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The Strategies and Projections for Energy Transition in West Java: A Policy Analysis Towards Indonesia's Net Zero Emission (NZE) 2060

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ABSTRACT

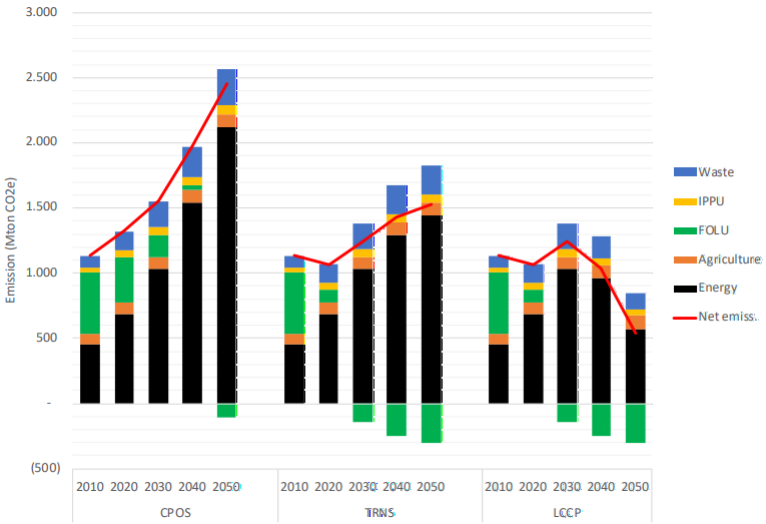
This study examines the strategic policy framework for energy transition in West Java Province, Indonesia, aligned with the national Net Zero Emission (NZE) target by 2060. Through a qualitative analysis of provincial policy documents and energy modeling projections, the research outlines the revision process of the Regional General Energy Plan (RUED) in response to updated national directives. The methodology involves content analysis of the 2023 policy dialogue and energy modeling reports from the West Java Energy Office. Key findings highlight a dual strategy focusing on demand-side management through electrification and efficiency, and supply-side transformation via renewable energy maximization and decarbonization technologies such as green hydrogen, biofuels, and carbon capture. The study concludes that achieving NZE requires robust cross-sector collaboration, rational energy pricing, and significant investment in renewable infrastructure, with West Java serving as a critical regional model for Indonesia's low-carbon transition.

Keywords: renewable energy, energy transition, net zero emission, the Regional General Energy Plan, West Java Province

I. INTRODUCTION

The global imperative to limit temperature rise in accordance with the Paris Agreement has compelled nations to embark on deep decarbonization of their economies, with the energy sector at the forefront of this transformation. Indonesia, as a major emerging economy and archipelagic nation, faces a dual challenge: sustaining economic growth while radically reducing its greenhouse gas emissions. In response, the Indonesian government has ratified the Paris Agreement through Law No. 16 of 2016 and submitted an Enhanced Nationally Determined Contribution (NDC), committing to an unconditional 31.89% reduction in emissions by 2030, which can be elevated to 43.20% with international support. A cornerstone of this commitment is the national pledge to achieve Net Zero Emission (NZE) in the energy sector by 2060, as outlined in the Ministry of Energy and Mineral Resources' strategic roadmap. This ambitious target necessitates a fundamental realignment of national energy policy and, crucially, its coherent translation into actionable plans at the sub-national level.

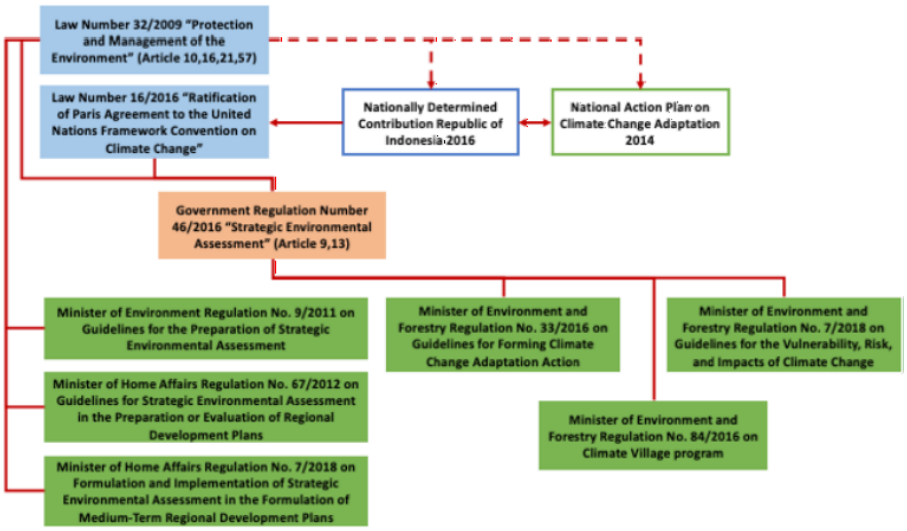
Figure 1: Indonesia's Climate Commitment Pathway based on Current Policy Scenario (CPOS), Transition Scenario (TRNS), and Low Carbon Scenario Compatible with Paris Agreement Target (LCCP)



Source: Indonesia LTS-LCCR (analyzed), 2021.

The success of Indonesia's energy transition hinges significantly on the capacity of its regions to implement the national vision. West Java, the nation's most populous province and a primary engine of economic activity, contributes substantially to national energy demand and associated emissions. Consequently, its strategic approach to energy planning is not only critical for provincial sustainability but also a determinative factor for national NZE success. This context provides the impetus for the ongoing revision of West Java's Regional General Energy Plan (*Rencana Umum Energi Daerah - RUED)* for the period 2024–2060. This update is directly driven by the comprehensive revision of the National Energy Policy (Kebijakan Energi Nasional - KEN), which shifts its grand strategy from securing energy independence to maintaining energy resilience through a managed transition, explicitly integrating decarbonization as a core objective.

Figure 2: Multi-Level Energy Governance Framework



Source: Indonesia LTS-LCCR (analyzed), 2021.

This article aims to conduct a critical analysis of the policy strategies and modeling projections developed by the West Java Energy and Mineral Resources Office in its pursuit of NZE. Specifically, it seeks to: (1) examine the implications of the revised National Energy Policy (KEN) for provincial-level planning and governance, (2) analyze the demand-side and supply-side intervention scenarios encapsulated in West Java's draft the revision of West Java's

Regional General Energy Plan (*Rencana Umum Energi Daerah - RUED*) for the period 2024–2060, including electrification, renewable energy maximization, and adoption of decarbonization technologies, and (3) evaluate the proposed multi-stakeholder collaborative framework essential for implementation, involving central and local government, state-owned enterprises, the private sector, and civil society.

By investigating the interplay between national policy directives and sub-national planning in West Java, this study makes a twofold contribution. First, it enriches the literature on multi-level governance in energy transitions, particularly within the context of large, decentralized developing countries. Second, it provides a timely and concrete case study on the complexities of operationalizing long-term NZE targets into regional energy policy, offering insights that may inform similar processes in other Indonesian provinces and comparable regions globally.

II. LITERATURE REVIEW

A. *The Global and National Imperative for Energy Transition*

The global commitment to climate change mitigation, crystallized in the Paris Agreement, has established a clear imperative for nations to transition their energy systems towards net-zero emissions (NZE) (UNFCCC, 2015). Indonesia, as a signatory, has translated this commitment into national policy through the Enhanced Nationally Determined Contribution (NDC), targeting a 31.89-43.20% reduction in emissions by 2030 and an NZE goal by 2060 (Republic of Indonesia, 2016; Ministry of Environment and Forestry, 2021). The energy sector is projected to be the largest contributor to CO2 emissions after the forestry sector post-2030, making its decarbonization critical for national climate goals (NEC, 2023). This global-to-national policy cascade forms the foundational context for sub-national energy planning.

B. *Evolution of Indonesia's National Energy Policy (KEN) and Multi-Level Governance*

Indonesia's primary energy governance framework, the National Energy Policy (KEN) established under Government Regulation (PP) No. 79 of 2014, is undergoing a significant revision. As noted by Yudha (2023), the urgency for this update stems from several factors: the misalignment between original macroeconomic assumptions and actual economic growth, the failure to meet several energy supply and utilization targets, and the necessity to harmonize energy policy with national and international climate commitments. The draft revised KEN marks a strategic shift from a focus on "Energy Resilience and Independence" to maintaining "Energy Resilience during Transition," explicitly incorporating decarbonization and NZE as core objectives (NEC, 2023).

This revised national policy introduces new strategic pillars, such as maximizing renewable energy, minimizing fossil fuels (coal and gasoline), optimizing gas as a transitional fuel, and considering new energy sources like nuclear for balancing decarbonization targets (NEC, 2023). Crucially, the KEN mandates the development of Regional General Energy Plans (RUEDs), creating a multi-level governance structure where provincial plans must synchronize with national directives. The literature on policy implementation emphasizes that such vertical integration is vital for the coherence and effectiveness of national climate strategies (Betsill & Bulkeley, 2006). The revision of KEN, therefore, is not an isolated national event but a critical driver for comprehensive policy renewal at the provincial level, as seen in the revision of West

Java's Regional General Energy Plan (*Rencana Umum Energi Daerah - RUED*) process.

C. *Strategic Pathways for Decarbonization: Demand-Side and Supply-Side Interventions*

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The technical pathways for NZE, as outlined in both national and West Java documents, align with established literature on energy transition, which emphasizes a dual approach of demand-side management and supply-side transformation (Grubb et al., 2022). On the demand side, strategies focus on energy conservation, efficiency, and electrification. National and provincial models project aggressive electrification of transport (100% electric vehicle sales targets), industry (e.g., electric heat pumps), and households (induction stoves) (Dwidaningsih, 2023; NEC, 2023). This "electrify everything" strategy, powered by a clean grid, is a recognized cornerstone of deep decarbonization (Williams et al., 2021).

On the supply side, the transition requires a fundamental shift from fossil-based to renewable-based energy systems. The national and West Java roadmaps detail the phased increase of the New and Renewable Energy (EBT) share in the primary energy mix to over 70% by 2050-2060. This involves not only scaling up conventional renewables like solar and geothermal but also deploying frontier technologies such as green hydrogen, ammonia, biomass co-firing, and Carbon Capture and Storage (CCS) for hard-to-abate sectors like cement and steel (NEC, 2023; Dwidaningsih, 2023). The incorporation of carbon pricing mechanisms (carbon tax and trading) into the draft KEN further underscores a systemic approach to internalizing the cost of carbon emissions (NEC, 2023).

D. *West Java's Performance Indicator Target: Level of Efforts to Reduce Greenhouse Gas Emissions*

The institutionalization of climate commitments into measurable performance indicators represents a critical governance mechanism for ensuring accountability and tracking progress. In West Java, the Governor's Key Performance Indicator (Indikator Kinerja Utama - IKU) explicitly includes the "Level of Efforts to Reduce Greenhouse Gas Emissions" as a strategic target. This indicator, formalized under Provincial Regulation No. 8 of 2021 amending the 2018-2023 Regional Medium-Term Development Plan (RPJMD), establishes a quantifiable benchmark for climate action within the provincial bureaucracy. The target is measured against a Business-as-Usual (BAU) baseline projected to the year 2030, anchoring current efforts to a long-term reference scenario (West Java Province, 2022).

The evolution of this target reflects both political commitment and pragmatic adjustment. Originally set at 7.72% emission reduction for 2023, the target was subsequently revised to 5.22% . This recalibration, while appearing as a reduction in ambition, may also indicate a refinement of baseline assumptions, improved data availability, or a realistic appraisal of implementation capacity. Critically, the reported achievement for 2022 stands at 5.86% against a target of 4.75%, indicating that the province has consistently exceeded its annual targets. This over-achievement is significant, as it demonstrates that the institutional machinery for emissions

reduction—spanning energy, forestry, waste, agriculture, and transportation sectors—is operational and delivering measurable results.

Figure 3: West Java GHG Emission Reduction Performance – Target vs. Achievement

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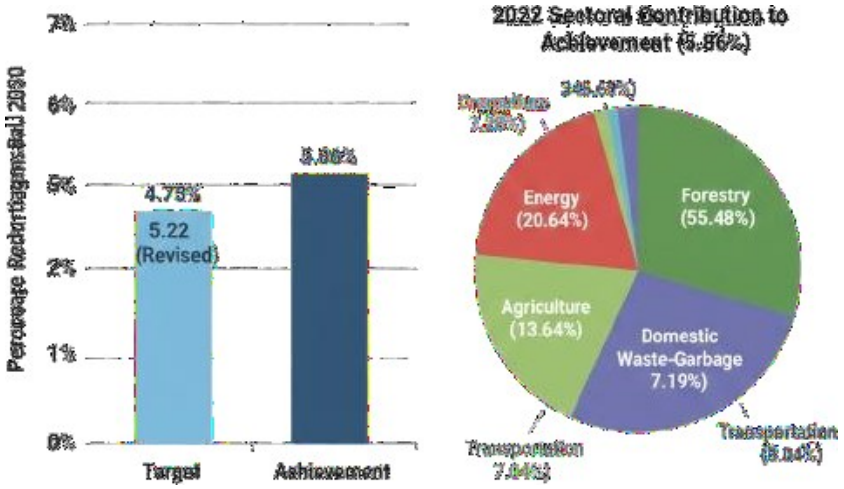

Source: West Java Regional Low Carbon Development Plan (analyzed), 2022.

The Sectoral disaggregation of the 2022 achievement reveals a distinct pattern with significant implications for energy transition policy. The forestry sector contributed an overwhelming 55.48% of total emission reductions, far exceeding its 17.54% target. This dominance suggests that West Java's current climate mitigation success is heavily reliant on nature-based solutions and carbon sink enhancement rather than energy sector transformation. The energy sector, while contributing a respectable 20.64% against a modest 5.13% target, remains a secondary contributor. This asymmetry poses a strategic challenge: as forestry sinks approach saturation and land-based mitigation opportunities diminish, the burden of future emission reductions must increasingly shift to the energy and transportation sectors. The current underperformance in transportation (3.04% contribution against 0.61% target, though exceeding target, remains minuscule in absolute terms) underscores the urgency of accelerating the electric vehicle transition, public transport modernization, and energy efficiency programs outlined in the revised RUED.

This performance indicator framework thus serves a dual function. Operationally, it provides a clear, quantifiable mandate to sectoral agencies (Perangkat Daerah) and enables evidence-based policy adjustment. Strategically, it exposes the imbalanced portfolio of mitigation actions and reinforces the necessity of the ambitious energy transition scenarios modeled in West Java's NZE roadmap. The integration of this IKU into gubernatorial performance assessment further elevates climate action from a discretionary environmental program to a core governance priority, creating political incentives for sustained implementation across administrative tenures.

III. RESEARCH METHODOLOGY

This study employs a qualitative research design centered on documentary analysis and comparative policy review. The methodology is designed to analyze the alignment

between evolving national energy policy and provincial-level strategic planning in Indonesia's context of transitioning to Net Zero Emission (NZE).

A. *Data Sources and Collection*

The research utilizes primary policy documents as the main data source:

1. National Policy Documents: (1) Government Regulation No. 79 of 2014 on National Energy Policy (PP KEN): Serves as the baseline policy framework, (2)

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the Draft Revision of the Government Regulation on KEN by Dr. Ir. Satya Widya Yudha of the National Energy Council (NEC, 2023): Provides the authoritative source on the rationale, new structure, and strategic shifts within the updated national policy. This document is critically analyzed for its implications for regional governance; (3) Ministry of Energy and Mineral Resources' NZE Roadmap (2022) and related national strategic documents (e.g., Updated NDC, Long-Term Strategy).

2. Provincial Policy Document: Policy Dialogue on "Energy Transition Towards NZE: Transition through the Update of West Java's the revision of West Java's Regional General Energy Plan (*Rencana Umum Energi Daerah - RUED*)" by the Head of the West Java ESDM Office (Dwidaningsih, 2023): Serves as the primary case study material, detailing the provincial government's projections, sectoral strategies, and planned initiatives in response to national directives.

B. *Data Analysis Procedure*

The analysis was conducted in three sequential stages:

1. Content Analysis of National Policy Revision: The NEC (2023) presentation was analyzed to identify key drivers for the KEN update, major strategic shifts (e.g., from energy independence to resilience-in-transition), new policy instruments (e.g., carbon pricing), and explicit NZE targets and pathways. This established the "national directive."
2. Content Analysis of Provincial Strategy: The West Java policy dialogue document (Dwidaningsih, 2023) was analyzed to extract its energy modeling results, demand and supply-side intervention scenarios, and proposed governance mechanisms. This established the "regional response."
3. Comparative and Deductive Analysis: The findings from stages 1 and 2 were systematically compared to assess the degree of alignment and operationalization. The analysis focused on:
   a) How provincial targets (e.g., EBT mix, EV penetration) reflect or adapt national goals.
   b) How national strategic pillars (e.g., maximizing EBT, minimizing coal) are translated into specific provincial programs.
   c) The role of multi-level governance as outlined in both documents, identifying the envisaged responsibilities for central government, local government, SOEs, and private actors.

This methodological approach allows for a robust examination of the policy coherence and implementation framework between national and sub-national levels in

Indonesia's energy transition, using West Java as a focused case study.

IV. RESULT AND DISCUSSION

A. *Policy Context and Targets: Aligning Provincial Planning with National Decarbonization Directives*

The existing Regional General Energy Plan (RUED) of West Java, established under Regional Regulation No. 2 of 2019, set foundational but now insufficient targets for renewable energy integration. The ongoing revision is driven by two imperative forces: Indonesia's enhanced climate commitments and the comprehensive overhaul of the National Energy Policy (KEN). The draft revised KEN represents a paradigm shift, moving from a strategy centered on "Energy Independence" to one focused on "Energy

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Resilience during Transition." This reframing explicitly prioritizes decarbonization, mandating the maximization of renewable energy, minimization of fossil fuels (with explicit mentions of coal and gasoline phase-down), optimization of natural gas as a transitional fuel, and the conditional inclusion of nuclear energy as a balancing tool for a low-carbon grid.

The revision of West Java's Regional General Energy Plan (*Rencana Umum Energi Daerah - RUED*) for the period 2024–2060 is a direct operationalization of this national strategic shift. The province aims to translate the national NZE 2060 target and the emissions peaking goal of 2040–2045 into a concrete provincial roadmap. This alignment is not merely aspirational but structural, as the revised KEN and its derivative National Energy General Plan (RUEN) legally bind regional plans (RUED). The challenge, however, lies in adapting national-level strategies to West Java's unique socio-economic and geophysical context—characterized by high population density, significant industrial activity, and varying renewable energy potential across its regions.

Figure 4: Alignment of National and West Java Energy Policy Frameworks

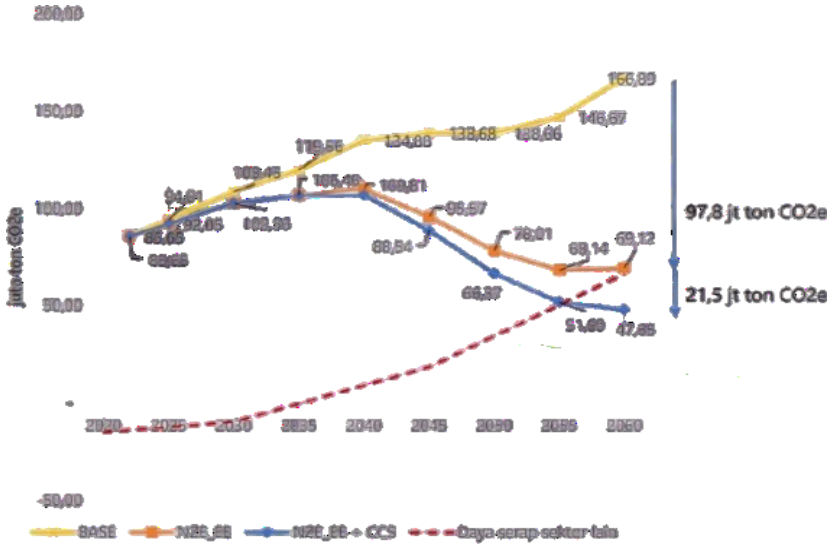
Source: The Energy and Mineral Resources Office of West Java Province (analyzed), 2024.

B. *Demand-Side Management Strategies*

Energy modeling for West Java confirms a steady rise in final energy demand, closely correlated with projected economic growth. To break this link, the revision of West Java's Regional General Energy Plan (*Rencana Umum Energi Daerah - RUED*) proposes aggressive demand-side interventions across key sectors, representing a shift from supply-side capacity addition to active consumption management. To decouple growth from emissions, the province plans significant demand-side interventions:

1. Industry Sector: The strategy targets a dual approach: energy efficiency and electrification. Audits and energy management systems could reduce industrial energy consumption by 50-60%, while the electrification of low-temperature thermal processes (<100°C) via electric heat pumps targets 55% sectoral electrification by 2060. This shift not only reduces direct fossil fuel use but also transfers the emissions burden to the power sector, where decarbonization can be managed centrally.
2. Transportation Sector: This sector undergoes the most transformative vision. The plan mandates 100% sales penetration for electric motorcycles by 2035 and electric cars by 2040, supported by the development of a comprehensive charging infrastructure network (SPKLU). Furthermore, it emphasizes modal shift through the expansion of high-capacity public transport (BRT, MRT, LRT) and the implementation of Intelligent Transport Systems (ITS) to optimize traffic flow. This multi-pronged approach addresses both vehicle technology and systemic efficiency.
3. Public and Household Sectors: Interventions here focus on fuel switching and appliance standards. The promotion of induction stoves and the expansion of city gas networks (Jargas) aim to displace LPG and kerosene. Concurrently, enforcing Minimum Energy Performance Standards (SKEM/MEPS) for appliances like air conditioners and developing markets for high-efficiency products are crucial for curbing baseload energy growth.

Figure 5: Projected Energy Demand Reduction from Key DSM Interventions in West Java (2025-2060)



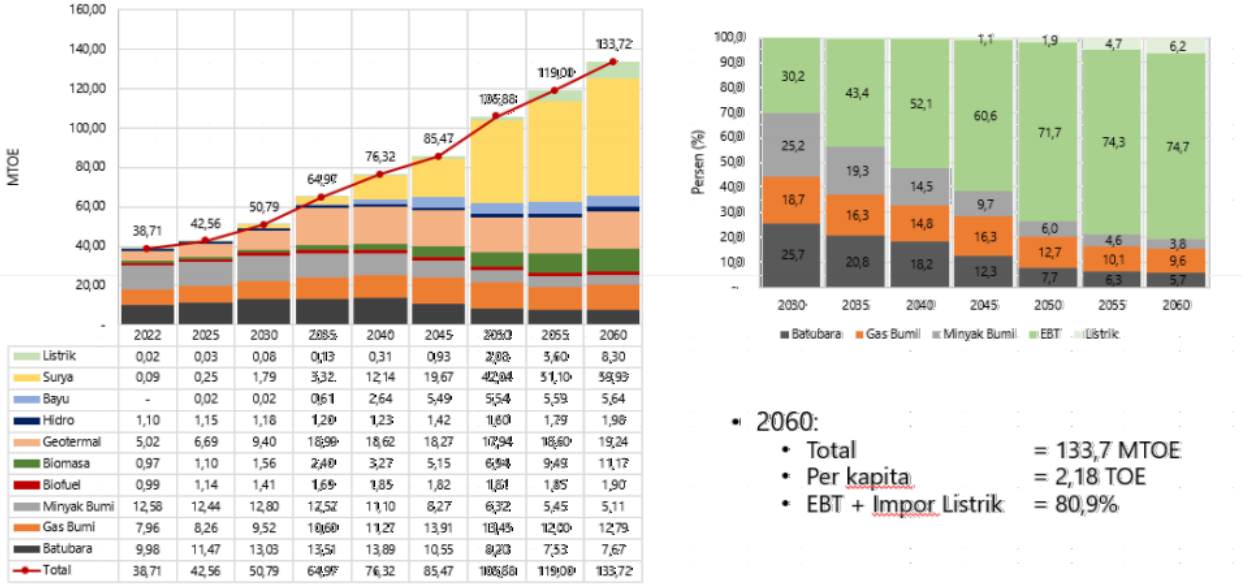
Source: West Java Regional Low Carbon Development Plan (analyzed), 2022.

C. *Supply-Side Transformation*

The supply-side strategy is fundamentally centered on exploiting local renewable energy (EBT) potential and deploying a suite of decarbonization technologies in a phased manner:

1. Renewable Energy Integration: The target to raise the EBT share in the primary energy mix to at least 30% by 2030 and 70% by 2050 is ambitious. It necessitates adding at least 7.09 GW of EBT-based power capacity by 2030. This requires not only investment in solar, geothermal, hydro, and bioenergy but also upgrades to grid infrastructure to handle variable renewable energy (VRE) sources.
2. Technology Deployment for Hard-to-Abate Sectors: The plan acknowledges that not all emissions can be eliminated through direct electrification. For high-temperature industrial heat (e.g., in cement, steel), it proposes green hydrogen as a substitute for natural gas post-2041 and biomass co-firing as an interim solution. Most notably, it introduces Carbon Capture and Storage (CCS) for the cement and steel sectors from 2036, representing a significant technological and regulatory undertaking for a developing region
3. Bioenergy Expansion and Infrastructure: The continued reliance on biofuels is evident in targets for B40 biodiesel and significant bioethanol blending. This creates a demand link to agricultural policy and land use. Simultaneously, massive infrastructure projects are planned, including city gas networks for nearly 1 million households by 2030 and the development of biogas/biomethane systems for rural communities and farms, integrating waste-to-energy principles.

Figure 6: Projection of West Java's Primary Energy Mix to Achieve Net Zero Emissions (NZE)



	2022	2025	2030	2035	2040	2045	2050	2055	2060
Listrik	0,02	0,03	0,08	0,13	0,31	0,93	2,88	5,60	8,30
Surya	0,09	0,25	1,79	5,32	12,14	19,67	42,84	51,10	58,93
Bayu	-	0,02	0,02	0,61	2,64	5,49	5,54	5,59	5,64
Hidro	1,10	1,15	1,18	1,20	1,23	1,42	1,60	1,79	1,98
Geotermal	5,02	6,69	9,40	18,99	18,62	18,27	17,94	18,60	19,24
Biomasa	0,97	1,10	1,56	2,40	3,27	5,15	6,94	9,49	11,17
Biofuel	0,99	1,14	1,41	1,69	1,85	1,82	1,81	1,85	1,90
Minyak Bumi	12,58	12,44	12,80	12,52	11,10	8,27	6,32	5,45	5,11
Gas Bumi	7,96	8,26	9,52	10,60	11,27	13,91	18,45	12,00	12,79
Batubara	9,98	11,47	13,03	13,51	13,89	10,55	8,20	7,53	7,67
Total	38,71	42,56	50,79	64,98	76,32	85,47	105,88	119,00	133,72

Source: The Energy and Mineral Resources Office of West Java Province (analyzed), 2024.

D. *Enabling Collaborative Governance*

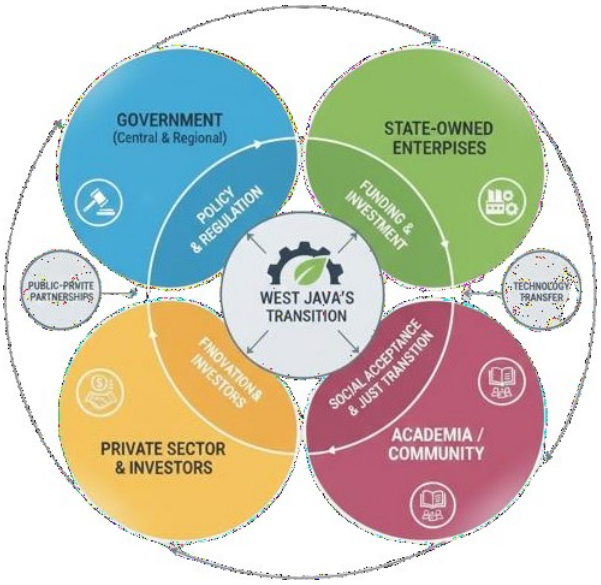
The olicy scenario underscores that successful implementation hinges on multi-stakeholder collaboration. The key pillars include:

1. Central Government and SOEs: Ensuring commitment to NZE in national policy,

rational energy pricing, and optimizing EBT plant development in PLN's electricity supply plan (RUPTL).

2. Regional Apparatus and Local SOEs: Implementing sectoral policies within regional authority, prioritizing local budgets, and developing business lines related to EBT and energy conservation.
3. Private Sector, Academia, and Community: Active investment in EBT infrastructure, research and development, capacity building, and public education on energy transition.

Figure 7: Multi-Stakeholder Governance Framework for West Java's Energy Transition



Source: The Updating of West Java's Regional General Energy Plan (analyzed), 2026.

E. *Mapping Low Carbon Activities and Energy Transition in West Java Province*

The provincial government's commitment to decarbonization extends beyond the energy sector, encompassing a comprehensive suite of low-carbon activities across multiple sectors. Table 1 (derived from the West Java Regional Development Planning Document) maps the strategic issues, specific interventions, and the responsible regional apparatus (Perangkat Daerah) tasked with implementation. This cross-sectoral mapping illustrates the mainstreaming of climate action into sectoral development planning, a critical enabler for achieving the NZE target.

Table 1: The Cross-Sectoral Low Carbon Activities and Institutional Mandates in West Java Province

The Strategic Issues	Program Details	Responsible Regional Apparatus
1. Increasing carbon reserves from the forestry sector	a. Development of Community Forests	Forestry Sector
	b. Mangrove Forest Planting	Forestry Sector
	c. Seed Development for Land Rehabilitation	Forestry Sector
2. Reducing emissions from the land sector	a. Organic Fertilizer Processing	Food Security and Animal Husbandry Sector
	b. Control of Plant Pest Organisms (OPT)	Plantation Sector

(agriculture and livestock)	c. Climate Change Impact Management (DPI)	Agriculture and Food Crops Horticulture Sector
3. Reducing emissions from the energy sector	e. Implementation of Rooftop Solar Power Plants	Energy and Mineral Resources Sector
	f. Use of electric vehicles as official operational vehicles	Energy and Mineral Resources Sector
	g. Guidance and supervision of various renewable energy (Rooftop Solar Power Plants)	Energy and Mineral Resources Sector
The Strategic Issues	**Program Details**	**Responsible Regional Apparatus**
	h. Implementation of Energy Conservation in facilities and infrastructure managed by regional government agencies in the field of Energy and Mineral Resources	Energy and Mineral Resources Sector
4. Reducing emissions from the transportation sector	i. Pilot Project Bus Rapid Transit (BRT)	Transportation Sector
5. Reducing emissions from the waste sector	j. Operationalization of Final Disposal Sites (TPA) / Newest Regional Waste Disposal Sites (TPST)	Environmental Sector
	k. Expansion of exiting Final Disposal Site (TPA)	Environmental Sector
	l. Implementation of Waste Bank	Environmental Sector
	m. Transmission Line Level of Legok Nangka Final Waste Processing and Processing Facility (TPPAS)	Environmental Sector
	n. Coordination, Synchronization and Implementation of Green House Gasses (GHG) Emission Control, Climate Change Mitigation and Adaptation	Environmental Sector
	o. Operationalization of the Final Waste Processing and Recycling Site (TPPAS)	Implementing Business Entity (BUP) in Government and Business Entity Cooperation (KPBU)
6. Reducing emissions from the waste sector	p. Domestic Wastewater Managemen pt	Housing and Settlements Sector

Source: West Java Regional Low Carbon Development Plan (analyzed), 2026.

Several insights emerge from this institutional mapping. First, the energy sector interventions directly align with the revision of West Java's Regional General Energy Plan (Rencana Umum Energi Daerah - RUED) supply-side and demand-side strategies. Activities such as rooftop solar deployment, electric vehicle adoption through government fleet leasing, and energy conservation in public infrastructure are concrete manifestations of the provincial NZE roadmap. These are exclusively mandated to the Energy and Mineral Resources Office, indicating a centralized execution model within the energy domain.

Second, the waste and wastewater sectors are assigned to the Environmental Sector and the Housing and Settlement Sector. Notably, the inclusion of the Final Waste Processing and Recycling Site (TPPAS), i.e. Legok Nangka and Nambo—regional waste-to-energy facilities—demonstrates the province's strategy to capture methane and generate electricity from waste, directly contributing to the renewable energy mix while addressing urban sanitation challenges. The involvement of a Implementing Business Entity (BUP) in Government and Business Entity Cooperation (KPBU) for the Final Waste Processing and Recycling Site (TPPAS) further illustrates the collaborative governance framework discussed earlier.

Third, the land-based sectors (forestry, agriculture, plantations, and livestock) are managed by multiple sectors. Their activities—ranging from mangrove rehabilitation to organic fertilizer production—enhance carbon sinks and reduce non-CO_2 emissions (e.g., methane from livestock, nitrous oxide from fertilizers). These interventions are essential for offsetting residual emissions from hard-to-abate energy sectors, thereby supporting the province's net-zero trajectory. The breadth of actors involved underscores the necessity of a whole-of-government approach, coordinated through the Regional Action Plan for Greenhouse Gas Emissions Reduction.

V. CONCLUSION

The energy transition pathway for West Java, as articulated in its evolving of West Java's Regional General Energy Plan (*Rencana Umum Energi Daerah - RUED*), represents a comprehensive attempt to localize Indonesia's national NZE ambition. The strategy is two-pronged: aggressively managing future energy demand through efficiency and electrification while fundamentally transforming the energy supply system towards renewables and clean technologies. The analysis reveals that the technical and policy roadmaps are well-articulated. However, the transition's success will ultimately depend on factors beyond planning: consistent regulatory support from the national level, attractive investment frameworks for private capital, rational and transparent energy pricing, and sustained cross-sectoral coordination. West Java's experience offers valuable insights for other Indonesian regions and developing economies navigating the complex socio-technical landscape of energy system decarbonization.

In summary, the West Java's energy transition is not siloed within the energy agency but is embedded in a broader low-carbon development agenda. The effectiveness of the transition will depend on the strength of horizontal coordination among these diverse agencies and vertical integration with national policies. Future research could quantitatively assess the emission reduction contributions of each cluster and their cost- effectiveness, thereby refining the provincial NZE roadmap.

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