PRE-FEASIBILITY STUDY (WASTE) OF LOMBOK

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Danish Energy Agency

Ministry of Environment of Denmark
Environmental Protection Agency

EMBASSY OF DENMARK
Jakarta

INTRODUCTION TO THE PROJECT

Introduction

Strategic Sector Cooperation (**SSC**) within Energy and Environment in Indonesia Sustainable Island Initiative (**SII**) is a joint add-on initiative and part of the existing SSC.

The SII addresses strategic challenges as well as constraints in the framework conditions and develop replicable solutions related to **solid waste**, **circular economy** and **Waste to Energy** (WtE).

Stakeholders

- Indonesian Ministry of Environment and Forest (**KLHK**),
- **Local authorities of Lombok**,
- Danish Energy Agency (**DEA**),
- Danish Environmental Protection Agency (**DEPA**) and
- Danish **Ministry of Foreign Affairs** (MFA).

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INTRODUCTION TO THE PROJECT

Objective

The overall objective was to **prepare a study on current and future scenarios** for solid waste management as basis for **future investments in WtE projects** at Lombok.

Scope of Work

The scope of work is divided into the following three main phases:

- **Assessment of the current situation**;
- Waste analysis in a few selected areas (if found necessary) and collection and **analysis of existing data**;
- **Analysis** (technical, financial and economical, institutional, social, environmental and risks) **and recommendations** for options for enhanced MSW and WtE solutions.

Output

The output of the Project is the **identification of best options** for future investments in WtE projects at Lombok.

This has been based on two main outputs:

- A final **Pre-feasibility Study Report**, including analysis and recommendations for organic waste separation, collection and treatment and options for SWM and WtE;
- **Final Workshop** conducted with key stakeholders.

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WASTE MANAGEMENT

WASTE MANAGEMENT IN INDONESIA

Indonesia	Information
Total population (2019)[a]	270 Million
Total urban population (2019) [a]	56%
Waste generation rate[b]	0.68 kg/capita/day
Waste generation (estimation) [c]	184,025 tons/day or 67 Million tons in 2019
Waste composition (2019)[d]	39.77% Food waste; 15.67% green waste; 16.39% plastics; paper 11.37%; metals 3.41%; textiles 2.54%; rubber/leather 1.84%, glass 2.1%, others 6.91%
Administrative model[b, c] (Regional Government Act 23/2014)	Highly decentralized, shared responsibilities among 3-level of government that involves 2 sectoral government affairs → Local Government leads the implementation of waste management.
Operational model[b]	Communities organize waste collection with user fees, city organizes waste transport and disposal from local budget
Scope of waste category (Waste Management Act 18/2008)	**Household waste, Waste similar to Household Waste**, Specific Waste (**GR 81/2012**; GR 27/2020)
Current Sector Performance (Nation-wide)[e]	67% of waste handling; 2.3% of waste reduction at source
Policy and Strategy to improve sector performance	Jakstranas that aiming at 30% waste reduction & 70% waste handling nationwide by 2025, supported by Jakstrada at sub-national level

***Source**: [a]World Development Indicators (World Bank, 2021); [b]What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2025 (World Bank, 2018); [c]Team Analysis; [d]SIPSN (MoEF); [e]RPJMN 2020-2024*

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WASTE MANAGEMENT IN NTB PROVINCE

NTB Province	Information
Total **Waste Generated** (incl Sumbawa)	**3,509** tons/day in 2018
Waste Flow (Provincial Jakstrada)	Total **waste managed** = **39.81%** (33.01% to final disposal; 6.80% waste reduced at source); 60.19% unmanaged by formal system
Regional Program/Initiative	• **Local Regulation 5/2019** (Perda 5/2019) on Waste Management; **Provincial Jakstrada** (Pergub 14/2020) • **NTB Zero Waste:** strengthen community-based system and partnership between govt and non-govt actors
Direct **Involvement on SWM** (Regional Government Act 23/2014)	**Regional infrastructure and facilities:** Regional Landfill Kebon Kongok, Regional TPST (Lingsar), and Regional Central Waste Bank
Main Findings - **Regional Landfill**/TPAR Kebon Kongok	✓ **Waste Input**: 80% Mataram City + 20% West Lombok Regency = **300 to 330 tons/day** ✓ **Operational activities**: landfilling of waste, composting – trial phase (25 kg/day), pre-treatment of recyclables (50 kg/day), RDF production at pilot stage/R&D (100 kg/day), incineration (small-scale of 200 kg/day), landfill gas recovery, & leachate treatment. ✓ Current **landfilling status** at **level 6 – emergency state** (height of 25 meters); March 2022 will reach 40 meters (level 8 – dangerous state) ✓ Currently, exploring **2 alternative solutions**: a) **short-term** plan (expand current area + adding RDF production facility); b) **long-term** plan (relocation of regional landfill to other areas)

***Source**: DLHK NTB Province, Provincial Jakstrada, Team Analysis (2021)*

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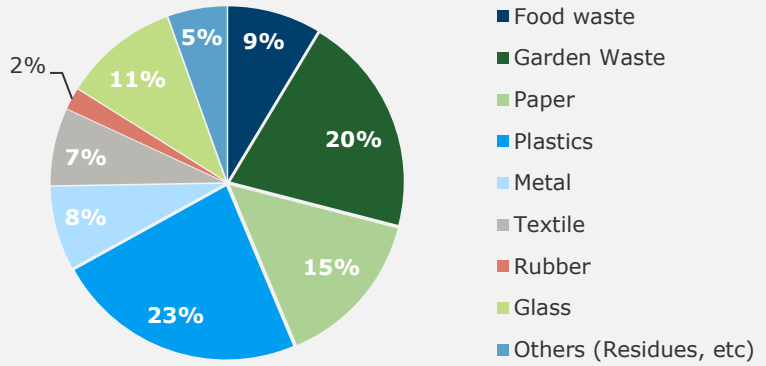
WASTE MANAGEMENT IN NTB PROVINCE

NTB Province	Information
Main Findings - **TPST** Lingsar	• **Segregated** waste **input** (hospitals, markets, hotels); • **Capacity** (designed) 4 tons/day of organic waste → existing **input** 0.5 - 1.2 tons/day (pre-pandemic 1.5 tons/day); • Treatment technology: **Composting** (Black Soldier Flies) • Introduced **incentive mechanism** (increased input to 3.4 tpd until budget discontinued, segregation activity also ended)
Main Findings - **Financial Situation**	**1)** **O&M cost** of TPAR IDR 6 billion/a (< 1 Mio USD/a; tipping fee (KJP) **IDR 50,000/ton = 3.5 USD/ton** → 75% Prov. Govt subsidy + 25% municipalities); compensation fee (KDN) of IDR 2,5% of tipping fee (IDR 1,250/ton) 2) SWM **budget refocusing** to handle pandemic

***Source**: DLHK NTB Province, Team Analysis (2021)*

Waste Composition at TPAR Kebon Kongok (2019)



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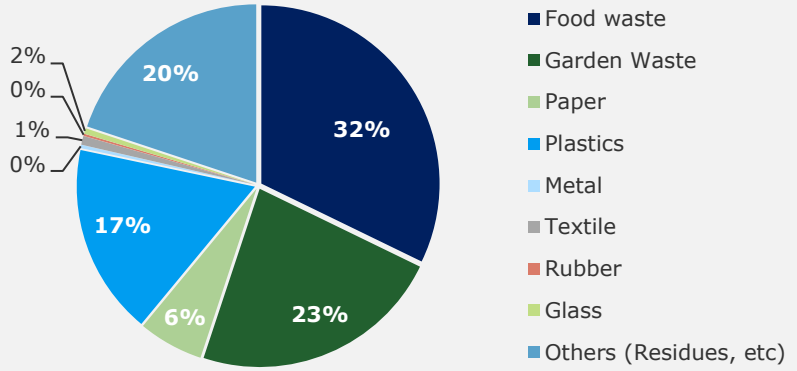

***Source**: DLHK NTB Province and Team Analysis (2021)*

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OVERALL SITUATION IN CITY/REGENCIES

Key Parameter	Unit	Mataram City	West Lombok Regency	Central Lombok Regency	East Lombok Regency	North Lombok Regency
Total Population	Inh	486,700	695,000	955,400	1,200,600	220,400
Total Area	km^2	61.3	1,054	1,208	1,606	810
Topography	-	Mostly flat	flat + hilly	flat + hilly + mountainous	flat + hilly + mountainous	flat + hilly + mountainous
Estimated Waste Generation	Tons/a	98,600 – 122,000	177,700	126,400 – 190,000	175,300 – 176,500	31,300
Waste Composition						
Food Waste	%	n/a	31	55	49	60 (in total)
Garden Waste	%	n/a	20	-	30	
Non-Organics	%	n/a	39	27	21	39
Others	%	n/a	10	18	0.10	0.80
Coverage Area of Service (mainly urban areas)	%	86	20	25	<20	n/a
Total Waste Managed (Collection Rate est.)	**%**	**88**	**18 - 22**	**24 - 36**	**27 - 35**	**54**
Waste Reduced (est.)	%	3.3	<5.0	1.0	5.0 – 6.0	2.7
Waste Handled (est.)	%	85	17 – 19	23 - 25	22 - 29	51
Unhandled waste (est.)	%	12	78 - 82	64 - 76	65 - 73	46
Portion SWM Budget	% APBD	1.2 – 1.3	0.53	0.17 – 0.30	0.19 - 0.20	0.45 – 1.2
Retribution Revenue to O&M/SWM Budget	%	49	26	(0.41) (historical data)	17	12

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***Source**: SIPSN 2017 – 2020 (Ministry of Environment and Forestry); Master Plan of North Lombok (2019); Jakstrada of each city/regencies; Discussion with Environmental Agency of Mataram City, West Lombok Regency, Central Lombok Regency, East Lombok Regency, North Lombok Regency; Team Analysis (2021)*

WASTE MANAGEMENT SYSTEM

SWM system applied

✓ Mostly **decentralized** system; focused on the provision **basic service** of collection, transfer/transport, and disposal, along with **3R initiatives** at community level

Source Segregation	Primary Collection	Treatment (3R Initiatives)	Secondary Collection (Transport)	Landfill
• Not commonly practiced (fragmented) • Mostly practiced in villages lead by committed leaders • Weak public participation • Limited segregated facilities / infrastructures	• Topography + settlement patterns = Community-based collection system • Accessible areas: door-to-door collection • Organized by communities or villagers (CSOs, NGOs) • Usually financed through user fee • Requires community participation and cooperation with local authority	• Waste bank, TPS3R, TPST • Mostly managed by communities • Facilities often faces financial constraints (O&M) • Insecurity of feedstock & off-takers • **Organics**: Composting (Black Solid Files, takakura bins, windrow), RDF production, household-biogas • **Inorganics**: pre-treated (washed / crushed / packed), then sold to aggregators & shipped to Java Island; pyrolysis	• Managed by DLH • Limited number of transport fleets • No large-scale treatment facilities to significantly reduce waste transported • O&M budgeting (Regional standard unit cost)	• Managed by DLH • Shortage of operational budget • Limited number of well-functioning heavy equipment • System operation: semi-controlled (soil cover every > 7 days) and controlled (soil cover every 7 days)

***Source**: Analysis (2021)*

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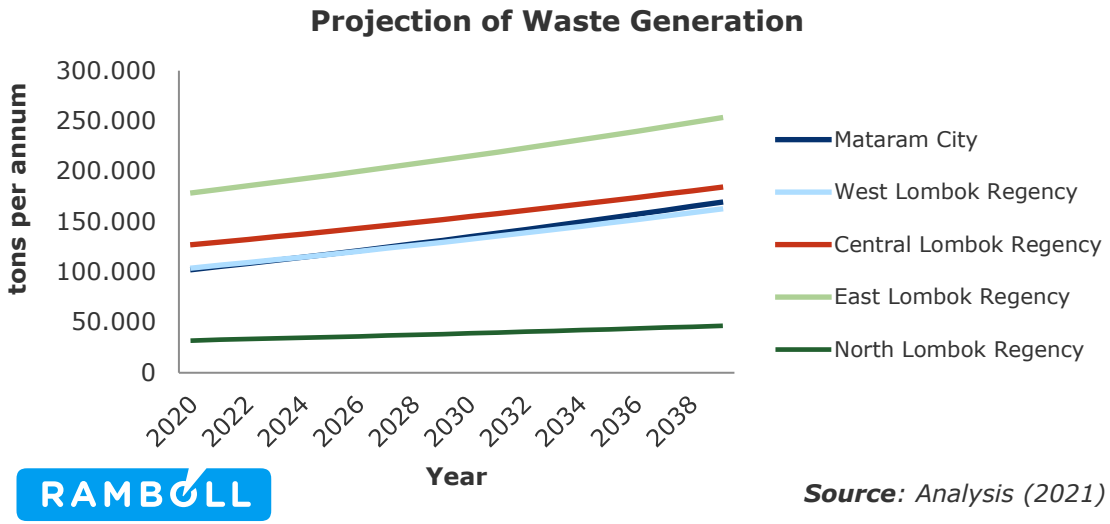
HIGHLIGHTED ISSUES & SYSTEM IMPROVEMENT

Consideration for System Improvement

- Current **system** applied;
- Low **collection rates** and its root causes;
- **Financial situation** that particularly relates to operational budget;
- Increasing **waste generation** without significant **treatment capacities**;
- **High share of organic waste** with **agriculture sector** leads the economic activities that creates potential application of Circular Economy approach;
- **Experience** working under **regional scheme**



***Source**: Analysis (2021)*

*Without significant treatment capacities, the current system puts a **heavy burden** on **transport** and the **landfill system** that implicates on **high dependency on land** and the **environmental impacts**, along with increasing waste generation*

***Source**: Analysis (2021)*

RECOMMENDED IMPROVEMENT STRATEGY

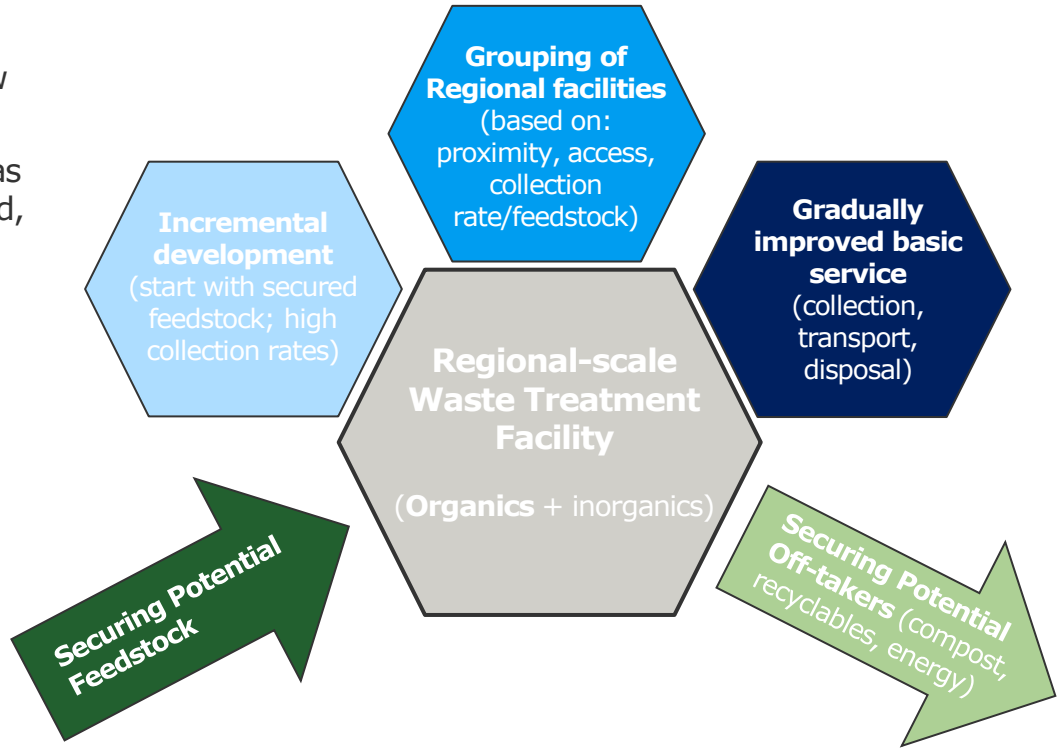
Improvement Strategy

Incremental development of **regional-scale** waste **treatment facility** in Lombok Island starting with areas with a high collection rate (secured feedstock), balanced with **gradually improved basic service**, particularly for areas with low collection rates.

Particular attention may be put on **organic waste** (dominating waste streams), as the low-hanging fruit, **in securing** and **increasing** the portion of waste processed, while also processing the non-organics.

Advantages of improved scenario

- Offer opportunities for **Circular Economy application**
- **Increase recycling rate,** supporting Jakstrada implementation
- **Reduce GHGs emission** and climate impact
- Potential **revenue generation**
- **Reduce** the amount of **waste landfilled**
- **Potentially Reduce** the need for waste **transport**



***Source**: Analysis (2021)*

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POTENTIAL ORGANIC FEEDSTOCK

Main objective: Prevent the shortage of organic feedstocks

Traditional Market

- Mixed Waste (high portion of organics > 75 %)
- Waste also originated from surrounding neighborhood / HH
- High amount of daily waste generation

Household Stream

- TPS3R, waste banks, similar facilities (insignificant capacities)
- Further identify other point of sources (TPS, primary source/HH)
- Mixed waste

Home Industries

- Low amount of daily waste generation
- Some generates uncertain amount of waste (dependency on supply of raw materials)
- Located far from the regency's capital
- Mostly managed by communities
- Some portion of organic waste is collected & utilized by third parties

Hotel

- Low amount of daily waste generation
- Unstable generation during certain periods (e.g pandemic)
- Partly waste segregation (mixed again during collection/transport)

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***Source**: Team Survey (2021)*

POTENTIAL ORGANIC FEEDSTOCK

Cattle farms, slaughterhouses, livestock markets

- Low amount of daily waste generation
- Located far from the regency's capital
- Not supported with waste collection
- No waste service provided in livestock markets
- Poor access
- Coordination with local agency is required

Agriculture Areas

- High amount of waste generation in harvesting season
- Small portion of waste is utilized (animal feed), the rest is burned
- Located very distanced from regency capital
- The area is not covered by waste service
- No TPS available in the areas

Plantation Areas

- Low amount of daily waste generation
- Located remotely and very distanced to regency's capital
- The road is inaccessible for large vehicles
- Some portion of organic waste is collected & utilized by third parties

- Potential source of organic waste: **Traditional market**, followed by **household waste stream**
- Organic waste from slaughterhouses, cattle farms, livestock farms can be utilized as **starter**, however, **additional investment** is needed for **collection**

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***Source**: Team Survey (2021)*

POTENTIAL OFF-TAKER/END USER

Compost
(30% subsidized, 70% non-subsidized)

- Supplied as subsidized fertilizer: registered & met national standard (SNI 7763:2018/Kepmentan 261/2019)
- Distributed through free market
- Soil cover (landfill): Ministerial Regulation 03/2013

Energy (electricity)
National target (2025): Energy mix of 23% from RE
Lombok existing: 5.5% RE

- Off-grid: supply to remote or rural areas (prioritizing RE)
- On-grid (PLN): to increase the share of RE mixture
- FiT (Non-Thermal technology): Ministerial Decree (Kepmen ESDM) 55/2019 = 14.34 Cent US$/kWh (NTB)

Energy (biogas)
Energy consumption in NTB: transport, commercials, others (agriculture, construction, mining)

- Biogas conversion to LNG tube → high costs
- Upgrading biogas as fuel for public transport: required appropriate infrastructure → high costs

Potential source of revenue (AD facility) → voluntary participation in **carbon market**

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KEY RECOMMENDATION – WASTE MANAGEMENT

1. Coverage Area & Primary Collection

- **Strengthen/support** CSOs/NGOs providing **collection service;**
- Increased **collection capacities** (provision of adequate waste collection equipment and vehicles);
- Fostering and enhancing **CSOs/NGOs capacities;**
- Ensure **financial security** & **sustainability** (operational budget);
- **Explore collaboration** with start-ups in providing waste service.

2. Segregation at source

- **Continuous social behavior** changes activities at all level, particularly at schools **(innovative approaches**: social media, link to local values);
- Provision of waste **segregated facilities and infrastructures;**
- Support & participate in **EPR implementation** initiated by private sectors.

3. Secondary collection

- Ensure sufficient **number of proper transport fleet;**
- **Appropriate** allocation of waste **budget** (APBD) based on Permendagri 07/2021.

4. Waste Treatment

- **Incremental development** of treatment facility: start with high collection rates/secured feedstock;
- **Grouping of regional facility** based on proximity, access, collection rates among municipalities;
- Balanced **with gradually improved basic service** (collection, transport, disposal);
- Potential **sources of organic waste** prioritized to be secured: **Traditional market**, followed by **Household** waste stream.

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KEY RECOMMENDATION – WASTE MANAGEMENT

5. Final Disposal

- **Appropriate** allocation of **O&M budget** based on Permendagri 07/2021;
- Increased **resource** (technical) **capacity;**
- **Reducing** amount of **waste landfilled** (saving land required for expansion).

6. Financing Aspect

- **Adjustment** of **budget** allocation & **retribution tariff**, referring to Permendagri 07/2021;
- Explore other **potential sources of revenue;**
- Increase efficiency of waste **retribution collection mechanism.**

7. Jakstrada Monitoring

- Taking account of **more inclusive measures** in reduction initiatives (private sector, NGOs);
- Support private sector/local businesses in **implementing** the **waste reduction roadmap/EPR;**
- **Collaborate with startups/innovators** (better tracking of waste data collected by informal sector);
- Improve the **collection of primary data;**
- Better **data inventory on waste facilities/infrastructures** (collab with local universities, startups, NGOs);
- Improve **data management** (close consultation with national government);
- **Strengthen coordination** on data among three level of governments (validity & consistency of data).

INSTITUTIONAL ANALYSIS

INSTITUTIONAL MAPPING OF MWSM IN LOMBOK ISLAND

Institutional Aspects	NTB Province	Matram	West Lombok	Central Lombok	East Lombok	North Lombok
Mandated Agencies	• Environment and Forestry Agency (Regulator) • Bappeda, • Public Work Agency, and • Village and Community Empowerment Agency	• Environment Agency (Regulator) • Bappeda, • Public Work Agency, • Housing and Settlement Agency, • Village and Community Empowerment Agency, • Subdistrict and • Urban Village	• Environment Agency (Regulator) • Bappeda, • Public Work Agency, • Housing and Settlement Agency, • Village and Community Empowerment Agency, • Subdistrict and • Village	• Environment Agency (Regulator) • Bappeda, • Public Work Agency, and • Energy Management Agency	• Environment Agency (Regulator) • Bappeda, • Public Work Agency, • Housing and Settlement Agency, • Village and Community Empowerment Agency, • Village	• Environment Agency (Regulator) • Bappeda, • Public Work Agency, • Housing and Settlement Agency, • Village and Community Empowerment Agency, • Village
Mandated Operator	Regional Landfill UPTD	Waste Bank UPTD	Waste Management Section	Landfill UPTD	Ijobalit Landfill UPTD	Waste Management UPTD
Non-Government Partners	PLN and Universities	Waste Bank, Neighbourhood Waste Org (KSM)	Waste Bank, Neighbourhood Waste Org (KSM)	Waste Bank, Neighbourhood Waste Org (KMPS)	Waste Bank, NeighborhoodWaste Org (KMPS)	Waste Bank, Neighbourhood Waste Org (KSM) and Facilitators

***Source**: Team Analysis (2021)*

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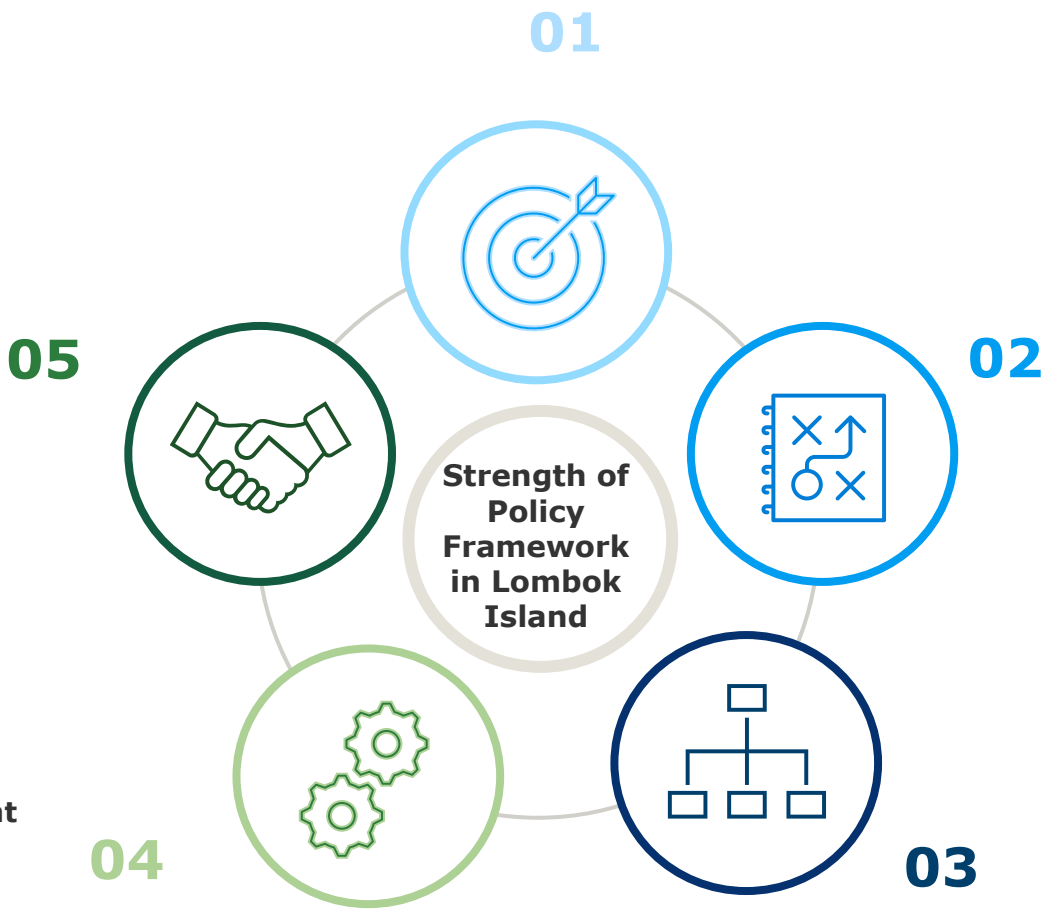
Important Findings

- **Lack of flexibility** of the existing Regional Landfill UPTD is potential hampering the operationalization of the WtE project scenario.
- **Absence of a dedicated operator unit** in West Lombok.
- Delegation to manage waste management at neighborhood **level is not clearly stated** in the Waste Management Regulation in Central Lombok and East Lombok.
- The **need for synchronization** of policies, programs and activities between provinces and districts/cities on SWM in Lombok Island.

INSTITUTIONAL ENABLING FACTORS FOR IMPLEMENTATION OF THE SCENARIO



01. Goal, Objective and Target

- **Medium-Term Dev Plan (RPJDM) at Provincial and Municipal Level** state goal, objective and target of SWM clearly.
- **Jakstrada Target**: 30% reduction and 70% handling by 2024.

02. Operational Strategy

- **Waste Management Local Regulation** Government of Mataram, West Lombok and North Lombok, have shared responsibility clearly from regency / city to neighborhood level, and provide clear guidance on waste segregation.
- **Jakstrada at Provincial Level:** clear task and responsibility, including responsibility of village in waste management.

03. Supporting Policy & Program

- **Mataram:** LISAN Program and incentive for several urban villages.
- **West Lombok:** Regent Regulation on Village Fund Allocation for SWM.
- **East Lombok:** Regent Regulation on Waste Bank, and Padasuka Program (waste management at village level).
- **North Lombok:** Regent Reg on Waste Management Perm.

04. Potential Media/Instrument

Strengthening Waste Management at Village Level Village regulation and customary law (*awig-awig* as a potential instrument).

05. Operational Strategy

- **Provincial Level:** Village and Community Empowerment Agency and Agriculture and Plantation Agency, PLN, and Pupuk Indo.
- **Municipality:** Quran Study Group at neighborhood level, religious leaders, traditional local leader, KMPS.

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HUMAN RESOURCE CAPACITY

Problem Situation:

- Operational constraints due to the composition change of the waste management team as a result of **frequent personnel mutations**.
- In dealing with the complexity of the tasks within regional waste management, almost everyone in the line positions perceives the **need for capacity building**.
- The need for and **incentive** for waste management in the **operator team** in the field.

Potential Solutions

- Explicit statement of targeted performance and strategic programs, activities, and strategic outputs of SWM in the strategic plans of provincial DLHK and DLH at regency/city level
- Personnel mutation needs to follow National Civil Service Agency Regulation No. 5/2019 concerning Procedures for Implementation of Mutations

Proposed Training Themes	NTB Province	Matram	West Lombok	Central Lombok	East Lombok	North Lombok
Waste processing facilities and infrastructure management	V	V	V	V	V	V
Waste Transport Operations	V	V	V	V	V	V
Leachate Treatment Plant Operation	V	X	X	V	V	V
Waste Compaction	V	X	X	V	V	V
Landfill Environment Protection	V	X	X	V	V	V
Emergency Response Activity	V	X	X	V	V	V
Technology Selection	V	V	V	V	V	V
Waste Management Information System Management	V	V	V	V	V	V
Community involvement and empowerment, and the informal sector-waste collectors	V	V	V	V	V	V
Refuse Derived Fuel (RDF) Operation	V	V	V	V	V	V

Notes : V = needed; X = not needed

WASTE MANAGEMENT INFRASTRUCTURE

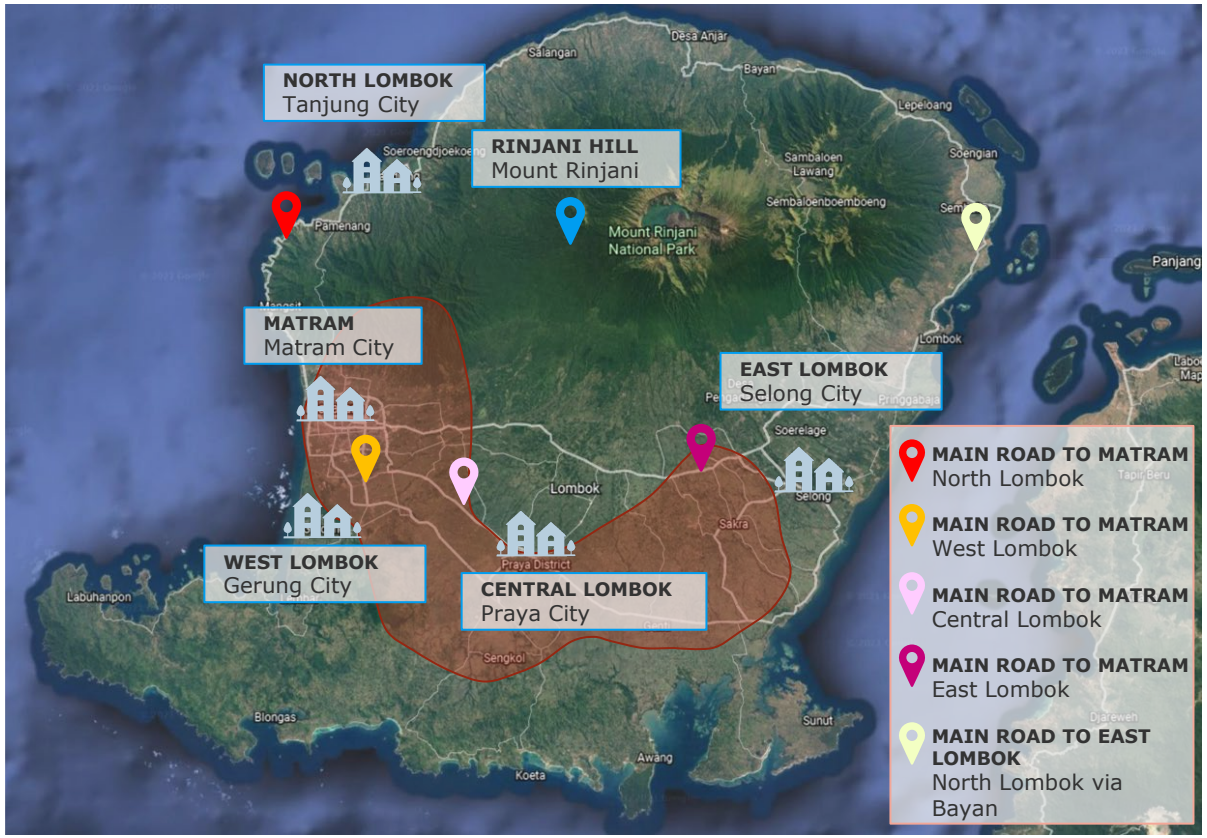
Infrastructure

The landscape of Lombok Island is characterized by stratovolcanoes in the north of the island and scattered hills in the south.

- The road conditions on the Lombok Island are suitable for heavy vehicle transport (asphalt and concrete).
- The topographical condition is a constraint in the planning of collection and transport activities

Waste generation in Lombok

- Almost each city in Lombok has a local waste management program.
- The concentrated area for waste generation in the Lombok Island is in the red zone (see figure), dominated by the inhabitants who live in the capital area.



Main cities and roads in Lombok Island. The red zone is the concentrated area for waste generation, based on waste generation from North Lombok Regency, East Lombok Regency, Central Lombok Regency, West Lombok Regency, and Mataram city.

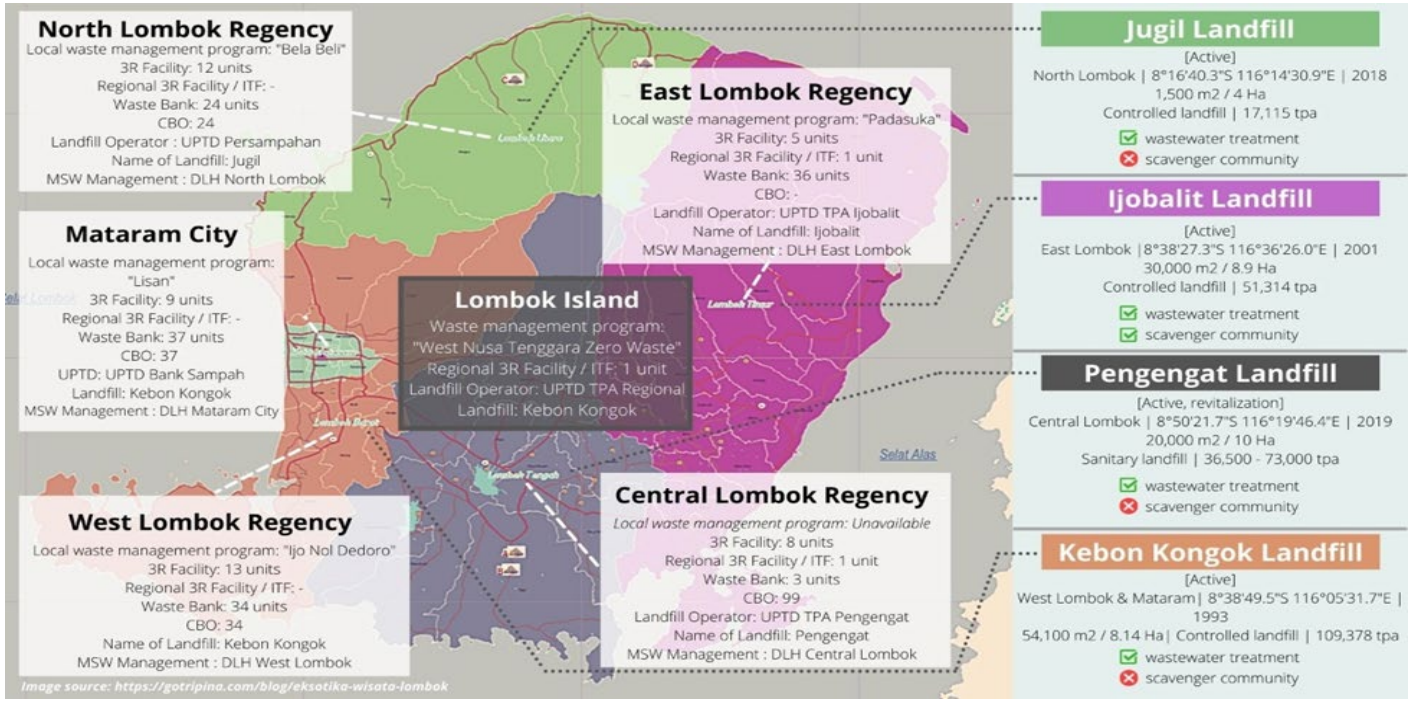
Source: *Team Analysis, 2021*

WASTE MANAGEMENT INFRASTRUCTURE

Facilities

The Lombok Island have 4 active landfills

- Kebon Kongok is the oldest, while Pengengat was commissioned in 2019;
- Kebon Kongok and Ijobalit are operated as controlled landfill system;
- Jugil is operated as semi-controlled landfill system, with soil covering activity occurring once a month.



***Source**: Team Analysis, 2021*

The Kebon Kongok Landfill, West Lombok Regency

- serving the waste coming from Mataram City and West Lombok Regency.

COLLECTION AND TRANSPORT VEHICLE

Waste Infrastructure

	NTB Province	Matram City	West Lombok	Central Lombok	East Lombok	North Lombok
Waste Transport Vehicle						
Trash Cart	-	78	0	0	50	20
Three-Wheeler	-	68	111	517	60	35
Pick-up Truck	-	0	9	12	18	15
Arm Roll Truck	-	18	9	8	2	2
Dump Truck	-	33	9	15	24	10
Waste Infrastructure						
TPS	0	11	10	529	254	20
TPS 3R	1	9	13	9	5	12
TPSTR	0	0	0	0	1	0
Waste bank	0	37	36	91	34	24
Recycling Centre (PDU)	0	0	0	1	0	0

Key takeaways

- Lombok Island has **1 unit regional of TPST**, the East Lombok Regency. A second unit is to be established in the West Lombok Regency.
- There is a large **gap in the number of TPS** in Lombok Island.
- Lombok Island has **1 PDU unit** only.

TPS serves as a temporary collection point of waste from the surrounding sources before the waste is further transported to landfill.

- Waste cart, three-wheeler, and pick-up truck are mainly used to collect the waste from source to TPS.
- Arm-roll trucks and dump trucks are mainly used to transport the waste from TPS to the landfill.

TPS3R is a waste processing facility where the incoming organic waste is usually processed into compost and the recyclables are sold to the aggregators, while the residue is then transported to landfill.

TPST is typically located in landfills and usually operates in larger-scale with more sophisticated equipment.

Waste Bank is basically a collection facility that receives the segregated waste (mostly recyclables) in returns of credits, which then can be transferred into cash or other valuable goods, managed by communities.

The segregated waste or recyclables is pre-treated further (washing, crushing, packing) before stored or further delivered to aggregators.

The Recycling Center (PDU) has a similar concept to TPST.

CONCLUSION AND KEY RECOMMENDATIONS

- The **regulatory framework** at the provincial and municipalities level have supporting the scenarios.
- **The improvement of the UPTD (PelayananTerpadu/ Regional Technical Implementation Unit) Regional to BLUD (Badan LayananUmumDaerah / Public Service Agency)** should be the main agenda to support the implementation of the Waste to Energy project scenario. At the same time, it is necessary for the West Lombok Regency to develop their UPTD to ensure the operational activities in the area.
- **The development of the Lombok Island Regional Waste Management Coordination Forum** is very important to get started, to ensure that waste sorting and collection takes place more efficiently at the **district and city level** and to influence the effective management at the regional level. In addition, this forum can serve to tailor policies, strategies and waste management efforts between provincial and district governments as well as between districts and cities.
- **To ensure the sustainability of the waste management scenario,** which is often disrupted due to frequent staff changes, especially in strategic management positions, provincial, regional and urban governments must ensure that the exchange system in DLHK and DLH complies with National Civil Agency Regulation No. 5/2019 on procedures for implementing changes.
- **In order to protect the waste management operators in the field,** provincial, district and city governments must provide remuneration in accordance with the provisions or standard of the minimum wage for the province of NTB and each district and / or city, protect their health through the BPJS health insurance mechanism.
- •**Regarding the waste facility**, it is necessary to evaluate ownership, optimal number, level of maintenance and performance regularly.

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TREATMENT TECHNOLOGY

EVALUATION OF TREATMENT OPTIONS

	Landfill	MBT	AD (Wet/Dry)	Incineration (WtE)	Pyrolysis and Gasification	Composting
Assessment criteria			**Value**			
CAPEX	Low	Medium to High	Medium	High	Medium to High	Low
OPEX	Low	Medium to High	Medium	High	High	Low to Medium
Potential Incomes	Recyclables (waste pickers), Gate fee	Recyclables, RDF, Energy (power or gas), Gate fee	Energy (power or gas), Gate fee	Energy (power), Gate fee	Energy (power), Gate fee	Gate fee, (sale of compost)
Nutrient recovery	No	Yes – Digestate and/or compost	Yes – Digestate	No	No	Yes – Compost (soil improvement)
Energy potential/other	Landfill gas (power or gas)	Biogas (power or gas), Caloric value from RDF	Biogas (power or gas)	Caloric value from RDF	Fuel and/or materials for chemical production	-

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RECOMMENDED WASTE TREATMENT SOLUTION - MBT

Mechanical

MRF (Dirty)

- Recyclables (plastic, metal, glass, paper and cardboard)
- Bio-waste (feedstock for AD)
- RDF (Energy and raw material)

Biological

AD (Dry)

- Biogas (Energy)
- Digestate (Fertiliser – Nutrients)

Composting

- Compost (soil improvement)

(Bio-drying)

- RDF (co-firing)

Recommendation

MRF

- Focus on high purity output
  ➡ higher value of recyclables
- Source segregation in two fractions (organic and inorganic)
  ➡ higher recovery rate

RDF – Focus on:

- **Moisture content**,
- Caloric value,
- Density,
- Size,
- Chloride and Sulphur content

Bio-drying (optional) – further analysis of existing project

- RDF – for co-firing

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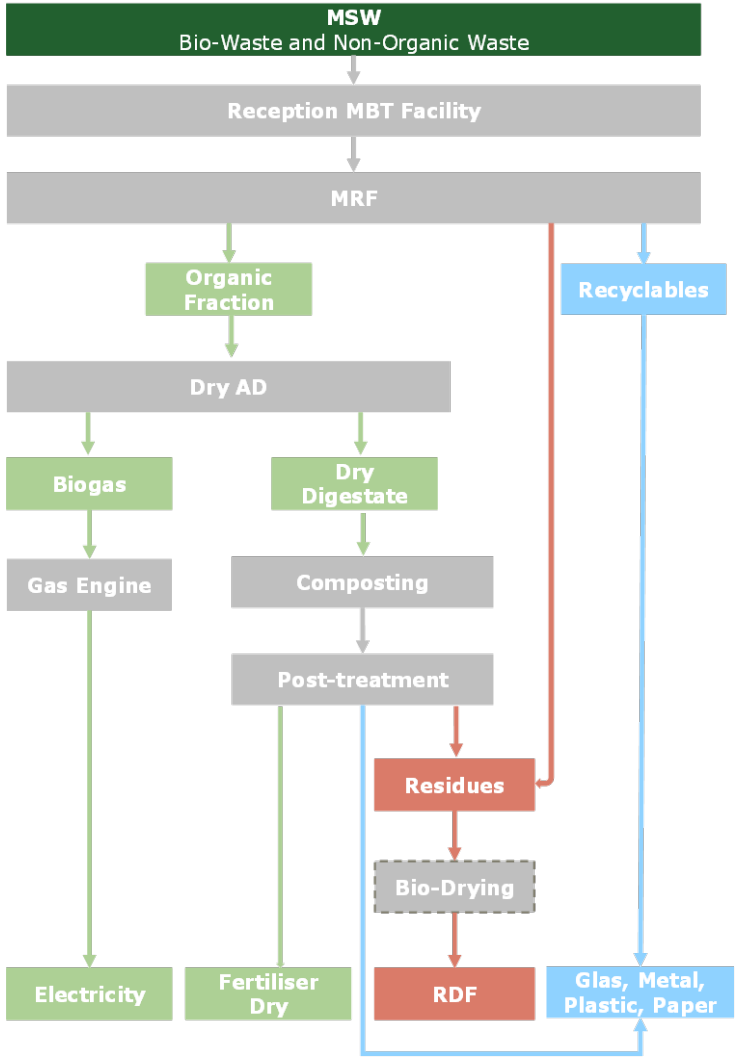
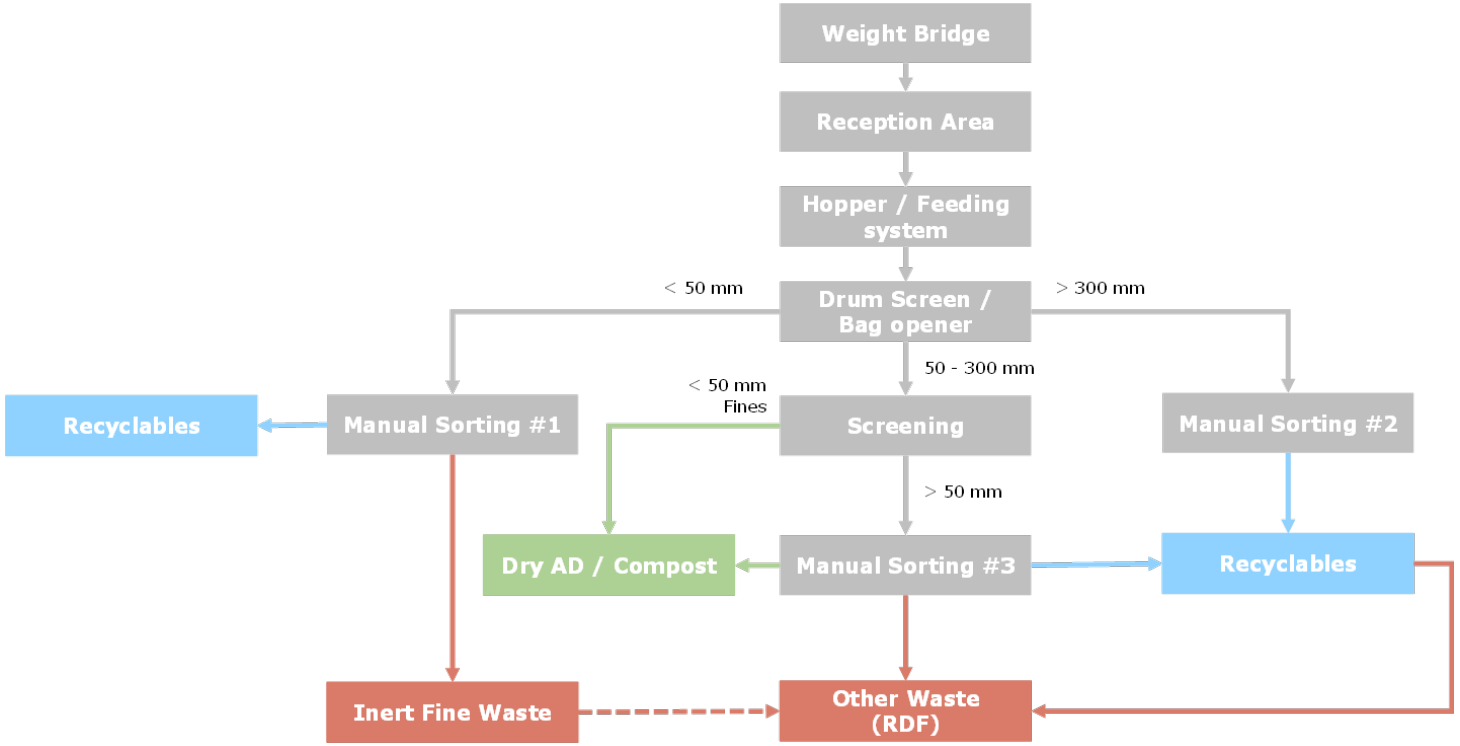
FLOW DIAGRAM MBT AND MRF

Flow diagram, MBT

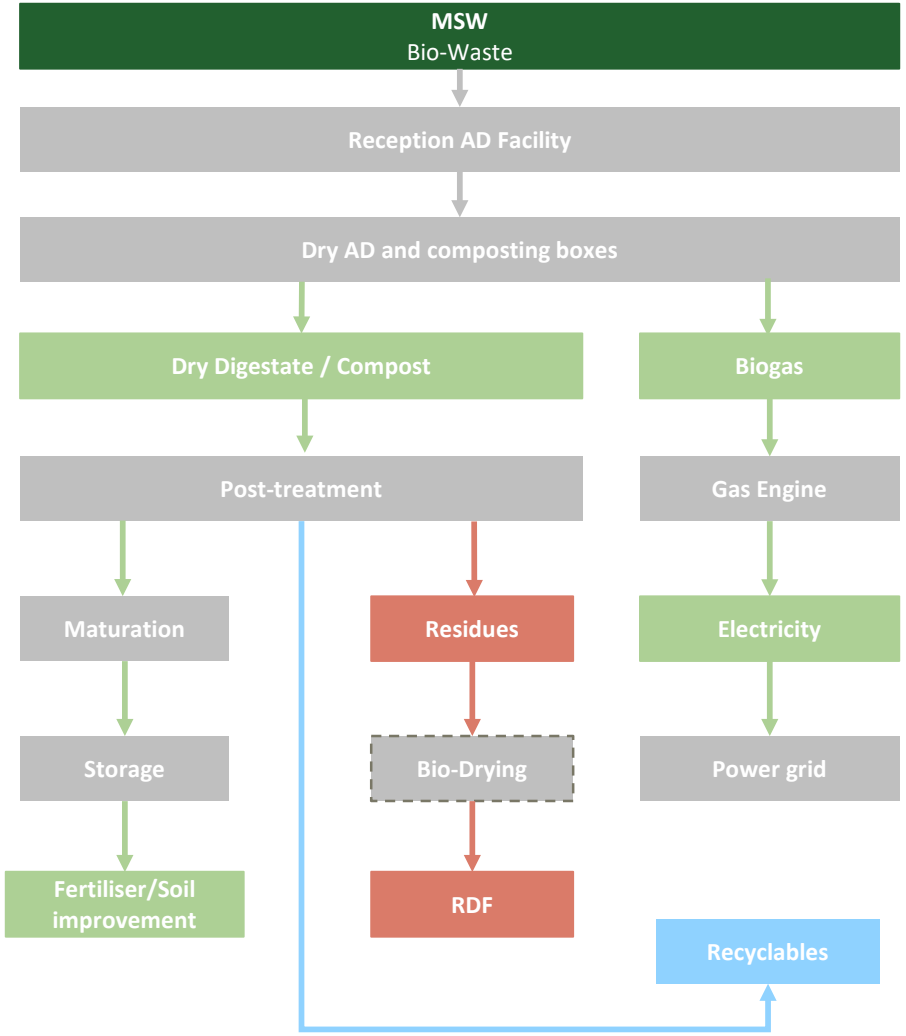


Flow diagram, MRF

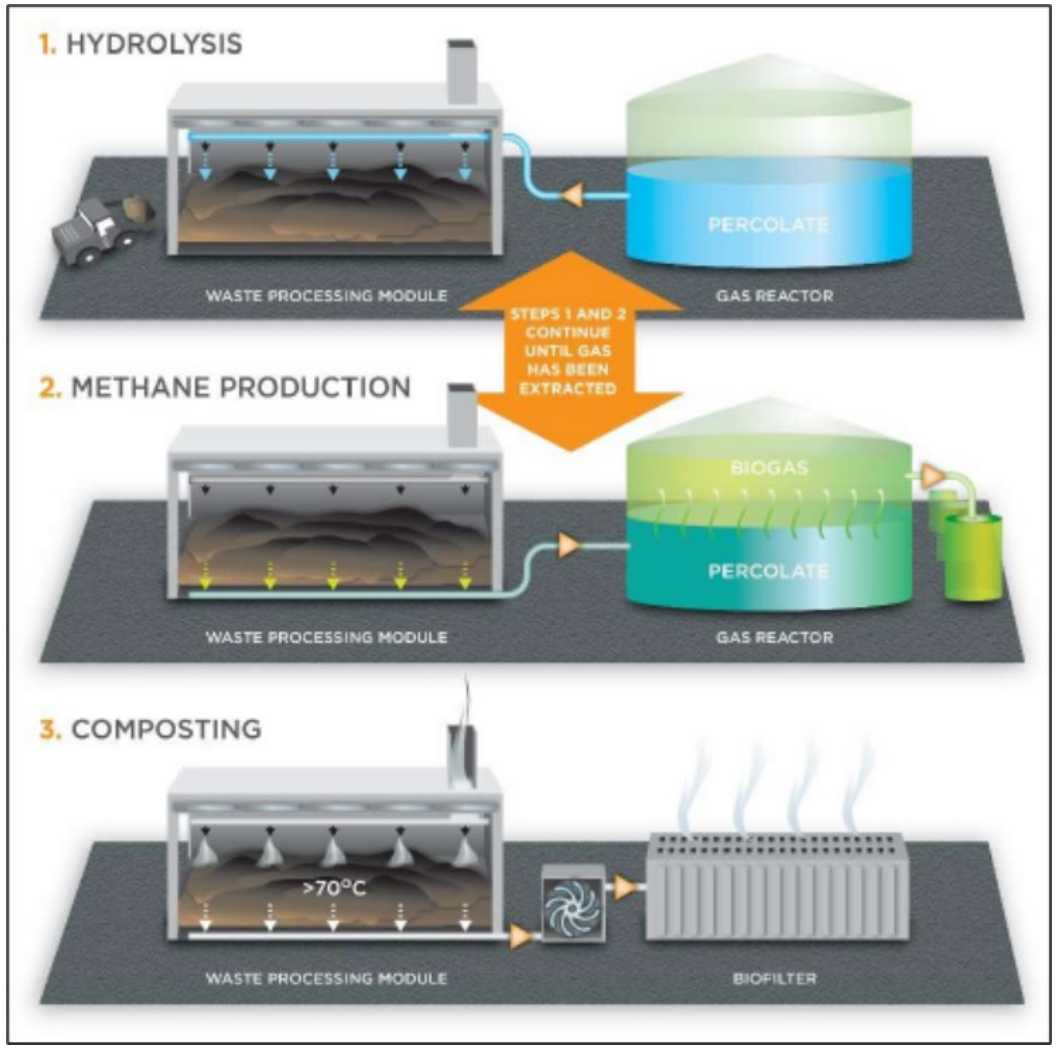


FLOW DIAGRAM DRY AD & COMPOSTING

Flow diagram, Dry AD



Flow diagram, Dry AD & Composting



DESCRIPTION OF SELECTED TECHNICAL OPTIONS, REQUIRED LAND AND COST FOR LAND

The technical solution is based on two waste treatment facilities on Lombok as a **model**.
Scenario 1 and 2 are example of models that are adjustable and useful for other similar simulations.

Scenario 1

- One facility for treatment of waste from e.g. **Mataram City** (MC) and **West** Lombok Regency (WLR).
- MRF: 60,000 tpa and Dry AD/Composting: 40,000 tpa

Scenario 1 – Required land	
MRF:	6,500 m2
Dry AD:	10,000 m2
Composting:	8,500 m2
Total:	**25,000 m2**

Scenario 1	Cost price IDR/m²	Cost price USD/m²	Used Cost price USD/m²	Cost for land USD
Mataram City	400,000 - 1,000,000	28 to 70	49	1,225,000
West Lombok	100,000 - 400,000	7 to 28	18	437,500

Scenario 2

- One facility for treatment of waste from e.g. **Central** Lombok Regency (CLR), **East** Lombok Regency (ELR) and **North** Lombok Regency (NLR).
- MRF: 50,000 tpa and Dry AD/Composting: 30,000 tpa

Scenario 2 – Required land	
MRF:	5,500 m2
Dry AD:	8,500 m2
Composting:	6,000 m2
Total:	**20,000 m2**

Scenario 2	Cost price IDR/m²	Cost price USD/m²	Used cost price USD/m²	Cost for land USD
Central Lombok	500,000	35	35	700,280
East Lombok	350,000	25	25	490,196
North Lombok	100,000 - 300,000	7 to 21	14	280,000

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FINANCIAL SUMMARY

CAPEX	Scenario 1	Scenario 2	Units
MRF	60,000	50,000	tpa
	2.7	2.4	MUSD
	44.8	47.2	USD/ton
Dry AD and Composting	40,000	30,000	tpa
	19.1	14.3	MUSD
	483	468	USD/ton
Total:	**21.8**	**16.7**	**MUSD**

OPEX	Scenario 1	Scenario 2	Units
MRF	60,000	50,000	tpa
	0.92	0.82	MUSD/year
	15.4	16.3	USD/ton
Dry AD and Composting	40,000	30,000	tpa
	0.56	0.45	MUSD/year
	14.1	15.1	USD/ton
Total:	**1.5**	**1.3**	**MUSD/year**

Revenue	Scenario 1	Scenario 2	Units
Recyclables	2,770	2,300	tpa
	0.58	0.48	MUSD/year
	209	209	USD/ton
Biogas FIT	5,533,500	4,150,125	kWh/year
	0.79	0.60	MUSD/year
	0.14	0.14	USD/kWh
Compost	19,130	15,940	tpa
	0.19	0.16	MUSD/year
	10	10	USD/ton
Tipping fee	60,000	50,000	tpa
	0.21	0.18	MUSD/year
	3.5	3.5	USD/ton
Total:	**1.8**	**1.4**	**MUSD/year**

Below parametres have not been calculated:

- Carbon credits and
- Reduced amount of GHG

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EVALUATION OF SELECTED TECHNOLOGY

MBT	Score	
Key parameter	**Scenario 1**	**Scenario 2**
CAPEX	16.7 MUSD	21.8 MUSD
OPEX	29.5 USD/ton	31.4 USD/ton
Amount of Recyclables	2,757 tpa	2,298 tpa
Income from recyclables	480,000 USD/year	576,000 USD/year
Amount of Bio-Methane	1,958,000 Nm^3/year	1,632,000 m^3/year
Amount of RDF	17,107 tpa	14,256 tpa
Income from energy production	595,000 USD/year	794,000 USD/year
Amount of Compost	19,132 tpa	15,944 tpa
Income from nutrient recovery	160,000 USD/year	192,000 USD/year
Technical availability	85% availability	
Job creation and other socio-economic benefits	Job creation for operators at the MBT facility	
Adjustment to Indonesian context	Manual sorting, which creates jobs for local waste pickers	
Reduction of greenhouse gas emissions	Utilisation of organic material results in GHG reduction on fossil fuel and reduction in landfill emissions.	
Environmental impacts	GHG reduction, Circular Economy	
Scalability	The MBT facility consist of various technologies that each are scalable.	

CONCLUSION

There is a **huge potential for utilising the available waste** on Lombok for **energy and fertiliser** respectively as **biogas and RDF** and as **compost**.

There is a **minor potential in sorting out recyclables** from the none segregated collected MSW.

Based on high-level estimations in the report it seems probable to establish a **MBT solution** that is **economical feasible**, provided that the solution is kept simple and robust.

- There are **high amounts of organic waste** available on Lombok.
- There seems to be **limited sources of co-substrates** like manure from cows and similar. There is a logistic challenge to collect potential co-substrates.
- There is **high consumption** of both organic (liquid) and inorganic (Urea and NPK) **fertiliser** on Lombok.
- There is an **ongoing project** with a potential local off-taker for **RDF** – Jerangjang Power Plant.
- Analysis shows a **potential need for gas and electricity** on Lombok.
- The transport sector has a huge energy demand, but at the moment only for gasoline and diesel.
- According to performed calculations **OPEX and potential revenues** are in balance.

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KEY RECOMMENDATION

In order to support the development of regional and big scale waste treatment facility in Lombok some key recommendations in connection with the technical part is listed.

It is recommended to:

- Implement **waste sorting with minimum two fractions** – organic and non-organic waste. Segregation of waste in two fractions will enable higher recovery rate and purity of recyclables.
- Establish a **campaign** to avoid removal of recyclables during transportation from source to treatment plant.
- **Investigate further** in a MBT solution for treatment of both organic and non-organic waste.
- **Locate a few appropriate sites**, preferably close to existing landfills for location of MBT facilities.
- Focus on **electricity (power) from biogas**. Upgrading and compacting of biogas is expensive and technologically complicated.
- Further analysis of **potential need for fertiliser as compost**.
- Investigate further advantage/disadvantage and economy in **bio-drying** of RDF. The advantage of drying RDF is lower moisture content and higher caloric value and higher sales value.
- Establish a **cooperation with existing RDF project** at Jerangjang Power Plant.
- Conduct further analysis and calculations of the opportunity to get a **revenue from sales of carbon credits**.

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