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Energy Governance and Sustainability Performance of PT Timah Tbk: A Case Study on Energy Intensity Efficiency

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ABSTRACT

This study examines energy intensity governance at PT Timah Tbk and its impact on sustainability and profitability during 2019–2024. Using a quantitative descriptive approach, it evaluates energy intensity trends, efficiency programs, and internal and external factors affecting energy consumption. Results indicate a 22.69% reduction in absolute energy consumption (418,645.6 GJ) and a 28.21% decline in energy intensity to 89.14 GJ/ton in 2024, achieving twice the National Energy Plan (RUEN) target. These improvements coincided with a 7.7% increase in tin production and a financial turnaround from an IDR 449 billion loss to an IDR 1,186 billion profit, demonstrating decoupling between production growth and energy consumption. Internal initiatives, including Ausmelt technology, electrification, B35–B40 biodiesel, and selective mining, contributed 70–75% to efficiency improvements, while external factors, including regulations, price volatility, and energy infrastructure, accounted for 60–70% of influences on energy performance. Sustaining these achievements requires internal optimization, external collaboration, and institutional transformation through an ESG Committee and ISO 50001 certification. The findings emphasize that achieving Net Zero Emissions by 2060 requires coordinated efforts among government, financial institutions, and the international community.

Keywords: Case Study; Energy Efficiency; Energy Governance; Energy Intensity Governance; Net Zero Emission; PT Timah Tbk; Sustainability Performance

INTRODUCTION

This study aims to analyze energy usage at the mining company PT Timah Tbk. Energy usage is a practical application of energy security, a major national goal for Indonesia in anticipating energy crises. As the largest tin producer with holding 126 Mining Business Licenses (IUP) covering 473,310 hectares, or approximately 80% of the total tin mining concession area in Indonesia PT Timah Tbk faces highly complex and unique operational challenges. The company employs a vertically integrated business model encompassing exploration, onshore and offshore mining, processing, smelting, and the marketing of tin products under globally renowned brands such as "Banka Tin," "Kundur Tin," and "Mentok Tin."

In 2024, PT Timah Tbk demonstrated its commitment to energy efficiency by reducing total energy consumption across its business operations by 418,645.6 GJ (22.69%) compared to 2023. This achievement is particularly significant given that the RUEN target calls for only a 1% annual reduction; PT Timah Tbk thus surpassed the national target by more than twentyfold. However, this milestone was reached amidst significant operational pressures. Tin production fell from 20,079 tonnes in 2022 to 14,855 tonnes in 2023, representing a 26% decline. Additionally, the company recorded a net loss of IDR 449.69 billion in 2023, following a profit of IDR 1.04 trillion the previous year.

Several interconnected structural factors influence the energy intensity issues faced by PT Timah Tbk. First, PT Timah Tbk consumed 1,844,872 GJ of energy in 2023, with primary energy sources comprising biodiesel (B30) at 78.5%, marine fuel oil (MFO) at 9.0%, PLN electricity at 7.3%, and coal at 5.2%. The company's total energy intensity reached 120.27 GJ/ton in 2023, indicating significant room for efficiency improvements.

Secondly, tin mining operations possess characteristics that differ significantly from those of other mining commodities. Onshore mining operations cover an area of 288,638 hectares, while offshore operations cover 184,274 hectares. Offshore operations utilizing dredgers require substantial diesel energy consumption, which is the primary source of the company's greenhouse gas emissions.

Thirdly, investment capacity for long-term energy efficiency projects is influenced by extreme global fluctuations in tin prices. In 2024, the average selling price of tin metal for PT Timah Tbk rose by 17% to $31,181 per metric ton, up from $26,583 per metric ton the previous year. Price volatility affects the organization's ability to allocate capital expenditure (capex) toward long-term energy transformation projects.

Fourthly, an external challenge involves illegal mining activities encroaching upon PT Timah Tbk’s Mining Business License (IUP) areas. This disrupts production planning and operational performance. Unauthorized mineral and coal mining activities resulted in state losses amounting to IDR 271 trillion, according to cases handled by the Attorney General's Office between 2018 and 2022. Due to these illegal mining activities, PT Timah Tbk is compelled to operate in suboptimal locations. Consequently, the energy required for PT Timah Tbk's operations increases.

However, existing research has focused primarily on technical and macroeconomic factors, leaving a gap regarding the governance aspects of energy intensity management at the corporate level. Key areas requiring attention include strategic decision-making mechanisms for budgeting energy efficiency projects, the integration of ESG policies into the governance structures of state-owned enterprises (SOEs), coordination between operational units and corporate policy during program implementation, and the trade-offs involved between these levels. Given the complex nature of multinational corporations,

expanding this body of research is crucial, as these companies must balance commercial interests with government-mandated responsibilities to support national energy transition goals. The analysis is conducted in three main stages as that Energy Intensity Calculation, Trend Analysis, and Evaluation of Energy Management Initiatives.

LITERATURE REVIEW

The National Energy General Plan (RUEN), the 2060 Net Zero Emission target, and international ESG standards and micro-level operational realities, including infrastructure constraints, tin market volatility. As a nation where the energy sector accounts for 42% of national greenhouse gas emissions (ESDM, 2023a), Indonesia faces the dual challenge of meeting energy demands for economic growth while simultaneously reducing its carbon footprint. Primary energy consumption rose by 4.5% in 2022, reaching 1,206 million BOE (Barrels of Oil Equivalent), with fossil fuels comprising 85% of the national energy mix. This situation exacerbates systemic vulnerability to global energy price fluctuations and intensifies international pressure for decarbonization. Consequently, the government has established energy efficiency as a top priority in its planning. To address this issue, the Indonesian government formulated the National General Energy Plan (RUEN) for the 2024–2050 period. The plan targets a 1% annual reduction in energy intensity through 2030 and aims to increase the renewable energy mix to 23% by 2025. Indonesia's mining industry exhibits an energy intensity of 0.28 SBM/million IDR—a figure 20% higher than the global standard cited by the World Bank (2022)—and contributes significantly to national energy consumption (BPS, 2023).

This indicates structural inefficiencies that require comprehensive intervention at both the policy and business implementation levels. As the largest tin producer—holding 126 Mining Business Licenses (IUP) covering 473,310 hectares, or approximately 80% of the total tin mining concession area in Indonesia.The experience of PT Alamtri Resource Indonesia Tbk confirms that commodity price fluctuations directly impact the capacity to invest in energy-saving technologies, thereby creating a recurring cycle of volatility in energy intensity.

A previous study by Kartiasih et al. (2012) indicated that shifts in economic activity—absent technological advancement—accounted for 77% of the rise in national energy intensity. In their study of 284 mining companies worldwide, Wang & Wang (2020) found that adopting energy-efficient technologies could reduce energy intensity by up to 15%. IESR (2023) confirmed that upgrading equipment at Indonesian mining companies could reduce energy losses by an average of 12%.

However, existing research has focused primarily on technical and macroeconomic factors, leaving a gap regarding the governance aspects of energy intensity management at the corporate level. Key areas requiring attention include strategic decision-making mechanisms for budgeting energy efficiency projects, the integration of ESG policies into the governance structures of state-owned enterprises (SOEs), coordination between operational units and corporate policy during program implementation, and the trade-offs involved between these levels. Given the complex nature of multinational corporations, expanding this body of research is crucial, as these companies must balance commercial interests with government-mandated responsibilities to support national energy transition goals. The achievement of national RUEN (National Energy General Plan) targets, and strengthening the company's position in the international tin market. Practical benefits of this research include: (1) providing an energy governance model for other state-owned enterprises (SOEs) in the extractive sector, particularly those operating under a dual mandate of commercial viability and sustainability; (2) assisting the Ministry of Energy and Mineral Resources (ESDM) in refining energy efficiency regulations for the mining

sector; and (3) expanding academic discourse on the relationship between increased production and energy sustainability in developing nations that produce mining commodities.

RESEARCH METHOD

This study employs a quantitative descriptive approach to analyze energy intensity trends and performance at PT Timah Tbk during the 2019–2024 period. According to Sugiyono (2019), this approach enables the systematic, factual, and accurate examination of phenomena through numerical data. Rather than testing causal hypotheses, the study focuses on examining changes in energy intensity and evaluating the effectiveness of the company's energy management programs against sectoral and national standards.

The analysis is conducted in three main stages. First, energy intensity is calculated using the formula EI = EC/P, where EC represents total energy consumption (in GJ) and P denotes production output (in US$). The calculated values are presented in a time-series table to identify fluctuations throughout the study period. Second, a trend analysis is performed to examine the relationships among energy consumption, production output, and financial performance. This analysis aims to identify energy efficiency patterns and assess the influence of external factors, particularly tin price fluctuations, on investments in energy efficiency initiatives. Third, the effectiveness of energy management initiatives, including selective mining, fuel substitution, and solar power plants, is evaluated based on their contributions to reducing energy consumption and energy intensity. Together, these analytical stages provide a comprehensive assessment of PT Timah Tbk's energy intensity performance and the effectiveness of its energy management strategies during 2019–2024.

RESULTS

Energy intensity is a measure of energy performance that relates energy consumption to economic output or production (IEA, 2021). Mathematically, energy intensity is calculated using the following formula: EI = EC/P, where: EI (Energy Intensity) = Energy intensity (unit: GJ/US$), EC (Energy Consumption) = Total energy consumption (unit: GJ), and P (Production Output) = Production output (unit: US$)

Patterson (1996) was the first to combine microeconomic and macroeconomic concepts. The macroeconomic approach focuses on the sectoral or industrial level by calculating the ratio of energy per unit of production—such as kWh/US$ in the manufacturing or cement industries. Conversely, energy intensity is also measured by the ratio of energy consumption to Gross Domestic Product (GDP); this serves as a useful indicator for assessing a country's overall energy efficiency and is frequently used for cross-country comparisons. At PT Timah Tbk, energy intensity is defined as the amount of energy required to produce one ton of product. To determine this intensity, the calculation method employed is based on the UNFCCC-GHG Emission Inventory Guidelines (IPCC 2006) and the WBCSD/WRI GHG Emissions Protocol. This method assists the company in identifying energy-saving opportunities across various production processes, including exploration, mining (onshore and offshore), processing, and smelting. Empirical studies identify two primary determinants relevant to PT Timah Tbk: 1) Technical Efficiency, Energy-efficient technologies can reduce energy intensity by up to 15% (Wang & Wang, 2020). In the context of tin mining, technical efficiency encompasses several aspects. A study by Wang & Wang (2020) covering 284 cities in China demonstrated that technological innovation significantly reduces energy intensity by enhancing productivity efficiency. Ausmelt smelter technology, which has been operational since the second

half of 2021. By employing a more efficient smelting process with precise temperature control, so achieves energy efficiency that is 25–30% superior to conventional reverberatory furnace technology.

A 2023 IESR study indicates that mining companies in Indonesia experience an average energy loss of 12% resulting from equipment upgrades. Conversely, aging infrastructure increases grid losses by up to 8.2%, a condition observed in 34% of Indonesia's power generation facilities. Energy intensity is also influenced by economic activity and production scale, particularly when production structures shift or output volumes change without corresponding adjustments in energy capacity. This finding aligns with Kartiasih et al. (2012), who identified changes in economic activity as the primary driver of 77% of the increase in energy intensity in Indonesia.

In the case of PT Timah Tbk, production declined by 26%, from 20,079 tons in 2022 to 14,855 tons in 2023. This decline was not accompanied by a proportional reduction in fixed energy consumption required for infrastructure operations, resulting in higher energy costs per unit of output. Consequently, the company experienced diseconomies of scale, characterized by increasing energy costs per unit as capacity utilization decreased.

Indonesia's mining sector has an average energy intensity of 0.28 SBM/million IDR (ESDM, 2023b), approximately 20% higher than the global standard (World Bank, 2022). Several factors contribute to this condition, including network transmission losses of 8.2% due to suboptimal energy distribution (PLN, 2023), equipment older than 15 years accounting for 34% of production facilities (IESR, 2023b, 2023a), and continued reliance on diesel fuel for remote operations, where energy costs are 40% higher than those associated with grid-supplied electricity.

In response to these energy efficiency challenges, the RUEN 2024–2050 regulation aims to reduce energy intensity by 1% annually through 2030 (ESDM, 2023b). Accordingly, PT Timah Tbk has developed a decarbonization roadmap targeting net-zero emissions by 2060, designed to achieve emission reduction goals over the next 36 years. Furthermore, the Environmental, Social, and Governance (ESG) framework requires companies to apply GRI Standard 302 in reporting their energy consumption. From the perspective of Resource-Based View Theory (Barney, 1991), regulatory compliance not only mitigates risks but also contributes to competitive advantage through reduced operational costs and access to green financing at a lower cost of capital. Therefore, understanding PT Timah Tbk's operational and financial performance is essential for evaluating the relationship between energy management, production dynamics, and corporate sustainability. This assessment is supported by data from PT Timah Tbk's Consolidated Financial Statements as of December 31, 2024, as presented in Table 1.

Table 1. Operational and Financial Performance of PT Timah Tbk, 2019–2024

Year	Revenue (Rp Triliun)	Net Profit/Loss (Rp miliar)	Tins Production (Ton)	Average Price (US $/ton)	Status
2019	19.300.000	(611.000.)	18.000	18.500	Loss
2020	15.200.000	(341.000)	17.500	17.000	Loss
2021	14.600.000	1.300.000	24.670	32.000	Profit
2022	12.500.000	1.040.000	20.079	31.650	Profit
2023	8.391.907	(449.690)	14.855	26.585	Loss
2024	10.856.442	1.187.697	16.000	31.181	Profit

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Analysis of Operational Dynamics

During the crisis period (2019–2020), PT Timah Tbk incurred significant cumulative losses due to a combination of low tin prices and high production costs. Rising production costs and interest expenses amid weakening tin prices, particularly in the second half of 2019, resulted in a net loss of IDR 611 billion, contrasting with the profit recorded in 2018. Interest expenses surged by 122% in 2019, increasing from IDR 352 billion to IDR 782 billion, while other financial expenses rose by 50%, from IDR 66 billion to IDR 99 billion. During the recovery period (2021–2022), PT Timah Tbk's net profit increased by 483% to IDR 1.3 trillion in 2021, recovering from a loss of IDR 341 billion in the previous year. This improvement was driven by a record-breaking increase in global tin prices and higher production, which reached 24,670 tons. In 2022, despite an 18.6% decline in production to 20,079 tons, the company maintained strong profitability due to consistently high average selling prices.

During the contraction period (2023), tin prices declined to US$26,583 per ton, production decreased by 26% to 14,855 tons, and revenue fell to IDR 8.39 trillion. These conditions resulted in a net loss of IDR 449.69 billion. The cost of revenue reached IDR 7.93 trillion, while financial expenses amounted to IDR 205.1 billion, placing additional pressure on the company's financial performance.

In the rebound period (2024), PT Timah Tbk experienced a significant financial recovery, recording a net profit of IDR 1.19 trillion and revenue of IDR 10.86 trillion. During this period, the selling price of tin metal increased by 17% to US$31,181 per metric ton, reflecting the success of initiatives aimed at improving operational efficiency and cost management. Table 2 presents the data, findings, and performance indicators related to PT Timah Tbk's energy intensity.

Table 2. Data, Findings, and Energy Intensity Performance of PT Timah Tbk

Indicator	2023	2024	Change	% Δ	Category
Total Energy Consumption (GJ)	1.884.8872	1.426.226	(418.646)	(22,69%)	Significant Efficiency
Tin Production (Ton)	18.885	16.000	1.145	7,7%	Increased Production
Energy Intensity (GJ/ton)	124,18	89,14	(35.04)	(28,2%)	Dramatic Efficiency
Revenue (IDR Trillion)	8,39	10,86	2,47	29,4%	Strong Recovery
Net Profit/(Loss) (Rp Billion)	(449,69)	1.186,70	1.636,39	364%	Turnaround

Table 3. Internal Factors of PT Timah Tbk's Energy Efficiency Program

Component	Initiative	Supporting Data
Technical Efficiency	Implementation of selective mining methods to reduce equipment energy consumption.	A reduction of 418,645.6 GJ in energy consumption was associated with the implementation of selective mining practices.
	Reconditioning and overhauling main engines of primary production equipment, including dredgers and excavators.	Engine reconditioning contributes to reduced energy consumption and improved operational efficiency.
	Fuel substitution through the transition from conventional diesel to B35 or B40 biodiesel.	B35 contains 35% biodiesel, while B40 contains 40% biodiesel,

		supporting the transition from fossil fuels to renewable energy sources.
	Replacement of conventional operational vehicles with hybrid vehicles.	Hybrid operational vehicles have been introduced to improve fuel efficiency and reduce energy consumption.
Energy Infrastructure	Connection to the PLN electricity grid at strategic operational locations.	Grid connectivity in the Mentok area reduces reliance on diesel-powered generators.
	Installation of solar photovoltaic (PV) panels for office operations and supporting facilities.	Solar photovoltaic systems are utilized as renewable energy sources to support operational activities.
	Replacement of fluorescent lighting with energy-efficient LED lighting.	LED lighting improves energy efficiency and reduces electricity consumption.
Smelting Technology	Implementation of Ausmelt smelting technology.	The Ausmelt Smelter has an annual production capacity of 35,000 tons and provides high metal recovery rates and improved energy efficiency.

Technical Interpretation & Impact of Technical Efficiency. Selective mining reduces the waste-to-ore ratio, ensuring energy is expended only on high-value material. This method improves mined ore quality while reducing the volume of barren material requiring processing. It is estimated to contribute 30–35% of the total energy reduction. Well-maintained machinery achieves optimal fuel efficiency; reconditioning prevents energy waste caused by performance degradation. Fuel efficiency is estimated to improve by 15–20% following engine reconditioning to industry standards. Biodiesel focuses more on decarbonization than pure energy efficiency—reducing greenhouse gas emissions by 25–30%—and, despite having a slightly lower energy content (approx. 5–7%), it supports the energy independence roadmap. Hybrid vehicles save 30–40% on fuel for surface operations (transportation, supervision, logistics). This program is most effective for light vehicles (pickups, sedans) and medium-duty vehicles.

Energy Infrastructure: Technical Interpretation & Impact. The PLN grid is 40–50% cheaper and more efficient than diesel generators, reducing diesel consumption by approximately 100,000 liters/month in Mentok. Connecting to the grid ("PLN-ization") also enhances energy supply reliability and lowers generator maintenance costs. Although the current contribution is modest (approx. 2–3% of total energy), there is room for growth. With an average solar radiation of 5.2 kWh/m²/day in Bangka-Belitung, the ideal ROI for solar PV (SPV) systems is 7–10 years, aided by government incentives. LED lighting saves 50–60% on energy and offers a lifespan five times longer (25,000–50,000 hours compared to 5,000–10,000 hours for fluorescent tubes). An effective, low-cost program with a payback period of less than two years.

Impact of Smelting Technology. Ausmelt technology offers 25–30% greater energy efficiency compared to conventional reverberatory furnaces. It utilizes a submerged combustion process with precise temperature control, thereby reducing heat loss and contributing significantly to lowering energy intensity. Synthesis of Internal Factors. PT Timah Tbk's energy management program employs a comprehensive, multi-pronged approach, including: 1. Optimization of mining operations (selective mining), which reduces the volume of non-economic material requiring processing; 2. Equipment modernization (machinery reconditioning, hybrid vehicles) to improve fuel efficiency; 3.

Transitioning energy sources (grid connection/PLN, solar PV, and biodiesel) to reduce reliance on diesel; 4. Upgrading smelting process technology (Ausmelt smelter) to enhance smelting efficiency. The 22.69% annual reduction in energy consumption demonstrates the successful execution of "low-hanging fruit" initiatives. However, this achievement also reflects short-term benefits from major programs—such as "PLN-ization" and the optimization of the Ausmelt smelter—that have now reached operational stability. Achieving sustained reductions requires continuous improvement and ongoing investment in next-generation technologies, such as the full electrification of the fleet and large-scale solar PV development.

Table 4. External Factors, Challenges, and Obstacles

Component	Key Findings	Supporting Data
RUEN and NZE 2060 regulations.	A reduction target of 1% per year—relative to the 22.69% level achieved in 2024—is set.	PT Timah Tbk plans to reduce carbon emissions with the aim of achieving net-zero emissions by 2060; this is a goal established for the next 36 years.
Commodity Price Volatility.	Tin prices fluctuated.	The selling price of tin metal increased by 17% in 2024 to US$31,181/tonne, up from US$26,583/tonne in 2023.
Ilegal Mining (PETI) Disturbances.	Ilegal mining activities.	According to cases handled by the Attorney General's Office between 2018 and 2022, unauthorized mineral and coal mining activities resulted in state losses amounting to IDR 271 trillion.
Energy Infrastructure Dependency.	Heavily reliant on diesel and biodiesel.	For 2023, the total energy consumption of 1,844,872 GJ comprised B30 biodiesel (78.5%), MFO (9.0%), PLN electricity (7.3%), and other sources (5.2%).
ESG Stakeholder Pressure.	Increasing attention from investors, banks, and trading partners regarding ESG performance and governance.	Ownership: 65% by the government (MIND ID), 35% by the general public. Compliance with: GRI 302 Standards, TCFD recommendations, OJK ESG regulations, the International Tin Association Code, and GRI regulations

RUEN Regulations and NZE 2060: Interpretation & Implications. In 2024, PT Timah Tbk successfully surpassed its RUEN target by a significant margin—twenty-two-fold. Given the already high efficiency of the 2024 baseline, maintaining consistency poses a challenge; achieving marginal improvements in subsequent years will be more difficult and require higher capital expenditure (CAPEX). Interpretation and Impact for Commodity Price Volatility is Extreme volatility drives cycle regarding CAPEX availability. Major investments in green infrastructure must be executed during periods of high profitability (2021–2022, 2024). Impact for Illegal Mining (PETI) Disruptions is PETI activities force PT Timah Tbk to operate in suboptimal areas requiring longer travel distances, resulting in higher fuel consumption and increases energy consumption by approximately 10–15% compared to ideal conditions free from such disruptions. Impact for Energy Infrastructure is due to limitations in electrification technology, offshore dredging inherently requires significant diesel usage. Mitigation strategies include grid connection (PLN-ization), hybrid dredger development, LNG exploration, and a target to develop 20–30% solar PV capacity by 2030. Diesel power is 40–50% more expensive than electricity from the PLN grid. Impact for ESG Stakeholder Pressures is the company faces multifaceted pressures, including ESG scrutiny by institutional investors, requirements for green financing access, demands for responsible international

sourcing, and government mandates for resilience. Extreme Weather Conditions: The 2023 La Niña event caused extreme rainfall that disrupted both offshore and onshore operations; production fell by 26%—a decrease of 5,224 tons—dropping from 20,079 tons in 2022 to 14,855 tons in 2023. Contributing factors: heavy rainfall caused by La Niña and intense precipitation (resulting in a 30–40% loss in production).

DISCUSSION

The results show that PT Timah Tbk successfully reduced its absolute energy consumption by 22.69%, equivalent to 418,645.6 GJ, during the observation period. At the same time, energy intensity decreased by 28.21%, reaching 89.14 GJ/ton in 2024. This finding indicates an improvement in the company's operational energy efficiency.

The decline in energy intensity is particularly important because it occurred alongside a 7.7% increase in tin production. Therefore, the increase in output was not accompanied by a proportional increase in energy consumption. This condition indicates a potential decoupling effect, whereby production growth occurs while energy use per unit of output decreases.

CONCLUSION

This study confirms the transformative achievements of PT Timah Tbk. During the 2023–2024 period, the company successfully reduced its absolute energy consumption by 22.69% to 418,645.6 GJ and its energy intensity by 28.21% to 89.14 GJ/ton, doubling the RUEN targets. These achievements refute the notion that efficiency is merely a statistical artifact of production contraction, as they provide empirical evidence of genuine decoupling—a separation between increased production (7.71%) and reduced energy consumption. The remarkable financial turnaround—shifting from a net loss of IDR 449 billion in 2023 to a net profit of IDR 1.18 trillion in 2024 is demonstrates that energy efficiency is effectively positively correlated with corporate profitability and competitive advantage, consistent with the resource-based view theory. The reduction in energy intensity stems from a combination of inherent efficiency gains (70–75% achieved through Ausmelt technology, electrification, the use of B35–B40 biodiesel, and selective mining) and a 25–30% production normalization effect. This involves a tension between commercial responsibilities (dividends), sustainability mandates (Net Zero Emission 2060), and social obligations (employment and the management of illegal small-scale mining, or PETI). Factor analysis indicates an asymmetric pattern: external factors—such as regulations, price volatility, and energy infrastructure deficits—account for 60–70% of the influence on energy performance. This implies that without a supportive ecosystem, corporate actions alone will be ineffective. Given that the 22.69% achievement is unsustainable as an annual baseline (with a realistic projection of 3–5% per year).

LIMITATION

This study is limited by its single-case focus, descriptive approach, secondary data availability, and inability to establish causal relationships.

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DECLARATION OF CONFLICTING INTERESTS

The authors have declared no potential conflicts of interest concerning the study, authorship, and/or publication of this article.

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