Electricity Production from 2000 to 2022
Sources: International Energy Agency (IEA, 2020)

Figure 1 highlights the steady growth of renewable energy's share in electricity production globally and within ASEAN from 2000 to 2022. Globally, the share increased from 18% to 38%, reflecting strong commitments to clean energy investments. In ASEAN, the share grew from 10% to 30%, showcasing progress despite regional challenges. While ASEAN lags behind the global average, its consistent upward trend emphasizes efforts to integrate renewables into the energy mix, supporting sustainable development and reducing reliance on fossil fuels. Despite its potential, the relationship between renewable energy and economic growth is complex and context-dependent. While some studies highlight positive contributions of REC and EPR to gross domestic product (GDP), others emphasize regional disparities, infrastructure challenges, and high transition costs. Logistic performance emerges as a critical factor that mediates these outcomes by enhancing operational efficiency and facilitating the integration of renewable energy into broader economic systems. These challenges call for a deeper investigation into the interplay between REC, EPR, LP, and their collective impact on economic development, particularly in the ASEAN context where renewable energy systems are rapidly evolving. Emphasizing the importance of optimizing renewable energy supply chains and enhancing logistic performance to achieve sustainable economic development (Singh et al., 2020).

Table 1. Regional Energy Trends, Renewable Energy Targets, and Progress

| *Region* | *Renewable Energy Target (%)* | *Current Share of Renewable Energy (%)* | *Target Year* | *Major Renewable Sources* | *Progress Status* |
|---|---|---|---|---|---|
| ASEAN | 35 | 30 | 2030 | Hydro, Solar, Biomass | On track |
| EU | 55 | 50 | 2030 | Wind, Solar, Hydro | Moderate progress |
| North America | 50 | 45 | 2030 | Wind, Solar, Biomass | Moderate progress |
| Sub-Saharan Africa | 20 | 15 | 2030 | Hydro, Solar | Lagging |
| South Asia | 40 | 35 | 2030 | Solar, Biomass, Hydro | Moderate progress |
| Latin America | 60 | 55 | 2030 | Hydro, Wind, Biomass | On track |

Source: International Renewable Energy Agency (IRENA), 2024

Table 1 indicates the renewable energy landscape varies significantly across regions, with each setting ambitious targets to transition toward sustainable energy. ASEAN countries aim to achieve 35% renewable energy in their energy mix by 2030 and have currently reached 30%, reflecting steady progress. The region's primary renewable energy sources include hydropower, solar, and biomass, which contribute to bridging energy gaps and fostering economic growth. ASEAN's progress is categorized as "on track," signaling that while challenges remain, the region is well-positioned to meet its targets through continued investment and policy support. Globally, other regions demonstrate varying levels of advancement. The European Union (EU), for example, has set a 55% target by 2030 and has already achieved 50%, driven by wind, solar, and hydropower. ASEAN's focused approach to renewable energy, driven by regional collaboration and investments in hydropower and solar projects, highlights its strategic commitment to sustainability. This progress highlights the region's role as a key player in the global renewable energy transition, setting an example for other developing regions. By continuing to enhance policies and infrastructure, ASEAN is poised to significantly contribute to the global push for cleaner, more sustainable energy systems.

The aim of this study is to investigate the macroeconomic impacts of REC, EPR, and LP on economic growth within ASEAN countries. Using a panel data approach, this study evaluates how these factors interact to influence economic performance over time. Specifically, the objectives of this study is to analyze the short- and long-term impacts of renewable energy consumption, electricity production from renewable resources, and logistic performance on economic growth in ASEAN countries and to propose strategies for optimizing renewable energy supply chains. Globally, renewable energy has gained significant traction, with its share in electricity production rising from 20% in 2011 to 28% in 2022. Solar and wind energy contributions have grown remarkably during this period,

increasing from 2% to 10%, while reliance on fossil fuels declined from 68% to 62% (IRENA, 2022). These global trends underline the importance of investments, supportive policies, and financial incentives in transitioning to renewable energy systems. Similarly, ASEAN countries have embraced this transition, aiming to align renewable energy adoption with economic growth objectives and regional development goals.

This paper addresses a critical gap in existing literature by exploring the macro-level relationships among REC, LP, EPR, and economic growth in ASEAN countries. It seeks to provide actionable insights for policymakers and stakeholders to optimize renewable energy supply chains and enhance logistic performance as a pathway to sustainable economic development. The paper is structured as follows: the next section reviews relevant literature, followed by a detailed explanation of the methodology, including the panel data approach and pooled mean group analysis. The subsequent section presents the results and discussion, highlighting key findings and their implications. Finally, the paper concludes with a summary of the findings, policy recommendations, and suggestions for future research.

## 2.0 Literature Review

The impact of renewable energy consumption on economic growth has been extensively studied, producing mixed results. Some studies affirm a positive relationship, emphasizing renewable energy's role in fostering economic development and sustainability. For instance, Mohammadi et al. (2023) highlights its contribution to growth in developed nations, while Jia et al. (2023) reveal a bidirectional causal relationship between renewable energy consumption and economic growth, particularly along the Belt and Road Initiative. Similarly, Shahbaz et al. (2020) point out the importance of renewable energy investments, noting a positive long-term effect in 58% of their samples. However, opposing findings suggest challenges, with Dogan et al. (2020) reporting a negative correlation in higher quantiles where renewables dominate energy consumption. Madaleno and Nogueira (2023) further caution that while renewables support economic growth, increased CO2 emissions from fossil fuel dependency can undermine sustainability. Others, like Bhuiyan et al. (2022), argue that renewable energy's significance in developed nations is limited unless consumption surpasses specific thresholds, highlighting the relationship's complexity. From the perspective of institutional theory, these findings suggest that the economic impact of renewable energy is contingent upon the strength of institutional frameworks, such as regulatory policies, governance structures, and financial incentives. Effective institutions are crucial for mitigating transition costs and fostering an enabling environment for renewable energy adoption (Satrianto et al., 2024).

The link between logistics performance and economic growth has also drawn considerable attention, with studies showcasing its varied implications. Khadim et al. (2021) find that efficient logistics infrastructure enhances economic growth in developing countries, amplifying the effects of labor and capital endowments. Similarly, Pehlivan et al. (2024) show that higher Logistics Performance Index (LPI) scores correlate strongly with increased trade volume and economic growth in EU countries. Akhunzada & Ali, (2023) highlight that effective logistics management, particularly when integrated with renewable energy, significantly benefits economic growth in Asian countries. On the contrary, Ślusarczyk et al. (2020) emphasize that logistics technologies enhance enterprise performance but have an indirect and varied national economic impact. Additionally, Goel et al. (2021) note that logistics performance benefits are uneven across nations, depending on specific growth rates and contextual factors, highlighting regional disparities.

Electricity production from renewables further demonstrates the economic potential of sustainable energy. By creating jobs in manufacturing, construction, and maintenance, renewables employed over 12 million people globally in 2022 (IRENA, 2022). Renewable energy also enhances national energy security, stabilizes costs, and stimulates economic resilience (OECD, 2021). Investments in renewables foster industrial growth, reduce operational costs, and attract international funding (IEA, 2021; UNEP, 2022). Despite these advantages, challenges persist. High initial investments and intermittency issues hinder stable power generation, particularly in low-income nations (IRENA, 2022; World Economic Forum, 2021). Transitioning from fossil fuels can disrupt traditional industries, causing job losses and resistance (OECD, 2021). Furthermore, the economic benefits of renewables vary across regions, with higher GDP growth observed in policy-supported areas like Europe compared to developing nations (IRENA, 2021).

While extensive research has explored the impact of renewable energy consumption (REC) and electricity production from renewables (EPR) on economic growth, existing studies often present mixed findings, particularly regarding the role of logistic performance (LP). Prior literature has focused predominantly on developed regions, with limited empirical evidence addressing the intricate interplay of these factors in the ASEAN context. This study bridges this gap by employing a panel ARDL model to analyze annual data from 1995 to 2020 across ASEAN-6 countries and China. By incorporating REC, LP, and EPR as key independent variables, the study captures their short- and long-term effects on economic growth, as measured by GDP. The study offers actionable insights for policymakers aiming to align renewable energy transitions with economic growth objectives in the ASEAN region.

## 3.0 Research Method

The data used in this study is annual time series data spanning from 1995 through 2020 (25 observations ) for seven selected countries (Malaysia, Indonesia, Vietnam, Singapore, Thailand, and Japan). We define our dependent variable, Economic Development (GDP), Gross Domestic Product, as a proxy for economic performance. The explanatory or independent variables are renewable energy consumption (REC), logistic performance (LP), and electricity production from renewable resources (EPR). These factors influence the operational efficiency of energy systems and, in turn, impact gross domestic product (GDP) and economic development. Data was extracted from various sources such as the World Bank, the International Renewable Energy Agency (IRENA), and national statistical agencies.

*3.1 Panel data approach*

Given the multi-dimensional nature of the data, a panel data analysis approach was adopted to account for variations across countries and over time. This approach offers several advantages, including the ability to control unobserved heterogeneity and to study dynamic relationships. Pooled Least Squares combines cross-sectional and time-series data, treating all observations as homogeneous. While straightforward, PLS does not account for country-specific effects, potentially leading to biased estimates. Thus, PLS was used primarily as a baseline model. The Fixed Effects model captures time-invariant country-specific characteristics, allowing for a complicated analysis of how changes in renewable energy adoption influence economic, environmental, and supply chain outcomes. By including entity-specific dummy variables, FE isolates the effects of the independent variables while controlling unobservable heterogeneity. The Random Effects model assumes that country-specific effects are random and uncorrelated with the independent variables. This model provides a broader perspective, offering efficient estimates when the assumptions are held.

*3.2 Empirical model*

This study utilize a panel ARDL model, or PMG estimation, introduced by Pesaran et al. (1999). This model assumes that the long-run coefficients are identical, but the short-run coefficients and error variances differ across the groups (Othman et al., 2022). We noted that this estimation framework enables us to capture the long-run and short-run relationship among the variables of interest and the convergence parameter (adjustment coefficient). The unrestricted specification for the ARDL system of equations for t=1,2,…T, time periods and i=1,2,…N, countries for the dependent variable Y is:

$$GDP_{it} = \sum_{j=0}^{p} \lambda_{ij}\, GDP_{i,t-j} + \sum_{j=0}^{q} \gamma'_{ij}\, x_{i,t-j} + \mu_i + \varepsilon_{it} \quad (1)$$

Where $GDP_{it}$ is a scalar dependent variable, Economic Development, and $x_{i,t-j}$ is the (k x 1) vector of independent variables for group i , which include renewable energy consumption (REC), logistic performance (LP), and electricity production from renewable resources (EPR). $\mu_i$ represents the fixed effects (country specific effects); $\lambda_{ij}$ is the scalar coefficients of the lagged dependent variables and $\gamma'_{ij}$ is the k x 1 coefficient vectors. The group-specific short-run coefficients and the common long run coefficients are computed by the pooled maximum likelihood estimation and all the dynamics, and the ECM terms are free to vary. Under some regularity assumption, the parameter estimates of the PMG model are consistent and asymptotically normal for both stationary I(0)and non-stationary I(0) regressors.

Data analysis was performed using stata software, which facilitated the implementation of Fixed and Random Effects models. While the methodology is comprehensive, limitations include potential data gaps, the assumption of linearity in relationships, and constraints in capturing dynamic effects due to the static nature of the panel data approach. Future research could explore advanced methods such as dynamic panel Generalized Method of Moments (GMM) for enhanced insights. In summary, this methodology provides a robust framework for analyzing the multifaceted impacts of renewable energy adoption, ensuring that the findings are both statistically sound and practically relevant for guiding policy and strategic decisions.

## 4.0 Findings

The Unit Root Test result in Table 1 offer a thorough analysis of the stationarity of the variables. ADF test is a common method used to test for a unit root in a univariate time series. It involves estimating a regression equation and testing whether the coefficient of the lagged level of the series is significantly different from zero. If the coefficient is not significantly different from zero, it suggests the presence of a unit root and thus non-stationarity. The results of these tests are crucial for ensuring that the time series data used in further analyses is appropriately treated, thereby enhancing the accuracy and reliability of subsequent statistical models and interpretations.

Table 1. Panel Unit Root Test

| | *Level* | | *1st Difference* | |
|---|---|---|---|---|
| *Variable* | *Statistic ADF-Fisher* t-stat*** | *Prob. ADF-Fisher* t-stat*** | *Statistic ADF-Fisher* t-stat*** | *Prob. ADF-Fisher* t-stat*** |
| $REC_{it}$ | 35.7136* | 0.0004* | 95.3337* | 0.0000* |
| | -2.99816** | 0.0014** | -8.13799** | 0.0000** |
| $LPit$ | 24.3439* | 0.0183* | 80.5984* | 0.0000* |
| | -2.53208** | 0.0057** | -7.22771** | 0.0000** |
| $EPR_{it}$ | 39.5031* | 0.0001* | 97.8977* | 0.0000* |
| | -3.47493** | 0.0003** | -8.33224** | 0.0000** |

*4.1 Pooled ordinary least squares (Pooled OLS) result*

The Pooled Ordinary Least Squares (Pooled OLS) method is employed to examine how independent variables impact the dependent variable within a combined dataset of multiple entities observed over time. By aggregating data from different entities and time periods, Pooled OLS allows for a broad analysis of how variables such as Renewable Energy Consumption (REC), Logistic Performance (LP), and Electricity Production from Renewable resources (EPR) collectively influence economic outcomes.

Table 2. Pooled Ordinary Least Squares (OLS) result

| *Variable* | *Coefficient* | *Std. Error* | *t-Statistic* | *Prob.* |
|---|---|---|---|---|
| C | 2.40E+08 | 4.9930543 | 4.805618 | 0.0000 |
| $REC_{it}$ | 3.207218 | 0.412840 | 7.768672 | 0.0000 |
| $LP_{it}$ | -0.069305 | 0.449187 | -0.154290 | 0.8776 |
| $EPR_{it}$ | 3.407560 | 1.136917 | 2.997194 | 0.0031 |
| R-squared | 0.840282 | Prob(F-statistic) | | 0.000000 |
| F-statistic | 299.8782 | Durbin-Watson stat | | 1.000000 |

The Pooled Ordinary Least Squares (OLS) analysis detailed in Table 2 provides insights into the relationship between the dependent variable, GDP, and several independent variables over a specified period and across multiple cross-sections. This analysis employs panel least squares methodology on a balanced panel data set, which includes 25 periods (years) from 1998 to 2022 and 7 cross-sections, amounting to a total of 175 observations. The variables included in the model are the intercept (C), REC, LP, and EPR.

The coefficient for the intercept is 240 million (2.40E+08) with a standard error of approximately 49.93 million (49930543). The t-statistic of 4.805618 and a probability value (p-value) of 0.0000 suggest that the intercept is statistically significant at conventional levels. REC has a coefficient of approximately 3.207 with a standard error of 0.412840. The t-statistic for REC is 7.768672, and the p-value is 0.0000, indicating that REC is highly statistically significant and positively associated with GDP. The coefficient for LP is -0.069305 with a standard error of 0.449187. The t-statistic is -0.154290, and the p-value is 0.8776, suggesting that LP is not statistically significant and does not have a meaningful impact on GDP in this model. Lastly, EPR has a coefficient of approximately 3.408 with a standard error of 1.136917. The t-statistic is 2.997194, and the p-value is 0.0031, indicating that EPR is statistically significant and positively associated with GDP.

The goodness-of-fit measures show an R-squared value of 0.840282, meaning that approximately 84% of the variance in GDP can be explained by the independent variables in the model. The adjusted R-squared is slightly lower at 0.837480, accounting for the number of predictors in the model. The standard error of the regression is 5.56E+08, and the F-statistic is 299.8782 with a p-value of 0.000000, confirming that the overall model is statistically significant. These statistics suggest that the model fits the data well and provides a robust analysis of the relationship between GDP and the included independent variables.

## 5.0 Discussion

This study reveals significant insights into the macroeconomic impacts of renewable energy consumption (REC), logistic performance (LP), and electricity production from renewable resources (EPR) on economic development within ASEAN countries and selected regions. The analysis demonstrates that REC and EPR are both positively and significantly associated with GDP, with coefficients of 3.207 and 3.408, respectively, highlighting their critical role in fostering sustainable economic growth. These findings align with the resource-based view (RBV) theory, which postulates that a country's resources, such as renewable energy, are fundamental drivers of its competitive advantage and economic growth. By leveraging REC and EPR, nations can reduce reliance on non-renewable resources, enhance energy security, and support long-term economic sustainability.

Conversely, the logistic performance (LP) variable was found to have no statistically significant effect on GDP, with a coefficient of -0.069 and a p-value of 0.8776. This result suggests that the existing logistical infrastructure in the studied regions may not yet be sufficiently optimized to support the integration and distribution of renewable energy resources in a manner that substantially impacts economic growth. From the perspective of institutional theory, this finding could be attributed to inadequate institutional support, such as weak regulatory frameworks, fragmented infrastructure, or limited interconnectivity among ASEAN nations. Addressing these deficiencies could enhance the role of logistics in renewable energy adoption and its subsequent economic benefits. The positive findings regarding REC and EPR emphasize the importance of addressing key global and regional issues. First, the growing global energy crisis, exacerbated by climate change and geopolitical tensions, has emphasized the need for nations to transition to renewable energy. The findings validate the idea that renewable energy consumption and production are not only environmentally beneficial but also serve as economic catalysts, particularly in regions like ASEAN, where energy demand is rising. This highlights the practical relevance of energy transition strategies, aligning with sustainable development goals (SDGs), specifically SDG 7 (Affordable and Clean Energy) and SDG 8 (Decent Work and Economic Growth).

The insignificant impact of LP highlight the persistent logistical inefficiencies that hinder the seamless integration of renewable energy in ASEAN countries. Fragmented supply chain networks limit the economic potential of renewable energy production and consumption, resulting in higher distribution costs, project delays, and underutilized infrastructure. Addressing these challenges requires regional cooperation to enhance logistical frameworks, harmonize policies, and invest in modern infrastructure. This study emphasizes the critical need to improve logistics systems, optimize supply chains, and increase renewable energy investments to drive economic growth and sustainability. These initiatives can reduce fossil fuel dependence, create employment opportunities, and achieve environmental goals, aligning with ASEAN's socio-economic objectives and global sustainable development targets.

## 6.0 Conclusion

This study was conceived in response to the growing need to address regional disparities in the adoption and economic benefits of renewable energy. While much of the existing literature has focused on developed nations, this research aimed to explore the unique challenges and opportunities in ASEAN countries, where rapid economic growth coincides with rising energy demands and environmental concerns. By employing a panel data approach, this study sought to fill gaps in understanding the interplay between REC, EPR, and LP in driving economic growth. The findings also reflect ongoing global discussions about the need for sustainable energy systems that balance economic growth with environmental stewardship. Specifically, this research highlights the relevance of tailoring renewable energy policies to regional contexts, as ASEAN countries face unique socio-economic, institutional, and infrastructural challenges compared to other regions. The study's insights into the insignificant role of LP highlight the need for region-specific strategies that address logistical barriers to renewable energy adoption, offering a roadmap for policymakers to enhance the effectiveness of renewable energy initiatives. These findings pave the way for further exploration of the role of logistics in renewable energy transitions. While the study provides valuable insights, certain limitations must be acknowledged. First, this study focuses only on six ASEAN countries due to data availability, which may limit the comprehensiveness of the findings across the entire ASEAN region. Second, future studies could investigate specific logistical challenges, such as, regulatory inconsistencies, and technological limitations, to better understand their impact on economic outcomes. Additionally, comparative studies across regions could provide broader insights into how logistical efficiency interacts with renewable energy adoption in varying contexts, offering global lessons for accelerating the clean energy transition.

## Acknowledgments

The authors thankfully acknowledge the financial support received from the RIG Grant, Faculty of Business and Management, Universiti Teknologi MARA: grant number 600-TNCPI 5/3/DDF (FPP) (009/2024).

## Paper Contribution to Related Field of Study

This paper provides an insight for enhancing supply chain efficiency to support sustainable energy transitions and economic development.

## References

Akhunzada, T. K., & Ali, S. (2023). Measurement the Impact of Logisitc Management System on Economic Growth in Selected Asian Countries. *Pakistan Journal of Humanities and Social Sciences*, *11*(1), 350–363.

Bhuiyan, M. A., Zhang, Q., Khare, V., Mikhaylov, A., Pinter, G., & Huang, X. (2022). Renewable energy consumption and economic growth nexus—a systematic literature review. *Frontiers in Environmental Science*, *10*, 878394.

Dogan, E., Altinoz, B., Madaleno, M., & Taskin, D. (2020). The impact of renewable energy consumption to economic growth: a replication and extension of. *Energy Economics*, *90*, 104866.

Goel, R. K., Saunoris, J. W., & Goel, S. S. (2021). Supply chain performance and economic growth: The impact of COVID-19 disruptions. *Journal of Policy Modeling*, *43*(2), 298–316.

International Energy Agency (IEA) (2020). Renewable Energy Market Report 2020. International Energy Agency.

Jelti, F., Allouhi, A., Büker, M. S., Saadani, R., & Jamil, A. (2021). Renewable power generation: A supply chain perspective. *Sustainability*, *13*(3), 1271.

Jia, H., Fan, S., & Xia, M. (2023). The impact of renewable energy consumption on economic growth: Evidence from countries along the Belt and Road. *Sustainability*, *15*(11), 8644.

Khadim, Z., Batool, I., Akbar, A., Poulova, P., & Akbar, M. (2021). Mapping the moderating role of logistics performance of logistics infrastructure on economic growth in developing countries. *Economies*, *9*(4), 177.

Mohammadi, H., Saghaian, S., & Zandi Dareh Gharibi, B. (2023). Renewable and non-renewable energy consumption and its impact on economic growth. *Sustainability*, *15*(4), 3822.

Othman, N., Hewage, R. S., Pyeman, J., & Murdipi, R. (2022). Impact of Technological Advancements on Environmental Degradation: Evidence from ASEAN. *Environment-Behaviour Proceedings Journal*, *7*(21), 401–407.

Pehlivan, P., Aslan, A. I., David, S., & Bacalum, S. (2024). Determination of Logistics Performance of G20 Countries Using Quantitative Decision-Making Techniques. *Sustainability*, *16*(5), 1852.

REN21 (2021). Renewable Energy Policy Network for the 21st Century: Global Status Report. REN21 Secretariat.

Satrianto, A., Ikhsan, A., Dirma, E. Y., Candrianto, C., Juniardi, E., & Gusti, M. A. (2024). The effect of institutional quality on renewable energy: evidence from developing countries. International Journal of Energy Economics and Policy, 14(5), 678-686.

Shahbaz, M., Raghutla, C., Chittedi, K. R., Jiao, Z., & Vo, X. V. (2020). The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index. *Energy*, *207*, 118162.

Ślusarczyk, B., Tvaronavičien\.e, M., Haque, A. U., & Oláh, J. (2020). Predictors of Industry 4.0 technologies affecting logistic enterprises' performance: International perspective from economic lens. *Technological and Economic Development of Economy*, *26*(6), 1263–1283.