

DRIVERS AND BARRIERS TO RENEWABLE ENERGY CERTIFICATE PURCHASE: A CASE STUDY OF INDONESIAN ENERGY SECTOR

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Abstract

This study examines the driving and inhibiting factors influencing Renewable Energy Certificate adoption among industrial customers of PLN in the Pandaan Customer Service Unit area. The study is motivated by the uneven adoption of RECs among Indonesian industrial consumers despite growing sustainability pressure and the availability of REC products, as well as the limited understanding of behavioral, organizational, and market factors influencing corporate REC purchasing decisions in the Indonesian context. A mixed methods approach with an exploratory sequential design was employed, combining qualitative exploration through semi-structured interviews with one hundred and thirty-three industrial consumers followed by quantitative prioritization using the Fuzzy Analytic Hierarchy Process with three experts. The results indicate that regulations and policies emerged as the most dominant factor influencing REC adoption, followed by corporate strategy, while knowledge and access to information and REC product characteristics remain the primary barriers. External pressures, particularly global market demands and policies supporting the energy transition, have a greater influence than internal corporate motivations in driving REC purchasing decisions. The study also developed the REC Readiness Index as a tool to measure industrial customer readiness, showing that most respondents fall into the not ready to somewhat ready categories, indicating that improving literacy and understanding of REC benefits remain key priorities. The findings provide valuable insights for PLN and policymakers in designing strategies to enhance REC awareness, improve outreach programs, and strengthen renewable energy adoption in Indonesia's industrial sector.

Keywords: Renewable Energy Certificate, REC Adoption, Industrial Consumers, Fuzzy AHP, Energy Transition

1. Introduction

The global transition toward low-carbon energy systems has accelerated in response to climate change, increasing energy demand, and international commitments to reduce greenhouse gas emissions (Perpres 112/2022, 2022). Many countries have adopted renewable energy policies and market-based instruments to support the achievement of sustainability targets and Net Zero Emission (NZE) commitments. Among these instruments, Renewable Energy Certificates (RECs) have gained significant attention as a mechanism that enables organizations to claim the environmental attributes of renewable electricity generation without requiring direct investment in renewable energy infrastructure (Ferdous et al., 2023). Through RECs, companies can demonstrate their commitment to sustainability, improve environmental performance, and contribute to renewable energy deployment (Xu et al., 2022).



In Indonesia, the development of renewable energy has become a national priority, particularly following the government's commitment to achieve Net Zero Emissions by 2060. To support this objective, PT PLN (Persero) introduced Renewable Energy Certificates in 2020 as a market-based mechanism that allows electricity consumers to verify the renewable origin of the electricity they consume (Kusumawati & Putri, 2024). REC purchases provide organizations with an opportunity to reduce market-based Scope 2 emissions and align their operations with sustainability frameworks, environmental regulations, and Environmental, Social, and Governance (ESG) requirements. Despite the growing importance of sustainability reporting and green business practices, the adoption of RECs among industrial consumers remains uneven. Although PLN has reported increasing REC transactions since their introduction, the level of utilization is still below its expected potential (Kusumawati & Putri, 2024).

A Renewable Energy Certificate (REC) serves as evidence that 1 MWh of electricity has been generated from renewable sources, enabling companies to contribute to green energy without the need to establish their own power generation facilities, while simultaneously helping them achieve carbon emission reduction targets in an efficient manner (Xu et al., 2022). Previous studies have identified various factors influencing REC adoption across different countries and market contexts. Research in Singapore found that renewable energy targets, corporate sustainability commitments, and environmental leadership aspirations were among the primary drivers of REC procurement, while limited understanding of REC mechanisms represented a significant barrier (Li et al., 2022). A global review conducted by Jia et al. (2023) highlighted the importance of regulatory support, corporate renewable energy commitments, and market maturity in promoting REC adoption, whereas regulatory uncertainty, high costs, and inadequate tracking systems often hinder implementation. Other studies have demonstrated that REC purchases may generate positive market signals and enhance corporate value, particularly among manufacturing firms with substantial environmental impacts (Chung et al., 2024). Furthermore, market-related factors such as electricity prices and REC price dynamics have been shown to influence purchasing behavior and trading volumes (Irfan, 2021). In the Indonesian context, Haryani et al. (2025) emphasized that transparency, traceability, and user awareness remain critical challenges in improving the effectiveness of REC implementation.

The urgency of this research is driven by several critical factors. First, the global transition toward low-carbon energy systems has created increasing pressure on corporations to demonstrate their commitment to sustainability, yet the adoption of RECs among Indonesian industrial consumers remains uneven and below its expected potential (Kusumawati & Putri, 2024). Second, while research on renewable energy adoption has been extensively conducted at the global level, studies examining industrial consumer behavior toward REC purchasing in Indonesia remain very limited. Similar research has been conducted by Noorlitaria et al. (2023) and Halimatussadiah et al. (2024) concerning regulation, government support, and renewable energy procurement issues in Indonesia; however, these studies have not yet examined REC purchasing behavior at the corporate level. Third, international studies have shown that REC purchasing decisions are influenced by various factors, such as sustainability commitment, cost perception, and trust in certification systems (Li et al., 2022; Zhuang et al., 2021; Shannon et al., 2024; Wei et al., 2021). These factors have been proven to significantly influence purchase intention and renewable energy adoption behavior, particularly within the corporate sector. Fourth, empirically, PLN faces a major challenge in expanding REC adoption



within the industrial sector, namely that a significant portion of industrial consumers tend to prefer developing their own renewable energy generation (self-generation) rather than purchasing REC certificates. According to the Just Energy Transition Partnership (JETP) report (2023), approximately 23 GW of captive power plant capacity is currently in operation to meet the energy needs of various industries. This indicates that the majority of industries in Indonesia prefer to rely on their own captive power plants to fulfill their energy requirements. Fifth, to date, no research has comprehensively examined the driving and inhibiting factors influencing REC purchasing decisions among Indonesian industrial corporations.

The research gap in this study lies in the limited understanding of the driving and inhibiting factors influencing Renewable Energy Certificate purchasing decisions among industrial consumers in Indonesia. While individual studies have examined REC adoption in other countries or focused on regulatory aspects in Indonesia, the integrated framework connecting behavioral, organizational, and market factors in the Indonesian context remains underexplored (Noorlitaria et al., 2023; Halimatussadiah et al., 2024). Additionally, most previous studies have used single-method approaches, leaving a significant gap in knowledge regarding the behavioral dimensions, perceptions, and organizational dynamics underlying the low adoption of RECs.

The novelty of this research lies in several aspects. First, this study focuses on REC purchasing decisions among Indonesian industrial corporations, representing a unique context characterized by growing sustainability pressure, increasing corporate ESG commitments, and specific challenges related to captive power plant preferences. Second, this study employs a mixed-methods approach that combines qualitative exploration through semi-structured interviews with stakeholders followed by quantitative analysis using the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) method. The use of Fuzzy AHP is important to address the uncertainty (fuzziness) and subjectivity involved in prioritizing decision criteria, thereby producing more structured weightings of driving and inhibiting factors (Chang, 1996; Buckley, 1985). Third, this study contributes to the limited empirical evidence on REC adoption behavior in Indonesia, providing insights into the behavioral dimensions, perceptions, and organizational dynamics underlying corporate decisions to purchase RECs. Fourth, this study extends the application of the Theory of Planned Behavior and Stakeholder Theory to the context of REC purchasing decisions, validating theoretical predictions in an under-researched institutional context. Fifth, based on the priority ranking results from the Fuzzy AHP, expert validation is subsequently conducted to ensure the relevance, accuracy, and consistency of the weightings of the driving and inhibiting factors influencing REC purchasing decisions, so that the resulting recommendations have a strong and applicable foundation in practice.

The purpose of this study is to identify and analyze the driving and inhibiting factors influencing Renewable Energy Certificate purchasing decisions among Indonesian industrial corporations. Specifically, this research aims to: (1) identify the key driving factors that encourage industrial consumers to purchase RECs, (2) identify the key inhibiting factors that hinder REC adoption, (3) prioritize these factors using the Fuzzy AHP method, and (4) provide strategic recommendations for PT PLN (Persero) to increase REC penetration.

The contribution of this research is multifaceted. From a theoretical perspective, this research contributes to the enrichment of literature on renewable energy adoption behavior by proposing and testing an integrative model that links behavioral, organizational, and market factors with REC purchasing decisions, extending the



application of the Theory of Planned Behavior and Stakeholder Theory to the context of green market mechanisms in developing countries. The findings contribute to the understanding of how specific factors influence corporate REC adoption behavior, providing a more nuanced theoretical framework for analyzing sustainability behavior in different organizational contexts. From a practical perspective, this study provides actionable insights for PT PLN (Persero), policymakers, and industrial consumers in assessing and managing REC adoption strategies. For PT PLN (Persero), the findings provide guidance on which factors should be prioritized in marketing and educational strategies to increase REC penetration. For policymakers, the results offer insights into the importance of regulatory support, transparency, and tracking systems in promoting REC adoption. For industrial consumers, this study provides evidence on the benefits and challenges of REC adoption, supporting informed decision-making regarding renewable energy procurement.

2. Theoretical Background

2.1 Theory of Planned Behavior (TPB)

The Theory of Planned Behavior, developed by Ajzen (1991), explains that individual behavioral intention is determined by three main factors: attitude toward the behavior, subjective norms, and perceived behavioral control (Ajzen, 1991). Attitude refers to the individual's evaluation of the behavior as positive or negative. Subjective norms reflect the social pressure perceived by the individual to perform or not perform the behavior. Perceived behavioral control refers to the individual's perception of the ease or difficulty of performing the behavior, which is influenced by past experience and anticipated obstacles (Ajzen, 1991).

In the context of Renewable Energy Certificate (REC) adoption, TPB provides a robust framework for understanding corporate and individual decisions to purchase RECs. Research on green power certificate consumption has demonstrated the applicability of TPB in predicting purchase intention in developing nations (Wei et al., 2021). Wei et al. (2021) found that TPB effectively predicts consumer purchase intention towards green power certificates, with environmental concern, face concern, and green perceived value serving as additional constructs that improve the stability of the proposed theoretical model (Wei et al., 2021). Perceived behavioral control was identified as the most significant factor influencing purchase intention towards green power certificates, differing from normal green products where environmental value is the main driving force (Wei et al., 2021).

In this study, TPB is used to explain how corporate attitudes toward renewable energy, social pressure from stakeholders and regulators, and perceived control over REC adoption influence the intention to purchase RECs. Companies with positive attitudes toward sustainability, facing pressure from stakeholders (such as multinational corporations and sustainability initiatives like RE100), and having sufficient resources and knowledge to adopt RECs are more likely to purchase them (Wei et al., 2021; Ajzen, 1991).

2.2 Stakeholder Theory

Stakeholder Theory, developed by Freeman (1984), explains that companies are responsible not only to shareholders but also to various stakeholders affected by corporate activities, including customers, suppliers, communities, governments, and the environment (Freeman, 1984). In the context of REC adoption, stakeholder pressure plays



a significant role in driving corporate decisions to purchase RECs. Multinational corporations increasingly demand that their suppliers demonstrate commitment to renewable energy use and carbon emission reduction (Lichtenstein, 2023). This pressure creates a cascading effect where companies in the supply chain are motivated to adopt RECs to maintain business relationships with global buyers (Lichtenstein, 2023).

In Indonesia, the REC market has grown significantly, driven by corporate demand from companies seeking to meet sustainability targets, reduce emissions, and fulfill requirements from consumers or regulators (Kusumawati & Putri, 2024). Companies exporting products to Europe and other markets face particular pressure to meet sustainability requirements, including the use of clean energy (Kusumawati & Putri, 2024). Stakeholder theory helps explain why companies voluntarily adopt RECs beyond regulatory requirements, driven by the need to maintain legitimacy and competitive advantage in global markets (Freeman, 1984).

2.3 Renewable Energy Certificate (REC) as a Market-Based Instrument

A Renewable Energy Certificate (REC) is a tradable certificate that serves as proof that 1 MWh of electricity was generated from a renewable energy source (Ferdous et al., 2023). RECs separate the environmental attributes from the electricity produced, allowing companies to claim the use of renewable energy without having to build their own power plants (Ferdous et al., 2023). This mechanism has been widely adopted in various countries as a market-based instrument to support the energy transition and the achievement of sustainability targets (Ferdous et al., 2023; Lichtenstein, 2023).

The implementation of RECs adheres to the standards of the International Tracking Standard Foundation (I-TRACK Foundation), which ensures the transparency and traceability of the certificates (Lichtenstein, 2023). The I-TRACK Foundation is acknowledged by major reporting frameworks such as the Greenhouse Gas Protocol (GHGP), CDP, and RE100 as a reliable backbone for credible and auditable tracking instruments, ensuring adherence to best practices designed to avoid double counting and double attribute claims (Lichtenstein, 2023). In Indonesia, PT PLN (Persero) began providing REC services in 2020 through several service schemes—such as Signature REC, Retail REC, and Enterprise REC—to meet the needs of customers across various segments (Kusumawati & Putri, 2024). The availability of RECs offers companies a more flexible alternative for meeting renewable energy usage targets compared to direct investment in renewable energy power plants (Kusumawati & Putri, 2024).

From an environmental economics perspective, RECs are a type of market-based economic instrument that enables companies to achieve environmental goals through a certificate trading mechanism (Pigou, 1920). This approach aligns with the concept of externalities internalization proposed by Pigou (1920), in which market mechanisms are used to encourage behavioral changes toward more sustainable practices. RECs allow companies to internalize the environmental benefits of renewable energy, thereby addressing the market failure associated with negative externalities from fossil fuel consumption (Pigou, 1920).

2.4 Barriers to REC Adoption

Despite the growing REC market in Indonesia, several barriers hinder wider adoption. A study on barriers to renewable energy investment in the Indonesian power sector identified that a combination of regulatory uncertainty, financial weakness of the national electricity utility (PLN), and ineffective feed-in tariffs have had a dampening effect on



renewable energy investment (Sambodo & Novandra, 2023). In the absence of credible, mandatory renewable energy targets, PLN has prioritized coal and gas over renewables, partly because renewable power projects carry higher upfront investment costs (Sambodo & Novandra, 2023).

Specific challenges in REC market implementation include policy and governance issues, market development constraints, and limited international recognition (Kusumawati & Putri, 2024). Disputes over REC ownership between PLN and Independent Power Producers (IPPs) have arisen due to ambiguities in legacy contracts, leading to market disruptions and impacting market credibility and buyer confidence (Kusumawati & Putri, 2024). The absence of a comprehensive legal framework aligned with international standards hinders international recognition of Indonesian RECs, limiting their appeal to global buyers and investors (Kusumawati & Putri, 2024). Additionally, reporting frameworks like RE100 do not currently recognize cross-border REC transactions in the ASEAN region, limiting the financial value and export potential of Indonesian RECs (Kusumawati & Putri, 2024).

Consumer perceptions also present barriers to REC adoption. A qualitative study exploring consumer experience and perception of renewable energy services found that some consumers do not fully understand the direct benefits of RECs and consider purchasing RECs as an additional burden without real benefits (Putri & Kusumawati, 2025). Lack of in-depth understanding of REC products and their benefits, as well as initial costs and accessibility of services, are major barriers for some consumers (Putri & Kusumawati, 2025). These findings indicate that education and awareness campaigns are needed to improve understanding of REC benefits and encourage broader adoption (Putri & Kusumawati, 2025).

2.5 Fuzzy Analytical Hierarchy Process (Fuzzy AHP)

The Fuzzy Analytical Hierarchy Process (Fuzzy AHP) is an extension of the Analytical Hierarchy Process (AHP) that integrates fuzzy set theory to accommodate uncertainty and subjectivity in multicriteria decision making (Saaty, 1984; Chang, 1996). The weights of criteria and subcriteria in the Fuzzy AHP method are calculated step by step and systematically, beginning with the development of a hierarchical decision-making structure, followed by the distribution of questionnaires and the calculation of the geometric mean of respondents' ratings (Saaty, 1984; Buckley, 1985).

A pairwise comparison matrix between criteria and subcriteria is then created using the AHP scale and converted using the Triangular Fuzzy Number (TFN) scale (Chang, 1996). A consistency test is subsequently performed to ensure that the pairwise comparison matrix is consistent, by calculating the maximum eigenvalue ($\lambda_{\max}$), the Consistency Index (CI), and the Consistency Ratio (CR) (Saaty, 1984). The weights of each criterion and subcriterion are then determined using the Fuzzy Synthetic Extent method, which involves summing the fuzzy values for each row, calculating the fuzzy synthesis value, determining the degree of possibility, calculating the weight vector values, and finally normalizing the weights (Chang, 1996; Buckley, 1985). This method allows researchers to handle the uncertainty and subjectivity inherent in expert judgments when identifying and prioritizing factors influencing REC adoption.

3. Methods

3.1 Research Design

This study employs a mixed-methods approach with an exploratory sequential design. This design was chosen based on the study's objective to identify and prioritize the factors



influencing industrial consumers' decisions to purchase Renewable Energy Certificates (RECs) (Creswell & Plano Clark, 2018). In the initial phase, the study was conducted qualitatively through semi-structured interviews to explore the drivers and barriers to REC purchases based on respondents' experiences and perspectives, adopting the principles of Grounded Theory (Aurah, 2013). Subsequently, the results of the qualitative exploration were used as the basis for developing a hierarchical structure in the quantitative phase using the Fuzzy AHP method (Chang, 1996; Buckley, 1985). The exploratory sequential design was chosen because it enables a more comprehensive understanding by combining in-depth factor identification with a systematic determination of their levels of importance.

3.2 Population and Sampling

The study was conducted among industrial consumers located within the service area of PLN's Pandaan Customer Service Unit (ULP) with a minimum power capacity of 240 kVA. Based on PLN data, the population meeting these criteria consisted of 199 companies. The sample size for the qualitative phase was determined using the Slovin formula with a 5% margin of error, resulting in a sample size of 133 respondents.

The sampling technique used was purposive sampling, which involves selecting respondents based on specific criteria relevant to the research objectives (Sugiyono, 2016). Respondents consisted of company officials or staff who had knowledge of or were directly involved in decision-making processes related to energy use, whether at companies that had or had not purchased RECs. In the quantitative phase, the Fuzzy AHP weighting process was conducted through expert judgment involving three PLN experts with expertise and experience in the implementation and management of REC programs.

3.3 Data Collection Techniques

This study used primary data obtained through semi-structured interviews and pairwise comparison questionnaires. Semi-structured interviews were used to explore respondents' experiences, perceptions, and considerations regarding REC purchase decisions. The interview guidelines were developed based on a literature review of renewable energy adoption, environmental market instruments, and REC implementation (Li et al., 2022; Wei et al., 2021; Kusumawati & Putri, 2024).

The interview results were then analyzed to identify key themes, which were subsequently used as the basis for constructing a Fuzzy AHP hierarchy. In the quantitative stage, the instrument used was a pairwise comparison questionnaire designed based on the fundamental AHP scale and converted into Triangular Fuzzy Numbers (TFN) to accommodate uncertainty in expert assessments (Saaty, 1984; Chang, 1996).

3.4 Data Collection Procedures

Data collection was conducted in stages according to an exploratory sequential design. The first stage was a qualitative phase conducted through semi-structured interviews with 133 respondents from industrial companies in the PLN ULP Pandaan region. Interviews were conducted in person or via online communication platforms, depending on the respondents' availability. All interview results were documented in the form of notes and transcripts for further analysis.

After the interviews were completed, a thematic analysis was conducted to identify the factors driving and hindering REC purchases. The factors identified were then organized into a hierarchical decision structure to serve as input for the quantitative phase. Next, a



pairwise comparison questionnaire was administered to three PLN experts to assess the relative importance of each identified factor.

3.5 Operational Definition of Variables

The operational definitions of the variables examined in this study are presented in Table 1.

Table 1. Operational Definition of Variables

Variable	Definition	Measurement	References
REC Purchase Decision	The decision of industrial consumers to purchase Renewable Energy Certificates	Binary (Purchase/Not Purchase)	Li et al. (2022); Xu et al. (2022)
Regulatory Support	Government policies, regulations, and incentives supporting renewable energy adoption	Qualitative (Thematic)	Jia et al. (2023); Sambodo & Novandra (2023)
Sustainability Commitment	Corporate commitment to environmental sustainability, ESG, and emissions reduction	Qualitative (Thematic)	Wei et al. (2021); Chung et al. (2024)
Cost Perception	Perception of REC costs relative to benefits and alternative options	Qualitative (Thematic)	Li et al. (2022); Putri & Kusumawati (2025)
Trust in Certification	Trust in the transparency, traceability, and credibility of REC certification systems	Qualitative (Thematic)	Haryani et al. (2025); Lichtenstein (2023)
Awareness and Knowledge	Understanding of REC mechanisms, benefits, and availability	Qualitative (Thematic)	Li et al. (2022); Putri & Kusumawati (2025)
Stakeholder Pressure	Pressure from multinational corporations, consumers, and regulators	Qualitative (Thematic)	Freeman (1984); Lichtenstein (2023)
Perceived Behavioral Control	Perception of ease or difficulty in adopting RECs	Qualitative (Thematic)	Ajzen (1991); Wei et al. (2021)

Source: Developed for this research (2026)



3.6 Data Analysis Techniques

Qualitative data were analyzed using thematic analysis. The analysis process consisted of the following stages: transcription, coding, categorization, identification of themes, and interpretation of the relationships among themes (Braun & Clarke, 2006). This analysis aimed to identify the key factors influencing industrial consumers' REC purchasing decisions.

To enhance the credibility of the research findings, triangulation was performed by comparing interview results with supporting documents, field observation results, REC-related policies, and findings from previous studies (Denzin, 1978). This step was intended to reduce bias and ensure the consistency of the identified themes.

Quantitative data were analyzed using the Fuzzy Analytical Hierarchy Process (Fuzzy AHP) method. This method was chosen because it can accommodate the uncertainty and subjectivity in expert evaluations that cannot be fully addressed by conventional AHP methods (Saaty, 1984; Chang, 1996). The analysis stages included constructing a hierarchical structure, aggregating expert assessments using the geometric mean, compiling a pairwise comparison matrix, conducting consistency testing, converting values into Triangular Fuzzy Numbers (TFN), calculating the fuzzy synthetic extent, determining the degree of possibility, and normalizing priority weights (Buckley, 1985; Chang, 1996). The final result of the analysis is a priority ranking of the factors driving and inhibiting REC purchases based on their level of importance.

4. Results and Discussion

4.1 Overview of the Research Subject and Respondent Profiles

This study was conducted among medium-voltage industrial customers in the service area of PT PLN ULP Pandaan, Pasuruan Regency, East Java, which was selected because it is an industrial area with high electricity demand but a still low adoption rate of Renewable Energy Certificates (RECs).

Table 2. Customer Distribution by Rate Category

No	Rate Category	Description	Customers	Percentage
1	I3	Medium Voltage Industry	177	92.19%
2	B3	Medium Voltage Business	7	3.65%
3	I3P	Medium Voltage Industry (Prime)	6	3.12%
4	S2K	Medium Voltage Utilities	1	0.52%
5	LI3	Specialized Industrial Services	1	0.52%

Source: PLN ULP Pandaan customer data (2026)

A total of 192 industrial customers were identified, with 92.19% falling under the I3 tariff category (Medium Voltage Industry). In terms of business sectors, the population is dominated by Food & Beverages (25.00%), Packaging, Rubber & Plastics (17.19%), and Textiles, Leather & Footwear (15.62%), which collectively account for more than half of the customer population. This composition indicates that strategies to increase REC adoption should ideally prioritize energy-intensive industries focused on manufacturing and exports.

Table 3. Customer Distribution by Business Sector Group

No	Sector Group	Customers	Percentage
1	Food and Drink	48	25.00%
2	Packaging, Rubber, and Plastic	33	17.19%



No	Sector Group	Customers	Percentage
3	Textiles, Leather, and Footwear	30	15.62%
4	Other Sectors	29	15.10%
5	Metal and Construction	25	13.02%
6	Chemistry and Pharmacy	16	8.33%
7	Wood and Furniture	11	5.73%

Source: PLN ULP Pandaan customer data (2026)

Based on this population, the sample size for the qualitative phase of the study was determined to be 133 companies using the Slovin formula (5% margin of error), with six informants selected through purposive sampling for in-depth semi-structured interviews. The selection of informants took into account the representation of companies that had and had not purchased RECs, in order to obtain a balanced perspective between post-adoption experiences and pre-adoption perceptions.

4.2 Result of the Qualitative Phase

The qualitative phase of this study aimed to identify the factors influencing companies' decisions to adopt Renewable Energy Certificates (RECs). Data were collected through semi-structured interviews with six informants from medium-voltage customer companies of PLN ULP Pandaan, including both companies that had adopted RECs and those that had not. All interview transcripts were analyzed using thematic analysis through the processes of open coding, axial coding, and theme formation.

Prior to conducting the thematic analysis, the interview results were compared with findings from previous studies to ensure that the identified factors had a strong theoretical foundation. A synthesis of the literature review indicates that various studies categorize the factors influencing REC adoption into the aspects of corporate strategy, regulation, knowledge and information, and product characteristics. The results of this synthesis served as an initial reference in the qualitative data analysis process while also helping to identify factors relevant to the conditions of the industry in Indonesia.

Table 4. Key Themes and Findings from Thematic Analysis

No	Theme	Key Findings
1	Corporate Strategy	A company's commitment to sustainability is influenced by its market orientation
2	Regulation and Policies	International buyers have more influence than government regulations
3	Knowledge and Access to Information	Most companies do not yet understand how RECs work
4	REC Product Characteristics	Users find RECs more practical, while non-users view them as an additional cost

Source: thematic analysis of interview transcripts (2026)

Based on the results of a thematic analysis of the interview transcripts, four main themes were identified, which were subsequently used as the basis for developing criteria in the weighting stage using the Fuzzy AHP method, namely (1) Corporate Strategy, (2) Regulations and Policies, (3) Knowledge and Access to Information, and (4) REC Product Characteristics.

Under the Corporate Strategy theme, it was found that the level of a company's commitment to sustainability is strongly influenced by its market orientation. Export-



oriented companies tend to have integrated sustainability policies into their business strategies, whereas companies focused on the domestic market generally have not yet made sustainability a top priority in their energy investment decision-making.

The Regulation and Policy theme indicates that pressure from international buyers is the most dominant external factor driving REC adoption. In contrast, domestic government regulations have not provided a significant impetus, as they were rarely mentioned spontaneously by informants during the interviews.

Under the Knowledge and Access to Information theme, there was a striking difference in the level of understanding between companies that have used RECs and those that have not yet adopted them. Informants who use RECs were able to comprehensively explain the purchasing mechanisms, benefits, and implementation of RECs, while the other five informants consistently stated that they still had limited information regarding the mechanisms and benefits of RECs, which influenced their companies' decisions to adopt them.

Meanwhile, the REC Product Characteristics theme shows that perceptions of the product are heavily influenced by user experience. Informants who have adopted RECs consider these products to be more practical, flexible, and economical compared to building their own solar power plants (SPPs). Conversely, companies that have not yet used RECs tend to view RECs as an additional cost with benefits that cannot yet be felt directly, mainly because RECs do not have a physical form like SPP installations.

4.3 Result of the Quantitative Phase (Fuzzy AHP)

The four main themes identified during the qualitative analysis phase were subsequently developed into a three-level hierarchical structure using the Fuzzy Analytic Hierarchy Process (Fuzzy AHP), consisting of goals, criteria, and subcriteria. This hierarchical structure was used to determine the relative importance of each factor influencing industrial customers' decisions to purchase Renewable Energy Certificates (RECs). Based on the results of the thematic analysis, four main criteria were identified: Corporate Strategy (C1), Regulations and Policies (C2), Knowledge and Access to Information (C3), and REC Product Characteristics (C4). These four criteria were broken down into ten subcriteria, which were then evaluated by three experts using a pairwise comparison questionnaire. The weighting process was conducted using the Fuzzy AHP method with the Triangular Fuzzy Number (TFN) approach.

Description

Table 5. Normalization of the Weight Vectors for Criteria and Subcriteria

Criteria	Criteria Weight	Subcriteria	Value	Subcriteria Weight	Rank
K1	0.344	K01	0.00	0	7
		K02	1.00	0.34	2
K2	0.402	K03	1.00	0.402	1
		K04	0.00	0	7
		K05	0.00	0	7
K3	0.130	K06	1.00	0.13	3
		K07	0.00	0	7
K4	0.124	K08	0.33	0.04	4
		K09	0.33	0.04	4
		K10	0.33	0.04	4

Source: Fuzzy AHP expert-judgment analysis (2026)



The dominance of the Regulations and Policies criterion indicates that companies' decisions to adopt RECs are influenced more by external pressures than by internal factors. This finding suggests that government policies, demands from international buyers, and global market pressures remain the primary drivers of REC implementation in the industrial sector. These results align with the Institutional Theory perspective, which explains that organizations tend to adjust their behavior and business strategies in response to regulatory and normative pressures from the external environment.

At the subcriterion level, the analysis shows that Product Needs (K02) and Government Policy (K03) are the subcriteria with the highest levels of importance within their respective criteria. Additionally, Understanding of RECs (K06) is also a key subcriterion within the Knowledge and Access to Information group. Since the degree-of-possibility method (Chang, 1996) yielded several zero weights for certain subcriteria - namely K01, K04, K05, and K07 - the subcriteria weights used in constructing the REC Readiness Index (RRI) were recalculated using the geometric mean approach (Buckley, 1985). This approach ensures that all subcriteria retain proportional weights, thereby serving as a basis for the development of the customer readiness index.

Table 6. Global Weights of Subcriteria for Index Calculation

Code	Subcriteria	Local Weight	Criteria Weight	Global Weight (w)
K01	Company Vision and Mission	0.284	0.344	0.098
K02	Product Requirements	0.716	0.344	0.246
K03	Government Policy	0.098	0.402	0.040
K04	Consumer Demands	0.267	0.402	0.107
K05	International Standards	0.634	0.402	0.255
K06	REC Level of Understandin	0.823	0.130	0.107
K07	Resources	0.177	0.130	0.023
K08	REC Price	0.382	0.124	0.047
K09	Ease of Purchase and Use	0.370	0.124	0.046
K10	Product Differentiation	0.248	0.124	0.031

Source: Fuzzy AHP expert-judgment analysis (2026)

As a practical application of the results of the Fuzzy AHP weighting, this study developed the REC Readiness Index (RRI) to measure the level of readiness among industrial customers to adopt Renewable Energy Certificates. This index was constructed by coding interview results using a 1-5 scale assessment rubric across ten subcriteria, which were then aggregated using the Simple Additive Weighting (SAW) method based on the global weights of the subcriteria. The final value is then normalized to a range of 0-100 and classified into three readiness categories: Not Ready (0-33.33), Somewhat Ready (33.34-66.66), and Ready (66.67-100).

The results of applying the REC Readiness Index to the six respondents show that one respondent (16.7%) falls into the Ready category, two respondents (33.3%) fall into the Somewhat Ready category, while three respondents (50.0%) remain in the Not Ready category. The average customer readiness index score was 36.4, indicating that, in general, industrial customers in the study area are still at a relatively low level of readiness to adopt REC.

Table 7. Results of the REC Readiness Index (RRI)

ID	Respondent	REC Status	WS	RRI	Category
R001	PT Amarta	Not Yet	2.565	39.1	Just Ready



ID	Respondent	REC Status	WS	RRI	Category
R002	PT Eastern Tex	Not Yet	2.184	29.6	Not Ready
R003	PT Coca Cola Bottling Indonesia	Already	4.221	80.5	Ready
R004	PT Osaki Medical Indonesia	Not Yet	1.290	7.2	Not Ready
R005	PT Agip Lubrindo Pra	Not Yet	2.111	27.8	Not Ready
R006	PT Sampoerna	Not Yet	2.362	34.0	Just Ready

Source: REC Readiness Index calculation (2026)

The most significant finding is that the only respondent that has implemented REC achieved the highest RRI score (80.5) and was the only company classified as Ready. This suggests that the developed index has good face validity, as it consistently distinguishes between companies that have adopted REC and those that have not. Further analysis shows that the Ready group scored high on the sub criteria of Product Need and Understanding of RECs, while the Not Ready group generally scored low on both of these sub criteria as well as on the aspect of Access to Information. Another interesting finding is the presence of one company with a strong commitment to decarbonization, yet it was still categorized as Not Ready because it preferred to invest in standalone solar power plants (PLTS) rather than purchasing RECs. Furthermore, this company also had a relatively low level of understanding regarding the REC mechanism. This situation indicates that a commitment to sustainability does not necessarily correlate with readiness to adopt RECs if it is not supported by adequate product literacy and access to information.

4.4 Formulating Strategy Based on SWOT Analysis

The results of the Fuzzy AHP weighting were then mapped into a SWOT framework to formulate strategies for increasing REC adoption among industrial customers. Regulations and Policies (K2; weight 0.402) were identified as the primary opportunity, Corporate Strategy (K1; 0.344) as a strength, Knowledge and Access to Information (K3; 0.130) as a threat, and REC Product Characteristics (K4; 0.124) as a weakness. The integration of these four factors resulted in ten strategies grouped into SO, WO, ST, and WT strategies, as shown in Table 8.

Table 8. SWOT Matrix for the Strategy to Increase REC Adoption

	Opportunities (O)	Threats (T)
Strengths (S)	SO1. Integrating RECs into the company's sustainability strategy to comply with regulations and international standards SO2. Leveraging consumer demand as a driver for increasing the use of RECs SO3. Strengthening the company's positioning as a green-energy-based industry	ST1. Enhancing the company's internal capacity regarding understanding of RECs through training ST2. Strengthening collaboration with PLN in providing information on RECs ST3. Leveraging the company's commitment to encourage adoption despite information limitations
Weakness (W)	WO1. Enhancing the REC value proposition through education on economic and environmental benefits WO2. Simplifying the process of purchasing and using	WT1. Intensifying outreach and education on REC for industrial consumers WT2. Providing transparent and easily accessible information WT3. Developing



Opportunities (O)	Threats (T)
RECs WO3. Adjusting pricing schemes or incentives based on government policy	incentive programs or pilot projects to increase consumer confidence

Source: Fuzzy AHP and SWOT integration analysis (2026)

Validation results from three experts showed that seven out of ten strategies were rated as highly feasible (scores of 4.21-5.00). The strategies with the highest ratings included integrating RECs into corporate sustainability strategies (SO1), leveraging international buyer demands (SO2), enhancing internal capacity through training (ST1), strengthening collaboration with PLN (ST2), improving the value proposition through education (WO1), and intensifying outreach and providing transparent information (WT1 and WT2). Conversely, strategy ST3 received the lowest score (3.33), indicating that a commitment to sustainability is not yet sufficient to drive REC adoption without adequate information. These findings suggest that improving literacy, ensuring information transparency, and strengthening collaboration between PLN and industrial customers are strategies that should be prioritized over the provision of economic incentives alone.

4.5 Development of a Strategic Implementation Framework

Based on the integration of the results of the thematic analysis, weighting using the Fuzzy AHP method, and strategy formulation through a SWOT matrix, this study produced a strategic framework for the implementation of Renewable Energy Certificates (RECs) as its primary conceptual output. This framework illustrates the relationship between factors that drive or hinder REC adoption and implementation strategies that can be applied to enhance industrial customers' readiness to adopt RECs.

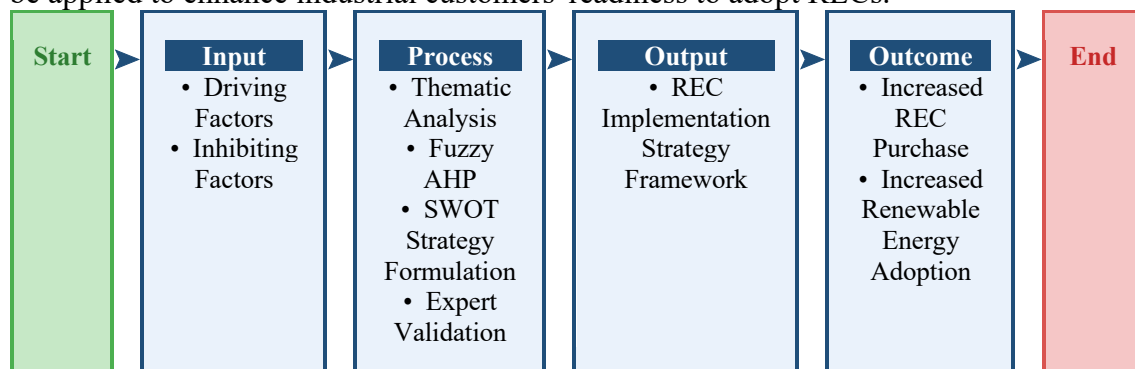


Figure 2. Development of a Framework for REC Implementation Strategies

The framework was developed sequentially, starting with the identification of factors through thematic analysis, followed by the determination of priority levels using Fuzzy AHP, and culminating in the formulation of strategies based on SWOT analysis. The integration results show that Regulations and Policies are the factors with the greatest influence in driving REC adoption, while low levels of knowledge and access to information are the main barriers that require attention. Therefore, the proposed strategies focus on strengthening customer education, improving information transparency, enhancing collaboration between PLN and industrial customers, and integrating REC into corporate sustainability strategies.

Validation by experts indicates that the resulting framework effectively represents the relationships among the factors influencing REC purchase decisions while providing a systematic implementation roadmap for both PLN and industrial companies. Thus, this framework serves not only as a conceptual model but also as a practical guide for

designing strategies to increase REC adoption, thereby supporting the acceleration of the energy transition and the achievement of renewable energy mix targets in Indonesia.

4.6 Discussion

Overall, the findings of this study confirm that industrial consumers' decisions to purchase RECs result from a complex interaction between external and internal factors. External factors - particularly regulatory pressure and demands from global buyers - serve as the primary driving force, consistent with the findings of Jia et al. (2023) regarding the role of corporate commitments (RE100) as a driver of adoption in the Asia-Pacific region. However, this study expands on those findings by demonstrating that, in the context of Indonesia's domestic industry, global supply chain pressures (export buyers) are actually more dominant than domestic regulations themselves - a nuance that has not been widely explored in previous studies, which have focused more on the macro level (Irfan, 2021) or the impact of RECs on firm value (Chung et al., 2024).

On the other hand, low product literacy and a lack of structured outreach were identified as major barriers, consistent with the findings of Li et al. (2022) regarding companies' limited understanding of RECs in Singapore, as well as Haryani et al. (2025), who highlighted limitations in traceability and transparency in REC implementation in Indonesia. This study enriches these findings by empirically demonstrating, through the REC Readiness Index, that even companies with strong internal sustainability commitments may still fall into the Not Ready category if they lack adequate product understanding.

The main contribution of this study lies in the integration of thematic, Fuzzy AHP, and SWOT approaches into a single mixed-methods analytical framework - an approach that has not been widely applied in the context of micro corporate behavior regarding REC purchasing decisions at the domestic industry level - thereby filling a research gap identified in previous studies, which tended to focus solely on the macro level or technical issues. In practical terms, these findings recommend that REC providers (in this case, PLN) prioritize education and information transparency as key interventions, supported by the strengthening of the national regulatory framework and the development of service schemes that are more adaptable to the segmented needs of industrial consumers.

5. Conclusion

This study aimed to identify and prioritize the factors influencing the adoption of Renewable Energy Certificates (RECs) among industrial customers of PLN ULP Pandaan, as well as to formulate implementation strategies that can increase the rate of REC adoption. Using a mixed-methods approach with an exploratory sequential design, the study successfully integrated the results of thematic analysis and the Fuzzy Analytic Hierarchy Process (Fuzzy AHP) to prioritize the factors influencing REC purchase decisions.

The results indicate that there are four main factors influencing REC adoption: Corporate Strategy, Regulations and Policies, Knowledge and Access to Information, and REC Product Characteristics. Of these four factors, Regulations and Policies emerged as the most dominant factor, followed by Corporate Strategy, while Knowledge and Access to Information and REC Product Characteristics remain the primary barriers to increasing REC adoption. These findings suggest that external pressures, particularly global market demands and policies supporting the energy transition, have a greater influence than internal corporate motivations in driving REC purchasing decisions. This finding aligns



with Stakeholder Theory, which explains that companies are influenced by pressure from various stakeholders including multinational corporations, regulators, and consumers (Freeman, 1984; Lichtenstein, 2023).

This study also developed the REC Readiness Index (RRI) as a tool to measure the readiness level of industrial customers to adopt RECs. The results of applying the index show that most respondents still fall into the Not Ready to Somewhat Ready categories, indicating that improving literacy, access to information, and understanding of the benefits of RECs remain key priorities. Furthermore, integrating the results of the Fuzzy AHP with SWOT analysis yielded strategies that prioritize customer education, information transparency, strengthening collaboration between PLN and industrial customers, and integrating RECs into corporate sustainability strategies. These strategies are consistent with the Theory of Planned Behavior, which emphasizes the importance of perceived behavioral control and knowledge in shaping behavioral intentions (Ajzen, 1991; Wei et al., 2021).

The main contribution of this study lies in the development of an approach that integrates qualitative analysis, Fuzzy AHP, the REC Readiness Index, and SWOT analysis into a single conceptual framework to support decision making regarding REC adoption. The resulting framework not only provides a methodological contribution to research on renewable energy adoption but also offers practical implications for PT PLN (Persero), the government, and industry stakeholders in designing more effective strategies to increase the utilization of RECs as part of efforts to accelerate the energy transition in Indonesia.

From a practical perspective, this study provides actionable insights for PLN, regulators, and industrial consumers. PLN needs to strengthen customer education and information transparency regarding REC mechanisms and benefits. Regulators should provide clearer policy frameworks and incentives to encourage REC adoption among industrial consumers. Industrial consumers need to integrate RECs into their corporate sustainability strategies to meet global market demands and ESG requirements.

This study has several limitations that should be acknowledged. First, the study focused only on industrial customers in the service area of PLN ULP Pandaan, which may limit the generalizability of the findings to other regions or customer segments. Second, the number of respondents in the exploratory phase was still limited, which may affect the comprehensiveness of the identified factors. Third, the study relied on self-reported data from respondents, which may be subject to social desirability bias. Fourth, the study did not examine the moderating role of organizational characteristics such as company size, industry sector, or ownership structure in the relationships examined.

Future research should expand the geographical scope to include other PLN regions and involve a larger number of respondents to enhance the generalizability of the findings. Researchers should test the developed model in other industrial sectors and use a more comprehensive quantitative approach to validate the priority rankings. Future studies should also examine the moderating role of organizational characteristics such as company size, industry sector, and ownership structure in REC adoption decisions. Finally, future research could employ longitudinal designs to examine how the factors influencing REC adoption evolve over time as the market matures and regulatory frameworks develop.

In conclusion, this study contributes to the growing body of literature on renewable energy adoption behavior by providing empirical evidence on the driving and inhibiting factors influencing REC purchasing decisions in the Indonesian context. The findings



suggest that Regulations and Policies are the most dominant factor, followed by Corporate Strategy, while Knowledge and Access to Information and REC Product Characteristics remain the primary barriers. As Indonesia accelerates its energy transition toward Net Zero Emissions by 2060, understanding these factors becomes increasingly important for developing effective strategies to increase REC adoption and promote renewable energy deployment in the industrial sector.

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