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Optimising Waste-to-Energy Development as an Alternative Renewable Energy Source in Indonesia

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ABSTRACT
Indonesia faces escalating challenges in municipal solid waste management and supply of electricity due to fast population growth and climate commitments. Waste-to-Energy (WtE) has emerged as a strategic approach to address waste accumulation while advancing national decarbonization goals. Despite Indonesia's establishment of a legal framework for WtE through PR 109/2025, implementation remains constrained by governance complexity, financial viability, and environmental issues. This article analyses Indonesia's WtE policy and regulatory framework while incorporation of Environmental, Social, and Governance (ESG) principles as a supplementary method to optimizing WtE implementation. The study employs a normative legal methodology, incorporating statutory, comparative, and conceptual approaches, the analyses Indonesian regulations and evaluate overseas WtE practices, specifically in Singapore and the United Arab Emirates. The results indicate that PR 109/2025 enhances coordination and investment certainty, while the inclusion of ESG, as evidenced by international standards, establishes a stronger basis for the future governance of sustainable technologies and accountable WtE operation in Indonesia.

KEYWORDS: Waste-to-Energy; Environmental, Social, and Governance (ESG), Renewable Energy Policy; Municipal Solid Waste.

1. Introduction

Indonesia, spanning approximately 1,904,569 square kilometers (735,358 square miles), had an estimated population of 284.4 million in 2025 and is projected to reach to 329.03 million by 2045,[1] intensifying the country's waste management challenges. In 2023, Indonesia produced approximately 56.63 million tons of waste, of which only 39.01% was efficiently managed. Consequently, 60.99% of waste remained unmanaged, with a significant fraction discarded via open dumping methods.[2] These circumstances have resulted to a significant negative impact on the environment and public health, as emissions from open dumping, including dioxins, furans, mercury, and other hazardous substances, contribute to air, water, and solid pollution.[3] The problem is particularly severe in metropolitan areas, where high population density and increased economic activities significantly raise waste production, thereby exacerbating environmental challenges and highlighting the urgent need for comprehensive and sustainable waste management strategies.[4] As a result, this activity

1 "Second Nationally Determination Contribution Republic of Indonesia," 2025, p. 1.
2 Presidential Regulation Number 109 of 2025 on Urban Waste Management through Processing Waste into Renewable Energy Based on Environmentally Friendly Technology ("PR 109/2025").
3 UNEP, "Open Dumping," <https://www.unep.org/topics/waste/open-dumping>, accessed 13 December 2025.
4 PR 109/2025, Preamble.

directly contributes to global warming by releasing greenhouse gases ("GHG") emissions and other pollutants into the atmosphere.[5]

At the same time, electricity generation also contributes to global warming in Indonesia by around 600 million tonnes of carbon dioxide (Mt CO_2), making Indonesia the ninth-largest emitter worldwide.[6] The National Energy Transition Roadmap ("RUPTL") projects that Indonesia's total installed power generation capacity will attain 443 gigawatts by 2060, consisting of 41.5% variable renewable energy, supported by 34 gigawatts of storage, and 58.5% dispatchable renewable generation, with contribution of waste-to-energy ("WtE"), alongside geothermal and hydropower.[7] Indonesia's optimism regarding its long-term decarbonization strategy is reflected in the RUPTL to be executed by PLN, which prioritizes the expansion of renewable energy including WtE facilities, as a comprehensive approach to the nation's dual challenges of waste accumulation and increasing electricity demand.[8] The increasing volume of waste, inadequate waste management, and disorder at numerous dump sites make "municipal waste to energy" a feasible solution for the significant waste management challenge in Indonesia.[9]

Although Indonesia has established a legal framework for WtE through Presidential Regulation in 2018, its implementation remains ineffective due to complex governance arrangements and unresolved economic viability issues.[10] In particular, the fragmented authority structure under the regulation created two separate and chronically misaligned revenue streams, whereby local governments were responsible for paying tipping fees under distinct cooperation were responsible for paying tipping fees under distinct cooperation agreements while PLN purchased electricity through separate Power Purchase Agreements (PPA).[11] This institutional fragmentation was further compounded by economic challenges, notably the relatively low feed-in tariff of USD 0.13/kWh and the limited fiscal capacity of local governments to sustain long-term tipping fee commitments, ultimately rendering most WtE projects financially unbankable.[12]

Under new WtE Regulation framework, WtE is not simply a supplementary technology but a strategic intervention aimed at tackling increasing domestic house-hold waste challenges while simultaneously enhancing national emissions reduction commitments.[13] Accordingly, endeavours to optimize WtE implementation may be complemented by the utilization of an innovative ESG framework, facilitating a more comprehensive evaluation of

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5 Letícia Sarmento dos Muchangos and Akihiro Tokai, "Greenhouse Gas Emission Analysis of Upgrading From an Open Dumping to a Semi-Aerobic Landfill in Mozambique – the Case of Hulene Dumpsite," *Scientific African Vol. 10*, 2022, p. 2.

6 International Energy Agency, *An Energy Sector Roadmap to Net Zero Emissions in Indonesia* (IEA), 2022.

7 Ministry of Energy & Mineral Resources Regulation Number 10 of 2025 on the Roadmap for Energy Transition in the Electricity Sector ("MoEMR 10/2025").

8 PT PLN (Persero), *Rencana Usaha Penyediaan Tenaga Listrik (RUPTL) 2025-2034* (PLN 2024), III-23 ("PLN RUPTL").

9 PR 109/2025, Preamble.

10 Indonesia Business Post, "OMBUDSMAN Suggests Revision on WTE Regulation," (3 January 2024), <https://indonesiabusinesspost.com/1446/Politics/ombudsman-suggests-revision-on-wte-regulation>, accessed 10 December 2025.

11 Frederic Draps and Dan Trevanion, Ashurst, 'Accelerating Waste-to-Energy in Indonesia: PR 109/2025's Impact and Challenges' (Ashurst, 2025).

12 *Ibid.*

13 PwC Indonesia, "Power in Indonesia: Investment and Taxation Guide," 2023, <https://www.pwc.com/id/en/pwc-publications/industries-publications/energy--utilities---mining-publications/power-guide-2023.html>, accessed 1 December 2025.

waste management options through the integration of factors such as GHG emissions, energy efficiency, and other sustainability-related considerations.[14]

2. Methodology

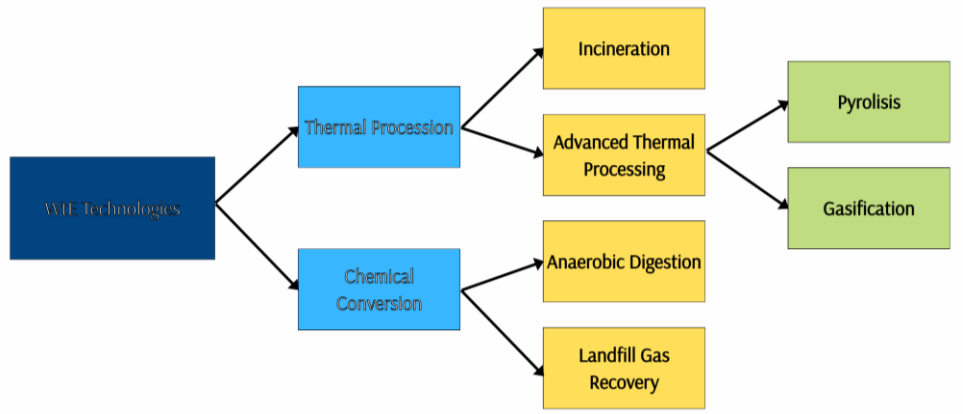
This article employs a normative legal research method to analyse the coherence of legal norms governing WtE development in Indonesia. A statutory approach is applied by analysing relevant regulations, particularly PR 109/2025. A comparative approach is used to review WtE policies in selected countries, notably Singapore and the United Arab Emirates. In addition, a conceptual approach is employed to assess the integration of Environmental, Social, and Governance ("ESG") principles in WtE implementation and their role in supporting sustainable regulation, technology selection, and stakeholder accountability.
analysis.

3. WtE Policy and Legal Framework in Indonesia: Seeking Renewable Energy

3.1. Waste as a Source of Energy

From Waste is one of the biomass and renewable energy source that can generate electricity through a conversion process.[15] The most well-known WtE technologies include incineration, gasification, pyrolysis, and anaerobic digestion.[16] Various types of waste (solid, semi solid-liquid) can be converted into usable energy sources.[17] The electricity produced can be fed into the grid, while the heat from combustion may be utilized to produce steam or support industrial and agricultural operations.

As WtE is closely linked to bioenergy, degradable waste can also be converted into biofuels, including biogas, by anaerobic digestion. The main benefits of WtE encompass the reduction of waste volume, generating energy, and mitigating environmental impacts. Broadly, WtE technologies fall into two categories: (i) thermal processing and (ii) chemical conversion.[18]



[14] "A Complete Guide to ESG Waste Management: Environmental, Social, and Governance Strategies," Waste Harmonics Kelter, <https://www.wasteharmonics.com/resource/esg>, accessed 13 December 2025.

[15] Ministry of Energy and Mineral Resources, "Waste to Energy Guidebook," https://ebtke.esdm.go.id, accessed 2 December 2025, ("MoEMR 2015").

[16] *Ibid.*

[17] UNFCCC, "Waste to Energy Technologies," <https://unfccc.int/technology/waste-to-energy-technologies>, accessed 2 December 2025.

[18] Sadah AT Muawad and Adil AM Omara, "Waste to Energy as an Alternative Energy Source and Waste Management Solution," in *2019 International Conference on Computer, Control Electrical, and Electronics Engineering*, 2019.

Figure 1. WtE Technologies Category.[19]

Incineration is a thermal processing that burns solid waste along with certain liquid residues, such as landfill leachate, by-products of agricultural or industrial activities, and organic materials containing water, fatty acids, pulp, or plant fragments. This process generates nitrogen oxides, oxygen, carbon dioxide, water vapor, and ash by chemical oxidation. Contemporary waste management techniques such as incineration diminish waste volume by converting it into ash, gases, and minimal liquid residues. It can supply district heating and produce electricity.[20] The advanced thermal process known as pyrolysis decomposes organic substances in the absence of oxygen. Waste is subjected to temperatures of 400–800°C in a controlled environment to inhibit complete combustion and generate biochar, liquid bio-oil, and syngas. Biochar enhances soil quality and sequesters carbon; bio-oil can be transformed into biofuels or chemical precursors; and syngas can generate heat or electricity or be utilized for fuel and chemical production.[21]

Gasification is a thermochemical process that transforms organic materials, such as wood waste, agricultural wastes, sewage sludge, and plastic waste, into synthetic gas (syngas) at temperatures ranging from 800 to 1200ºC with regulated oxygen supply.[22] Anaerobic digestion (AD) employs bacteria in the absence of oxygen to decompose organic waste. This treatment generates biogas mostly composed of CH4 and CO2, together with digestate for use as fertilizer.[23] The quality and yield of gas are influenced by the type of organic feedstock and the circumstances of digestion.[24]

3.2. Regulatory Framework

Indonesia is diligently working to improve the amount of renewable energy in its energy balance in order to become less reliant on fossil fuels and reach net zero energy use by 2060, as required by the RUPTL in MoEMR 10/2025, in accordance with the ratified Paris Agreement.[25] Renewable energy sources, such as solar, wind, and biomass, are essential to RUPTL. Although they cannot fully replace natural gas power plants to satisfy increasing electricity demand, they are essential for improving energy resilience and environmental sustainability. Among renewable energy sources, WtE offers an effective solution by addressing waste management issues while producing sustainable electricity. The preliminary strategy outlined in the General Plan for National Energy *(Rencana Umum Energy Nasional "RUEN")* specifies that the total capacity of various biomass types, including waste, is 1.9 GW.[26]

Despite being perceived as late, Indonesia has pursued WtE initiatives since 2018, as articulated in PR 25/2018, which targets 12 cities/provinces for the expedited development of

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19 *Ibid*.
20 Abdelkader Anouzla and Salah Souabi, "Generation of Energy from Municipal Solid Waste: Circular Economy and Sustainability," *Springer*, 2024, p. 38.
21 Shahbaz, et. al., "A Review of Waste Management Approaches to Maximise Sustainable Value of Waste from the Oil and Gas Industry and Potential for the State Qatar," *Fuel*, Volume 332, 2023.
22 *Ibid*.
23 A. J. Rayner, et. al., "Design of an Organic Waste Power Plant Coupling Anaerobic Digestion and Solid Oxide Fuel Cell Technologies," *Renewable and Sustainable Reviews*, 2017.
24 *Ibid*.
25 MoEMR 10/2025, Preamble.
26 IRENA, "Indonesia Energy Transition Outlook," *Abu Dhabi*, 2022.

WtE Facilities Utilizing Environmentally Friendly Technology.[27] However, the regulatory framework established under PR 35/2018 was ultimately considered ineffective and was later replaced by PR 109/2025, which restructured the procurement framework and expanded the list of priority cities.[28] The failure of PR 35/2018 can be attributed to three interrelated factors: (i) the dual-revenue model placed unsustainable financial obligations on municipalities with limited creditworthiness; (ii) the feed-in tariff of USD 0.13/kWh was insufficient to justify high capital costs of USD 150-192 million per facility; and (iii) the selected gasification technology proved unreliable when processing unsorted, high-moisture mixed waste at the intended mid-scale capacity.[29]

3.3. Presidential Regulation 109/2025

Indonesia's current policy on WtE has been constituted by PR 109/2025 aims to address the waste emergency, where a significant amount of waste remains unmanaged, resulting environmental pollution and health concerns, while accelerating the WtE project.[30] The regulation advocates for the implementation of WtE technologies to generate electricity, bioenergy, renewable fuel oil, and additional by-products, thereby enhancing national energy resilience.[31]

PR 109/2025 enacts significant modifications to improve project viability, strengthen institutional collaboration, and address implementation problems that prevented previous WtE initiatives. PR 109/2025 consolidates numerous entities responsible for the design, construction, and operation of WtE projects. The Central Government is responsible for policy formulation, coordination, environmental oversight, expediting licensing, financial monitoring, and providing incentives. Each ministry possesses distinct responsibilities, including assessing the preparedness of local governments (Ministry of Environment),[32] establishing technical requirements for renewable energy outputs (Ministry of Energy and Mineral Resources), ensuring budgetary expenditures (Ministry of Finance),[33] and managing the accelerated support for licensing and non-licensing matters (other Ministries).[34]

Local governments play a crucial role in waste management by generating a minimum of 1,000 tons of waste daily, allocating land, formulating regional budgets for waste collection and transportation, and preparing regional planning documents.[35] PR 109/2025 significantly expands the scope of WtE development, increasing the number of participating districts and cities from 12 to an unrestricted number. WtE projects may now be implemented in Indonesia, contingent upon the fulfilment of specific basic requirements by the relevant local government, including the generation of waste quantities exceeding the daily minimum threshold. This

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27 Presidential Regulation Number 35 of 2018 on Acceleration of Waste-to-Energy Plant Construction Based on Environmentally Sound Technology ("PR 35/2018"), Art. 3(1).
28 PR 109/2025, Preamble.
29 Ashurst OSP, Frédérick Draps and Dan Trevanion, "Accelerating Waste-to-Energy in Indonesia: PR 109/2025's Impact and Challenges" 2025, <https://www.ashurst.com/en/insights/accelerating-waste-to-energy-in-indonesia-presidential-regulation-109-2025/> accessed 13 December 2025; S.D. Rosi and A. Sandria, "Multi-Actor Governance of Waste-to-Energy: A Case Study of the Putri Cempo WtE Power Plant in Surakarta City" *Industrial and Domestic Waste Management* 195, 2025; Mudofir M et al., "Waste harvesting: lessons learned from the development of waste-to-energy power plants in Indonesia" *International Journal of Energy Sector Management*, 2025.
30 PR 109/2025, Preamble.
31 PR 2019/2025, Art. 1(3).
32 PR 109/2025, Art. 1(5).
33 PR 109/2025, Art. 8(1).
34 PR 109/2025, Art. 19.
35 PR 109/2025, Art. 4.

expansion was introduced in response to the inadequate outcomes of the previous regulatory framework under PR 25/2018, which resulted only two facilities becoming operational, Benowo in Surabaya and Putri Cempo in Surakarta. As of 2025, the Benowo WtE Plants remains the sole operational WtE facility in Indonesia, processing approximately 1.000 tons of waste per day and generating around 11-12 MW of electricity through a combination of landfill gas collection and gasification technologies. Throughout its operational lifespan, the facility has supplied approximately 122.04 GWh of clean energy to the East Java electricity grid.

Nevertheless, despite its operational continuity and contribution to renewable energy generation, persistent air quality concerns reported by WALHI East Java between November 2024 and January 2025 demonstrates that the environmental performance of WtE facilities continues to require stricter regulatory oversight and monitoring.[36] In contrast, the Putri Cempo plant in Surakarta has severely underperformed as its inauguration in October 2023, operating at only 15-20% of its designed capacity of 389-545 tons/day. This resulted from insufficient local waste supply, inadequate household-level waste sorting that disrupted the gasification process, and the local government's initial refusal to commit to tipping fee payments. By early 2026 the facility was subject to a ministerial financial investigation.[37]

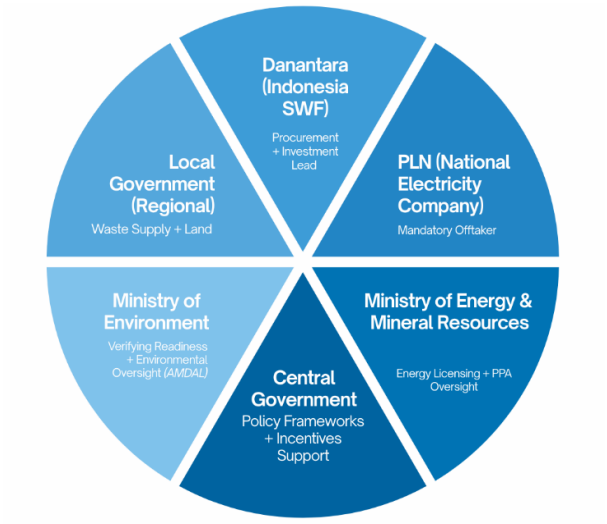


Figure 2. Parties in PR 109/2025

The regulation appoints BPI Danantara (Badan Pengelola Investasi Daya Anagata Nusantara) as the principal coordinator for organizing WtE projects, including the recruitment of project developers and the conduct of technical and economic evaluations,[38] with support from State-Owned Enterprises (BUMN) and their affiliates.[39] BPI Danantara, Indonesia's

[36] UCLG ASPAC, "Surabaya: Breaking through Challenges, Launching the First Waste to Energy Plant in Indonesia", 2021 <https://uclg-aspac.org> accessed 25 April 2026; Changemaker Asia, "Eight Years of Clean Energy: Surabaya's Benowo WtE Plant" January 2025 <https://changemakr.asia> accessed 25 April 2025; Basten Gokkon, "Air quality study of East Java waste-to-energy plant sparks dispute" Mongabay, August 2025 <https://news.mongabay.com> accessed 25 April 2026.

[37] S.D. Rosi and A. Sandria, "Multi-Actor Governance of Waste-to-Energy", *Op. Cit.*; PT Centra Rekayasa Enviro, "Anatomi Kegagalan PLTSa Putri Cempo Solo", April 2026 <https://cr-enviro.com> accessed 26 April 2026; The Jakarta Post, "Surakarta landfill crisis highlights Indonesia's growing waste problem", 11 February 2026.

[38] PR 109/2025, Art. 5.

[39] *Ibid.*

sovereign wealth fund established under Law 1/2025 to manage government investments in State-Owned Enterprises (BUMN), was specifically designated for this role under PR 109/2025 in response to the persistent failures of the previous governance framework, which had been characterized by fragmented authority among ministries, local governments, and project developers.[40] By leveraging its cross-sectoral authority and capacity to mobilize large-scale capital, Danantara is intended to function as an institutional integrator that centralizes coordination among stakeholders and replaces the decentralized municipality-led model that previously struggled to attract bankable investment.[41]

Under this framework, the selected project developer and operator (BUPP/PSEL) is responsible for the development, construction, licensing, and management of PSEL facilities,[42] as well as the obligation to sell electricity to PT PLN (Persero), which is turn is required to purchase electricity at a predetermined tariff and fulfil the corresponding Power Purchase Agreements (PPA).[43] The framework enables other businesses to participate when procurement rounds are unsuccessful, thus maintaining the project and enhancing investment prospects.[44]

The appointment of Danantara has nevertheless generated both support and criticism. Proponents argue that centralized coordination eliminates the fragmentation that undermined PR 35/2018, while Danantara's equity investment capacity and Patriot Bond financing provide resources unavailable to individual local governments. Critics, however, raise concerns about transparency and political interference, noting that Danantara's leadership is dominated by political elites, and that national auditors initially lacked clear authority to scrutinize its assets.[45]

3.4. Government Support Through Investment and Procurement Framework

According to PR 109/2025, BPI Danantara is entrusted with the responsibility of selecting PSEL developers and the investing in projects that are deemed commercially and financially viable. To qualify, participants must demonstrate the use of validated sustainable technology, sufficient financial capability, and relevant operational experience.[46] The regulation further authorizes direct appointment mechanisms in specific circumstances, namely when only one participant satisfies the qualification requirements, during a declared waste emergency, or when a previously appointed developer has been definitively terminated. In carrying out this mandate, BPI Danantara, together with the relevant state-owned enterprises must conduct technical and economic analyses that include waste characteristics, site suitability, supporting systems, and risk allocation.[47]

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[40] Danantara Indonesia, "About Danantara Indonesia" <https://www.danantaraindonesia.co.id/about> accessed 27 April 2025; GovInsider Asia, "Indonesia's sovereign wealth fund to lead the next big push in waste-to-energy", November 2025 <https://govinsider.asia> accessed 27 April 2026; SUPRA International, "Indonesia's Waste-to-Energy Update: Danantara's Tender Process", 2025 <https://supra-international.com> accessed 27 April 2026.

[41] *Ibid*.

[42] PR 109/2025, Art. 8.

[43] PR 109/2025, Art. 19.

[44] PR 109/2025, Art. 16.

[45] Indonesia at Melbourne (University of Melbourne), "Danantara: a new hope or a phantom menace?", March 2025 <https://indonesiaatmelbourne.unimelb.edu.au> accessed 27 April 2026; Leo Suryadinata and Siwage Dharma Negara, "Danantara's Patriot Bond and the Unchanged Role of Chinese-Indonesian Conglomerates" ISEAS Perspective 2026/23; Syahriza Alkohir Anggoro, "Indonesia's Waste-to-Energy Strategy Threatens Human Rights" *Earth.org*, 2026.

[46] PR 109/2025, Art. 13.

[47] PR 109/2025, Art. 4(1).

To further strengthen project feasibility and investment attractiveness, the Central Government may offer incentives, including VAT exemptions and various fiscal or non-fiscal measures, to enhance viability, especially for developers utilizing indigenous technology.[48] In addition, the President also requires BPI Danantara to design a WtE financing strategy through *Patriot Bonds*.[49] In this regard, *Patriot Bonds* are institutional debt instruments issued by Danantara through private placements to Indonesian conglomerates and are specifically structured to prioritize national development objectives over purely commercial returns.[50] These instruments offer a fixed annual coupon of 2% with maturities ranging from five to seven years. The initial issuance in October 2025 reportedly raised approximately USD 3.1 billion (equivalent to around Rp50 trillion), with the proceeds allocated to WtE projects and other green infrastructure initiatives. Considering that each WtE facility requires an estimated capital investment of approximately USD 150–192 million, Danantara subsequently prepared a second bond tranche valued at approximately USD 900 million by early 2026 to finance the next phases of project development.[51]

WtE projects will be carried out in two phases, as outlined in PR 109/2025: (1) planning; and (2) implementation, which will be supervised by Danantara.[52] The planning phase begins upon receipt of a written declaration from the relevant government affirming its readiness to meet the program's minimum eligibility criteria.[53] The Minister of Environment ("MOE") then assesses and evaluates the preparedness of the local government utilizing data from the Ministry of Energy and Mineral Resources ("MEMR") and the Ministry of Home Affairs. Upon confirmation, the MOE formally designates the eligible city or region and transmits the information to Danantara. Furthermore, Danantara is required to conduct an economic and technical analysis, including an assessment of waste volume, caloric value, location suitability, system support, and risk factors.[54] Subsequently, the project developer and operator are then appointed by Danantara.[55]

The WtE developers must demonstrate that they possess a validated technology that is environmentally safe, sufficient financial resources, and relevant WtE experience.[56] Following the regulations governing State Owned Enterprises (and their subsidiaries) and third-party collaboration, the procurement process concludes in a cooperation agreement between the local government and the selected WtE developer, which alongside the Power Purchase Agreements (PPA) with PT PLN, serves as the contractual foundation for project execution.[57]

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48 PR 109/2025, Art. 26.

49 Jakarta Globe, "Parliament Pulls Danantara Patriot Bonds Bills From Priority List," 2025, <https://jakartaglobe.id/business/parliament-pulls-danantara-patriot-bond-bills-from-priority-list>, accessed 10 December 2025.

50 Indonesia Business Post, "Danantara allocates up to Rp3.2T per WtE project, to use patriot bond funding", November 2025 <https://indonesiabusinesspost.com> accessed 27 April 2026; Indonesia Business Post, "Danantara Indonesia to issue US$3.1 billion 'Patriot Bonds'", August 2025 <https://indonesiabusinesspost.com> accessed 27 April 2026; Leo Suryadinata and Siwage Dharma Negara, *Op. Cit*.

51 *Ibid*; see also: Syahriza Alkohir Anggoro, *Op. Cit*.

52 PR 109/2025, Art. 6.

53 PR 109/2025, Arts. 4(1) and 8.

54 PR 109/2025, Arts. 13(3) and 14(2), (3).

55 PR 109/2025, Art. 14(1).

56 PR 109/2025, Art. 15(1).

57 PR 109/2025, Arts. 17 and 19.

3.5. Feed-in Tariff and Power Purchase Obligations

A feed-in tariff system establishes a set price for power purchased by PT PLN (Persero) from WtE Projects as a guarantee for the sustainability of these projects. In this regard, PR 109/2025 established the final regulatory framework for PSEL by requiring a feed-in tariff of USD 0.20 per kWh for a non-negotiable 30-year PJBL duration, which must be used without price escalation.[58] This tariff represents a substantial increase from the previous tariff of USD 0.13/kWh under PR 35/2018 and is also significantly higher than Indonesia's solar feed-in tariff range of approximately USD 0.059-0.15/kWh. The higher tariff structure was specifically designed to ensure that WtE projects could recover their substantial capital expenditures, estimated at approximately USD 150–192 million per facility, through a single and predictable revenue stream derived from PLN. Based on pre-construction feasibility analyses, projects operating at full capacity are projected to generate annual electricity revenues of approximately USD 30–45 million, resulting in an estimated payback period of around 8–15 years and thereby allowing investors to benefit from a substantial remaining revenue horizon within the 30-year Power Purchase Agreements (PPA) term.

To further enhance feasibility and attract private investment, the government also provides a range of fiscal and non-fiscal incentives, including VAT exemptions for local technology.[59] In addition, PSEL developers are not penalized for under-delivery due to technological limitations or inadequate waste supply, and PT PLN (Persero) is required to purchase all energy produced by PSEL with priority for must-dispatch. At the same time, PLN is obligated to purchase all electricity generated by PSEL facilities on an must-dispatch basis, thereby guaranteeing priority grid access. The regulation further requires PLN to execute the Power Purchase Agreements (PPA) within then working days after the developer fulfils all pre-construction licensing requirements.[60] Moreover, where the mandatory purchase obligation results in an increase in PLN's reimbursement to PLN.[61]

Nevertheless, despite the improved tariff structure and investment guarantees, the non-escalating nature of the USD 0.20/kWh tariff continues to present potential long-term inflation risks, particularly over the 30-year contractual period, indicating that further implementing regulations may still be necessary to ensure the long-term financial sustainability of the scheme.[62]

4. International WtE Trends and Indonesia's Benchmark

Several WtE facilities have been established globally due to of their effectiveness in waste management, mitigation, and electricity generation. Indonesia may compare itself to the WTE Project of another emerging country. Similar to Indonesia, Singapore has gradually replaced and improved its national WtE infrastructure over the last two decades, resulting in a relatively new yet rapidly growing WtE economy.[63] TuasOne (TWTE), Keppel Seghers Tuas

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58 PR 109/2025, Art. 19(2).
59 PR 109/2025, Art. 26.
60 PR 109/2025, Art. 19(7).
61 PR 109/2025, Art. 20.
62 A&O Shearman, "Waste-to-Energy Projects Indonesia: PR 109 Reshapes Regulation", October 2025 <https://www.aoshearman.com> accessed 27 April 2026; IDNFinancials, "Prabowo signs on waste-to-energy projects, tariffs above solar power", October 2025 <https://www.idnfinancials.com> accessed 27 April 2026; Adhianti Roswulandari et al., "Waste to Energy (WTE) Putri Cempo As Urban Innovation: A Financial Analysis" in Proceedings of SENVAR 2018, Atlantis Press, 2019.
63 Singapore National Environment Agency, "Solid Waste Management Infrastructure," <https://www.nea.gov.sg/our-services/waste-management/waste-management-infrastructure/solid-waste-management-infrastructure>, accessed 10 December 2025.

(KSTP), Tuas South Incineration Plant (TSIP), and Senoko WtE Plant (SWTE) are the four WtE facilities operating in Singapore.

The most recent, TuasOne (TWTE), was put into operation in 2021. These facilities, which are the fundamental component of Singapore's waste management system, effectively reduce waste volume by approximately 90% and thereby extend the operational longevity of its sole landfill, Semakau.[64] In addition, data from the National Environment Agency (NEA) and the Energy Market Authority (EMA) of Singapore indicate that the country's WtE sector contributes approximately 2,8% (345 MW) of Singapore's total installed electricity generation capacity.[65] Nevertheless, the relatively modest electricity contribution demonstrates that Singapore primarily values WtE as a waste management solution driven by severe land constraints, rather than as a major source of electricity generation.[66]

The WtE development model of Singapore provides a significant reference for Indonesia. Numerous essential facilities in Singapore were developed through Design, Build, Own, and Operate (DBOO) initiatives, such as the KSTP plant (commissioned in 2009) and the TWTE plant (commissioned in 2021) demonstrating a long-term collaboration strategy that integrates private-sector participation with public-sector oversight. This framework is largely analogous to the integrated concession model outlined in PR 109/2025, in which project revenues are generated within a consolidated contractual arrangement with the government.

In Singapore, the government functions as the primary coordinating entity for both waste management and electricity procurement, while privately operated WtE facilities supply electricity to the national grid under long-term agreements. Unlike Indonesia, however, Singapore does not implement a dedicated WtE feed-in tariff. Instead, WtE facilities sell electricity at market prices averaging approximately USD 0.074-0.148/kWh, while project viability is primarily supported through tipping fees ranging from USD 57-72 per ton.[67]

By comparison, Indonesia's fixed tariff of USD 0.20/kWh combined with a guaranteed 30-year electricity offtake by PLN provides greater certainty for electricity-based revenue streams, thereby making Indonesia's framework comparatively more attractive for electricity-focused project financing. Nevertheless, Indonesia's model still lacks the tipping fee stability that forms a crucial financial foundation within Singapore's WtE system.[68] This concept, supported by predictable concession terms, a single government partner, and assured offtake, serves as a valuable benchmark for Indonesia as it endeavours to accelerate WtE deployment and mitigate technical, commercial, and regulatory risks.[69]

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64 *Ibid.*

65 *Ibid*.; Energy Market Authority (EMA) Singapore, Singapore Energy Statistics Chapter 2: Energy Transformation, 2024 <https://www.ema.gov.sg/resources/singapore-energy-statistics/chapter2> accessed 13 December 2025.

66 Ibid.; see also: Zuno Carbon, "How does Singapore generate electricity?", 2024 <https://www.zunocarbon.com/blog/how-does-singapore-generate-electricity> accessed 27 April 2026.

67 Energy Market Authority (EMA) Singapore, "Buying at Regulated Tariff" (Q2 2026) <https://www.ema.gov.sg/consumer-information/electricity/buying-electricity/buying-at-regulated-tariff> accessed 27 April 2026; YSEALI Fulbright, Analyzing the potential of municipal solid waste-to-energy in ASEAN <https://yseali.fulbright.edu.vn/upload/Team%203_Municipal%20Solid%20Waste%20to%20Energy.pdf> accessed 27 April 2026.

68 *Ibid*.

69 Singapore National Environment Agency, "Solid Waste Management Infrastructure," *Op. Cit.*; Energy Market Authority (EMA) Singapore, Singapore Energy Statistics Chapter 2, *Op. Cit*.

Additionally, the UAE has also emerged as a relevant comparative example for Indonesia's WtE development framework.[70] Although the UAE only began developing large-scale WtE projects in Sharjah in 2017, the sector has expanded rapidly, culminating in the commencement of operations of the Warsan WtE facility in Dubai in 2024. The Warsan facility, developed through a public-private partnership arrangement, is currently regarded as one of the largest WtE plants in the world, with the capacity to process approximately 1.9 million tons of municipal waste annually.[71] The plant possess an installed electricity generation capacity of 200 MW, although approximately 145-165 MW net electricity is supplied to the Dubai Electricity and Water Authority (DEWA) grid after accounting for internal consumption requirements, including energy use for the adjacent wastewater treatment facility and the WtE plant itself. Since entering full commercial operation in September 2024, the facility has reportedly processed more than 4.5 million tons of waste.[72]

The Warsan project is supported by a 35-year concession agreement between Dubai Municipality, acting as the purchasing authority, and the project company.[73] Similar to the integrated concession framework introduced under Indonesia's PR 109/2025, the Warsan scheme consolidates project revenue within a single contractual structure coordinated by the government. Dubai Municipality achieved this by centralizing project-related electricity usage and entering into a long-term Power Purchase Agreement (PPA) with DEWA for the sale of excess electricity generated by the facility.[74]

Unlike Indonesia, however, the UAE does not publicly implement a dedicated feed-in tariff for WtE projects. Instead, electricity generated by the Warsan facility is sold to DEWA under an undisclosed tariff arrangement, while overall project viability is supported through a diversified revenue structure consisting of electricity sales, recovered metals, and avoided landfill costs.[75]

5. Indonesia WtE Projects Prospect and Potential

In Indonesia, renewable energy sources derived from biomass and waste are to intended to replace a portion of coal used in electricity generation and to generate biogas for transportation and industrial applications.[76] According to PLN's RUPTL, two energy mix scenarios were created: (i) RE Base and (ii) ARED. *First*, in the RE Base Scenario, renewable energy is prioritized as the primary provider, while taking into account operational efficiency

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[70] BEEAH, "Sharjah Waste to Energy Plant Achieves Major Milestones Towards Zero-Waste, Net-Zero Emissions in First Year of Operations," 2023, <https://www.beeahgroup.com/sharjah-waste-to-energy-plant-achieves-major-milestones-towards-zero-waste-net-zero-emissions-in-first-year-of-operations/>, accessed 10 December 2025.

[71] *Ibid.*

[72] Ramboll, "Largest of its kind waste-to-energy facility in Dubai" <https://www.ramboll.com/projects/energy/largest-of-its-kind-waste-to-energy-facility-in-dubai> accessed 27 April 2026; Dubai Waste Management Centre, "Dubai Waste-to-Energy Plant 2026: Phase 2 Launch This Year", February 2026 <https://www.dubaiwaste.com/waste-to-energy/> accessed 27 April 2026.

[73] The National, "Construction of UAE's First Waste-to-Energy Plant Complete," 2022, <https://www.thenationalnews.com/uae/environment/2022/04/26/construction-of-uaes-first-waste-to-energy-plant-complete/>, accessed 10 December 2025.

[74] *Ibid*.

[75] Zawya, 'Dubai Municipality, DEWA sign Power Purchase Agreement' (February 2023) <https://www.zawya.com> accessed 27 April 2026; Ramboll, *Op. Cit.*; YSEALI Fulbright, *Op. Cit*.

[76] Government Regulation Number 40 of 2025 on the National Energy Policy ("GR 40/2025").

and economics viability; *second*, the ARED Scenario aims to enhance the energy mix 2030 and restrict emissions afterwards. [77]

To achieve this, strategies include accelerating Sumatra-Java interconnection, scaling up VRE (11.9 GW by 2030) with solar, wind, and rooftop power plants, and gradually increasing co-firing share to 20%.[78] As to the RUPTL, Indonesia intends to develop WtE as a source electricity, targeting 98 GWh of generation by 2025 and further escalating to 2,485 GWh by 2034. This indicates the government's increasing dedication to incorporating WtE facilities into the national energy framework as part of a comprehensive strategy to enhance renewable energy capacity and optimize waste management efficiency.

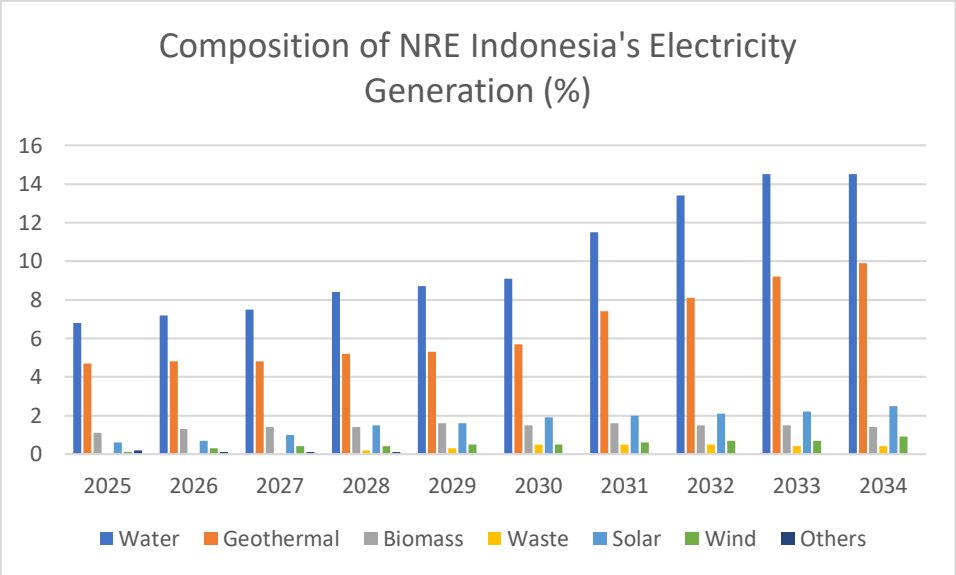


Figure 3. Composition of New Renewable Energy Generation in Indonesia (%)[79]

PR 109/2025 broadens the scope of WtE development beyond a predetermined group of pilot cities to encompass all district and municipalities that satisfy the minimum requirements for eligibility.[80] These modifications to policy address the insufficient and poor implementation of the previous regulation, and also aligns the growth of the national WtE development with Indonesia's overarching energy transformation goals under RUEN and RUPTL.

6. Challenges

6.1. Financial Challenges

Under PR 35/2018, the deployment of WtE infrastructure encountered substantial structural and financial challenges, leading to only two facilities becoming operational, Benowo in Surabaya and Putri Cempo in Surakarta.[81] Numerous alternative sites, including several major projects in Jakarta, have long experienced delays owing to ongoing challenges in land acquisition, securing a dependable waste supply, and establishing financially viable

77 PLN RUPTL, II-1.
78 PLN RUPTL, V-233.
79 PLN RUPTL, V-233.
80 PR 109/2025, Art. 4.
81 Frédérick Draps and Dan Trevanion, Ashurst, 'Accelerating Waste-to-Energy in Indonesia: PR 109/2025's Impact and Challenges' (Ashurst, 2025).

arrangements.[82] A primary source of complexity arose from the dual-revenue model mandated at the time, which divided income into a tipping fee paid by local governments for refuse processing under a cooperation agreement and a feed-in tariff from PT PLN under a power purchase agreement.[83]

The constrained fiscal capacity and creditworthiness of numerous local governments, coupled with inconsistencies and inadequate alignment between cooperation agreements and PPAs circulated within the market, compromised project bankability and resulted in the suspension of multiple projects. These challenges ultimately led to the revocation of PR 35/2018 and its replacement with PR 109/2025, which seeks to streamline governance and expedite WtE development through renewed political commitment and a more consistent regulatory framework.[84]

6.2. Environmental Impact of Waste to Energy Facilities

Renewable energy is typically less damaging than fossil fuels.[85] Nevertheless, multiple studies have shown that it is not entirely free of environmental consequences.[86] Although renewable energy aims to be environmentally friendly and sustainable, it presents several challenges.[87]

The methods utilized in the operation of WtE Plant at Benowo ("WTEP Benowo"), Surabaya, Indonesia consist of landfill gas collecting and gasification.[88] The initial method has been implemented since 2015, encompassing the collecting of waste and its subsequent storage for around three weeks to produce electrical energy.[89] Recent evidence from the WTEP Benowo facility in Surabaya demonstrates the significant environmental and health risks that associated with WtE plants. WALHI East Java's participatory air quality monitoring from November 2024 to January 2025 recorded persistent breaches of WHO's daily limits for $PM_{2.5}$ (15 µg/m³) and PM_{10} (45 µg/m³).[90]

The concurrent exposure to elevated $PM_{2.5}$ and PM_{10} is associated with various health consequences. The PM_{10} can irritate the upper respiratory tract and exacerbate asthma and bronchitis, while $PM_{2.5}$, which can penetrate the alveoli and enter the bloodstream, is linked to systemic inflammation, stroke, cardiovascular disease, and heightened chances of chronic

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82 Jessica Gabriela Soehandoko and M. Fatkhul Maskur, 'Waste-to-energy-plant: Jakarta has not given up' (*Bisnis Indonesia*, translated by PwC Indonesia, 18 June 2025) <https://www.pwc.com/id/en/media-centre/infrastructure-news/june-2025/waste-to-energy-plant-jakarta-has-not-given-up.html> accessed 13 December 2025.

83 PR 35/2018, Arts. 6 and 7.

84 PR 109/2025, Preamble; Indonesia Business Post, 'Ombudsman suggests revision on WtE regulation' (3 January 2024) <https://indonesiabusinesspost.com/1446/Politics/ombudsman-suggests-revision-on-wte-regulation\> accessed 13 December 2025.

85 M. Kumar, "Social, Economic, and Environmental Impacts of Renewable Energy Resources," in *K.E. Okedu, A. Tahour, and A.G. Aissaou* (eds.), *Wind Solar Hybrid Renewable Energy System*, 2020.

86 R. de Arce, et. al., "A Simulation of the Economic Impact of Renewable Energy Development in Morocco," *Energy Policy,* Vol, 46, 2012.

87 S. Pratiwi and N. Juerges, "Review of the Impact of Renewable Energy Development on the Environment and Nature Conservation in Southeast Asia," *Energy Ecol. Environment* Vol. 5(4), 2020.

88 Andrew Cahyo, et. al., "The Framework of Waste to Energy Technology Decision in Indonesia," *Paper 60*, p. 586.

89 *Ibid*.

90 WALHI Report, Policy Brief Mengungkap Bahaya Polusi Udara dari PLTSa Benowo: Tantangan Regulasi dan Urgensi Transisi ke Sistem Zero Waste," 2025, p. 3.

lung disease.[91] Notwithstanding these discoveries, local authorities assert that emissions from the facility comply with regulatory limitations, although the foundational monitoring data have not been disclosed to the public. This absence of transparency has raised concerns over accountability and independent verification.[92]

7. Integration of Environmental, Social, and Governance (ESG) into The WtE

The WtE plants align with the SGDs7 (affordable and clean energy), particularly support access to affordable, reliable, sustainable and modern energy,[93] while the integration of ESG aspects ensures a balanced and responsible approach to WtE planning and implementation.[94] In practice, the ESG framework significantly influences corporate decision-making and global investment;[95] however, it is also applicable to WtE management, as technology selection is heavily reliant on waste stream composition, energy efficiency, cost, an environmental implications.[96] This growing significance of ESG principles is reflected in KPMG's 2024 global survey, which reported that approximately 96% of the world's 250 largest companies now publish sustainability reports, thereby demonstrating the increasing centrality of ESG considerations in global investment practices and reinforcing the relevance of ESG frameworks within the governance and implementation of WtE projects.[97]

The application of ESG framework in WtE projects can be observed through the adoption of relevant international standards, such as ISO24161 (waste collection and transportation management vocabulary), ISO14001 (environmental management system),[98] as well as guidance issued by the UN Environment Programme (UNEP).[99] International waste management standards further confirm that technology selection in WtE projects is inherently guided by ESG-related considerations, particularly environmental compliance, energy efficiency, and compatibility with waste-stream characteristics.[100]

Subsequently, the ESG assessment criteria for the implementation of WtE are categorized into three main aspect, for instance: (i) the environmental aspects focuses on

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91 M. Lippmann, "Toxicological and Epidemiological Studies of Cardiovascular Effects of Ambient Air Fine Particulate Matter (PM2.5) and Its Chemical Components: Coherence and Public Health Implications," *Critical Reviews in Toxicology*, Vo. 44(4), 2014.

92 Andrew Cahyo, et. al., "The Framework of Waste to Energy", *Op. Cit.*

93 United Nations: Sustainable Development Goals 17, *Op. Cit*; United Nations, Sustainable Development Goal 7: Affordable and Clean Energy <https://sdgs.un.org/goals/goal7> accessed 13 December 2025.

94 Yin Ting Chu, et. al., "Constructing an Environmental, Social, and Governance (ESG) Metrics Framework for Assessing Medical Waste Valorization Alternatives: A Novel Integrated MDCM Model Under Decomposed Fuzzy Environment," *Journal of Environmental Management*, 2024, pp. 2, 16.

95 Upalat Korwatanasakul, "Environmental, Social, and Governance Investment: Concepts, Prospects, and the Policy Landscape" in *Environmental, Social, and Governance Investment: Opportunities and Risks for Asia*, Naoko Nemoto and Peter J Morgans eds., 2020, p. 2.

96 Cui Quan, et. al., "Thermochemical Conversion of Waste into Energy: A Review," *Environmental Chemistry Letters*, Springer, 2025, p. 9.

97 Upalat Korwatanasakul, *Op. Cit*; see also: KPMG, Survey of Sustainability Reporting 2024, *KPMG International*, 2024.

98 Conor Murphy, "ISO Standards in Waste Management: A Global Compliance Guide for Businesses," Gradeall International Ltd., <https://gradeall.com/iso-standards-in-waste-management-a-global-compliance-guide-for-businesses/>, accessed 13 December 2025.

99 UNEP, "Municipal Solid Waste Generation is Predicted to From 2.1 Billions Tonnes in 2023 to 3.8 Billion Tonnes by 2050, Affecting the Climate, Ecosystems, and Human Health," <https://www.unep.org/topics/waste>, accessed 13 December 2025.

100 Cui Quan, et. al., "Thermochemical Conversion of Waste into Energy", *Loc. Cit*; Conor Murphy, "ISO Standards in Waste Management", *Op. Cit*.

GHG emissions, energy efficiency, and the utilization of renewable energy; (ii) the social aspect includes labour contribution, occupational safety and health, and impacts on surrounding communities; and (iii) the governance aspects covers regulatory compliance, consistency with the governmental strategies, risk monitoring, as well as transparency and accountability.[101] This serves as a determining factor and provide significant value for policymakers and waste management organizations in selecting the most appropriate and sustainable WtE technologies.

Comparative international practice also demonstrates the increasing importance of ESG integration within WtE procurement and operational frameworks. Both Singapore and the UAE have embedded ESG-aligned standards into WtE procurement, though not under an explicit "ESG" label. Singapore, for example, mandates ESG disclosure for listed energy infrastructure operators under SGX rules and integrates sustainability performance indicators into public procurement.[102] Similarly, the UAE's Warsan WtE project assessed technology providers based on compliance with EU-equivalent emissions standards, local partnership requirements, and concession governance structures.[103] This suggests ESG integration in WtE operator selection is an emerging international norm that Indonesia's implementing regulations under PR 109/2025 should formally adopt.

In this regard, ESG principles should not merely function as aspirational policy objectives, but rather as binding evaluation criteria throughout the procurement and operational lifecycle of WtE projects.[104] Such integration may be implemented through a three-tiered structure. First, ESG standards should operate as threshold eligibility requirements, including mandatory compliance with ISO 14001, occupational health and safety systems, and anti-corruption governance mechanisms. Second, ESG indicators should form part of the scored technical evaluation criteria within the tender process, with a weighting of approximately 20–30% of the overall technical assessment score. Third, ESG obligations should be incorporated directly into concession agreements as enforceable contractual commitments, including provisions for independent environmental monitoring and community oversight rights. This framework would also address governance and transparency concerns identified in previous Indonesian WtE projects, particularly at the Benowo facility, where air quality complaints generated public controversy amid the absence of transparent disclosure of environmental monitoring data.

8. Conclusion

Indonesia is significantly dependent on coal for electricity generation, with 75% of the nation's electricity derived from coal-fired power stations. The pressing necessity to diversify the national energy portfolio and alleviate global warming has intensified the drive for renewable energy advancement. Among the diverse renewable alternatives, municipal solid waste (MSW), especially its carbon-neutral biowaste component, has surfaced as a promising possibility. Nonetheless, PR 35/2018 does not establish a cohesive, bankable, and

[101] Yin Ting Chu, et. al., "Constructing an Environmental", *Op. Cit*, p. 5.
[102] SGX/ACRA, Singapore Sustainability Reporting Advisory Committee Final Recommendations (2023) <https://www.acra.gov.sg> accessed 27 April 2026; Global Arbitration Review, 'Construction arbitration in Singapore: an ESG focus' (2025) <https://globalarbitrationreview.com> accessed 27 April 2026.
[103] Zawya, *Loc. Cit*.
[104] *See* UNEP, "Municipal Solid Waste", *Op. Cit.*; Global Arbitration Review, "Construction arbitration in Singapore", *Op. Cit*.; Basten Gokkon, "Air quality study of East Java waste-to-energy plant sparks dispute", *Op. Cit*.

enforceable structure, resulting in uncertainty for developers on project viability and hindering progress.

A crucial component for a successful WtE initiative is the feed-in-tariff scheme and regulatory certainty, as developers necessitate reliable revenue streams, clear risk allocation, and governmental assurances that tariffs would be upheld throughout the project duration. In addition, the ESG framework plays an important role in WtE implementation by supporting technology selection and guiding stakeholder-related considerations and performance evaluation. This stability is crucial for attracting private capital, securing financing, and promoting long-term investment. Nonetheless, the shortcomings of Indonesia's prior regulation indicate that substantial enhancements are necessary in aligning local government responsibilities with PLN's Power Purchase Agreements, guaranteeing fiscal preparedness for tipping fees, streamlining procurement processes, and rectifying inconsistencies that have previously hindered or aborted major projects.

Finally, environmental considerations must be prioritized, ensuring that WtE development employs truly clean technologies, incorporates rigorous and transparent emissions monitoring, and does not introduce new health or ecological hazards for nearby communities, especially given the documented concerns regarding air quality surrounding existing facilities.

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