



A Multi-Winner Multi-PPA Procurement Strategy to Accelerate RUPTL 2025–2034 at PLN Indonesia

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Abstract

Background: Indonesia's Electricity Supply Business Plan (RUPTL) 2025–2034 sets ambitious renewable energy targets, yet project realization remains substantially below plan. Between 2021 and 2024, only 1,606.18 MW of the 5,096 MW target reached Commercial Operation Date, while only 8.34% of capacity entering procurement initiation during 2021–2025 progressed to Power Purchase Agreement signing.

Objective: This study aims to identify the principal factors associated with renewable energy procurement bottlenecks at PT PLN (Persero), examine stakeholder perceptions of the current procurement process, and prioritize an appropriate procurement strategy to support RUPTL implementation.

Methods: This study employed a mixed-methods approach that included performance gap analysis, the Kepner–Tregoe method, the fishbone diagram, SWOT–PESTEL analysis, a purposive survey of 24 respondents, and AHP. The AHP assessment involved 12 internal experts from PLN, with 10 experts retained in the final analysis after two respondents were excluded for failing to meet the consistency threshold ($CR \leq 0.10$). The strategic priorities were then tested through a sensitivity analysis.

Results: The analysis identified fragmented project-by-project procurement and the relatively small scale of individual projects as primary controllable factors associated with low procurement conversion. Stakeholder findings also highlighted regulatory uncertainty, PPA risk allocation, and procurement-process complexity. AHP prioritized the Bundling: Multi-Winner, Multi-PPA alternative with a global priority weight of 0.399, and sensitivity analysis showed that this priority remained stable across most criterion-weight variations.

Conclusion: The proposed strategy provides an integrated procurement framework for reducing process fragmentation while preserving flexibility across project characteristics. The framework may support PLN and other single-buyer utilities in structuring more coordinated renewable energy procurement.

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INTRODUCTION

Global warming remains one of the most pressing challenges facing the international community, with widespread consequences including climate change, prolonged droughts, floods, rising sea levels, and melting polar ice. International climate action gained momentum with the 1992 Rio Earth Summit and the 1997 Kyoto Protocol, culminating in the 2015 Paris Agreement, under which 195 countries committed to limiting the global average temperature increase to well below 2°C above pre-industrial levels. According to the World Meteorological Organization

(2025), the global average surface temperature in 2024 reached $1.55^{\circ}\text{C} \pm 0.13^{\circ}\text{C}$ above the 1850–1900 baseline, the warmest year in 175 years of observation and part of a decade-long streak of record-breaking temperatures. The energy sector, particularly electricity and heat generation, remains the single largest contributor to global CO₂ emissions, a pattern closely tied to the continued dominance of coal, oil, and gas in electricity systems worldwide, including in developing countries such as Indonesia.

Indonesia ratified the Paris Agreement through Law No. 16 of 2016 and has committed, through its Nationally Determined Contribution, to reducing emissions by 31.89% through domestic effort and up to 43.2% with international support by 2030, reinforced by a national target of Net Zero Emissions (NZE) by 2060. Indonesia possesses substantial renewable energy potential estimated at 3,643 GW and dominated by solar resources (3,294.4 GW; [Nasional, 2022](#)), yet by the end of 2024 only 14.3 GW, or roughly 0.39% of this potential, had been developed, with renewable sources contributing 18.10% of national electricity production. This wide gap between potential and utilization reflects structural constraints in Indonesia's electricity sector, including a monopolistic market structure and a complex, often burdensome regulatory framework that complicates project financing ([Maulidia et al., 2018](#); [Wahyuni & Ardiansyah, 2022](#)). Because renewable energy plants involve high upfront investment, limited or no fuel costs, and intermittent output, their procurement requires a departure from methods historically designed around conventional fossil-fuel generation ([Suhud & Pranadi, 2022](#)).

PT PLN (Persero), Indonesia's state-owned, vertically integrated electricity utility, is the principal off-taker for renewable energy projects developed under Independent Power Producer (IPP) schemes, making its procurement function central to the pace of the national energy transition. As of September 2025, fossil-fuel plants still accounted for 88.3% of PLN's 79.99 GW installed capacity, with renewable energy contributing only 14.16% of the energy mix well short of the 23% target originally set for 2025 ([Persero, 2025](#)). Renewable energy projects that reached Commercial Operation Date (COD) between 2021 and 2024 totaled only 1,606.18 MW against a target of 5,096 MW, an overall achievement rate of just 31.52%. The RUPTL 2025–2034 has since set a more ambitious target of 15.1 GW of renewable energy capacity within the next five years and 37.73 GW over the following five years, comprising 952 projects totaling 52.9 GW, 76% of which involve the IPP scheme. As of July 2025, however, only 0.6 GW of the 1.7 GW target for that year had been realized, and cumulative PPA signings for renewable energy projects from 2021 to 2025 totaled only 1,215.7 MW.

A review of PLN's project pipeline shows that although the volume of projects entering the procurement initiation stage has grown substantially each year, the proportion that progresses to completed bidding documents and, ultimately, to signed PPAs has remained low an early indication that the procurement stage itself, rather than construction alone, constitutes the principal bottleneck limiting renewable energy realization.

The design of renewable energy procurement and auction mechanisms has received substantial attention in the international literature, encompassing auction design principles and outcomes in Europe ([Anatolitis et al., 2022](#); [Bichler et al., 2020](#); [Haelg, 2020](#); [Winkler et al., 2017](#)), risk allocation and bankability considerations ([Dobrotková et al., 2018](#); [Kruger & Alao, 2024](#)), and country-specific experiences in India ([Bose & Sarkar, 2019](#); [Shrimali et al., 2016](#); [Thapar et al., 2018](#)), Turkey ([Özcan, 2021](#); [Şirin & Sevindik, 2021](#); [Yalılı et al., 2020](#)), Brazil ([Tolmasquim et al., 2021](#)), Nigeria ([Arowolo, 2019](#)), Kazakhstan ([Darke & Karatayev, 2025](#)), and sub-Saharan Africa ([Kruger & Alao, 2024](#)). More recent work has examined combinatorial and multidimensional auction governance Ehrhart et al. (2024) and Mathieu & Valenzuela (2025) confirmed that procurement and auction outcomes depend on the interaction among multiple design elements rather than any single feature ([Anatolitis et al., 2022](#); [Bichler et al., 2020](#); [Matthäus, 2020](#)). Much of this literature, however, examines procurement design from a market-policy perspective external to the buyer, with comparatively limited attention to how a vertically integrated, single-buyer utility can internally diagnose and redesign its own procurement structure, validate that diagnosis against its stakeholder ecosystem, and prioritize among structural alternatives using a transparent multi-criteria method. This study addresses that gap by combining root-cause diagnosis, stakeholder validation, and Analytic Hierarchy Process (AHP) prioritization following established multi-criteria decision-making applications in procurement and contractor selection

(Mathagul et al., 2019; Odum et al. (2022) and Saaty (2008) within the operational context of PLN's renewable energy procurement function. Specifically, no prior study has combined internal root-cause diagnosis, stakeholder validation, and AHP-based prioritization to redesign the procurement structure of a single-buyer utility such as PLN the specific contribution advanced here.

Against this background, the present study aims to (1) identify and analyze the principal factors behind the low realization of renewable energy projects relative to RUPTL targets, (2) examine the perceptions and experience of key stakeholders regarding the current procurement process, and (3) propose and prioritize, using a multi-criteria decision-making approach, a new procurement strategy capable of accelerating renewable energy implementation under the RUPTL 2025–2034. The study focuses specifically on the procurement of electricity from Solar PV plants, which account for the single largest technology share (17.1 GW) in the RUPTL 2025–2034; techno-economic evaluation (e.g., LCOE, IRR, NPV) of individual projects lies outside its scope. The urgency of this study is underscored by the widening gap between the RUPTL 2025–2034 targets and actual realization: with procurement conversion below 9% and the 23% energy-mix target already missed, delayed procurement reform directly threatens Indonesia's Net Zero Emissions 2060 trajectory. Its novelty lies in shifting the analytical lens from the market-policy, auction-design perspective that dominates prior studies del Río & Kiefer (2021, 2023) and Anatolitis et al. (2022) toward the internal procurement structure of a vertically integrated single-buyer utility, an angle largely unaddressed by earlier work on PLN and Indonesian renewable energy procurement (Yudha & Tjahjono, 2019; Yustika, 2024). Theoretically, the study extends multi-criteria decision-making to utility-level procurement redesign; practically, it offers PLN an evidence-based, prioritized procurement model; and in terms of implications, it provides a replicable diagnostic-to-decision framework for other single-buyer utilities pursuing accelerated renewable energy deployment.

METHOD

This study adopted a mixed-methods design intended to generate a systematic, evidence-based line of reasoning toward a renewable energy procurement strategy capable of accelerating the RUPTL 2025–2034. The design begins by establishing the performance gap between planned and realized renewable energy capacity, followed by an internal–external environmental analysis (SWOT and PESTEL) and a structured root-cause analysis using the Kepner–Tregoe (KT) method and a fishbone diagram. Stakeholder perceptions were then collected and analyzed to validate the diagnosis and surface practical considerations for strategy formulation. Finally, alternative procurement strategies were formulated through an internal Focus Group Discussion (FGD) and evaluated using the Analytic Hierarchy Process (AHP), including a sensitivity analysis to test the robustness of the resulting priorities. Specifically, this sequential mixed-methods design proceeds in four interconnected phases: (1) a quantitative performance-gap analysis identifies the magnitude and location of the procurement shortfall; (2) structured root-cause analysis (Kepner–Tregoe and fishbone) explains why the gap occurs; (3) a quantitative–qualitative stakeholder survey independently validates the diagnosis; and (4) AHP converts the validated diagnosis into a prioritized strategy, with each phase supplying the input for the next so that the final strategy remains traceable to the original performance gap.

Data collection combined secondary and primary sources tailored to the three research questions. Secondary data includes PLN's internal records regarding the initiation of procurement, the completion of tender documents, the signing of Power Purchase Agreements (PPAs), and the achievement of Commercial Operation Dates (CODs) during the 2021–2025 period, the list of projects in the 2025–2034 RUPTL, as well as relevant regulations, particularly Presidential Regulation No. 112 of 2022. This data was used to conduct a performance gap analysis and identify the root causes of challenges in renewable energy procurement. Primary data was collected through a structured online questionnaire involving 24 respondents selected through purposive sampling from four stakeholder groups: five respondents from renewable energy developers/Independent Power Producers (IPPs), five respondents from the Ministry of Energy and Mineral Resources (as regulators), eight respondents from academia, think tanks, and research organizations, and six internal PLN staff members involved in renewable energy

planning and management. The respondents' experience profiles showed that 16 had more than 10 years of experience, six had 5–10 years of experience, and two had less than five years of experience. Respondent selection took into account knowledge, experience, and institutional roles relevant to renewable energy procurement, planning, or policy, as well as their involvement in issues or projects related to PLN. In the final stage, alternative procurement strategies were formulated through internal Focus Group Discussions (FGDs) and evaluated using the Analytic Hierarchy Process (AHP).

The survey instrument combines five-point Likert-scale statements and open-ended questions, with a questionnaire format tailored to each stakeholder group. The questions cover perceptions regarding the transparency and efficiency of the procurement process, regulatory certainty, the financial viability and risk allocation in PPAs, as well as support for project aggregation and recommendations for improvement. The number and arrangement of items were not standardized across all respondents but followed the instrument format for each respective group. Respondent 01's questionnaire contained 21 Likert items (questions 9–29) and five open-ended questions (questions 6–8 and 30–31), in addition to the respondent profile questions. The instrument was reviewed through an internal focus group discussion (FGD) before distribution. Subsequently, AHP criteria (C1–C6) and strategic alternatives (A1–A4) were developed based on the findings of the root cause analysis as well as SWOT, PESTEL, and TOWS analyses, and were then confirmed through internal FGDs. This process was used to develop a decision hierarchy appropriate for the renewable energy procurement issues under study.

A separate quantitative instrument was provided to 12 internal PLN experts with relevant professional experience to conduct pairwise comparisons of procurement criteria and alternatives using a 1–9 Saaty scale in the AHP analysis. The initial panel consisted of three Vice Presidents with 15–33 years of experience, five Managers with 14–18 years of experience, and four Senior Engineers/Technical Staff with 10–15 years of experience. The criteria and alternatives were first validated through an internal Focus Group Discussion (FGD) with PLN's Renewable Energy Procurement Planning Division. Two respondents were excluded from the final analysis because their ratings did not meet the consistency threshold ($CR \leq 0.10$) thus, the final calculations were based on the ratings of 10 experts.

Secondary data were analyzed descriptively to quantify the performance gap between RUPTL targets and realized capacity, and to trace the conversion rate of the procurement pipeline from initiation to PPA signing. Root causes were identified using Kepner–Tregoe problem analysis structured around the WHAT, WHERE, WHEN, and EXTENT dimensions with an IS/IS NOT distinction Kepner & Tregoe (1981) and camp et al. (2022) organized into a fishbone diagram across five categories adapted to the characteristics of renewable energy procurement: Process, Project, People, Policy, and Market. SWOT and PESTEL analyses were conducted to map internal strengths and weaknesses against external opportunities and threats, with a TOWS matrix used to derive strategic implications. Likert-scale responses from the stakeholder survey were analyzed descriptively using mean scores and agreement levels, while open-ended responses were coded thematically to identify recurring issues; both were used to validate the root causes identified from secondary data. Thematic coding followed a six-step procedure: responses were compiled verbatim, read for familiarization, assigned initial open codes, grouped into candidate themes, reviewed and merged to remove overlap, and finally consolidated into eight recurring themes each retained only when raised by multiple respondents across more than one stakeholder group after which theme frequencies were tabulated to indicate salience. Finally, AHP pairwise-comparison data were processed in Microsoft Excel and Super Decisions software to calculate criterion weights, alternative scores, and global priority rankings, with the consistency of expert judgments verified using a Consistency Ratio (CR) threshold of ≤ 0.10 , followed by a one-way sensitivity analysis on each criterion weight.

RESULTS AND DISCUSSION

Results

Performance Gap in Renewable Energy Procurement

Table 1 compared the RUPTL targets for renewable energy COD realization against actual achievement for 2021–2024. The overall achievement rate across the period was only 31.52%, with a cumulative capacity gap of 3,489.82 MW. Performance was strongest in 2021 (82.98%) but deteriorated sharply thereafter, falling to 16.98% in 2023 before recovering only partially to 27.89% in 2024. Preliminary 2025 data show a similar pattern, with 664.32 MW realized against a target of 1,729.03 MW (38.4%).

Table 1

Comparison of COD Targets and Realization for Renewable Energy Power Plants, 2021–2024

Year	Target (MW)	Realization (MW)	Gap (MW)	Achievement (%)
2021	752	624.00	-128.00	82.98
2022	648	172.25	-475.75	26.58
2023	2,026	344.06	-1,681.94	16.98
2024	1,670	465.87	-1,204.13	27.89
Total	5,096	1,606.18	-3,489.82	31.52

Beyond the aggregate COD realization figures, an analysis of the procurement pipeline reveals the stages at which project conversion gaps occur. During the 2021–2025 period, projects with a combined capacity of 14,568.54 MW entered the initial procurement phase, but only 6,280.87 MW reached the tender document completion stage and 1,215.7 MW reached the PPA signing stage, equivalent to approximately 8.34% of the total capacity that entered the initial procurement phase. The annual conversion rate fluctuated, rising from 5.18% in 2022 to 13.22% in 2024, before dropping to 6.96% in 2025 despite a substantial increase in the capacity entering the initial procurement phase. This pattern indicates that significant capacity losses occur throughout the procurement process prior to the signing of PPAs. Project readiness including land status, permitting, grid connections, and the availability of technical data as well as financial viability are contributing factors that can affect the smooth progress of the process both before the PPA and during project implementation after the PPA. These factors are treated as part of the framework for diagnosing procurement barriers because they can influence a project's readiness to participate in tenders, the completion of procurement stages, and the continuation of implementation. Therefore, the conversion gap cannot be explained by a single factor but must be analyzed by considering the interrelationship between the design of the procurement process and project readiness.

Root Causes of Low Procurement Conversion

Kepner–Tregoe (KT) problem analysis was used to contrast renewable energy procurement with the more successful realization pattern observed in non-renewable and transmission projects. The distinction analysis showed that non-renewable and transmission projects are typically larger in scale and more centralized, whereas renewable energy projects are numerous, geographically dispersed, and processed individually conditions associated with longer, more complex procurement cycles. Following FGD validation with PLN's internal Renewable Energy Development and Control team, two factors were classified as primary, controllable root causes: (1) a fragmented, project-by-project procurement approach, which duplicates documentation, evaluation, and negotiation across many small transactions, and (2) the relatively small scale of individual renewable energy projects, which limits economies of scale and investor attractiveness. Regulatory and policy uncertainty particularly concerning tariff mechanisms and hybrid solar-plus-battery schemes was classified as a secondary, only partially controllable cause, while limited internal procurement resources and variability in project readiness were identified as contributing factors. High transaction cost was classified as a derived

effect of procurement fragmentation rather than an independent root cause.

A fishbone (Ishikawa) diagram was subsequently used to organize these validated causes into five categories adapted to the characteristics of renewable energy procurement: Process (fragmented, repetitive, non-standardized procedures), Project (small size, geographic dispersion, readiness variability), People (limited internal resources and capability gaps), Policy (regulatory and tariff uncertainty, an evolving renewable energy framework), and Market (low investor attractiveness of small projects, elevated risk perception, limited competition). The Process and Project categories emerged as the dominant categories, directly reflecting the two primary root causes identified through KT analysis; the Market category was found to amplify their effect, while People and Policy factors were positioned as comparatively supporting categories.

Table 2

Kepner–Tregoe Classification of Identified Factors

Factor	Kepner–Tregoe Classification	Fishbone Category
Fragmented, project-by-project procurement	Primary, controllable root cause	Process
Small scale of individual RE projects	Primary, controllable root cause	Project
Regulatory and tariff/policy uncertainty	Secondary, partially controllable	Policy
Project-readiness variability	Contributing factor	Project
Limited internal procurement resources	Contributing factor	People
Low investor attractiveness / high risk perception	Amplifying factor	Market
High transaction cost	Derived effect (not an independent root cause)	Process

Internal and External Environment

A PESTEL analysis identified strong external drivers for procurement reform: the government's NZE-2060 commitment and the RUPTL mandate (political), the need for bankable, competitively tariffed projects (economic), generally positive public acceptance tempered by land and social-conflict risk (social), the complexity of intermittent generation and battery energy storage system (BESS) integration (technological), mounting ESG and decarbonization pressure from investors (environmental), and the tariff and hybrid-scheme limitations of Presidential Regulation No. 112/2022 alongside lengthy approval processes (legal/regulatory). A complementary SWOT analysis found that PLN's position as the sole electricity off-taker, its clear RUPTL mandate, accumulated procurement experience, cross-functional coordination capacity, and growing internal appetite for reform constitute substantial strengths, but these are offset by the same structural weaknesses identified in the root-cause analysis fragmentation, small and dispersed project characteristics, limited internal resources, insufficient standardization, and dependence on external project readiness. A TOWS matrix synthesis indicated that the Weakness Opportunity (WO) quadrant contains the strategic emphases most frequently proposed, centered on transforming fragmented, small-scale procurement into a more integrated, standardized, and larger-scale approach.

Table 3

TOWS Matrix Linking SWOT/PESTEL Findings to Strategic Alternatives A1–A4

	Opportunities (O)	Threats (T)
Strengths (S)	SO: Leverage sole-off-taker role and RUPTL mandate to fast-track bankable, aggregated packages (supports A2–A4).	ST: Apply procurement experience and standardized PPA templates to mitigate regulatory and tariff risk.
Weaknesses (W)	WO: Convert fragmented, small-scale	WT: Phase reform via pilot

Opportunities (O)	Threats (T)
procurement into integrated, standardized, larger-scale bundling → A4 Multi-Winner, Multi-PPA (dominant).	bundles and readiness gates to limit concentration and construction risk.

Stakeholder Perceptions

The stakeholder survey ($n = 24$) drew on internal PLN staff (25.0%), developers/IPPs (20.8%), regulators (20.8%), and academics/think-tank representatives (33.3%), two-thirds of whom had more than ten years of relevant experience. Descriptive analysis of the Likert-scale items showed the highest mean agreement on statements concerning regulatory uncertainty affecting investment decisions (mean = 4.67; 95.8% agreement) and policy inconsistency (mean = 4.62; 95.8%), followed closely by PPA risk allocation (mean = 4.42; 95.8%) and procurement-process complexity (mean = 4.38; 95.8%). Support for a more integrated or aggregated procurement approach was also high (mean = 4.33; 91.7%). By contrast, only 12.5% of respondents agreed that the current procurement process is already efficient the lowest agreement level recorded in the survey.

Thematic coding of open-ended responses identified eight recurring themes, most frequently procurement efficiency and process simplification (23 of 24 respondents), followed by regulatory certainty and policy consistency (21), project scale/bundling/aggregation (21), market attractiveness and competition (21), project readiness land, permits, and grid issues (20), PLN's internal capacity and coordination (20), bankability, financing, and risk allocation (19), and alignment with RUPTL implementation targets (17). When mapped against the previously identified root causes, stakeholder evidence strongly validated fragmented procurement, small project scale, regulatory and policy uncertainty, and PPA bankability/risk-allocation concerns, while internal PLN resource limitations and geographic/technology dispersion received only partial validation.

Prioritization of Procurement Strategy Using AHP

Building on the FGD-validated root causes and stakeholder findings, four procurement strategy alternatives were formulated: A1, single project procurement (*business as usual*), in which each project is tendered and contracted individually; A2, bundling with a single winner and a single PPA; A3, bundling with a single winner but multiple, project-specific PPAs; and A4, bundling with multiple winners and multiple PPAs, in which a bundled package may be awarded to more than one developer across clusters, sub-clusters, or locations. These were evaluated against six criteria: procurement time efficiency (C1), cost efficiency/PPA tariff competitiveness (C2), market attractiveness and competitiveness (C3), bankability/financing feasibility (C4), low procurement and construction failure risk (C5), and strategic alignment to RUPTL targets (C6).

As shown in Table 5, the ten experts retained for the final analysis assigned the highest weight to cost efficiency/tariff competitiveness (0.267), followed by low risk of failure (0.189), financial viability (0.174), compliance with the RUPTL (0.171), market attractiveness (0.128), and efficiency of the procurement timeline (0.071). Applying these weights, Table 4 shows that A4 (Bundling: Multi-Winner, Multi-PPA) was ranked as the highest-priority strategy, with a global priority weight of 0.399 approximately 2.4 times that of the baseline A1 alternative (0.165). A3 (Bundling: Single Winner, Multi PPA) ranked second (0.234), followed by A2 (0.202) and A1 (0.165). These AHP results represent the strategy prioritized by expert judgment under the specified criteria; they indicate relative preference and expected suitability rather than empirically proven acceleration of RUPTL realization, which would require subsequent implementation and outcome evaluation.

Table 4

Final AHP Priority Ranking of Procurement Strategy Alternatives

Code	Procurement Strategy Alternative	Global Priority Weight	Rank
A1	Single Project Procurement (Business as	0.165	4

Code	Procurement Strategy Alternative	Global Priority Weight	Rank
	Usual): Single Winner, Single PPA		
A2	Bundling: Single Winner, Single PPA	0.202	3
A3	Bundling: Single Winner, Multi PPA	0.234	2
A4	Bundling: Multi Winner, Multi PPA	0.399	1

Table 5*AHP Criteria Weights for Procurement Strategy Selection*

Code	Evaluation Criterion	Weight	Rank
C2	Cost Efficiency / PPA Tariff Competitiveness	0.267	1
C5	Low Procurement and Construction Failure Risk	0.189	2
C4	Bankability / Financing Feasibility	0.174	3
C6	Strategic Alignment to RUPTL Target	0.171	4
C3	Market Attractiveness and Competitiveness	0.128	5
C1	Procurement Time Efficiency	0.071	6

A one-way sensitivity analysis conducted in Super Decisions showed that the top-ranked alternative, A4, remains stable across most plausible changes in criterion weights, including cost efficiency, bankability, failure risk, market attractiveness, and RUPTL alignment. The ranking is sensitive only to the procurement time efficiency criterion: if its weight were to exceed approximately 0.89 an extreme emphasis unlikely in practice given its already-low base weight of 0.071 alternative A3 would overtake A4. Similarly, if the weight on failure-risk minimization (C5) were to exceed approximately 0.486, the baseline alternative A1 would rise to second rank. The ten experts' pairwise comparisons were aggregated using the geometric mean of individual judgments (aggregation of individual judgments) prior to deriving priorities, and the consistency of every comparison matrix was verified against the Consistency Ratio threshold of $CR \leq 0.10$ (criteria matrix $CR = 0.017$; all alternative matrices $CR < 0.10$). The resulting local priorities of the four alternatives under each criterion are reported in Table 6; synthesizing them with the criterion weights reproduces the global priorities in Table 4 (differences ≤ 0.001 are due to rounding).

Table 6*Local Priorities of Alternatives under Each Criterion and Synthesized Global Priorities*

Criteria	Weight	A1	A2	A3	A4
C1 Time efficiency	0.071	0.142	0.291	0.294	0.273
C2 Cost / tariff competitiveness	0.267	0.140	0.243	0.259	0.358
C3 Market attractiveness	0.128	0.102	0.122	0.200	0.576
C4 Bankability	0.174	0.225	0.207	0.220	0.349
C5 Low failure risk	0.189	0.270	0.140	0.147	0.443
C6 RUPTL alignment	0.171	0.083	0.225	0.305	0.387
Global priority		0.165	0.202	0.234	0.399
Rank		4	3	2	1

Discussion

Structural Root Causes and Strategic Direction

The substantial gap between the volume of projects entering procurement initiation and the relatively small proportion reaching PPA signing suggests that the procurement stage represents a major point of attrition in the renewable energy project pipeline. This interpretation

is consistent with the root-cause analysis, in which the Process and Project categories were prominent in the fishbone analysis and aligned with the two primary controllable factors identified through the Kepner–Tregoe analysis: fragmented, project-by-project procurement and the relatively small scale of individual renewable energy projects. Taken together, these findings indicate that the way projects are organized and processed within procurement is an important structural consideration in explaining the observed conversion gap. However, because the study did not conduct causal testing, these findings should be interpreted as an integrated diagnostic assessment rather than as evidence that procurement factors alone determine the underachievement of renewable energy targets.

The dominance of Weakness–Opportunity (WO) strategies in the TOWS synthesis (Section 3.3) reinforces this interpretation: rather than depending solely on internal strengths or external opportunities, PLN's procurement transformation should directly target its structural weaknesses fragmentation and small project scale in order to capture the strong external momentum for renewable energy investment reflected in the PESTEL findings. The convergence between this internally derived diagnosis and the independently collected stakeholder evidence (Section 3.4) particularly the strong validation of fragmented procurement, small project scale, regulatory uncertainty, and PPA bankability concerns strengthens confidence that these are genuine structural barriers rather than artifacts of internal data or a single analytical perspective. Together, these findings foreshadow an aggregation-oriented procurement strategy.

Interpretation of the AHP-Based Strategy Prioritization

The AHP results reported in Section 3.5, in which A4 (Bundling: Multi-Winner, Multi-PPA) received approximately 2.4 times the priority weight of the baseline single-project approach, indicate that experts favor a procurement strategy that combines the scale benefits of project aggregation with flexibility in winner selection and contract structuring. This preference is consistent with the broader auction-design literature's finding that procurement performance depends on the interaction of multiple design elements rather than any single feature (Anatolitis et al., 2022; Bichler et al., 2020). That cost efficiency/tariff competitiveness received the highest criterion weight, ahead of failure-risk minimization and bankability, while procurement time efficiency was weighted lowest, suggests that experts view commercially reasonable tariffs as inseparable from project viability rather than as a trade-off against speed an ordering that echoes evidence elsewhere that competitively designed procurement need not sacrifice bankability for cost efficiency when risk allocation is well structured (Dobrotkóvá et al., 2018; Kruger & Eberhard, 2023).

The sensitivity analysis further demonstrates the stability of the AHP prioritization across variations in most criterion weights. A4 remains the highest-priority alternative under changes in cost efficiency, bankability, failure risk, market attractiveness, and RUPTL alignment. A change in the highest-priority alternative occurs when the weight assigned to procurement time efficiency increases to approximately 0.89, substantially above its baseline weight of 0.071, at which point A3 becomes the highest-priority alternative. In addition, when the weight assigned to failure-risk minimization exceeds approximately 0.486, A1 rises to the second position. These results indicate that the relative priorities are generally stable under the tested scenarios while also showing the specific weighting conditions under which the ordering of alternatives may change.

Proposed Business Solution: Multi-Winner, Multi-PPA Bundling

Based on the convergence of the root-cause diagnosis, SWOT/PESTEL/TOWS analysis, stakeholder validation, and AHP prioritization, this study proposes a Multi-Winner, Multi-PPA Bundling model for PLN's renewable energy procurement, initially focusing on Solar PV projects. Under this model, multiple projects are grouped within a single procurement program or tender package, while awards may be allocated to more than one qualified developer across clusters, sub-clusters, regions, systems, or project entities, with separate PPAs maintained for individual awarded projects. Conceptually, this structure is intended to respond to the two primary controllable factors identified in the analysis by reducing repetitive project-by-project procurement while aggregating smaller projects into larger procurement packages. The multi-winner arrangement is also intended to distribute award concentration across developers, while

the multi-PPA structure retains flexibility to accommodate differences in location, grid readiness, and project-specific risk profiles. Because the proposed model has not yet been evaluated through implementation outcomes, these expected advantages should be treated as design propositions to be tested through subsequent implementation and evaluation.

Successful implementation is expected to depend on several enabling conditions, most notably: clustering projects using explicit criteria such as COD alignment, electricity system, geographic area, voltage level, project readiness, and grid-interconnection status; establishing minimum project-readiness gates covering site certainty, technical data, and interconnection assessment before a project is admitted into a bundled package; sub-clustering large packages to preserve manageable risk and technical homogeneity while still enabling multi-winner allocation; standardizing procurement documents, evaluation methods, and PPA templates to reduce preparation time and repeated negotiation, while retaining annex-level flexibility for project-specific terms; adopting a Build-Own-Operate (BOO) contract structure as the preferred PPA scheme to strengthen long-term revenue certainty for developers and lenders; conducting market sounding prior to launching bundled tenders to validate package size and developer appetite; and beginning with pilot bundled packages prioritizing projects with higher readiness before full-scale rollout, with success measured not only by tender completion but by subsequent PPA signing, financial close, construction progress, and COD realization

CONCLUSION

This study demonstrates that the gap in renewable energy realization under the RUPTL 2025–2034 is closely associated with attrition within the procurement process, particularly between procurement initiation and PPA signing. The integrated Kepner–Tregoe, fishbone, SWOT–PESTEL, stakeholder-perception, and AHP analyses consistently indicate that fragmented project-by-project procurement and the relatively small scale of individual renewable energy projects are the principal controllable factors associated with the observed conversion gap, while regulatory uncertainty, project-readiness variability, internal procurement capacity, and PPA bankability remain important supporting considerations. Stakeholder evidence further reinforces the need for a more integrated procurement approach. Within the AHP framework, the Bundling: Multi-Winner, Multi-PPA alternative received the highest global priority weight of 0.399, ahead of the other evaluated alternatives, and its ranking remained stable across most sensitivity-analysis scenarios. These findings position the proposed model as the highest-priority procurement option under the criteria and expert judgments applied in this study, rather than as an intervention already proven to accelerate RUPTL realization.

Based on these findings, PLN may consider implementing the Multi-Winner, Multi-PPA Bundling strategy selectively for Solar PV projects that demonstrate sufficient readiness and compatible COD targets. Implementation should be supported by explicit project-clustering criteria, minimum readiness requirements, standardized procurement and PPA documents, prior market sounding, and a phased pilot-based approach so that subsequent outcomes can be evaluated before wider adoption. The study contributes a practical multi-criteria framework linking procurement diagnosis, stakeholder validation, and strategy prioritization for renewable energy procurement in a vertically integrated single-buyer utility. Nevertheless, because the analysis does not include project-level techno-economic assessment such as LCOE, IRR, or NPV and focuses specifically on Solar PV procurement, future research should examine the financial and operational performance of bundled procurement after implementation, including its implications for tariff efficiency, transaction costs, bankability, financial close, construction progress, and COD realization, while extending the analysis to other renewable energy technologies and a broader group of external stakeholders.

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AUTHOR CONTRIBUTION STATEMENT

Sidik Mustafa and Gatot Yudoko contributed to the development, review, and finalization of this manuscript. Both authors participated in ensuring the coherence of the research framework, interpretation of the findings, and preparation of the final manuscript, and both authors approved the final version for publication.

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