



Optimizing Renewable Energy Utilization in the Manufacturing Industry in Indonesia

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Abstract

Background: Indonesia's manufacturing sector contributes substantially to global energy demand and greenhouse gas emissions, yet renewable energy accounts for only about 15% of industrial energy use. Although relevant policies are in place, food and beverage manufacturers continue to encounter technical, financial, and institutional barriers to integrating clean energy.

Objective: This study aims to examine the associations of technical, economic, policy, and energy management factors with the optimization of renewable energy utilization in Indonesia's food and beverage manufacturing industry.

Methods: This study employed a quantitative approach using multiple linear regression analysis. Data were collected through questionnaires distributed to 102 stakeholders in the food and beverage manufacturing industry who were selected using purposive sampling. The data were analyzed using validity and reliability tests, t-tests, an F-test, and the coefficient of determination (R^2).

Results: The results indicate that, collectively, technical, economic, policy, and energy management factors are significantly associated with renewable energy optimization ($F = 577.237$, $p < 0.05$). Individually, technical factors ($t = 4.592$, $p < 0.05$) and policy factors ($t = 4.653$, $p < 0.05$) show positive and significant associations, whereas economic and energy management factors do not show significant associations. The R^2 value of 0.958 suggests that the model explains a substantial proportion of the variance, although this finding should be interpreted with caution given the characteristics of the sample.

Conclusion: The optimization of renewable energy utilization in the manufacturing industry is more strongly associated with technological readiness and policy support than with economic and energy management factors.

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INTRODUCTION

The shift toward a sustainable energy system has emerged as a strategic priority worldwide in response to climate change, environmental degradation, and continued reliance on fossil fuels. The International Energy Agency (2023) reports that industry accounts for approximately 37% of global final energy consumption and produces almost 25% of direct CO₂ emissions. Because manufacturing accounts for a considerable share of energy consumption and greenhouse gas emissions, it occupies an important position in national and international decarbonization efforts. Indonesia remains strongly dependent on fossil fuels, which account for 84.53% of its electricity generation (Tamimi & Paramita, 2025). The International Renewable Energy Agency IRENA (2024) further emphasizes that accelerating the adoption of renewable energy for industrial decarbonization is necessary to achieve the 1.5°C target. Such dependence

places additional pressure on environmental sustainability and exposes the country to fluctuations in international energy prices.

Within this context, renewable energy offers a strategic pathway for improving energy efficiency, reducing carbon emissions, and strengthening national energy security. Although a regulatory framework for renewable energy is already in place, its actual share remains only 15%, revealing a disparity between established policy and implementation (Kurniawan et al., 2025). Renewable energy adoption among manufacturers nevertheless continues to encounter technical, economic, and institutional constraints. In particular, inadequate infrastructure restricts the integration of renewable energy sources into the national grid and affects both system reliability and efficiency (Setiawan et al., 2025).

From a technical perspective, integrating renewable energy sources such as solar, biomass, and wind into industrial production systems requires technological adaptation and relatively large initial investments. From an economic perspective, uncertainty regarding returns on investment and limited fiscal incentives remain major obstacles for industry players. The initial capital required for these technologies can be prohibitive, hindering investment despite their potential to generate long-term savings (Chidolue et al., 2024; Kenneth Ifeanyi Ibekwe et al., 2024). A global survey by Okereke and Tyldesley (2024) confirmed that the three most prevalent barriers to renewable energy adoption in manufacturing are high upfront costs, inadequate grid infrastructure, and regulatory uncertainty. Furthermore, regulatory and policy frameworks that are not yet fully supportive also slow the adoption of clean energy in the manufacturing sector. Limited government financial incentives further complicate the decision-making process for companies considering renewable energy integration (Chidolue et al., 2024; Marouani et al., 2023; Onyinyechukwu Chidolue et al., 2024; Walmsley et al., 2023). This situation indicates a gap between macroeconomic policy and its implementation at the industrial operational level.

At the same time, advances in technology and optimization including energy management systems, smart grids, and artificial intelligence-based methods create further opportunities to improve the efficiency and effectiveness of renewable energy use in industry (Rahim & Jamhur, 2024). These approaches extend beyond simply replacing fossil fuels by enabling the integration of adaptive, efficient, and sustainable energy systems that correspond to the specific requirements of manufacturing processes (Sivaraman et al., 2024).

Existing research has addressed renewable energy use in industry, but much of the literature remains fragmented and does not thoroughly examine optimization within the Indonesian manufacturing sector (Noviati et al., 2024). Prior studies commonly examine technical feasibility, economic viability, or policy frameworks separately rather than assessing technical, economic, policy, and energy management factors together within an integrated model. Empirical evidence concerning Indonesia's food and beverage manufacturing subsector is also limited, even though this subsector makes an important contribution to national industrial energy consumption. An investigation capable of identifying suitable models and strategies is therefore required to improve the effectiveness and efficiency of renewable energy use in manufacturing.

Drawing on these issues, this research investigates the optimization of renewable energy use in Indonesian manufacturing by considering technical, economic, and policy dimensions. The study contributes theoretically by proposing an integrated energy optimization framework that jointly incorporates technological readiness, economic feasibility, the policy environment, and energy management capacity. In practical terms, the findings can help industrial decision-makers establish priorities for renewable energy investment and assist policymakers in formulating incentives that directly address the principal barriers to adoption. In this way, the research supports a faster transition toward a more sustainable and resilient manufacturing sector in Indonesia.

Recent investigations have considered renewable energy utilization and industrial performance from several perspectives, and their combined evidence identifies both common themes and unresolved issues. Judijanto et al. (2023) found that renewable energy use, energy efficiency, and the adoption of green technology jointly reduce carbon emissions in Tangerang City's manufacturing industry, supporting the integration of renewable energy into production as a viable sustainability measure. From a financial perspective, Haryati et al. (2025) showed that investment in renewable energy improves operational efficiency and subsequently strengthens financial performance, with energy efficiency acting as an important mediator. Abdillah et al.

(2025), meanwhile, linked energy consumption patterns to carbon emissions at the macroeconomic level and proposed the renewable energy transition as a central strategy for sustainable development. Together, these findings demonstrate environmental, financial, and macroeconomic benefits. They do not, however, assess technical, economic, policy, and energy management factors concurrently within a single analytical framework or specifically examine Indonesia's food and beverage manufacturing subsector. The present research addresses this gap through an integrated empirical assessment.

METHOD

A quantitative descriptive-explanatory design was employed in this study. Quantitative procedures enabled the measurement and assessment of relationships among variables associated with renewable energy optimization in the manufacturing industry. The descriptive component characterized current energy-use conditions, whereas the explanatory component examined the statistical relationships among the study variables.

The population comprised managerial- and technical-level employees of Indonesian food and beverage manufacturing firms that had been operating for at least three years. Respondents were selected using purposive sampling and were required to occupy positions directly related to production operations or energy management. Using the Slovin formula, a 10% margin of error, and an estimated population of approximately 150 eligible employees in the targeted firms, the resulting sample comprised 102 respondents. This sample size also met Hair et al. (2019) and Hair et al. (2022) recommended minimum of 15–20 observations per predictor in multiple regression analysis.

Four independent variables were examined: (1) Technical Factors (X1), represented by the compatibility of renewable energy technologies with production processes and their integration with production machinery; (2) Economic Factors (X2), represented by savings in operational energy expenditures and initial investment costs; (3) Policy Factors (X3), represented by the availability of government incentives and support for green industry programs; and (4) Energy Management Factors (X4), represented by energy-consumption monitoring and energy-use efficiency. Renewable Energy Optimization (Y), the dependent variable, was represented by reductions in operational energy costs and the reliability of the energy system. A five-point Likert scale was used to measure each variable.

SPSS Version 25 was used to analyze the data. Before the hypotheses were tested, the classical assumptions of regression analysis were assessed using the Kolmogorov–Smirnov normality test, multicollinearity testing ($VIF < 10$), the Glejser test for heteroscedasticity, and a linearity test. All required assumptions were satisfied. Multiple linear regression analysis was subsequently applied to evaluate the proposed relationships, with t-tests used to assess partial effects, the F-test used to assess the simultaneous effect of the independent variables, and the coefficient of determination (R^2) used to indicate the proportion of variance in the dependent variable explained by the regression model.

RESULTS AND DISCUSSION

Respondent Demographics

The demographic information collected provided a profile of respondents relevant to renewable energy optimization in the food and beverage manufacturing industry. Overall, 102 respondents from 35 companies participated in the study. Table 1 summarizes the demographic characteristics at both the respondent and company levels. Frequencies for company type, energy source, usage status, and EMS status refer to companies, whereas frequencies for occupational positions refer to individual respondents.

Table 1

Respondent demographics

No	Information	Frequency	presentation
1	Company Type		
	Small (<50 employee)	15	43%
	Intermediate (50–300 employee)	5	14%
	(>300 employee)	15	43%
2	Position		
	Operations Manager	5	14%

No	Information	Frequency	presentation	
3	Production Manager	5	14%	
	Supervisor	10	29%	
	Technician/Maintenance	5	14%	
	Engineering Staff	10	29%	
	PLN Electricity	7	20%	
	Gas (LPG/PGN)	13	37%	
	Solar/Diesel	10	29%	
	Renewable Energy	5	14%	
	Already Used	5	14%	
4	Usage Status	In planning	12	34%
		Not yet used	18	51%
5	EMS Status	Already implemented	29	83%
		Not yet implemented	6	17%

Source: Author's data processing results (2026)

Based on company size, respondents were distributed primarily across small and large companies, which accounted for 43% each, while medium-sized companies accounted for only 14%. This indicates a relatively balanced distribution across the two extremes of company size in the sample. Furthermore, the high proportion of large companies may indicate greater potential for renewable energy implementation, as larger companies tend to have greater financial and technological resources.

Supervisors and engineering staff constituted the largest occupational groups, each representing 29% of respondents. Operations managers, production managers, and technicians/maintenance personnel each accounted for 14%. Regarding energy sources, gas (LPG/PGN) was used by the largest proportion of companies (37%), followed by solar/diesel (29%), PLN electricity (20%), and renewable energy (14%).

Meanwhile, renewable energy use remains relatively low, at only 14%, indicating limited adoption of renewable energy in this sector. This situation highlights significant opportunities for renewable energy development and suggests that the energy transition in the manufacturing sector remains at an early stage.

In terms of renewable energy usage status, 51% of companies reported that they had not yet used renewable energy, 34% were in the planning stage, and only 14% had already implemented renewable energy. The high percentage of companies that had not yet adopted renewable energy indicates that renewable energy adoption in the manufacturing industry remains limited. However, the fact that 34% of companies were in the planning stage suggests a positive movement toward an energy transition.

These findings show that awareness of and interest in renewable energy are growing, even though actual implementation remains limited. Appropriate optimization measures are consequently necessary to accelerate renewable energy adoption within the industry. With respect to energy management systems, 83% of companies reported that an EMS had been implemented, while 17% reported that it had not.

Validity & Reliability Test

Instrument testing produced Pearson correlation coefficients and significance values (two-tailed) for the indicators of each research variable, together with an overall reliability coefficient. Indicator validity was assessed by correlating each indicator score with the total score for its respective variable. An indicator was classified as valid when its correlation coefficient exceeded the critical r value and its significance value was below 0.05.

Table 2

Validity & Reliability Test Table

Variables	Dimensions	indicator	Pearson Correlation	Sig. (2-tailed)	Reliability
Technical Factors	X1.1	Compatibility of renewable energy technology with production processes	.902**	0,000	0,989
	X1.2	Integration of renewable energy with production machines	.947**	0,000	
Economic Factors	X2.1	Operational energy cost savings	.926**	0,000	0,000
	X2.2	Initial investment costs of renewable energy technologies	.887**	0,000	
Policy Factors	X3.1	Availability of government incentives for industry	.946**	0,000	0,000
	X3.2	Government program support for green industry	.901**	0,000	
Management Factors	X4.1	Monitoring energy consumption in the production process	.903**	0,000	0,000
	X4.2	Efficiency of energy use in production machines	.904**	0,000	
Renewable Energy Optimization	Y1.1	Reducing operational energy costs	.946**	0,000	0,000
	Y1.2	Reliability of energy systems in supporting production	.902**	0,000	

Source: SPSS 25 Data Processing Results (2026)

Validity Test

The test findings show that every indicator has a very high Pearson correlation coefficient, ranging from 0.887 to 0.947, with a significance value of $p < 0.001$. Accordingly, each indicator is strongly and significantly correlated with the construct it measures.

Reliability Test

Instrument consistency was assessed through reliability testing. The reliability coefficient obtained was 0.989, substantially exceeding the commonly accepted minimum threshold of 0.70 and therefore indicating excellent internal consistency. Thus, the instrument demonstrates a very high degree of consistency in measuring the research variables.

T test, F test and coefficient of determination

Table 3*t-test, f-test & R Square*

Variables	Test F	Sig.	Test T	Sig.	R Square
Technical Factors	577,237	.000b	4,592	0,000	0,958
Economic Factors			0,161	0,873	
Policy Factors			4,653461	0,000	
Management Factors			1,480155	0,142	
Renewable Energy Optimization					

Source: SPSS 25 Data Processing Results (2026)

F Test (Simultaneous)

The simultaneous test produced an F statistic of 577.237 and a significance value of $p < 0.001$. Accordingly, technical, economic, policy, and energy management factors are jointly and significantly associated with renewable energy optimization.

The regression model is therefore statistically significant in explaining the relationship between the independent variables and the dependent variable.

t-Test (Partial)

The partial contribution of each independent variable to the dependent variable was assessed using the t-test.

- 1) Technical Factors (X1): Technical factors produced a *t*-value of 4.592 with a significance value of $p < 0.001$, demonstrating a positive and significant association with renewable energy optimization. This result indicates that technology compatibility, system integration, and infrastructure preparedness are important for the successful adoption of renewable energy in manufacturing. It is consistent with Nejla et al. (2025), who identified technical infrastructure readiness as a principal determinant of successful renewable energy integration into grids worldwide. The importance of this factor is understandable because food and beverage processes (including heating, cooling, and packaging) require a continuous and dependable power supply, making compatibility between renewable energy systems and existing machinery essential.
- 2) Economic Factors (X2): For economic factors, the *t*-value was 0.161 and the significance value was 0.873 (>0.05), indicating no significant association with renewable energy optimization. Investment and operating costs therefore did not emerge as significant determinants of renewable energy optimization in the industry examined. This outcome accords with Okereke and Tyldesley (2024), who observed that, after a firm makes a strategic commitment to renewable energy, operational costs tend to be secondary to technical reliability. The finding may also be related to the fact that 34% of companies were still planning adoption and 51% had not yet adopted renewable energy, leaving many companies with limited direct experience of its economic consequences. Firms may additionally give greater weight to long-term strategic value than to short-term financial considerations when assessing renewable energy alternatives.
- 3) Policy Factors (X3): Policy factors yielded a *t*-value of 4.653 and a significance value of $p < 0.001$. A positive and significant association was found between policy factors and renewable energy optimization. The result demonstrates the importance of clear regulations, incentives, and government support in promoting industrial renewable energy adoption. It supports Kurniawan et al. (2025) and Setiawan et al. (2025), who emphasized government-driven frameworks (including fiscal incentives, feed-in tariffs, and regulatory mandates) as important forces behind Indonesia's renewable energy transition. The significance of this factor suggests that, in a developing-country setting where market forces alone may be insufficient, proactive government intervention through supportive regulations and incentives can play an important role in facilitating renewable energy adoption.
- 4) Energy Management Factors (X4): The energy management factor generated a *t*-value of 1.480 and a significance value of 0.142 (>0.05). Energy management was not significantly associated with renewable energy optimization. Thus, although energy management systems were present, they did not show a statistically significant direct association with renewable energy optimization. This is notable because 83% of companies stated that their organizations had already implemented an EMS. One plausible interpretation is that these systems primarily monitor and reduce total energy consumption from conventional sources rather than facilitate renewable energy integration and optimization. Rahim and Jamhur (2024) similarly explain that an energy management system's contribution to renewable energy integration depends on an architecture capable of handling intermittent energy sources and hybrid configurations.

Coefficient of Determination (R Square)

An R^2 of 0.958 means that technical, economic, policy, and energy management factors collectively account for 95.8% of the variance in renewable energy optimization in the sample. This unusually high value nevertheless requires careful interpretation because self-reported questionnaires were used to measure both the dependent and independent variables, potentially

introducing common method bias, and because the predictors may exhibit multicollinearity. Future investigations should verify this result using appropriate diagnostic procedures for common method bias and multicollinearity, including Harman's single-factor test and variance inflation factor (VIF) analysis, respectively. Variables not included in the model account for the remaining 4.2% of the variance.

Hypothesis Testing

Technical factors significantly influence renewable energy optimization. The analysis generated a t -value of 4.592 and a significance value of $p < 0.001$; consequently, the hypothesis was supported. Technical factors were positively and significantly associated with renewable energy optimization. This means that technological compatibility, integration with production systems, and infrastructure readiness are important factors in renewable energy optimization in manufacturing.

Economic factors significantly influence renewable energy optimization. A t -value of 0.161 with a significance value of 0.873 (>0.05) was obtained, leading to the rejection of the hypothesis. Economic factors were not significantly associated with renewable energy optimization. Initial investment expenditure and operational savings therefore did not emerge as significant determinants of optimization in the industry investigated.

Policy factors have a significant influence on renewable energy optimization. The analysis produced a t -value of 4.653 and a significance value of $p < 0.001$, so the hypothesis was supported. Policy factors were positively and significantly associated with renewable energy optimization. Government assistance through regulations and incentives therefore appears to play an important role in facilitating industrial renewable energy adoption.

Energy management significantly influences renewable energy optimization. The result was a t -value of 1.480 with a significance value of 0.142 (>0.05); therefore, the hypothesis was rejected. No statistically significant association was identified between energy management and renewable energy optimization. Although an energy management system had been implemented by most companies, its presence was not significantly associated with increased renewable energy utilization.

Technical, economic, policy, and energy management factors simultaneously influence renewable energy optimization. The simultaneous test indicates that technical, economic, policy, and energy management factors collectively have a statistically significant association with renewable energy optimization.

CONCLUSION

This research assessed how technical, economic, policy, and energy management factors are associated with renewable energy optimization in Indonesia's food and beverage manufacturing industry. Collectively, the four factors show a significant association with renewable energy optimization ($F = 577.237$, $p < 0.001$, $R^2 = 0.958$). At the partial level, technical factors ($t = 4.592$, $p < 0.001$) and policy factors ($t = 4.653$, $p < 0.001$) are positively and significantly associated with optimization, whereas economic factors ($t = 0.161$, $p = 0.873$) and energy management factors ($t = 1.480$, $p = 0.142$) are not significantly associated. The evidence therefore indicates that technological readiness and supportive public policy have statistically significant associations with renewable energy optimization in manufacturing, whereas economic considerations and existing energy management practices did not show statistically significant associations in this sample.

Several limitations frame the interpretation of these findings. Because the design was cross-sectional, causal relationships cannot be established; the use of self-reported questionnaires may introduce common method bias; and restricting the sample to the food and beverage subsector limits the generalizability of the findings to other manufacturing activities. The exceptionally high R^2 should also be confirmed through replication. Future studies could adopt longitudinal designs to observe changes in renewable energy uptake over time, include other energy-intensive manufacturing subsectors, use qualitative approaches to explore organizational decision-making in greater depth, and test organizational culture, leadership commitment, and supply-chain pressure as possible mediating or moderating variables.

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AUTHOR CONTRIBUTION STATEMENT

Moden Purba was responsible for conceptualization, methodology, data acquisition, data analysis, and preparation of the initial manuscript. Zaenal Arifin undertook supervision, validation, interpretation of results, and manuscript editing. Both authors read and approved the final manuscript.

REFERENCES

- Abdillah, M. R., Firdaus, A., & Mulyadi, D. (2025). Energy consumption, economic growth, and carbon emissions: Evidence from Indonesian manufacturing sector. *Environmental Science and Pollution Research*, 32(1), 1045–1060.
- Agency, I. E. (2023). *World Energy Outlook 2023*. International Energy Agency. <https://doi.org/10.1787/827374a6-en>
- Chidolue, O., Fafure, A. V., Illojiana, V. I., Ngozichukwu, B., Daudu, C. D., & Ibekwe, K. I. (2024). Integration of renewable energy in industrial operations: Experiences from Canada, USA, and Africa. *GSC Advanced Research and Reviews*, 18(1), 213–221. <https://doi.org/10.30574/gscarr.2024.18.1.0014>
- Hair, J. F., Babin, B. J., & Anderson, R. E. (2022). Multivariate Data Analysis. In *Multivariate Data Analysis*. Cengage Learning.
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate Data Analysis* (8th ed.). Cengage.
- Haryati, S., Susanto, A., & Pratama, R. (2025). The role of renewable energy in improving financial performance of manufacturing companies: The mediating effect of operational efficiency. *Energy Reports*, 13, 112–125.
- IRENA. (2024). *World Energy Transitions Outlook 2023: Achieving the 1.5° C Goal*.
- Judijanto, L., Pambayun, R. M., & Nasution, A. (2023). The effect of renewable energy use, energy efficiency, and green technology on carbon emission reduction in the manufacturing industry in Tangerang City. *Journal of Environmental Science and Sustainable Development*, 6(2), 245–261.
- Kenneth Ifeanyi Ibekwe, Adefunke Fabuyide, Ahmad Hamdan, Valentine Ikenna Illojiana, & Emmanuel Augustine Etukudoh. (2024). Energy efficiency through variable frequency drives: industrial applications in Canada, USA, and Africa. *International Journal of Science and Research Archive*, 11(1). <https://doi.org/10.30574/ijrsra.2024.11.1.0113>
- Kurniawan, O. D. A., Sari, D. P., Wulandari, C., Bakri, S., Febriyano, I. G., Kurniawan, O. D. A., Sari, D. P., Wulandari, C., Bakri, S., & Febriyano, I. G. (2025). Evaluating Indonesia's Renewable Energy Transition Strategy: Policy Implementation Challenges Toward Net-Zero Emission Target 2060. *Publicus*, 3(2), 117–126. <https://doi.org/10.30598/publicusvol3iss2p117-126>
- Marouani, I., Guesmi, T., Alshammari, B. M., Alqunun, K., Alzamil, A., Alturki, M., & Hadj Abdallah, H. (2023). Integration of Renewable-Energy-Based Green Hydrogen into the Energy Future. *Processes*, 11(9). <https://doi.org/10.3390/pr11092685>
- Nejla, E., Saidani, K., & Besbes, M. (2025). Overcoming the integration bottleneck: a global review of renewable energy and grid adaptation strategies. *International Journal of Sustainable Energy*, 44(1), 2569922.
- Noviati, N. D., Maulina, S. D., & Smith, S. (2024). Smart Grids: Integrating AI for Efficient Renewable Energy Utilization. *International Transactions on Artificial Intelligence*, 3(1), 1–10. <https://doi.org/10.33050/italic.v3i1.644>
- Okereke, C., & Tyldesley, R. (2024). Barriers to renewable energy adoption in the manufacturing sector: A multi-country analysis. *Journal of Cleaner Production*, 434, 139876. <https://doi.org/10.1016/j.jclepro.2023.139876>
- Onyinyechukwu Chidolue, Adetomilola Victoria Fafure, Valentine Ikenna Illojiana, Bright Ngozichukwu, Cosmas Dominic Daudu, & Kenneth Ifeanyi Ibekwe. (2024). Integration of renewable energy in industrial operations: experiences from Canada, USA, and Africa. *GSC*

- Advanced Research and Reviews*, 18(1), 213–221.
<https://doi.org/10.30574/gscarr.2024.18.1.0014>
- Rahim, R., & Jamhur, A. I. (2024). Technological Innovation in Energy Management: A Case Study of Implementation in the Industrial Sector. *Jurnal Teknik Dan Teknologi Tepat Guna*, 3(2), 28–35. <https://doi.org/10.62357/j-t3g.v3i2.348>
- Setiawan, M. F. N., Fridayani, H. D., & Chiang, L. C. (2025). Government-Led Renewable Energy Transition to Address Indonesia's Energy Crisis and Climate Vulnerability. *E3S Web of Conferences*, 660, 02003. <https://doi.org/10.1051/e3sconf/202566002003>
- Sivaraman, K., Prema, E., & Sundar, V. (2024). *Revolutionizing the Energy Landscape* (pp. 89–104). <https://doi.org/10.1002/9781394261727.ch32>
- Tamimi, H. A., & Paramita, C. (2025). The strategic role of renewable energy in supporting net-zero emissions targets in industrial clusters: Pathways to achieving sustainability. *Applied Environmental Science*, 2(2), 93–107. <https://doi.org/10.61511/aes.v2i2.2025.1445>
- Walmsley, T. G., Philipp, M., Picón-Núñez, M., Meschede, H., Taylor, M. T., Schlosser, F., & Atkins, M. J. (2023). Hybrid renewable energy utility systems for industrial sites: A review. *Renewable and Sustainable Energy Reviews*, 188. <https://doi.org/10.1016/j.rser.2023.113802>