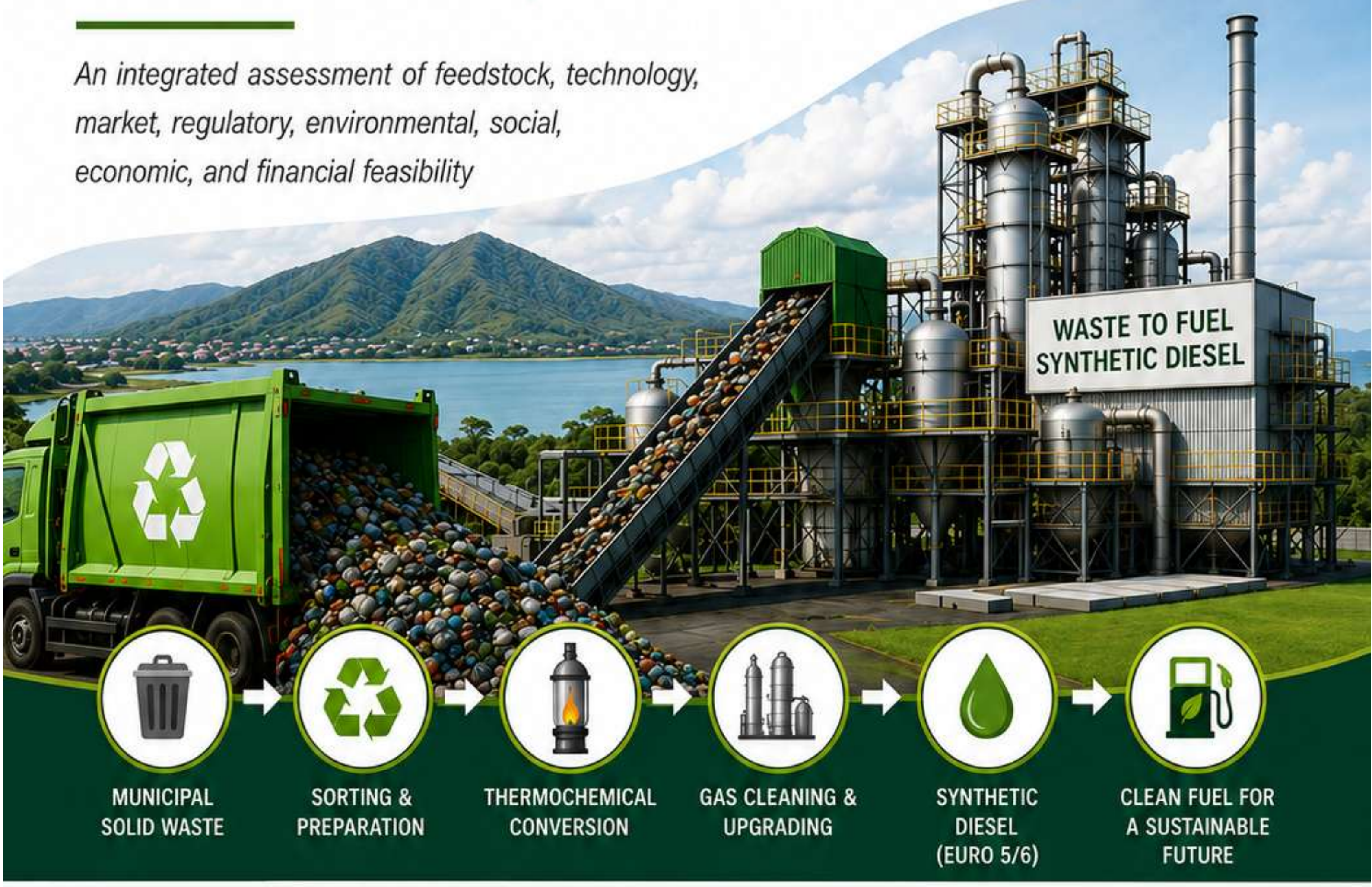
Feasibility of Municipal Solid Waste Conversion to Euro 5/6 Synthetic Diesel in West Lombok, Indonesia

An integrated assessment of feedstock, technology, market, regulatory, environmental, social, economic, and financial feasibility



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SUSTAINABLE SOLUTION

CIRCULAR ECONOMY

ENERGY SECURITY

LOW CARBON FUTURE

Executive Summary

The proposed project addresses two linked regional challenges: the increasing burden on the Kebon Kongok regional landfill and the continuing demand for diesel fuel in West Nusa Tenggara (NTB). The source study reports that Kebon Kongok receives approximately 300-320 tons of waste per day and is approaching the end of its operational life. The proposed plant would divert 120 tons per day, equivalent to roughly 37.5-40.0 percent of the current daily inflow, and convert selected waste fractions into marketable fuel and by-products.

Table 1. Dimension, Finding and Assessment

Dimension	Principal finding	General Assesment
Project scale	120 tons MSW/day; 333 operating days/year assumed	Scale is material but small relative to the regional waste and diesel markets.
Expected output	12,000-15,000 L/day diesel; 3,000 L/day naphtha; 2.5 t/day biochar	Output depends on feedstock preparation, moisture, availability, catalyst performance, and plant uptime.
Feedstock	TPAR inflow about 320 t/day; 2024 total 114,197 t	Sufficient gross quantity, but long-term usable fraction and seasonality require validation.
Market	NTB diesel demand estimated at 769,940 kL/year	Annual plant output of about 3,996 kL represents only about 0.5-0.7% of demand.
Environment	Reported landfill diversion of 40% and lower life-cycle impacts than landfilling	Benefits are plausible, but the source LCA uses non-site-specific assumptions.
Social	58.3% of local FGD participants agreed; 77.78% of waste pickers were positive	Acceptance is encouraging but samples are small and not demographically representative.
Financial	NPV USD 19.92m; IRR 21.42%; WACC 8.19%; payback 3.96 years	Preliminary only: full CAPEX/OPEX model is absent and another page reports 6.86-year payback.
Regulation	Waste and environmental permits identified; fuel-specific rules remain incomplete	Regulatory uncertainty is a critical path risk for commercialization.

Overall feasibility judgment

The integrated evidence supports a conclusion of conditional feasibility rather than an unconditional investment recommendation. The project has a credible strategic rationale, adequate gross waste availability, a large addressable diesel market, and potentially significant landfill and emissions benefits. Nevertheless, the bankability of the project depends on resolving four core uncertainties: (i) proof that the technology can process the actual heterogeneous and moisture-rich NTB waste stream at the claimed yield and uptime; (ii) a legally valid route to certify, register, distribute, and sell waste-derived synthetic diesel; (iii) binding feedstock and product offtake agreements; and (iv) an auditable financial model with reconciled assumptions, sensitivity analysis, and complete investment costs.

Immediate decision priorities

1. Commission an independent engineer to validate the mass balance, energy balance, reference-plant performance, emissions controls, catalyst requirements, and product-quality guarantees.
2. Undertake a longer seasonal WACS and secure enforceable waste-supply arrangements with Mataram, West Lombok, and backup suppliers.
3. Obtain written regulatory guidance from KLHK and ESDM, complete spatial and environmental approvals, and conduct LEMIGAS testing for the final product.
4. Convert active buyer discussions into conditional long-term offtake contracts with clear quality, price-indexation, logistics, and volume provisions.
5. Rebuild and independently audit the financial model, including all CAPEX, OPEX, financing, working capital, taxes, replacement costs, ramp-up, downtime, and downside scenarios.
6. Establish a stakeholder and livelihood plan that includes waste pickers, community grievance procedures, local employment pathways, traffic management, and odor/noise monitoring.

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1. Introduction

1.1 Background

Rapid urbanization, limited waste segregation, and landfill capacity constraints have made municipal solid waste management a persistent policy and infrastructure challenge in Indonesia. In NTB, the Kebon Kongok regional landfill serves Mataram City and West Lombok. The source study reports that the facility has operated for more than three decades, receives around 300 tons of MSW daily, and is already subject to restricted or open-close operations. This situation creates environmental, public-health, fiscal, and service-continuity risks for local governments.

The proposed response is a waste-to-synthetic-diesel plant using advanced pyrolysis and catalytic upgrading. The project seeks to reduce landfill dependency while producing Euro 5/6-grade synthetic diesel and the by-products naphtha, biochar, and pyrolysis gas. The proposal aligns conceptually with a circular-economy model in which waste is treated as an input to energy and material production rather than as a residual for disposal.

1.2 Research problem

The central research problem is whether the project can transform the region's heterogeneous MSW into consistent, legally marketable, and financially viable fuel at the proposed commercial scale without creating unacceptable environmental and social impacts. This problem requires simultaneous evaluation of resource availability, engineering performance, market absorption, licensing, environmental safeguards, social acceptance, and investment returns.

1.3 Research objectives

- Assess the adequacy, composition, calorific value, moisture content, and logistics of the proposed MSW feedstock.
- Evaluate the suitability and operational risks of the proposed pyrolysis and catalytic-upgrading technology.
- Estimate the scale and structure of the diesel, naphtha, biochar, and carbon-credit markets relevant to the project.
- Identify the spatial, environmental, construction, waste-management, water-use, fuel-quality, and trading approvals required.
- Assess the likely environmental and social benefits, impacts, and stakeholder concerns.
- Review the preliminary financial indicators and identify the assumptions and data gaps that affect bankability.
- Formulate an integrated feasibility conclusion and conditions that should precede an investment decision.

1.4 Research questions

The conversion of municipal solid waste (MSW) into Euro 5/6 synthetic diesel has emerged as a promising strategy to simultaneously address waste management challenges, improve energy security, and support the transition toward a circular economy. However, the commercial viability of waste-to-fuel projects depends not only on technological capability but also on the integration of technical, economic, environmental, social, and regulatory considerations. In West Lombok, where municipal waste generation continues to increase while landfill capacity remains limited, significant uncertainty exists regarding the adequacy and consistency of feedstock supply, the performance of conversion technology under local waste characteristics, the marketability of the resulting fuel, and the ability to secure the necessary permits and certifications. Without a comprehensive feasibility assessment, large capital investments may face substantial operational and financial risks.

Furthermore, the economic performance of the project is inherently sensitive to uncertainties in feedstock quality, plant utilization, product yield, capital and operating costs, financing conditions, fuel prices, and regulatory timelines. Environmental and social impacts, including emissions control, waste diversion, and the livelihoods of informal waste pickers, must also be evaluated to ensure that the project delivers net societal benefits alongside financial returns. Consequently, an integrated feasibility study is required to assess whether the proposed waste-to-synthetic diesel facility can operate sustainably and remain economically resilient under realistic market and operational conditions. This study addresses these issues through the following research questions:

1. Is there sufficient suitable feedstock to support 120 tons of daily plant input throughout the year?
2. Can the proposed technology achieve the claimed yield, uptime, product consistency, and Euro 5/6 quality using local waste?
3. Can the projected products be sold at the assumed prices and volumes under competitive market conditions?
4. Can all relevant permits and product approvals be obtained within the planned project schedule?
5. Do the environmental and social benefits outweigh the risks after mitigation?
6. Are the reported financial returns robust to changes in price, yield, uptime, CAPEX, OPEX, financing, and regulatory delay?

1.5 Scope and limitations

The report focuses on the proposed 120-ton-per-day facility in Dusun Bakong Dasan, Lembar, West Lombok. It is based on the contents of the supplied feasibility study and does not independently verify third-party market forecasts, technology-provider claims, legal interpretations, environmental performance, or financial calculations. The report therefore emphasizes internal consistency, reasonableness, evidence quality, and decision-critical gaps.

2. Conceptual and Analytical Framework

This study adopts an integrated feasibility assessment framework that evaluates the viability of converting municipal solid waste (MSW) into Euro 5/6 synthetic diesel through seven interrelated dimensions: resource/feedstock, technical, market, legal/regulatory, environmental, social, and financial feasibility. The framework recognizes that the success of a waste-to-fuel project depends on the performance of the entire value chain rather than on technical performance alone. Each feasibility pillar represents a necessary condition for project implementation, while the financial assessment serves as the final integrative measure of overall project viability. Failure in any critical pillar, such as inadequate feedstock, technology underperformance, regulatory delays, or weak market demand, may significantly reduce project profitability or prevent commercial operation.

Table 2. Feasibility Pillar, Core Test and Indicative Evidence

Feasibility pillar	Core test	Indicative evidence
Resource/feedstock	Quantity, quality, seasonality, supply control, and transport are adequate.	Waste records, WACS, laboratory tests, supply-chain design.
Technical	The plant can achieve stable throughput, yield, quality, uptime, safety, and emissions performance.	Process design, reference plant, guarantees, mass/energy balance, O&M plan.
Market	Products can be sold at bankable volumes and prices.	Demand, competition, buyer discussions, offtake terms, logistics.
Legal/regulatory	Site, construction, environmental, waste, water, product, and trading approvals are obtainable.	Spatial plan, environmental permits, ESDM/KLHK pathway, certification.
Environmental	Net impacts are acceptable and mitigation is implementable.	Emissions, wastewater, residue, noise, odor, traffic, life-cycle impacts.
Social	The project has a durable social license to operate.	Stakeholder mapping, FGD, livelihood effects, grievance mechanism.
Financial	Risk-adjusted cash flows exceed the cost of capital and remain resilient under downside cases.	CAPEX/OPEX, NPV, IRR, DSCR, payback, sensitivity and scenarios.

The analytical framework proceeds sequentially from upstream resource availability to downstream economic performance. First, the resource assessment evaluates whether sufficient quantities of suitable MSW can be supplied consistently throughout the year by examining waste generation records, waste composition analysis (WACS), laboratory testing, seasonality, logistics, and supply-chain arrangements. The technical assessment then determines whether the proposed conversion technology can reliably achieve the required throughput, fuel yield, Euro 5/6 quality, operational uptime, safety, and environmental performance based on process design, mass and energy balances, reference plant performance, and operation and maintenance strategies. Subsequently, the market and regulatory assessments examine commercial viability by evaluating product demand, pricing, logistics, buyer interest, permitting requirements, certification pathways, and compliance with national environmental and energy regulations.

The final stage integrates the environmental, social, and financial assessments to determine the project's overall sustainability and investment attractiveness. Environmental feasibility evaluates emissions, wastewater, solid residues, odor, traffic impacts, and life-cycle environmental performance, while social feasibility examines stakeholder acceptance, livelihood implications for informal waste pickers, community engagement, and grievance mechanisms to ensure a durable social license to operate. These assessments provide the basis for the financial evaluation, which estimates CAPEX, OPEX, revenues, cash flows, NPV, IRR, DSCR, and payback period under both baseline and downside scenarios. Sensitivity and scenario analyses are subsequently applied to test the robustness of investment returns against changes in feedstock quality, plant yield, operating availability, product prices, financing conditions, and regulatory delays, thereby providing an integrated assessment of the project's technical, economic, environmental, and social feasibility.

3. Research Methodology

3.1 Research design

The study is best characterized as an applied mixed-method feasibility assessment. Quantitative methods are used for waste-flow measurement, composition analysis, laboratory testing, market sizing, environmental comparison, and financial appraisal. Qualitative methods are used for site assessment, legal review, stakeholder mapping, technology review, and focus group discussions.

3.2 Data sources and analytical methods

This study employs a combination of primary and secondary data to evaluate the technical, economic, environmental, social, and financial feasibility of converting municipal solid waste (MSW) into Euro 5/6 synthetic diesel in West Lombok. Feedstock availability is assessed using daily, monthly, and annual landfill records obtained from the West Lombok Environmental Agency (DLHK) to determine whether the waste supply can consistently support the proposed plant capacity of 120 tons per day. Waste characteristics are evaluated through an eight-day Waste Analysis and Characterization Study (WACS), involving sampled waste collection vehicles, composite sampling, manual sorting, and weighing to estimate the proportion of usable feedstock. Laboratory analyses of moisture content and calorific value are further used to determine the energy potential and suitability of individual waste fractions. Site investigations, supported by maps and geotechnical information, provide the basis for assessing constructability, logistics, utility availability, and site-specific constraints.

The technical and commercial assessments combine engineering documentation with market intelligence. Technical feasibility is evaluated using vendor process information, reference-plant performance data, and engineering specifications to review process flow, expected fuel yield, operational uptime, maintenance requirements, and potential operational risks. Market feasibility is assessed using government energy statistics, industry reports, competitor analysis, fuel price information, and discussions with prospective buyers to estimate potential demand, market penetration, and commercialization opportunities. Legal and regulatory feasibility is examined through a comprehensive review of national and regional regulations, spatial planning documents, environmental and energy policies, and coordination with relevant government agencies to identify permitting requirements and potential regulatory constraints. Social feasibility is assessed through Focus Group Discussions (FGDs) involving local residents and stakeholders from the waste sector to understand community perceptions, employment expectations, livelihood implications, and potential social acceptance of the project.

The analytical approach integrates qualitative and quantitative assessments within a comprehensive feasibility framework. Resource availability is evaluated by comparing projected feedstock supply with annual plant demand while considering seasonal variation and waste quality. Technical and market analyses are conducted through engineering evaluation and commercial assessment to determine whether the proposed technology can achieve the required performance and whether the synthetic diesel products can be marketed under realistic conditions. Legal, environmental, and social analyses identify implementation risks and mitigation measures affecting project execution. Finally, financial feasibility is evaluated using standard investment appraisal indicators, including Net Present Value (NPV), Internal Rate of Return (IRR), Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA), payback period, and Weighted Average Cost of Capital

(WACC). To assess investment robustness, these indicators are complemented by sensitivity and scenario analyses that examine the effects of changes in feedstock availability, product yield, market prices, operating costs, financing conditions, and regulatory delays on overall project viability.

Table 3. Assessment, Data and Methods

Assessment	Data	Methods
Feedstock quantity	DLHK daily, monthly, and annual landfill records	Compare gross supply with plant demand and assess source concentration.
Waste composition	Eight-day WACS, 24 sampled trucks, 200 kg composite samples, manual sorting and weighing	Estimate usable fractions, preprocessing burden, and energy potential.
Waste quality	Laboratory moisture and calorific-value tests	Assess suitability of organic, paper, textile, and plastic fractions.
Location	Site visit, maps, road, utility, water, topographic and seismic information	Assess constructability, logistics, utilities, and sensitive receptors.
Technology	Vendor process information and reference-plant claims	Review process logic, output assumptions, uptime, O&M, and risks.
Market	Government statistics, market reports, competitor prices, prospective-buyer discussions	Estimate addressable demand and commercialization prospects.
Legal	Review of laws, regulations, regional plans, and agency coordination	Map permits and identify regulatory gaps.
Social	FGD with 15 residents and 10 waste-sector participants	Assess perceptions, concerns, employment expectations, and livelihood risks.
Financial	Reported NPV, IRR, EBITDA, net profit, WACC, and payback	Evaluate preliminary attractiveness and internal consistency.

3.3 WACS sampling approach

The WACS was conducted from 5 to 12 August 2025 and referred to SNI 19-3964-1994. The study selected three incoming trucks per day representing residential, traditional-market, and office/public-facility or commercial sources. Across eight days, 24 trucks were sampled. Waste was taken from the top, middle, and bottom of each selected load to reduce positional bias, combined into an approximately 200 kg composite sample, quartered, manually sorted, and weighed. Selected fractions were then tested for moisture content and calorific value.

3.4 Methodological limitations

This study is subject to several methodological limitations that should be considered when interpreting its findings. First, the feedstock assessment is based on an eight-day Waste Analysis and Characterization Study (WACS), which provides only a short-term snapshot of municipal solid waste characteristics. Consequently, the analysis may not fully capture seasonal variations between the wet and dry seasons, fluctuations associated with tourism peaks, religious festivals, policy changes, or long-term shifts in waste generation and composition. Although the WACS provides valuable baseline information for evaluating feedstock availability and quality, longer-term monitoring would improve the reliability of resource projections for commercial-scale operations.

Second, the technical assessment relies primarily on vendor documentation and reference-plant performance data, rather than on independent engineering verification or pilot-scale demonstrations using local waste. As a result, key performance indicators—including conversion efficiency, product yield, operational uptime, and Euro 5/6 fuel quality—remain dependent on assumptions that have not yet been validated under the specific feedstock conditions of West Lombok. Future studies should incorporate independent engineering reviews, pilot testing, and demonstration-scale operations to strengthen confidence in the projected technical performance.

Third, the market analysis combines information obtained from multiple data sources covering different time periods, including alternative assumptions regarding synthetic diesel prices. While this approach provides a broad assessment of commercial opportunities, it introduces uncertainty because market conditions, fuel prices, and demand may change over time. Similarly, the environmental comparison is largely based on literature-derived emission factors and transportation assumptions that do not fully reflect the actual local logistics routes, collection patterns, or transport distances expected within West Lombok. More detailed life-cycle assessment using site-specific operational data would improve the accuracy of environmental performance estimates.

The social assessment also has important limitations. Community perceptions were obtained through Focus Group Discussions (FGDs) involving 15 male participants, which do not adequately represent the diversity of stakeholders affected by the project. Women, youth, vulnerable households, informal waste pickers, and other community groups may hold different perspectives regarding employment opportunities, environmental concerns, and social acceptance. Broader stakeholder engagement using larger and more representative samples would provide a more comprehensive understanding of the project's social impacts and long-term social license to operate.

Finally, the financial evaluation is constrained by the availability of summary financial indicators, including NPV, IRR, EBITDA, payback period, and WACC, rather than a complete and transparent project financial model. Because the underlying cash-flow assumptions are not fully disclosed, the reported investment returns cannot be independently replicated or comprehensively validated. Although sensitivity and scenario analyses provide useful insights into the project's financial robustness, access to detailed cost structures, revenue assumptions, financing arrangements, and cash-flow projections would enable a more rigorous and transparent economic evaluation.

4. Results

4.1 Project Profile and Location

The site is strategically positioned relative to the waste source and regional infrastructure. The feasibility study reports distances of approximately 7.6 km to Kebon Kongok landfill, 5.2 km to Lembar Port, 6.3 km to nearby power facilities, and 30 km to Lombok International Airport. The principal access road is approximately 6 m wide, but the final village road is only about 4 m wide and may need widening to support construction equipment, waste trucks, and fuel transport.

Water supply is a key design issue. Nearby sources include brackish groundwater, the Dodokan River about 800 m away, and seawater about 1.6 km away. The source recommends a water-treatment plant. The site is flat and approximately 7 m above sea level, but it is located in an earthquake-prone region and must be designed to appropriate seismic standards. The nearest settlements are reported to be approximately 113-232 m from the site, increasing the importance of emission, odor, noise, traffic, and emergency controls.

Table 4. Parameter and Project Specification

Parameter	Reported project specification
Project	Municipal solid waste to Euro 5/6-grade synthetic diesel
Proponent	PT Kaltimex Energy
Site	Dusun Bakong Dasan, Lembar Village, Lembar District, West Lombok, NTB
Land area	1.6 hectares; reported as owned by PT Kaltimex Energy
Technology	GGIE advanced pyrolysis and catalytic upgrading, Japan
Input capacity	120 tons of MSW per day
Main output	Approximately 12,000-15,000 liters synthetic diesel per day
By-products	Approximately 3,000 liters naphtha and 2.5 tons biochar per day; pyrolysis gas used internally
Operating assumption	333 days per year in market calculations
Implementation	Permitting/financial close in 2027; construction and commissioning in 2028; steady operations in 2029-2030

The proposed waste-to-synthetic diesel facility benefits from several favorable location characteristics that support its technical and economic feasibility. The project is planned on owned land, thereby eliminating major land acquisition risks and reducing uncertainty during project development. The site is strategically located near the Kebon Kongok landfill and other municipal waste sources serving Mataram City and West Lombok Regency, providing relatively short transportation distances and a reliable feedstock supply for the proposed plant capacity of 120 tons per day. In addition, the site has good access to port facilities and the regional electricity network, facilitating the transportation of equipment and products while providing the infrastructure required for continuous plant operation. The relatively flat terrain further enhances constructability by reducing earthwork requirements and simplifying plant layout and foundation design.

Despite these advantages, several location-specific issues require further investigation before project implementation. The legal status of the land, industrial zoning designation, and compatibility with the adjacent KP2B (Sustainable Food Agricultural Land) area should be formally confirmed to ensure regulatory compliance. Daily plant operation is expected to require approximately 40 three-ton truck movements, necessitating careful logistics planning and potential upgrading of the existing four-meter village access road, together with an appropriate traffic management and safety plan. Utility requirements also require further verification, including electricity grid capacity, connection costs, backup power systems, water supply permits, and treatment facilities for brackish or process water. Furthermore, comprehensive geotechnical, hydrological, flood, drainage, tsunami, and seismic assessments should be completed to ensure long-term infrastructure resilience. As nearby settlements are located within several hundred meters of the proposed site, effective environmental controls, stakeholder consultation, and community engagement will be essential to minimize potential impacts and maintain the project's social license to operate.

Table 5. Location Factor, Strength and Constraint

Location factor	Strength	Constraint/required action
Land	Owned land reduces acquisition risk.	Confirm legal title, industrial designation, and compatibility with adjacent KP2B area.
Waste access	Close to Kebon Kongok and Mataram/West Lombok sources.	Daily logistics require about 40 three-ton truck movements for 120 t/day.
Port/power	Good access to port and electricity infrastructure.	Confirm grid capacity, connection cost, backup generation, and utility reliability.
Road	Main road accommodates medium vehicles.	Upgrade or manage the 4 m village road and prepare traffic-safety plan.
Water	Several potential sources are nearby.	Secure permit and install treatment for brackish/process water.
Geotechnical/seismic	Flat terrain supports construction.	Complete geotechnical, flood, drainage, tsunami, and seismic design studies.
Sensitive receptors	Community access supports local employment.	Settlements within a few hundred meters require stringent controls and consultation.

4.2 Feedstock Availability and Quality

Gross waste availability appears sufficient for the proposed plant. Administrative data reported in the study indicate an average of about 320 tons per day entering Kebon Kongok. Mataram contributes the largest share, followed by West Lombok, self-managed sources, and facilities requiring DLH recommendation. The plant's 120-ton daily requirement is therefore about 37.5 percent of the reported inflow.

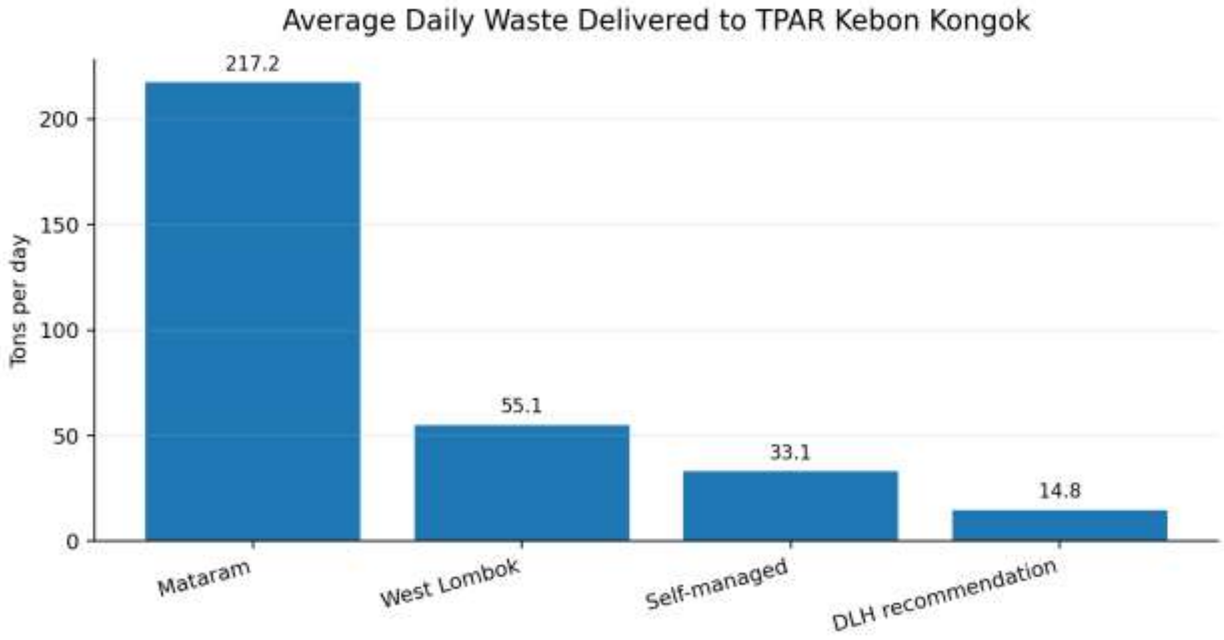

Figure 1. Average daily waste flow by source

Source: Reconstructed from DLHK data reported in the feasibility study (2025).

The 2024 total was reported at 114,197 tons, or 9,516 tons per month on average. A proposed logistics configuration allocates 75 tons per day from Mataram and 45 tons from West Lombok. This would require approximately 25 and 15 three-ton truckloads per day, respectively. Although the aggregate quantity is adequate, the project must secure control over the appropriate fractions and maintain quality through source agreements, sorting, and storage.

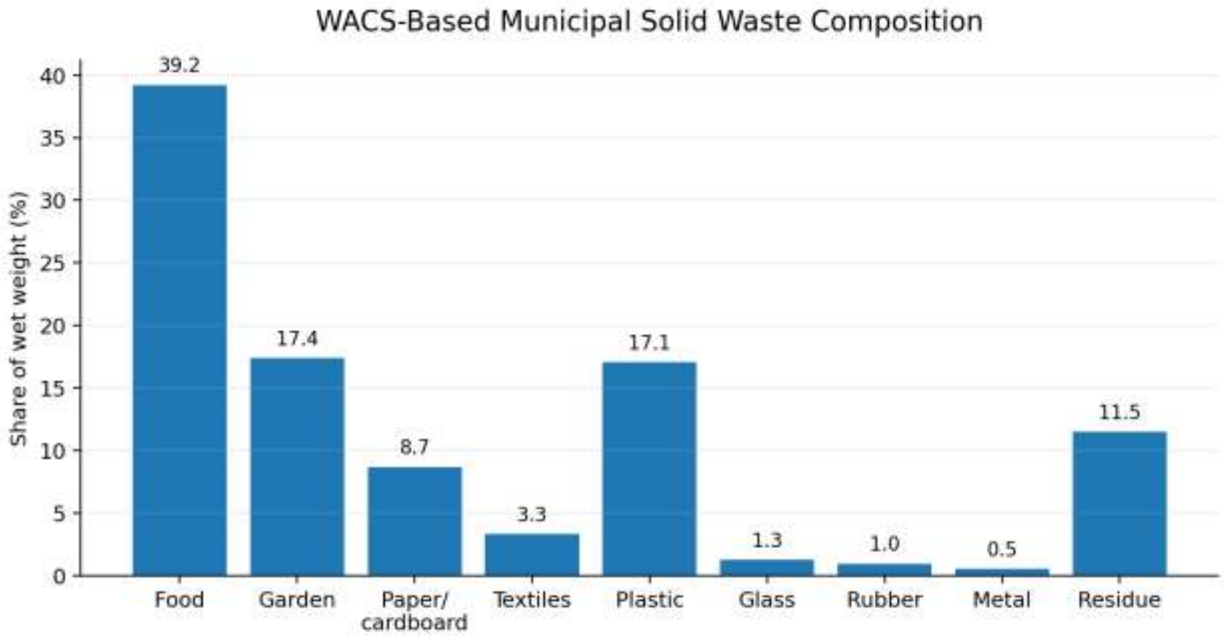

Figure 2. WACS-based waste composition

Source: Reconstructed from the WACS results reported in the feasibility study (August 2025).

Table 6. Municipal Solid Waste Composition and Feedstock Suitability

Waste fraction	Share (%)	Approx. tons/day at 120 t input	Technical relevance
Food waste	39.22	47.07	High moisture; low calorific value; significant drying/energy burden.
Garden waste	17.41	20.89	Potential biomass fraction; quality and particle size must be controlled.
Paper/cardboard/UBC	8.70	10.44	Moderate calorific value; possible RDF component.
Textiles	3.34	4.01	Higher calorific value than paper; contamination must be controlled.
Plastics (all codes)	17.05	20.46	Primary high-energy fraction; accepted plastic codes must be clarified.
Glass/rubber/metal	2.78	3.33	Rubber may be usable; glass and metal require removal.
Residue and B3	11.51+	13.81+	Must be rejected or separately managed; affects disposal and cost.

Table 7. Moisture Content and Calorific Value of Selected Waste Fractions

Tested fraction	Moisture (%)	Calorific value (kcal/kg)	Interpretation
Organic waste	66.93	2,237	Very wet; requires blending, drying, or energy-intensive preprocessing.
Paper waste	7.99	2,970	Relatively dry; useful as an auxiliary high-solids feedstock.
HDPE	0.26	10,554	Very high energy content and favorable for liquid-fuel production.
LDPE	0.33	10,218	Dominant plastic fraction and strong fuel potential.
PP	0.92	9,452	High energy content and favorable feedstock.
Textiles	1.87	4,905	Moderate-to-high energy content.

4.3 Technology Feasibility

The proposed process combines waste sorting and preparation, thermal decomposition, gas cleaning, hydrogen production, and catalytic upgrading/refining. The source indicates low-temperature operation around 500 degrees Celsius to maximize condensable hydrocarbons and higher-temperature operation around 1,000 degrees Celsius for thermal cracking or power generation. The claimed full-plant output is 12,000-15,000 liters of diesel, 3,000 liters of naphtha, and 2.5 tons of char per day from 120 tons of MSW.

The technology is presented as modular and supported by several international equipment and catalyst providers. A reference plant reportedly achieved about 88 percent availability and consistent output quality. These claims are encouraging, but they are not equivalent to a performance guarantee under the actual NTB feedstock. The heterogeneous input, high organic share, high moisture, potential chlorine from PVC, contaminants, and variability in pre-sorting are material risks to yield and product quality.

Table 8. Technology Assessment and Verification Requirements

Technical component	Reported strength	Due-diligence requirement
Process configuration	Integrated sorting, pyrolysis, gas cleaning, hydrogen, and refining.	Obtain complete process-flow diagrams, heat/mass balances, and design basis.
Reference performance	About 88% availability and stable product quality reported.	Verify operating records, feedstock comparability, downtime, yield, and independent test results.
Modularity	Prefabricated modules may reduce site construction risk.	Confirm interface engineering, local codes, spare parts, commissioning, and warranty.
Product quality	Euro 5/6 target, sulfur below 10 ppm.	Conduct pilot/batch tests using local feedstock and certify through LEMIGAS.
Catalyst	Hydrocracking/catalytic upgrading enables clean fuel.	Confirm catalyst life, replacement cost, import lead time, regeneration, and poisoning risk.
Utilities	Syngas may supply internal energy.	Validate net energy balance, grid load, water demand, WTP, cooling, and backup power.
Emissions controls	Closed handling, scrubber, carbon and limestone filters.	Set guaranteed emission limits, continuous monitoring, residue handling, and shutdown protocol.

4.4 Market Feasibility

Regional demand is much larger than the proposed output. The source estimates NTB diesel consumption at 769,940 kL per year, led by electricity generation, mining, and land transport. At the assumed 12,000 liters per day for 333 days, the project would produce around 3,996 kL annually. This represents approximately 0.52 percent of estimated NTB demand; the source describes it as about 0.69 percent, indicating a denominator or production-basis difference that should be reconciled.

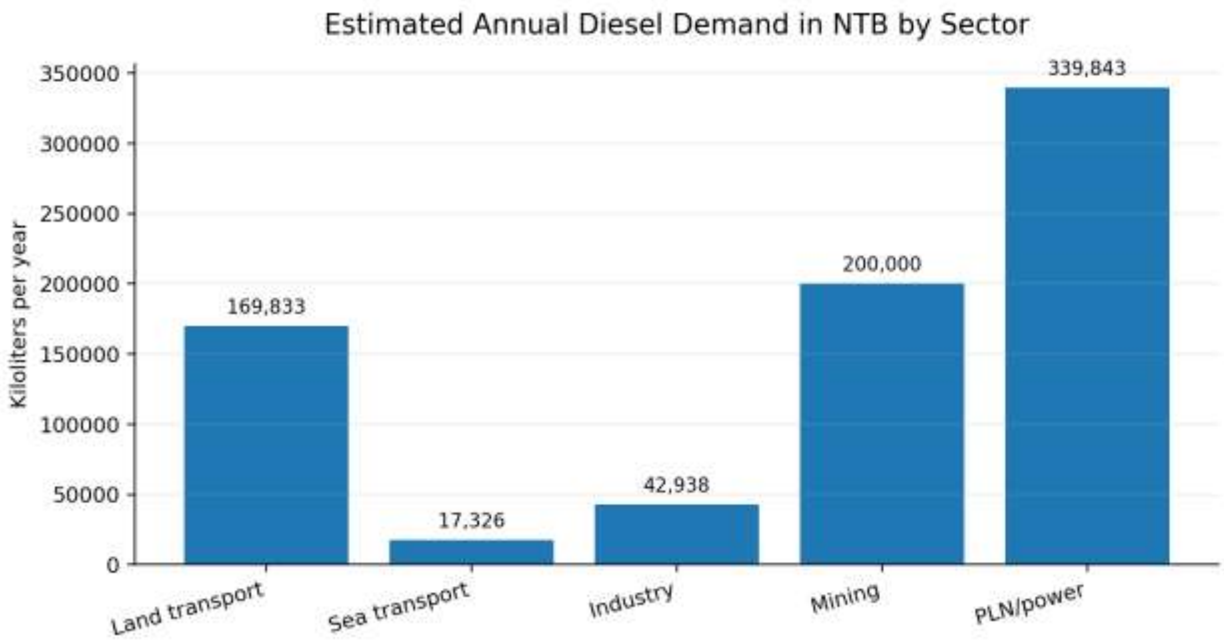

Figure 3. Estimated NTB diesel demand by sector

Source: Reconstructed from ESDM/DESDM data reported in the feasibility study.

The market strategy prioritizes business-to-business buyers that are less exposed to retail fuel subsidies, including power, mining, manufacturing, logistics, distributors, hotels, and resorts. The source reports active discussions with seven companies, identifies more than 100 manufacturing companies, and describes a wider pipeline of 173 potential companies. These discussions demonstrate interest but should not be treated as contracted demand.

Table 10. Laboratory Analysis of Selected Municipal Solid Waste Fractions

Revenue stream	Reported annual volume/assumption	Reported annual value	Critical validation
Synthetic diesel	3,996 kL at IDR 20,634/L	IDR 82.45bn (USD 4.85m)	Price differs from IDR 16,500/L shown in competitive analysis; secure indexed offtake.
Biochar	832,500 kg at IDR 2,159/kg	IDR 1.797bn (USD 105,728)	Confirm product specification, registration, agronomic efficacy, and demand.
Naphtha	999,000 L at IDR 6,800/L	IDR 6.793bn (USD 399,600)	Confirm quality, classification, buyer, storage, and transport requirements.
Carbon credits	14,700 tCO_2e equivalent reported	USD 50,845	Correct the inconsistent use of “20,000 m3/year”; establish approved methodology and verification.

The commercial case is exposed to subsidized diesel, B35 biodiesel policy, conventional fuel-price volatility, buyer bargaining power, and product-certification uncertainty. The project should therefore use long-term contracts with minimum take-or-pay volumes, clear testing protocols, delivery terms, price floors or indexation, and provisions for regulatory delay.

4.5 Regulatory and Legal Feasibility

The source study identifies a multi-agency licensing pathway involving the OSS system, spatial-use approval, waste-management licensing, environmental approval, technical approvals for emissions and wastewater, water-use authorization, building approval, functional-worthiness certification, product testing, and fuel trading authorization. Several components are familiar industrial permits; the principal uncertainty concerns the legal status and commercialization of synthetic diesel derived from waste.

Table 11. Legal and Regulatory Readiness Assessment

Requirement	Reported status/issue	Implication
Business classification	Addition of KBLI 38211 and 46610 proposed.	Update OSS and confirm risk-based licensing obligations.
Spatial conformity	Site reportedly accepted for industrial use, but near KP2B and plan update is required.	Obtain formal KKPR/PKKPR and documentary confirmation before financing.
Waste partnership	Regional rules allow cooperation with private parties and require a license.	Execute formal cooperation and waste-supply agreements.
Environmental approval	Existing approval must be amended/new document prepared under PP 22/2021.	Complete AMDAL or applicable instrument and technical approvals before construction.
Waste utilization	KLHK technical approval required for non-B3/B3 waste utilization.	Define allowable feedstock and prevent prohibited materials entering the plant.
Water	Surface-water use permit required under PUPR Regulation No. 2/2024.	Confirm source, allocation, treatment, discharge, and community impact.
Building	PBG follows spatial and environmental approvals; SLF after completion.	Include permitting sequence in critical path.
Fuel quality	Product must meet domestic/SNI or international standards; LEMIGAS testing proposed.	No commercial sale until product quality and registration pathway are confirmed.
Fuel trading	ESDM has no specific completed scheme for waste-derived synthetic diesel; draft regulation may delay approval.	This is a material regulatory and schedule risk requiring written government guidance.

4.6 Environmental Feasibility

The primary expected environmental benefit is diversion of approximately 120 tons of waste per day from landfill, equivalent to roughly 40 percent of the reported 300-ton daily inflow. The project may reduce methane emissions, uncontrolled dumping, leachate generation, and fossil-diesel dependence. It also creates material-recovery pathways through biochar and internal use of pyrolysis gas.

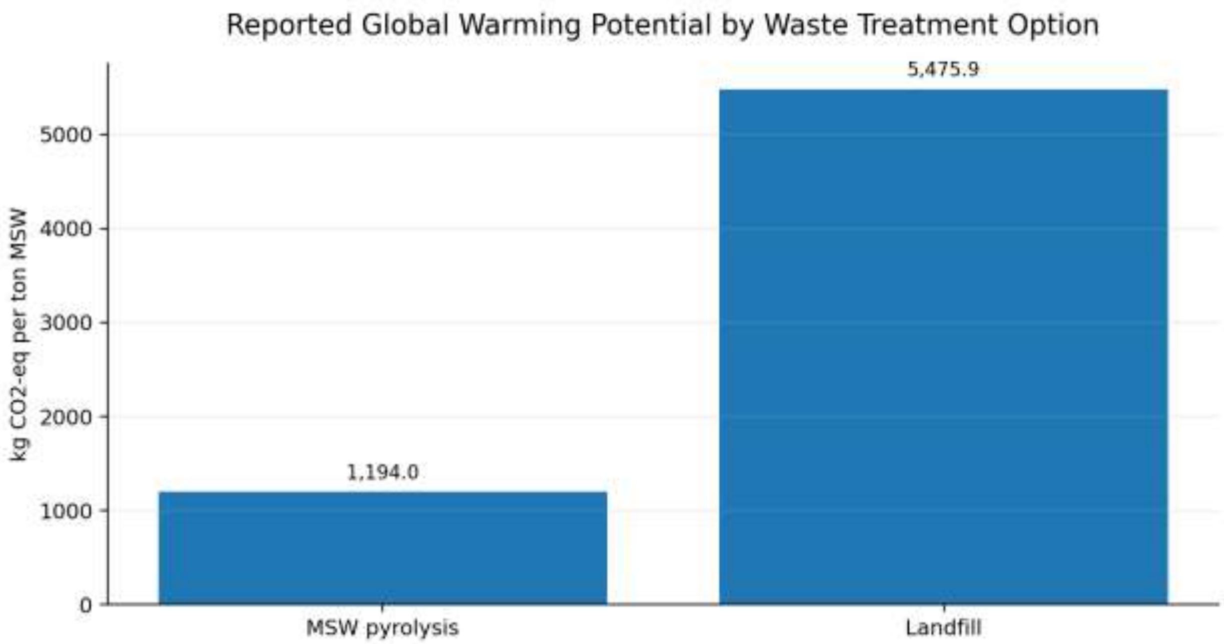

Figure 4. Reported GWP comparison between pyrolysis and landfill

Source: Reconstructed from literature values reproduced in the feasibility study. These values are not a site-specific life-cycle assessment.

The source reproduces literature estimates of 1,194 kg CO2-equivalent per ton for MSW pyrolysis compared with 5,475.9 kg CO2-equivalent per ton for landfill. It also reports lower acidification and eutrophication potentials for pyrolysis. However, the comparison assumes a 100-mile waste-transport distance and uses literature process values. A project-specific life-cycle assessment should therefore replace these values before carbon-credit claims or environmental-benefit commitments are made.

Table 12. Environmental Impact Mitigation and Monitoring Requirements

Potential impact	Required mitigation and monitoring
Air emissions	Guaranteed APCD performance, scrubber and filter maintenance, continuous or periodic monitoring, alarms, and public reporting.
Odor	Enclosed reception, sealed containers, negative pressure, rapid stock rotation, odor-control system, complaint tracking.
Leachate and runoff	Impermeable floors, covered storage, segregated drains, collection and treatment, groundwater monitoring.
Wastewater	Characterization, technical approval, treatment plant, reuse where feasible, discharge monitoring.
Solid and hazardous residues	Mass balance, classification, secure storage, licensed transporter and disposal/recovery route.
Noise and vibration	Acoustic enclosures, operating-hour controls, baseline and periodic monitoring at nearest settlements.
Traffic and road safety	Route plan, truck scheduling, road upgrade, wheel washing, speed limits, emergency response.
Climate claims	Project-specific LCA, approved carbon methodology, conservative baseline, monitoring/reporting/verification.

4.7 Social Feasibility

The project is expected to create more than 100 jobs across operations, logistics, and maintenance and may stimulate demand for local suppliers and transport services. The local-resident FGD included 15 men, mostly farmers: 58.3 percent agreed with the project and 41.7 percent were neutral. The main concerns were emissions, noise, and odor, while the principal expectation was local employment and participation in project decisions.

A second FGD involved nine waste pickers and one aggregator. Approximately 150 waste pickers are estimated to depend on Kebon Kongok. Most FGD participants viewed the project positively, but they feared loss of access to recoverable materials and reduced income. A just-transition approach is therefore needed, including preferential recruitment, formal sorting roles, skills training, occupational health and safety, and livelihood restoration where impacts cannot be avoided.

Table 13. Stakeholder Analysis and Engagement Strategy

Stakeholder	Interest/benefit	Principal concern	Required engagement
Local residents	Employment, sanitation, CSR, infrastructure.	Emissions, odor, noise, trucks, water, safety.	Representative consultation, disclosure, grievance mechanism, monitoring data.
Waste pickers/aggregators	Formal jobs, safer work, stable income.	Loss of material access and livelihood.	Census, livelihood plan, sorter roles, training, income restoration.
Local government/DLHK	Landfill relief and service efficiency.	Compliance, waste allocation, public response.	Formal agreements, transparent KPIs, contingency planning.
Farmers/irrigation users	Potential biochar and community programs.	Land-use compatibility and water/drainage effects.	Water study, drainage design, biochar trials, ongoing consultation.
Offtakers and distributors	Stable cleaner fuel supply.	Quality, price, legality, delivery reliability.	Testing protocol, contract, traceability, storage and logistics plan.

4.8 Economic Risk Assessment

The economic feasibility of converting municipal solid waste into Euro 5/6 synthetic diesel in West Lombok is strongly influenced by risks across the feedstock supply chain, technology performance, regulatory approval, market offtake, and financing structure. Since the project depends on heterogeneous municipal solid waste as the primary input, feedstock variability becomes one of the most critical economic risks. Changes in moisture content, calorific value, organic composition, and contamination levels may reduce conversion efficiency, increase preprocessing costs, and weaken revenue projections. Therefore, the project requires seasonal waste characterization, strict feedstock specifications, blending protocols, preprocessing facilities, and sufficient buffer stock.

A second major economic risk is technology underperformance, especially because local operating conditions may differ from those assumed in the technical design. If the conversion technology fails to achieve expected yield, fuel quality, uptime, or energy efficiency, the project's internal rate of return and debt-servicing capacity may decline significantly. This risk should be mitigated through pilot testing, independent engineering review, performance guarantees, and liquidated-damage clauses in EPC and technology contracts. The project also faces cost escalation and operational disruption risks related to imported catalysts, specialized equipment, and critical spare parts. Delays in procurement or exchange-rate fluctuations can increase capital and operating expenditures. Maintaining catalyst inventory, securing service agreements, and planning procurement lead times are therefore essential to protect plant availability and cash flow.

From the market side, product certification and offtake risk are highly material. Euro 5/6 synthetic diesel must meet fuel-quality standards and obtain approval from relevant Indonesian authorities. Delays in LEMIGAS testing, ESDM approval, or environmental clearance may postpone commercial operation. Even after certification, price uncertainty and buyer concentration could reduce revenue stability. Binding offtake contracts, indexed pricing, price floors, and diversified buyers are needed to strengthen bankability.

Table 14. Economic Risk Assessment and Priority Mitigation Measures

Economic Risk	Likelihood/impact interpretation	Priority mitigation
Feedstock variability	High likelihood; high technical and financial impact.	Seasonal WACS, specifications, preprocessing, blending, contracts, 3-day buffer.
Technology underperformance	Medium-high likelihood until local trial; very high impact.	Independent engineer, pilot test, performance guarantee, liquidated damages.
Catalyst/equipment imports	Medium likelihood; high downtime and cost impact.	Critical spares, catalyst inventory, service agreement, lead-time planning.
Product certification	High uncertainty; potentially project-stopping.	Early LEMIGAS testing and written ESDM/KLHK pathway.
Offtake and price	Medium-high likelihood; high revenue impact.	Binding contracts, price floor/index, diversified buyers and products.
Permitting delay	Medium-high likelihood; high schedule/financing impact.	Regulatory critical path, dedicated team, conditions precedent to notice-to-proceed.
Environmental nuisance	Medium likelihood; high social-license impact.	Enclosed handling, APCD, leachate/noise/odor controls and transparent monitoring.
Waste-picker livelihood loss	Medium likelihood; high social/reputational impact.	Livelihood restoration, formal jobs, grievance and monitoring.
Financial leverage/liquidity	High during construction/ramp-up.	Adequate equity, contingency, grace period, working-capital facility, DSCR covenants.
Seismic/utility disruption	Low-medium frequency but high consequence.	Seismic design, backup power/water, emergency response, insurance.

Regulatory and social risks also have direct economic consequences. Permitting delays may increase interest during construction, postpone revenue generation, and trigger contract penalties. Meanwhile, environmental nuisance and potential livelihood losses among waste pickers could create social resistance, reputational costs, and operational interruptions. These risks require a clear regulatory critical path, transparent monitoring, grievance mechanisms, livelihood restoration, and formal employment opportunities for affected groups.

Financially, the project is most vulnerable during the construction and ramp-up phase. High leverage, cost overruns, delayed commissioning, or slower-than-expected production could create liquidity pressure. The financial structure should therefore include adequate equity, contingency reserves, grace periods, working-capital facilities, and DSCR covenants. Finally, although seismic and utility disruption risks may have lower probability, their consequences can be severe; hence backup power, water redundancy, emergency response plans, insurance, and seismic-resilient design are necessary.

Overall, the project is economically feasible only if the main risks—feedstock quality, technology performance, certification, offtake, permitting, and financing—are addressed before financial close. The most important bankability conditions are: secured MSW supply with quality controls, proven technology performance under local conditions, early regulatory pathway confirmation, long-term offtake agreements, and conservative financial structuring.

4.9 Preliminary Financial Feasibility

The reported financial indicators suggest that the proposed municipal solid waste (MSW)-to-Euro 5/6 synthetic diesel project has the potential to generate attractive investment returns under the baseline assumptions. The project reports a Weighted Average Cost of Capital (WACC) of 8.19%, which serves as the investment hurdle rate, together with a Net Present Value (NPV) of USD 19.92 million, an Internal Rate of Return (IRR) of 21.42%, a payback period of 3.96 years, EBITDA of USD 8.18 million, and an estimated annual net profit of USD 5.02 million. Since the reported IRR substantially exceeds the WACC and the NPV is positive, the project appears financially attractive from an investment perspective. These indicators suggest that, under the reported assumptions, the facility would be capable of recovering its investment within a relatively short period while generating returns above its cost of capital.

Nevertheless, the reported financial performance should be interpreted with caution because several underlying assumptions are not fully disclosed. The financing structure used to derive the WACC is not presented, preventing independent verification of the hurdle rate. Similarly, the cash-flow model supporting the reported NPV and IRR is not publicly available, limiting the reproducibility of the investment analysis. An additional inconsistency exists in the reported payback period, where the project profile indicates 3.96 years while another section of the source documentation reports 6.86 years. Furthermore, the reported EBITDA and net profit do not specify the reference year, plant operating conditions, depreciation method, taxation assumptions, or financing structure. Consequently, although the reported financial indicators indicate promising commercial potential, additional transparency is required before these results can be considered sufficiently robust for investment decision-making.

Table 15. Financial Performance Indicators and Feasibility Assessment

Indicator	Reported result	Interpretation
Discount rate/WACC	8.19%	Used as the hurdle rate; financing structure and inputs are not disclosed.
Net present value	USD 19,924,404	Positive headline NPV, but cannot be independently reproduced.
Internal rate of return	21.42%	Above reported WACC; sensitive to price, yield, uptime, CAPEX and schedule.
Payback period	3.96 years in project profile	Attractive but inconsistent with 6.86 years reported in the financial-risk section.
EBITDA	USD 8,180,189	Time period and steady-state basis should be stated.
Net profit	USD 5,021,628	Time period, depreciation, tax, and financing assumptions should be stated.

To strengthen the financial assessment, the project should be complemented by comprehensive sensitivity and scenario analyses that evaluate the resilience of investment returns under adverse operating and market conditions. At a minimum, downside scenarios should examine reductions in synthetic diesel selling prices (e.g., 10% and 20% below the baseline), lower plant output caused by feedstock variability, reduced plant availability during commissioning and operation, increases in capital expenditure due to imported equipment and exchange-rate fluctuations, and higher operating costs associated with catalysts, electricity, water, labor, transportation, and residue management. Additional stress tests should assess the financial impacts of permitting and construction delays, delayed commercialization of by-products and carbon credits, and less favorable financing conditions, including higher borrowing costs, shorter debt tenors, reduced grace periods, and stricter debt-service coverage requirements. Conducting these analyses would provide investors with a more realistic understanding of project resilience, identify the key drivers of financial performance, and enhance the credibility and bankability of the overall feasibility assessment.

Table 16. Financial Downside Scenarios and Stress Tests

Required downside test	Minimum scenario to model
Selling price	-10%, -20%, and price linked to industrial diesel benchmark
Plant output/yield	10,000, 12,000, and 15,000 L/day; seasonal feedstock quality
Availability	70%, 80%, and 88%; extended commissioning and unplanned shutdown
CAPEX	+10%, +20%, and +30%; foreign-exchange and import escalation
OPEX	+10% and +20%; catalyst, electricity, water, labor, transport, residue disposal
Schedule	6-, 12-, and 18-month permitting/construction delays
By-products/carbon	Zero revenue case and delayed market-registration case
Financing	Higher interest rate, lower debt tenor, grace-period variation, DSCR covenant

5. Integrated Discussion

5.1 Strategic rationale

The project addresses a genuine infrastructure problem and operates at a scale that could materially reduce pressure on Kebon Kongok without saturating the regional diesel market. The combination of landfill diversion and local fuel production creates a strong public-policy narrative around circular economy, regional energy security, and reduced environmental burden. The project is also small relative to estimated NTB diesel demand, so market absorption is more likely to depend on price, certification, and contracting than on aggregate demand.

5.2 Key feasibility interactions

Feedstock and technology are tightly linked. The high proportion and moisture of food and garden waste can increase drying energy and reduce liquid-fuel yield, while the high-energy plastic fraction supports the fuel-production objective. Consequently, the relevant feedstock question is not whether 120 tons of mixed waste are available, but whether 120 tons can be supplied at a controlled composition, size, moisture, chlorine content, and calorific value after sorting.

Technology and regulation are also linked. Even if the plant produces a technically acceptable fuel, revenue cannot be realized until the product can be legally certified, registered, distributed, and sold. The source explicitly identifies a gap in the current ESDM regulatory scheme for waste-derived synthetic diesel. This regulatory uncertainty should be treated as a condition precedent rather than as a routine permit risk.

Market and finance are linked through price certainty. The source uses IDR 20,634 per liter in market sizing and revenue estimates but presents IDR 16,500 per liter in the competitor comparison. A reduction from the higher to the lower assumption would materially lower annual diesel revenue. Therefore, the financial model should be anchored to actual buyer term sheets or contracts rather than broad market prices.

Environmental and social feasibility depend on plant design and operations. The nearest residences are within a few hundred meters, and local participants are primarily concerned about emissions, odor, and noise. A technically compliant plant can still lose its social license if these impacts are poorly controlled or communicated. Continuous monitoring, a grievance mechanism, and transparent performance reporting should be embedded in operations from the start.

5.3. Evidence-quality assessment

The overall evidence base supporting the feasibility of the proposed municipal solid waste (MSW)-to-Euro 5/6 synthetic diesel project is moderate, with considerable variation across the different dimensions of assessment. The strongest evidence is available for feedstock quantity, where administrative landfill records and daily waste collection data provide a reasonably reliable basis for estimating gross waste availability and long-term supply trends. Similarly, the waste characterization employs a standard Waste Analysis and Characterization Study (WACS) supported by laboratory testing, providing useful information on waste composition, moisture content, and calorific value. However, because the sampling period is limited to eight days, the evidence remains only moderately robust and does not fully capture seasonal fluctuations, tourism-related variations, or longer-term changes in municipal waste characteristics.

The quality of evidence becomes weaker in the technical, market, regulatory, environmental, and social dimensions. The technical assessment is primarily based on process descriptions and vendor claims supported by reference-plant experience rather than independent engineering verification or pilot testing using local feedstock. Consequently, confidence in projected conversion efficiency, plant availability, and product quality remains moderate to low until local demonstration trials are completed. Market evidence indicates substantial regional demand and identifies potential target sectors for synthetic diesel and by-products; however, commercial feasibility is constrained by the absence of bankable offtake agreements and validated long-term pricing assumptions. Likewise, the regulatory assessment successfully identifies the principal permitting requirements and responsible agencies, but uncertainty remains regarding the regulatory pathway for waste-derived synthetic diesel, particularly product certification and commercial fuel trading approvals.

The weakest evidence relates to the environmental, social, and financial assessments. Environmental impacts and mitigation measures are identified, but the analysis relies largely on literature-based emission factors and generic life-cycle assumptions rather than project-specific baseline measurements. The social assessment is informed by stakeholder mapping and two Focus Group Discussions (FGDs), yet the relatively small and non-representative participant groups limit the generalizability of the findings. Financial evidence is also limited because only headline indicators—such as NPV, IRR, EBITDA, and payback period—are reported, while the underlying cash-flow model, financing assumptions, and detailed cost estimates are not disclosed. As a result, although the available evidence provides a useful foundation for a preliminary feasibility assessment, further due diligence is required before the project can be considered investment-ready. Priority areas for strengthening the evidence include year-round feedstock characterization, independent technology validation, bankable offtake agreements, site-specific environmental studies, broader stakeholder engagement, and a transparent financial model supported by comprehensive sensitivity and scenario analyses.

Table 16. Quality Assessment of the Supporting Evidence

Evidence area	Current strength	Research judgment
Waste quantity	Administrative time series and daily-source breakdown.	Moderate-strong for gross availability.
Waste composition	Standard-based WACS and lab tests.	Moderate, but short sampling period and seasonal gap.
Technology	Process description and reference-plant claims.	Moderate-low until independent verification and local trial.
Market size	Large regional demand and target sectors identified.	Moderate; demand is clear, but bankable offtake and price are not.
Legal pathway	Relevant permits and agencies mapped.	Moderate; major product-regulation uncertainty remains.
Environmental	Impact categories and mitigation identified.	Moderate-low because LCA is not site-specific and baseline data are limited.
Social	Two FGDs and stakeholder map.	Low-moderate due to small, non-representative samples.
Financial	Headline indicators only.	Low for bankability because underlying assumptions and cash flows are absent.

5.4 Overall assessment

On balance, the project is strategically attractive and potentially feasible, but not yet ready for an unconditional final investment decision. The strongest evidence concerns the existence of a waste-management problem and a large regional diesel market. The weakest evidence concerns bankable technology performance on the local feedstock, the regulatory route for commercial fuel sales, and the transparency and robustness of the financial model.

6. Recommendations and Conditions Precedent

6.1. Conclusions

1. The project has a strong problem-solution fit. It could divert approximately 120 tons of waste per day from an overloaded landfill while producing fuel and by-products.
2. Gross feedstock quantity is sufficient, but the high wet-organic content and heterogeneous plastic stream create preprocessing, energy, quality, and reject-management risks.
3. The proposed technology is plausible and modular, but the reported reference performance and product quality require independent verification using local waste and contractually enforceable guarantees.
4. The NTB diesel market is far larger than the project's expected output, but market feasibility depends on legal product status, competitive price, buyer testing, and binding offtake agreements.
5. The project has potential environmental advantages over landfilling, but the reported life-cycle comparison is not site-specific and carbon-credit claims have not yet been validated.
6. Initial community and waste-picker sentiment is generally positive, but consultation is limited and livelihood, odor, emissions, noise, traffic, water, and safety concerns require structured management.
7. The regulatory pathway is a critical constraint because specific rules for waste-derived synthetic diesel and fuel trading remain incomplete or uncertain.
8. The preliminary financial indicators are attractive but not auditable. Missing CAPEX/OPEX detail, price inconsistencies, carbon-credit ambiguity, and conflicting payback periods prevent a bankable conclusion.
9. The appropriate conclusion is conditional feasibility: the project may proceed to the next development stage, but construction and financial close should be subject to clearly defined conditions precedent.

6.2 Development-stage recommendations

Based on the overall feasibility assessment, the proposed municipal solid waste (MSW)-to-Euro 5/6 synthetic diesel project demonstrates promising technical and commercial potential but has not yet reached a level of maturity suitable for a Final Investment Decision (FID). Several critical uncertainties remain regarding feedstock consistency, technology performance under local conditions, regulatory approvals, product certification, and the transparency of the financial model. Accordingly, project development should proceed through a structured roadmap that prioritizes the completion of key technical, commercial, regulatory, environmental, and financial milestones before construction is authorized. These conditions precedent are intended to reduce investment risk, improve project bankability, and ensure that project assumptions are supported by verifiable evidence.

The highest priority should be given to independent technical due diligence and feedstock security. An independent engineering review should verify the reference plant's performance, validate mass and energy balances, and confirm projected yield, uptime, emissions, and utility consumption using local feedstock through pilot-scale testing. At the same time, long-term feedstock security should be strengthened through seasonal Waste Analysis and Characterization Studies (WACS), signed waste-supply agreements, feedstock acceptance specifications, contingency supply arrangements, and logistics planning. Regulatory certainty should also be established before financial close by securing all required spatial planning approvals, environmental permits, waste-utilization approvals, water-use permits, and written confirmation of the regulatory pathway for synthetic diesel production and trading. Product quality should be independently certified through LEMIGAS to demonstrate compliance with applicable Euro 5/6 fuel standards and to support commercial market entry.

Commercial and financial readiness should then be reinforced through binding offtake agreements covering product volumes, pricing mechanisms, quality specifications, delivery obligations, and separate commercialization arrangements for by-products. A transparent financial model should be prepared and independently audited, incorporating detailed CAPEX, OPEX, financing assumptions, taxation, working-capital requirements, replacement schedules, sensitivity analyses, and reconciled investment indicators. Environmental and social safeguards should also be strengthened by undertaking site-specific baseline studies, life-cycle assessment, emissions and wastewater management planning, stakeholder engagement, grievance mechanisms, local employment commitments, and livelihood restoration for affected waste pickers. Finally, infrastructure readiness, project governance, and monitoring systems—including geotechnical investigations, utility agreements, traffic management, risk registers, performance dashboards, independent monitoring, and change-control procedures—should be completed to ensure that the project progresses to implementation with an acceptable level of technical, financial, environmental, and social risk.

Table 17. Development Roadmap and Conditions Precedent

Priority	Action	Required deliverable before final investment decision
1	Independent technical due diligence	Independent engineer report; verified reference plant; local-feedstock pilot; guaranteed mass/energy balance, yield, uptime, quality, emissions, and utility consumption.
2	Feedstock security	Seasonal WACS; signed supply agreements; acceptance specifications; sorting and reject plan; backup sources; 3-day buffer and logistics plan.
3	Regulatory certainty	Formal spatial conformity; AMDAL/environmental approval; Pertek; waste-utilization approval; water permit; PBG; written ESDM/KLHK product and trading pathway.
4	Product certification	LEMIGAS test results confirming applicable Euro 5/6 parameters and approved product registration/classification.
5	Commercial contracts	Binding or financeable offtake covering minimum diesel volume, price mechanism, quality, delivery, and buyer remedies; separate by-product contracts where material.
6	Financial model audit	Complete model with CAPEX/OPEX, financing, tax, working capital, replacement, ramp-up, sensitivities, DSCR, and reconciled payback.
7	Environmental safeguards	Site-specific baseline and LCA; emissions/wastewater/residue plan; APCD guarantees; water and drainage plan; emergency response.
8	Social license and inclusion	Stakeholder-engagement plan, representative consultation, grievance mechanism, local hiring/training, waste-picker livelihood restoration, CSR framework.

Priority	Action	Required deliverable before final investment decision
9	Infrastructure readiness	Road and traffic design, geotechnical/seismic design, utility agreements, WTP and backup systems, construction logistics.
10	Governance and monitoring	Project governance, risk register, KPI dashboard, independent monitoring, reporting and change-control procedures.

6.3 Suggested project-stage gates

To reduce technical, commercial, and financial uncertainties, the proposed municipal solid waste (MSW)-to-Euro 5/6 synthetic diesel project should be implemented through a stage-gate development process, in which progression to the next phase is permitted only after predefined technical, regulatory, commercial, and financial requirements have been satisfied. This approach enables project sponsors and investors to make evidence-based decisions at each milestone while limiting exposure to unnecessary investment risks. Rather than committing substantial capital at an early stage, each gate serves as a formal decision point where the project's readiness is evaluated against objective performance criteria and independently verifiable evidence.

The first stage, Development Approval, should confirm the basic feasibility of the project by demonstrating site control, preliminary regulatory support, waste characterization through WACS, a technically credible process concept, and an initial stakeholder engagement baseline. Successful completion of this stage allows the project to proceed to detailed engineering and development activities. The second stage, Bankability Readiness, represents the most critical transition toward investment readiness. At this point, the project should provide an independent engineering assessment, validated technology performance, certified product quality, secured feedstock and offtake agreements, completed environmental studies, and an independently audited financial model. These deliverables provide the confidence required by lenders and equity investors to initiate financing arrangements and Engineering, Procurement, and Construction (EPC) procurement.

Table 18. Stage-Gate Roadmap for Project Development

Gate	Decision	Minimum evidence
Gate 1: Development approval	Continue detailed development	Site control, preliminary regulator support, WACS, technology concept, stakeholder baseline.
Gate 2: Bankability readiness	Launch financing and EPC procurement	Independent engineer, certified product sample, feedstock/offtake term sheets, environmental pathway, audited model.
Gate 3: Financial close	Commit capital	All key permits, binding contracts, fixed/controlled EPC price, guarantees, contingency, insurance, equity/debt documents.
Gate 4: Commissioning acceptance	Begin commercial operation	Performance tests for throughput, yield, quality, emissions, safety, and reliability.
Gate 5: Stable operations	Release final retention/expand	Sustained KPI compliance, community performance, audited production and environmental data.

The final stages focus on implementation and operational verification. During Financial Close, all key permits, commercial contracts, financing agreements, EPC pricing arrangements, insurance coverage, contingency provisions, and debt documentation should be completed before capital is committed. The Commissioning Acceptance stage should demonstrate that the facility consistently meets guaranteed throughput, product yield, Euro 5/6 fuel quality, emissions, safety, and operational reliability targets before commercial operation begins. Finally, the Stable Operations stage should confirm sustained compliance with key performance indicators (KPIs), environmental regulations, community commitments, and audited production performance before final retention payments are released or decisions regarding future plant expansion are undertaken. This structured stage-gate framework provides a disciplined pathway from preliminary feasibility to full commercial operation while ensuring that major investment decisions are supported by progressively stronger technical, regulatory, commercial, environmental, and financial evidence.

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Market, statistical, technology-provider, and journal sources reproduced in the supplied feasibility study are treated as secondary evidence and were not independently verified for this report.

Appendix A. Critical Data Gaps and Reconciliation Issues

Issue	Observation in source	Required resolution
Payback period	3.96 years in executive/project profile; 6.86 years in financial-risk section.	Recalculate from a single version-controlled cash-flow model and specify simple vs discounted payback.
Synthetic diesel price	IDR 20,634/L in TAM and revenue; IDR 16,500/L in competitor table.	Use buyer-supported price and run downside cases.
Investment value	Project profile heading shows “Investment Value: USD” without a visible amount.	Provide total installed cost, owner's cost, contingency, IDC, working capital, and escalation.
Carbon-credit unit	20,000 m3/year is equated with 14,700 tCO2e.	Correct units; document methodology, baseline, additionality, leakage, MRV, validation, and issuance risk.
Annual output share	3,996 kL is described as about 0.69% of 769,940 kL; arithmetic is about 0.52%.	Reconcile production and demand bases.
Plastic acceptance	Charts describe accepted three-plastic mix but other tables list all codes in composition.	Define accepted codes, chlorine/contaminant thresholds, and fate of PET/PVC/PS/other plastics.
Conversion efficiency	The source refers to 80% conversion and 60-80% plastic-to-liquid conversion.	Define numerator/denominator, wet vs dry basis, product yield, and energy efficiency.
Reference plant	88% availability and no rejected product reported.	Provide independent records, plant identity, feedstock, operating period, maintenance and performance test.
Environmental comparison	Literature LCA includes a 100-mile transport assumption.	Prepare site-specific LCA using actual routes, power mix, water, yield, residue, and avoided landfill baseline.
Social sample	Resident FGD included 15 men; waste-sector FGD included 10 people.	Broaden consultation to women, youth, nearby households, farmers, vulnerable groups, transport users, and institutions.