June 8

Final Report: Baseline Survey for Waste-to-Energy Pilot in Probolinggo City

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List of Abbreviation

APBD = Regional Government Budget

BLH = Environmental Agency

FORJAMANSA = Solid Waste Management Network Forum

Ha = Hectare

Km = Kilometer

Lt = Liter

m = Meter

P2DPL = Prevention and Handling of Environmental Impact

RPJMD = Regional Midterm Development Plan

TPA = Final Processing Site

TPS 3R = Material Recovery Facility

TPST 3R= Integrated Material Recovery Facility

UPTD = Local technical Implementation Unit

Introduction

The Baseline Survey Report is made upon request from the United Cities and Local Government (UCLG), United Nations of Economic and Social Commission for Asia and the Pacific (UN-ESCAP) and Waste Concern. The aim of this report is to identify potential locations for Waste-to-Energy pilot plant in Indonesia and to characterize in detail the shortlisted locations. In November 2014, The UN ESCAP and UCLG ASPAC organized a national workshop on Pro-Poor and Sustainable Solid Waste Management in Secondary Cities and Small Towns: Prospects for the application of anaerobic digestion to treat municipal solid waste in Indonesia. As a follow-up from the national workshop, 4 cities had been selected as the shortlisted candidates to host the waste-to-energy pilot in Indonesia. The selected cities are: 1. Jambi City in the Province of Jambi, 2. Malang City, 3. Malang Regency, and 4. Probolinggo City in the Province of East Java. In addition, this report pertains to the city of Probolinggo only.

The survey was conducted by Sustainable Waste Indonesia (SWI) Team from the beginning of February to middle of May 2015. The field visit to Probolinggo City was conducted in February 18th 2015. In between a member of SWI field assistant was staying until February 20th 2015. A Fact Finding Mission by the representatives from UN ESCAP, UCLG ASPAC, and Waste Concern was conducted in March 10th 2015. During the mission, a representative from SWI Team accompanied the delegation of UCLG ASPAC, UN ESCAP and Waste Concern on the field visit to the city. These field visits were important on many aspects, such as in shortlisting the possible locations for the Waste-to-Energy project, as well as in steering the work of the consultants.

A waste-to-energy pilot will be developed in a feasible location that meets certain requirements set by UN-ESCAP and Waste Concern. These requirements have been proposedto ensure the plant would operate optimally and sustainably when implemented.

The baseline survey aims to identify the source of organic waste and the potential location for waste-to-energy plant based on the criteria determined by UN ESCAP and Waste Concern. Both, the organic waste sources and potential locations for the plant, are proposed by the local government, as one of the form of participation and contribution from the local government for this project. Furthermore, the most feasible location would be further analyzed in order to understand the characteristics of the waste and the possible end users. Generally, the baseline survey is conducted in two phases as follows:

a. Phase 1: Baseline survey is conducted as a preliminary selection of the proposed locations in order to select the most feasible site that could host the waste-to-energy pilot. At this phase, the proposed locations are identified and characterized its feasibility as the waste source and the location for waste-to-energy plant.

b. Phase 2: Baseline survey is conducted to further analyze the site that could host the pilot project, particularly waste generation rates, the waste physical and chemical characteristics, the density of the waste, and the potential end users of the energy generated by the plant. Within this second phase, the waste sampling is conducted and questionnaires are distributed in order to identify and characterize the feasibility of the shortlisted site for hosting the waste-to-energy pilot.

After the baseline survey phase-1 is completed, a fact-finding mission by a team of representatives from ESCAP, UCLG-ASPAC together with a team member of SWI, and Waste Concern is conducted. During the mission, the proposed locations are visited and checked its feasibility for waste-to-energy pilot, in close discussion with the whole team member. As an output from UN-ESCAP mission, the shortlisted site to be further analyzed in the baseline survey phase-2 is determined. Consequently, only the shortlisted sites that would be further analyzed in the second phase of baseline survey. After the Fact Finding Mission with UN ESCAP, UCLG, and Waste Concern, it was concluded that these locations are not necessary to be further analyzed.

This report is structured as follow:

Part 1 consists of overview of municipal solid waste practices in the city. It describes the local authority's budget allocation for waste management, municipal waste collection methods, overview of formal collection system in the city, transfer and transport system of waste, methods for treating waste in the city, institutional capacity and key policies, practices for waste segregation, disposal sites and main characteristics, and informal sectors.

Part 2 presents the results of the empirical survey that was conducted to assess the viability of a waste-to-energy pilot. It describes the identification of the proposed locations of organic waste sources and waste-to-energy plant in the city, marketing of biogas and assessment of indicators for financial and economic analysis.

As conclusion, the team wraps up the report with recommendation of the shortlisted site for the waste-to-energy pilot implementation. Furthermore, the recommendation includes the improvement of municipal solid waste management system in the city and suggestions for waste management system, financial and institutional approaches.

Whereas part 1 mostly consists of secondary data, part 2 combines primary and secondary data. The primary data was produces during the field visit by SWI team. All report structure was following the guidelines given by the UN ESCAP, Waste Concern and UCLG.

Part I – Context and Background

1. Overview of Municipal Solid Waste Practices in Probolinggo City

1.1 City Profile

Probolinggo is one of the city in East Java province. It is located at 7^0 43' 41" to 7^0 49' 04" South Latitude to 113^0 10' to 113^0 15' East Longitude. This city is a transit center for east-west transportation. The border of the city is Madura strait, Dringu District, Leces District, Sumberasih District (Probolinggo Regency) on North, East, South and West side respectively.

Table 1 Administrative Information of Probolinggo City

No.	Districts	Area (km^2)	Inhabitants	Density (person/km^2)
1	Kademangan	12,754	39,695	3112.36
2	Wonoasih	10,981	32,690	2976.96
3	Mayangan	8,655	59,933	6924.67
4	Kanigaran	10,653	56,140	5269.88
5	Kedopok	13,624	31,816	2335.29
	Total	56,667	220,274	3,887.17

The Probolinggo City consists of 5 districts, ranges from 8,655 km2 to 13,624 km^2. The highest density district is Mayangan with 6,924 person/km^2 and the lowest is Kedopok with 2,335 km^2. In total Probolinggo has around 220,274 inhabitants.

The main economy activities in Probolinggo City are agriculture, marine and fisheries, Trading, Industry, Energy and Mineral Resources as it is written in the law no.32 year 2004 about Local Authority and also Regional Mid-term Development Plan (RPJMD) Probolinggo City.

Probolinggo City is a model city in Indonesia with regards to waste management, having been awarded Adipura for several times. Adipura is an annual award for a city in Indonesia that has shown best practices in waste management during the respective year.

This city generates 158.03 ton of waste per day, whereas in average 27% is transported to the Bestari, the only landfill in Probolinggo City. The waste in this city consists of 65.2% organic waste, 13.2% plastics, 6.9% papers, 5.7% wood, 4.7% diapers, 1.3% glass, and 3% others.

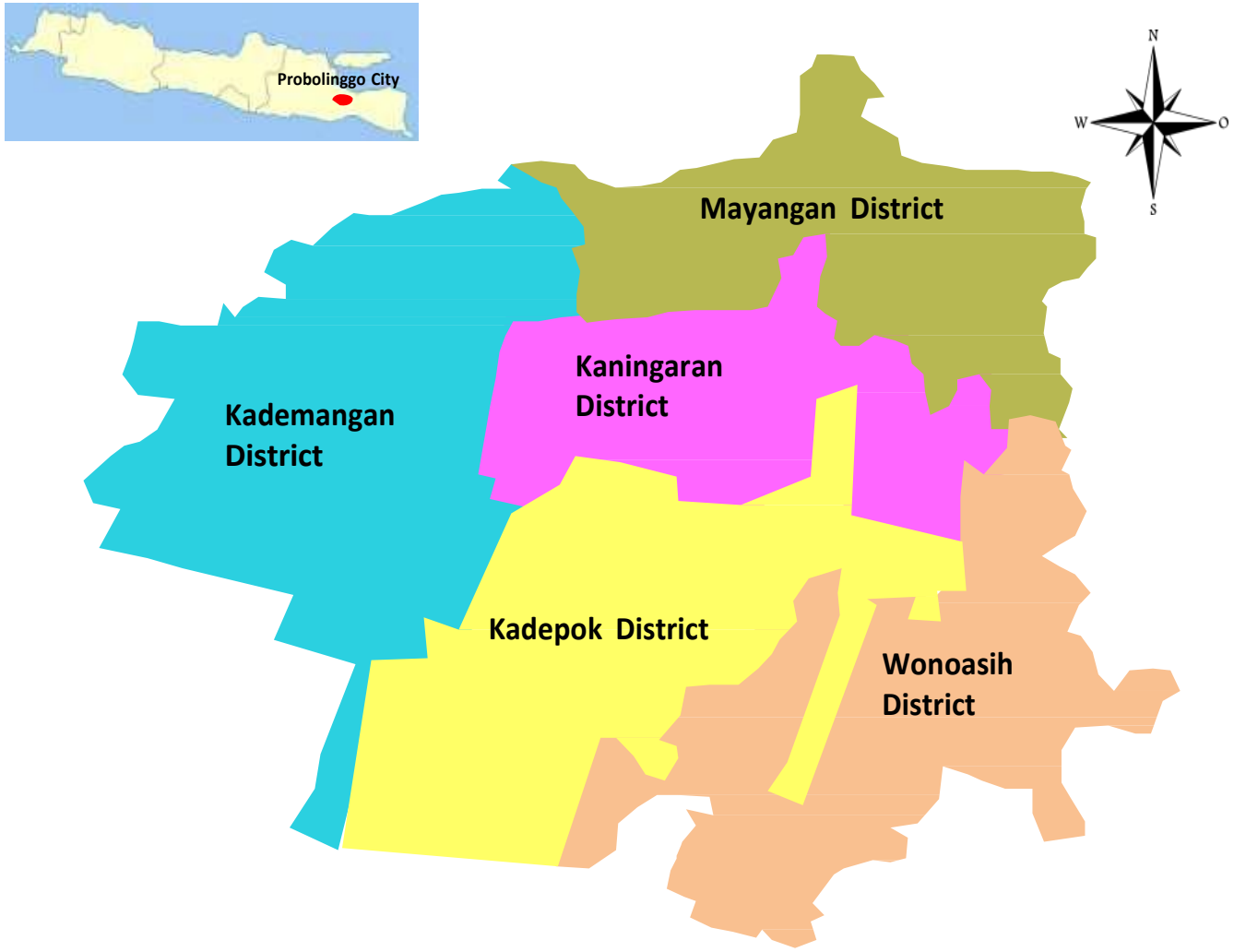

Figure 1 Map of Probolinggo City

In general the waste generated in the city is treated under the Material Recovery System and Waste Bank System. The city owns 2 MRFs and 69 unit of Waste banks whereas only 49% are active.

Local Authority's Budget Allocation for Waste Management

In Probolinggo City, the local authority who involve in the waste management related activity is mainly the Environmental Agency or *Badan Lingkungan Hidup* (BLH).

Like in other provinces in Indonesia, all budget allocations plan (expenditures and revenues) is set-up in *Anggaran Pendapatan Belanja Daerah* (APBD) or the Regional Government Budget. One of the items in APBD in Probolinggo City is direct expenditure for waste management improvement program. It includes waste tools and infrastructure procurement, the improvement of community involvement in the program of waste management, waste bins and other waste collection operational tools procurement, operational and infrastructure maintenance improvement, the improvement of the landfill and the temporary collection point, the operational of Solid Waste Management Forum in Probolinggo City or FORJAMANSA, and the technology development for waste management, the improvement of garden at the disposal sites, the development of sanitary landfill, and supporting infrastructure, and the development waste management based on environmental, socio-economic community.

The local authority's budget allocation for waste management includes salaries for permanent and contractual-based employees, expenditures for services and products and expenditures for capital/investment such as tools and buildings. In 2014, total budget for waste management at the local authority reached 0.41% or equivalent to 3,227,000,000 IDR from the total regional expenditure that is worth 787,247,077,927.92 IDR. The city projection for direct expenditure in the year 2015 is 7,485,478,000 IDR. Please refer to Table 2 for the proportion ratio of direct expenditure for waste management to the total city expenditure in APBD.

Table 2 Local Authority's Budget Allocation for Waste Management in Probolinggo City

City/ Regency	Institutional	Budget Allocation For Waste Management Program in 2014 (Rp)	Proportion To Regional Expenditure
Probolinggo City	1. Environmental Agency	3,227,000,000	0.41 %
	Total Expenditure	3,227,000,000	
	Total Regional Expenditure	783.247.077.917,92	

1.2 Municipal Solid Waste Collection Method

Waste Bin

At source the common storages for municipal solid waste in Probolinggo city is mainly waste bin made from rubber, woven bamboo, plastic bags or sacks. Some of the community built their own waste bin permanently and it is made from bricks. For public facilities such as streets, three bigger capacity waste bins are available and hanged over the streets and they are addressed for waste separation at source (wet, dry, and hazardous waste).

Street Sweeping

For all waste along the streets, the local authority prepares 136 street sweepers who are focusing on 40 locations (37 streets and 3 public facilities). For effectiveness of street waste sweeping, the sweeping is conducted 3 times a day. The waste is then brought in to the nearest conventional temporary collection point.

Temporary Collection Point

The appointed person at the community level conducts the collection of municipal solid waste at source. So far there are 200 persons who are involved in this activity. Meanwhile, the number of conventional temporary collection point in Probolinggo City is 122 units. It consists of 36 points of container (capacity of 9 m^3), 4 transfer depots (capacity of 50-100 m^3), 18 conventional temporary collection points (capacity of 10-50 m^3), small-sized conventional temporary collection points (capacity of 6-9 m^3). With waste density around 250 kg/m^2, these existing temporary collection points possibly collect 550 tons of waste per day. As the city generates 158.03 tons of waste per day, the number of these facilities is sufficient for a long term if all of these facilities are well functioning.

1.3 Formal Waste Collection: Organization and Structure

By legal the municipal solid waste management in Probilinggo City is the responsibility of Environmental Agency. These tasks are handled over by the Impact Mitigation and Management of Environmental pollution board or *Bidang Penganggulangan dan Penganganan Dampak Pencemaran lingkungan* (P2DPL), which include waste and wastewater management, and also waste and wastewater mobilization. The agency has 180 staff, where 74 persons are civil servant, 21 persons are contract-based employee and 85 persons are intern. Based on the ratio used by the Ministry of Public Works, 1 cleansing staff is equal to 1,000 inhabitants. It means in Probolinggo City the number of staff is not sufficient enough.

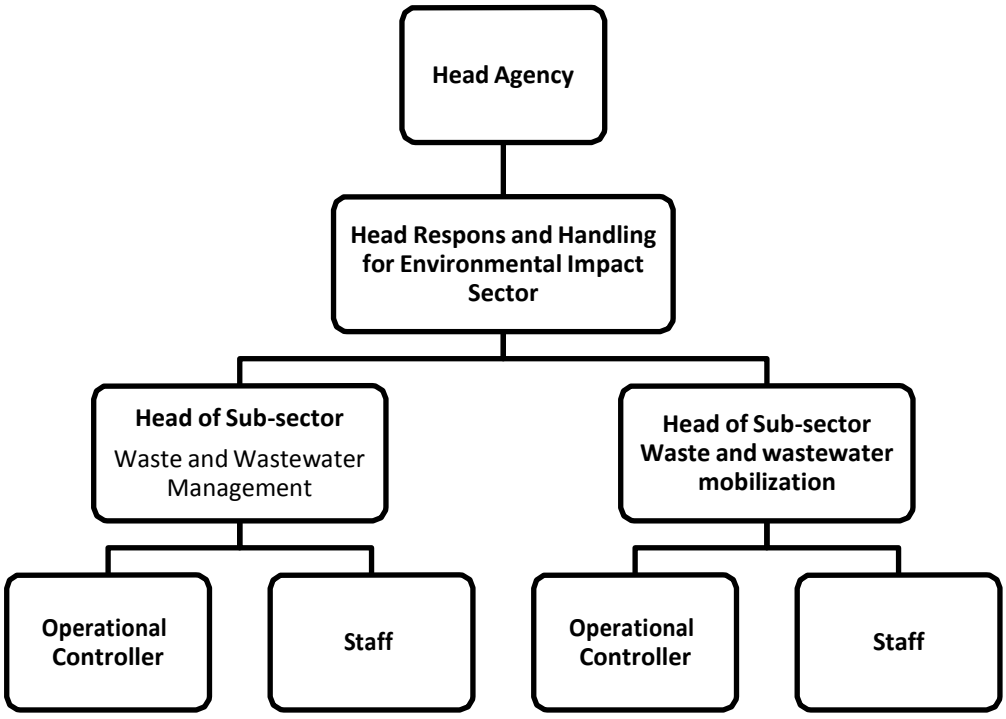

Figure 2 Organizational Structures of Environmental Agency in Probolinggo City

A head Agency leads the Environmental Agency in Probolinggo City. The Head Agency is directly supported by the Head Respons and Handling Sector for the Environmental Impact. From this point there are 2 divisions that is the Head of Sub-Sector for Waste and Wastewater Management and the Head of Sub-sector for Waste and Wastewater Mobilization. Additionally, Operational controller and staffs support each division.

1.4 Waste Collection Tools

At the community level, the collection of municipal solid waste at source uses handcart as their collection tool with capacity of 1-2 m^3. The collection frequency ranges from 1-3 times a day.

Apart from that, the municipal waste collection is also done by dump truck and arm roll truck. So far there are 30 drivers and co-drivers who are responsible for the collection activities. The collection is done from 05.30 to 11.00 in the mornings and from 12.00 to 3.00 in the afternoon. Waste is transported to the city landfill.

1.5 Waste Treatment Facilities

There are different types of waste treatment facilities in Probolinggo City. One of them are large-scale Material Recovery Facilities or TPST 3R, or known as Integrated Material Recovery Facility. These facilities already treat around 62 tons of waste per year.

Another type of waste treatment facility is the waste bank. This report describes the five largest waste banks in the city. Such facilities could treat around 1 to 13 ton waste per year, with the average income ranging from 1,150,000 to 15,700,000 IDR per month.

The last type is the multi-use waste treatment facility in Bestari landfill. It includes biogas utilization, composting and also waste bank. This landfill also has in place a landfill gas recovery and flaring technology, and also biogas for fuel technology. During the visit of SWI team, it was found that the produced gas is not yet distributed to the settlement, but only used to support the facility. In this facility there is a small-scale Anaerobic Digestion pilot project, which processes the food waste. These plants apply the wet-fermentation method, and have a processing capacity of 2-L per day of organic waste as the input, as shown on the figure below. There is another Anaerobic Digestion with dry fermentation that is no longer operated due to the low gas production compared to the wet fermentation being tested. Both of this Anaerobic Digestion facilities are a research project conducted by BPPT or Agency for the Assessment and Application of Technology. Please refer to the table below for the list of several waste treatment technologies in Probolinggo. Meanwhile, some of the waste treatment facility with high capacity in Probolinggo are presented in Figure 7.

Figure 3 Anaerobic Digester with Dry Fermentation

Figure 4 Anaerobic Digester with Wet Fermentation of Food Waste

Table 3 Waste Treatment Facilities in Probolinggo City

Treatment Facility	Name of Facility	Capacity (ton/year)	Operational details
Integrated Material Recovery (TPST 3R)	TPST Ungup-Ungup	62.57 (Max.capacity)	Organic waste for compost: 31,18 Ton
	TPST UPT PSL	80.67 (Max.capacity)	Organic waste for compost: 57,10 Ton
Waste Bank	MASPRO MESRA	13.03	Address : Mayangan district Income : 15,733,075 / year
	Pasar Baru	8.82	Address: Kanigaran district Income : 1,150,000 / year
	Rukun Budaya	4.99	Address: Kedupok district Income : 50,000,000 IDR / year
	Damai Sejahtera	2.38	Address: Kanigaran district Income : 2,335,795 IDR / year
	Edelwese	1.11	Address : Wonoasih district Income : 1,200,000 IDR / year
Biogas Utilization, Composting, and Waste Bank	Bestari Landfill	n.a.	Purpose : Gas and Flaring, biogas for fuel

Source: BLH, 2015. Notes: the data above is secondary data. However the validity is not verified.

Figure 5 MRF UPT PSL

Figure 6 MRF Ungup-Ungup

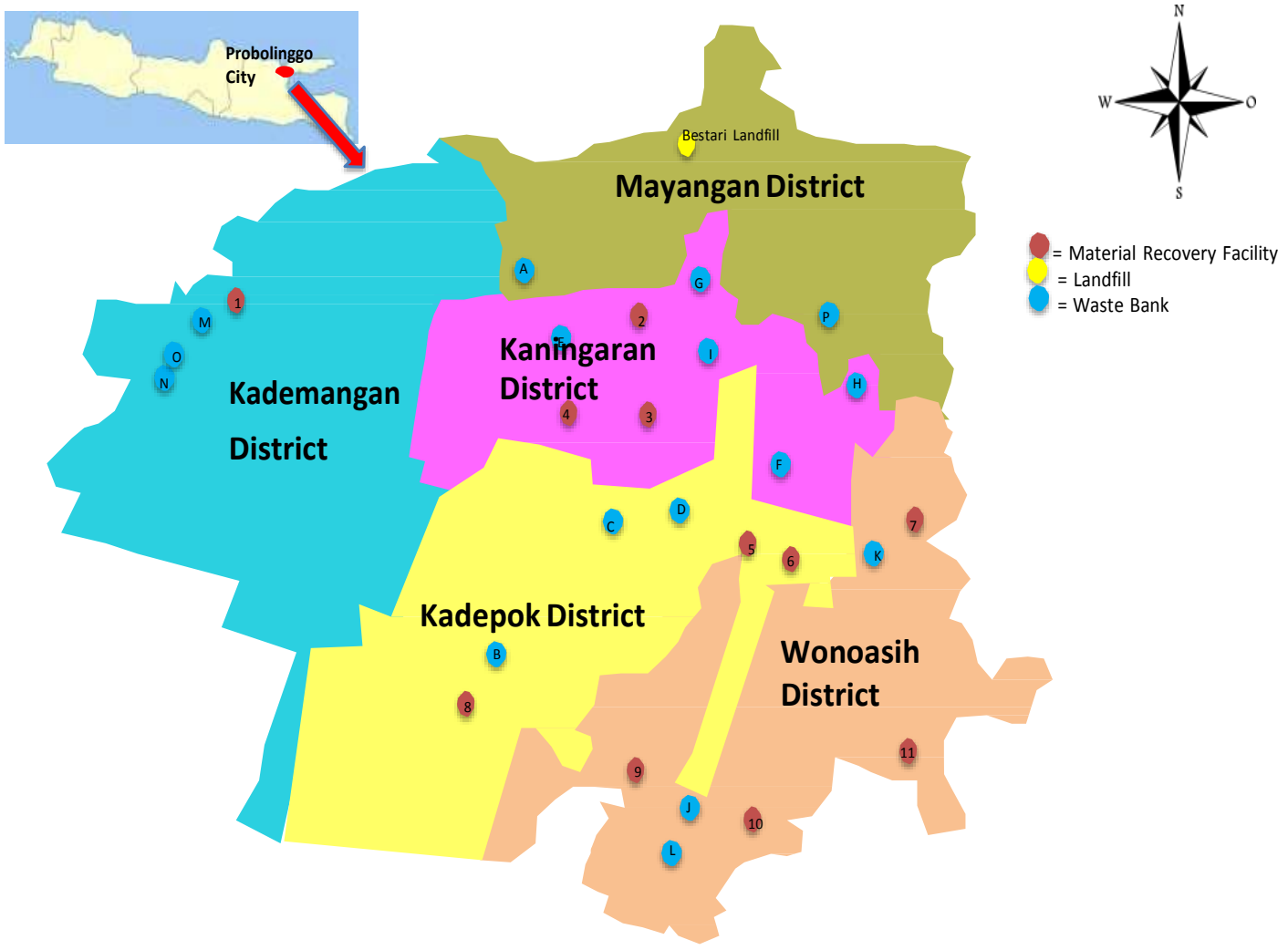

Figure 7 Location of waste treatment facilities in Probolinggo City

1.6 Existing Waste Separation Practices and 3R Initiatives

The local authority assists the community in doing the waste management at settlement level. They are expected to treat their own waste, especially the organic waste, through composting. Thus, it is expected that the community can be actively involved in waste reduction. Below are some examples of waste separation practices and 3R initiatives in Probolinggo:

Table 4 3R initiatives at the settlements

Name of the plant	Operational Detail	Notes
Asabari Housing	Type of waste treatment	Composting
	Treated Waste amount	100 kg/ 4 month
	Waste reduction amount	300 kg/ year
STI Housing	Type of waste treatment	Composting
	Treated Waste amount	200 kg/ 2 month
	Waste reduction amount	1200 kg/year
Bromo Housing	Type of waste treatment	Composting
	Treated Waste amount	200 kg/ 6 month
	Waste reduction amount	400 kg/year

One of the samples of the existing waste separation practices and 3 R initiatives described in this report is the Asabari Housing. It is a home composting facility, which treats around 25 kg of waste amount per month. It reduces around 300 kg of waste per year. Another sample is the STI housing and Bromo Housing. Among them, STI housing is the composting plant with the higher number of waste reduction amount. It can reduce the waste approximately 1.2 ton in a year. Please refer to table 4 for detailed figures.

Table 5 3R initiatives by the group of farmers

Name of the plant	Operational Detail	Notes
Tani Bangau Jaya Group	Type of waste treatment	Composting
	Treated Waste amount	4 ton / month
	Waste reduction amount	40 ton/ year
Tani Poh Sangit Kidul Group	Type of waste treatment	Composting
	Treated Waste amount	2 ton / 4 month
	Waste reduction amount	6 ton/ year
Tani Makmur II Group	Type of waste treatment	Composting
	Treated Waste amount	10 ton / 4 month
	Waste reduction amount	30 ton/ year

Another types of 3R initiatives come from farmers's groups and they are conducint mainly composting. This report describes three of them and those are Tani Bangau Jaya Group, Tani Poh Sangit Kidul Group and Tani Makmur II Group. Among these facilities, the Tani Bakau Jaya Group treats the highest number of waste (4 tons per month) and also reduces the highest number of waste (40 ton per year). Please refer to table 5 for detailed figures.

Table 6 3R Initiatives at Schools

Name of the plant	Operational Detail	Notes
SMAN 1 Probolinggo	Type of waste treatment	Composting
	Treated Waste amount	3500 kg / year
SMAN 2 Probolinggo	Type of waste treatment	Composting
	Treated Waste amount	4872 kg / year
SMAN 3 Probolinggo	Type of waste treatment	Composting
	Treated Waste amount	400 kg / year

Source : UPT-PSL (2011)

The last type is presented from the group of senior high school and they are also doing composting. These schools in average treat 0.4 to 3.5 ton or waste. Please refer to table 6 for detail number.

1.7 Final Disposal and Activities of the Informal Sector

The profile of Bestari Landfill in Probolinggo City is described in Table 7. This sanitary landfill is located in Sukabumi Sub-district, Mayangan District. This facility belongs to the government and has an area of 4 ha. The landfill has been in operation since 1973. Currently it has 18 employees. The distance to the nearest landfill is 1.5 km. Please note that the city area is very small compared to other cities surveyed by the team.

Table 7 Profile of Bestari Landfill, Probolinggo

Location	Sukabumi Sub-district, Mayangan District
Land Ownership	Local Government – Probolinggo Asset
Area	4 Ha
Operated Since	Year 1973
Number of employee	4 operator at weighing scale 2 operator for heavy infrastructures 5 security 7 landfill operator
Location border	North : embankment
	South : Anggrek Street
	East : Settlement
	West : River
Distance to the city center	1.5 Km
Operational System	Sanitary Landfill (since 2008)
Waste volume	42.69 ton/day
Waste Source	Housing Settlement, industry, market, stores/restaurant, parks, irrigation and hospital.
Technology	Methane piping system
	Leachate treatment system
	Drainage system

Source : Profil Pengelolaan Persampahan Kota Probolinggo 2015

1.8 Institutional Capacity and Key Policies, Laws and Regulation at The City/Provinces on Solid Waste Management

The government enacted the main regulation for waste management in Indonesia by launching Indonesian Regulation no.18 year 2008. In addition, the government launched the Indonesian Act no. 18 year 2012 about waste management, specifically about household waste. This supporting regulation emphasizes several issues, those are: (1). As a legally binding for the local authority to held environmental-based waste management, including the aspect of formal legal, management, technical operational, financial, organizational and resources, (2) to clarify the distribution of responsibility in performing waste management, started from the ministry/government, provincial level government, local authority, business sector, regional managers until the community members, (3) Giving the fundamental background for the operational 3R implementation in waste management on the way to replace the old paradigm (collect-transport-disposal) in to the new one (collect-separate-treated-disposal), and (4) Giving the fundamental background to get the business sector actively involve in the waste management.

There are 3 important issues, which are emphasized by the Government Regulation, those are (1). To underline the landfill transformation system from dumping in to an environmentally friendly landfill, (2) to implement Extended Producer Responsibility (EPR) for the business

sector as part of their contribution in improving the environmental quality and public health, (3). To message the order of waste separation at source, including the settlement, industrial, commercial regional managers.

In the case of Probolinggo City, the local authority adds the support by launching local regulation no. 5 Year 2010 about waste management. This regulation addresses the environmental health for cleanliness and city beautification in a sustainable way, by the local authority and the community. This regulation address (1) the develop and increase the community awareness and culture awareness for waste management, (2) to do research and technology development in waste management technology, (3) to actively involve in waste reduction, waste handling and waste utilization, (4) to conduct waste management and permission for waste management, (5) to facilitated the waste management improvement, (6) to encourage and facilitated utilization from waste products, (7) to facilitated technology on implementation to the local community in order to reduce and handling waste, (8) to conduct coordination among government institutions, community, business sector in order to perform integrated waste management. For more information please refer to Table 8.

Several issues related to the municipal solid waste management are mentioned in different local regulations in Probolinggo City. Those are about the business service retribution, public service retribution, main tasks of the local regulations and the instruction of the waste management it self. The Regulations related to Waste Management in Probolinggo city are listed in Table 8, as follow:

T8 Institutional Capacity and Key Policies

No.	Legal Form	Documents Number and Dates	About
1	Local Regulation or Perda Kota Probolinggo	No. 4, March 15th 2011	Business Service Retribution
2	Local Regulation or Perda Kota Probolinggo	No.3, March 15th 2011	Public Service Retribution
3	Local Regulation or Perda Kota Probolinggo	No.4, July 03rd 2012	Local Authority in Probolinggo
4	City Mayor Regulation, Probolinggo	No. 30, June 15th 2008	Main task and function of Local Authority Probolinggo
5	City Mayor Decree, Keputusan Walikota Probolinggo	No. 25, March 2006 03rd	Team for Cleansing and City Beautification
6	Local Regulation, Perda Kota Probolinggo	No.5, June 24th 2010	Waste Management
7	City Mayor Decree Keputusan Walikota Probolinggo	No, 3, February 3rd 2012	Instruction for Waste Management implementation

Source : Profil Pengelolaan Persampahan Kota Probolinggo 2015

1.9 Informal Sectors and their Involvement in MSW System

The recycling and reuse activities by the scavengers influence the fluctuation of waste generation in the city. The scavengers usually collect the recyclable material from the housing settlements, temporary collection points. Then they sell the recyclables to the collector who usually sends the materials to the industries in Sidoarjo. In this way they earn money from the selling of the recyclables. In Probolinggo city, the scavengers are hardly found at the landfill. Detail data about informal sectors, including the number of scavengers and the amount of reduced waste based on the scavenging activities are not available.

Observations and Conclusions

As the city model for waste management in Indonesia, the Probolinggo city owns a well-performed municipal solid waste system. The city applies MRF and Waste Bank system, and sanitary landfill as an integrated system to solid waste treatment. In fact, the city is very small in terms of area and population number therefore this reflects to the number of waste generation in the city.

Part II – Empirical survey to support the development of the waste-to-energy pilot

2. Identification of the proposed locations of organic waste source and waste-to energy plant in the city

The identification and characterization of the organic waste sources and the potential location for waste-to-energy plant proposed by the local government were conducted on the first phase of baseline survey. The technology of the waste-to-energy plant that would be implemented is an anaerobic digestion facility to treat the organic waste fraction with the following key design features:

a. Location:
   The location for the waste-to-energy plant is preferably at the source of organic waste or, at least, in proximity to the organic waste source;
b. Envisaged capacity of Anaerobic Digester:
   The capacity of 2-5 ton/day of source-separated organic waste;
c. Area:
   The area needed for waste-to-energy plant of 2-5 ton/day capacity is approximately between 800 to 1000 m^2.

Thus, in order to fulfill the key design features of the waste-to-energy plant, the criteria to identify the organic waste source of the proposed location in the city has been determined as follows:

a. Generation of a minimum 2 ton of organic waste per day
b. Organic waste is relatively free of contaminants or has been subject to some degree of segregation
c. Relative proximity to any site potentially earmarked by the local government for the waste-to-energy plant

Meanwhile, the criteria to identify the possible locations for waste-to-energy plant in order to meet key design features that has been determined, are mentioned as follows:

a. Minimum area of 800 m^2
b. Proximity to points of waste generation
c. Distance of households/markets from the plant
d. Co-location with existing waste processing facility or disposal site

According to the given criteria, the team has conducted a survey to identify and characterize the potential locations proposed by the local government that could be the source of feedstock

and the location for the waste-to-energy plant. The identified and characterized proposed locations are as follows:

Table 9 Proposed locations of organic waste source and waste-to-energy plant

No	Parameter	Location 1	Location 2
1	Potential Location for Waste to Energy Plant	Integrated MRF - Ungup ungup	Livestock Market
2	Total waste collected (ton/day)	1.5 ton/day; Max Capacity = 3 - 4 ton/day	n/a
	Organic waste (ton/day)	0.33	0.5 ton/week (animal manure)
3	Other possibility of waste input (ton/day):	a.Traditional market "kronong" = 0.5 ton/day (mixed waste) b. Nearby households = 1 ton/month	Traditional market "Wonoasih" + households = 1.5 ton/day
4	Availability large portion of meat and fish waste	n/a	n/a
5	Waste management: a. Waste collection	Door to door collection system, mostly generated from "Baru" traditional market using motorcart of 0.6 m^3	Bring-collection system to the temporary waste collection point, located on-site the market (once in a week)
	b. Waste transportation	Motor cart of 0.6 m^3	Dump truck
	c. Waste disposal	Residues transported to Landfill	Non-compostable transported to Landfill
6	Waste condition (segregated or mixed)	mixed	segregated
7	Energy consumed at the site/Power Installed	Average energy consumed/household = 117,3 kWh = 3,91 kWh/day	Average energy consumed/household = 117,3 kWh = 3,91 kWh/day
Proposed Location for Waste-to Energy Plant:			
1	Waste to Energy proposed location: a. Area	800 - 1000 m^2	800 - 1000 m^2
	b. Land Status	owned by the local government	owned by the local government
	c. Location	On site the integrated MRF - Ungup ungup	On site the livestock market
2	Distance from waste generation points (km)	50 m - 2 km	100 m to Livestock Market
3	Distance of households/markets from the plant (also within 1 km	a. Traditional market "Baru" (existing waste input) = 1 km	Traditional market "Wonoasih" and

	radius)	b. Traditional market "Kronong"(other possibility of waste input) = 2 km	settlements = 1 km
		c. Nearby settlements = 50 - 100 m	
4	Distance to disposal site	2 km	3 - 5 km
5	Distance to access road	50 m	500 m
6	Distance to transformer substation (km)	1 km	500 m
7	Transformer capacity (KVA)	n/a	n/a
8	Available system voltage and frequency at the site or in proximity to the site	380/220 (Voltage) & frequency (50 Hz)	380/220 (Voltage) & frequency (50 Hz)

Source: Field Survey - SWI Team (February - April, 2015)

Location 1: The Integrated Material Recovery Facility (TPST 3R) Ungup-ungup

In Probolinggo, the first proposed location is the integrated material recovery facility named Ungup-ungup. This city only has two integrated material recovery facilities. Those are Ungup-ungup and UPT PSL in Bestari Landfill. Ungup-ungup is located nearby the settlements and has the maximum capacity of waste input around 3 to 4 ton/day. However, the existing waste input only reached 1.5 ton/day, which mostly comes from “Baru” Traditional Market and the green area around the city.

The waste input of 1.5 ton/day comes in mixed condition, whereas the waste separation activity is conducted at this facility. Approximately only 0.33 ton/day of organic waste is composted at this facility while the rests are transported to the landfill. Furthermore, other waste input to this facility is also available. The additional waste comes from Kronong market around 0.5 ton/day of mixed waste and from the nearby settlements approximately 1 ton/month of mixed waste.

Also, the local government has a plan in the future to transport and treat all the organic waste from all traditional market in Probolinggo in this integrated MRF (Ungup-Ungup). In addition, the data of waste composition at this facility is not available, thus a portion of meat and fish waste could not be identified.

Since this city is categorized as a small city in terms of, both, the population and the total area, so waste transportation from one waste generation point to the other point would not be a problem. Moreover, the distance from the farthest point of this city to the city center is only around 7 km.

At Ungup-ungup, the waste collection system applied at source is door-to-door collection system. It uses motorcycle handcart with the capacity of 0.6 m^3. The motorcycle handcart collects the waste from the temporary waste collection point of Baru traditional market and other sources. Then the waste is transported to this integrated material recovery facility.

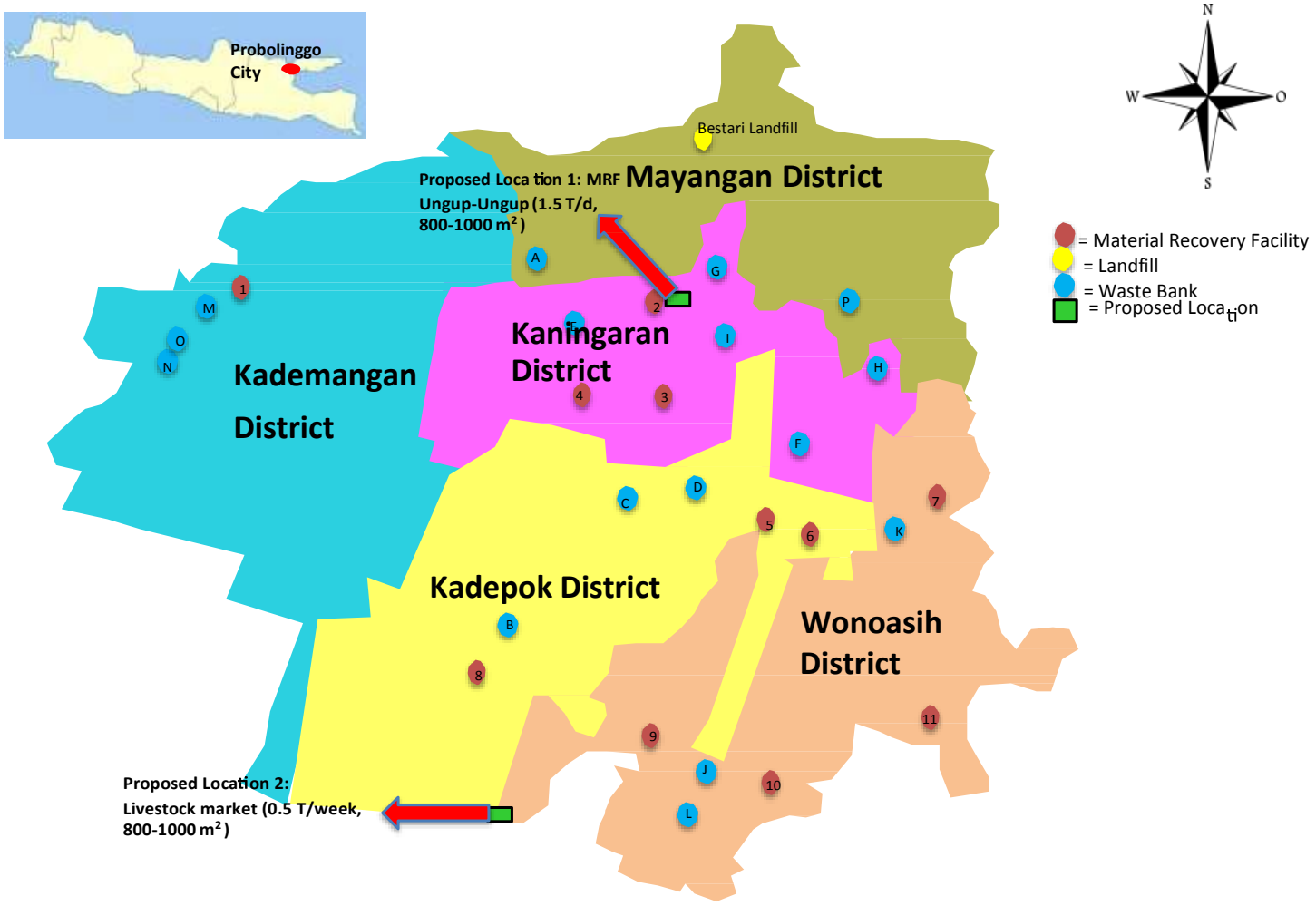

Figure 8 Proposed sites for waste-to-energy pilot in Probolinggo City

Normally, the waste from Baru traditional market reaches 0.5 ton/day. Windrow composting system is applied at this facility with the compost production per month reaches around 2.5 ton. The residues from composting process and the non-compostable waste were sent to Bestari Landfill that located 2 km away from Ungup-ungup.

Figure 9 Integrated MRF Ungup-Ungup

The average energy consumption around this facility, which mostly used by the household, is normally 900 watt/household or in total equal to 117.3 kWh per month (3.91 kWh/day). Since Ungup-ungup is surrounded by the middle to high-income settlements so the potential end user of waste-to-energy plant would be the surrounding houses and also the facility itself. The possibility of energy consumption might be used for cooking purposes since the surrounded households have already connected to the electricity.

Figure 10 Proposed site for waste-to-energy pilot (located at the back of this composting hall)

The proposed site for the plant at this facility is located at the back of this integrated MRF. It has an area of 800 – 1000 m^2. The distance from the site to the waste generation points is around 50 m to 2 km, which includes Baru traditional market and the green area around the city. Integrated MRF Ungup-ungup is surrounded by settlements in 50 – 100 m distances, whereas Baru traditional market in 1 km distances, and Kronong traditional market in 2 km distances. Within this Kanigaran district, there is animal breeding with the total number of dairy cows around 6, beef cattle reach 660, goats approximately 1425, and sheep around 505.

In general, this integrated MRF in location 1 has not been optimally operated since the waste treated at this facility is considerably low and has not yet reached half of the maximum designed capacity. In the case of transporting the waste, the distance from the generation points to the plant, in deed, would not be a problem. However, the operational costs still need to be considered when implementing the waste-to-energy plant at Ungup-ungup.

Location 2: Livestock market (Symbiocity)

The second proposed site is located at the south part of the Probolinggo City. This region is categorized as less developed area and has recentlybecome the main focus of the regional development. The development area named Symbiocity, located 3 to 4 km from integrated MRF Ungup-Ungup, where the settlement for low-income households and its facility will be constructed around this area. Thus, the local government has proposed the waste-to-energy plant at this area, which potentially demands high energy in the future.

In front of the livestock market, there is a small scale-composting house, which had started operation few months before the visit undertaken in March 2015. At that point, the organic waste input of 0.5 ton/week from the livestock market was composted at this composting house. However, the organic waste generated from the livestock market is very low. This is because the market only operates 2 times in a week.

Figure 11 Potential location nearby the Animal Livestock

Other possibilities of waste input to be treated at this location are the mixed waste generated from Wonoasih traditional market and the surrounding settlements. Waste generated from Wonoasih market and the surrounding settlement reach around 1.5 ton/day in total. Animal breeding also found within Wonoasih district with the total number of dairy cows reach 15, cows around 3042, goats 1445, and sheep approximately 703. Waste composition data at this facility is not available to be estimated so the portion of meat and fish waste in the livestock market could not be identified. Nevertheless, it can be assured, the main activity at this market is only animal trading and no other activities generating meat waste such as slaughtering or further processing the meat.

Once in a week, the organic waste includes animal manure, is collected to the temporary collection point at this market. Then it is delivered to the composting house using handcart. Windrow system is applied to process the organic waste at this small composting house. Only the compostable waste is transported to the composting house while the non-compostable waste is stored at the temporary collection point. This non-compostable waste is transported and disposed later to the landfill by dump truck that serving this area.

Currently, the potential end users at this location would be the livestock market and the nearby households. At the livestock market, the energy consumption might be used mainly for lighting. Meanwhile, at the households the energy consumption might be more varies since low-income settlements will be developed nearby. Energy consumption at households could be used for lighting purposes, cooking purposes, or even both. Normally, the energy consumption at the household reaches approximately 900 watt/household or in total equal to 117,3 kWh (3,91 kWh/day). However, the energy demand in the future would be increased along with the development within this area.

The proposed location is located in front of the composting house with the total area provided around 800 – 1000 m^2. The distance from livestock market, as the main waste generation point, to the proposed waste-to-energy site is only 100 m. This site is located 1 km away from Wonoasih market and settlements, which are the other potential waste input to the plant. Meanwhile, the distance from the site to Bestari Landfill is approximately 3 – 5 km.

Since this composting house is a new facility, thus, huge improvements are needed to optimize the operation. Increasing the waste input, establishing a proper management, developing the well-constructed facility and other supporting facilities are one of the main aspects to be reinforced and improved in order to operate the facility optimally and properly.

Observation and Conclusions

Based on the above findings, both proposed locations, have very low existing organic waste input, which is less than 2 ton/day. Although the other waste input is included to be process at the plant, the requirements for the organic waste source for the pilot still could not be fulfilled. One of the important keys for the pilot is the sustainability of the feedstock. Thus, the feedstock supply should be readily available in sufficient amount around the site, in which those parameters could not be satisfied by both proposed locations. This fulfillment is very crucial and considered as the key parameter that is compulsory to be satisfied.

In addition, the traditional markets in Probolinggo City do not have additional large area nearby for the proposed location. Therefore, the proposed potential sites for waste-to-energy plant in Probolinggo City are located outside the waste sources and would definitely need to transport the feedstock to the plant.

In terms of the site for the plant, both proposed locations have fulfilled the total area needed for the plant. Meanwhile, the proposed site in Location 1 is located approximately maximum 2 km from the waste source. This means, the waste transportation is needed. At the second proposed location, the main waste source generation is located nearby but the other waste input, which is necessary to be added to the plant, is located 1 km away. In conclusion, waste transportation is needed at both proposed locations and this will result in higher addition costs for operational.

Another parameter to be considered is the utilization of the energy produced from the plant to the surroundings area. One of the main important considerations for this is whether the potential end user is available nearby and how far they are located. Since the distribution of the energy produced to the consumer located far from the plant would result in high investment cost.

However, it needs to be emphasized that the energy produced would be principally used to support the waste-to-energy facility before it is distributed to the surrounding consumer. Related to the potential end users, location 1 has relatively near distances to the surrounding settlements, which makes them the potential end users. Although most of the settlements are already connected with the electricity but the energy consumption for cooking purposes could be of interest to nearby settlements.

In the second proposed location, the potential end users are the livestock market. As the new settlements will be developed nearby, thus there is a possibility of high-energy demand in the future. Consequently, the settlements are also the potential end users. Moreover, the energy consumption at the new settlements will has more variant, such as gas, electricity, or even both.

As a result, the energy demand in the second proposed location is higher compare to the first proposed location. It is due to the development of low-income settlements at the surrounding location 2.

Based on several considerations that previously explained, consequently, the proposed locations have not sufficiently met the criteria, mainly due to the relatively low availability of source segregated organic waste in proximity to the locations. The considerations are based on the parameters given by UN ESCAP and Waste Concern that mainly comprise of organic waste feedstock, location of the proposed site for the plant, energy consumption at the surrounding area, and the potential end user.

Furthermore, UN ESCAP's representatives visited the proposed sites during a fact-finding mission in March 2015. After UN ESCAP 's representat ives have completed the mission, it was concluded that the proposed locations were not sufficiently meet the requirement for the waste-to-energy pilot. Above conclusions confirm the assessment made by ESCAP's representatives when they visited the location in March 2015.

3. Marketing of biogas and assessment of indicators for financial-economic analysis

The SWI team also collected information related to the biogas and assessment of indicators for financial-economic analysis. For the price of land in Probolinggo city, it is found that the price of land in the near TPST Ungup-ungup is 800,000 IDR/m^2 and the price of land in the area of animal market in Wonoasih is 700,000 IDR/m^2.

A trip of waste dump truck that goes from the temporary collection point to the landfill consumes around 0.375 l/km. The distance to the landfill from the city center is 1.5 km. In Probolinggo City the price of diesel fuel is 6,900 IDR per liter and the price of low-octane fuel (premium) is 7,400 IDR per liter. Nowadays the price of fuel in the market is 140,000 IDR per LPG gas cylinders for the capacity of 12 kg and 16,000 IDR per LPG gas cylinders for the capacity of 3kg.

The government plans to increase the electricity tariff as per May 2015, as it is stated in the Ministry Regulation of Ministry of Energy and Mineral Resources of Republic Indonesia (ESDM) no.9 year 2015 about the changes of Regulation no. 31 Year 2014 about electricity tariff, which is served by the State Electricity Company (PLN). The decision of adjusting the basic electricity tariff refers to the Indonesian Crude Price/ICP, conversion of rupiah to US$ and the inflation rate. There is no increase for household with 450 and 950 VA.

As for the drinking water, the price of costumer is different by the type of costumers. For example the government institutions in Probolinggo City is charged by the State Drinking Water Company (PDAM), worth of 2,500 IDR/m^3 of water, for maximum of 10 m^3 water.

Recommendations

1. In general, the city of Probolinggo has a well-organized collection, transportation and disposal system. However, the waste management system needs to be optimized, particularly in maximizing the function of the waste treatment facility (MRF and Waste Bank), in order to reduce the waste transported and disposed to the landfill.

2. The city of Probolinggo is a compact city with 220,274 inhabitants in 56,600 km^2. This city is considered as a small city which influences the waste generation rate, including the proportion of organic waste, as the main feedstock for the waste-to-energy pilot. The designed waste-to-energy pilot plant requires minimum 2 ton of organic waste per day. In reality, Probolinggo generates less than the minimum requirement of organic waste at each potential waste source. As a conclusion, the UCLG ASPAC and UN ESCAP have decided not to further analyze the proposed locations.

3. For general improvement of waste management system in the city Probolinggo it is recommended to develop the centralized waste treatment facility that includes the combined technology of aerobic and anaerobic treatment. This could be done through optimizing or upgrading the capacity of the existing facility (MRF Ungup-ungup or MRF UPT PSL). Nevertheless, a comprehensive assessment needs to be conducted before implementing this centralized facility.

4. Based on rapid field observation in the city, the small-scale anaerobic food digestion in Bestari landfill is potentially to be up scaled and applied at the sources such as hotel, restaurant, hospital, canteen, etc. In addition, the mapping of potential sources should be provided.

5. Ratio of the waste management expenditure to the Regional Government Budget is 0.41%. It is equivalent to 3,227,000,000 IDR from the total regional expenditure that is worth 783,247,077,917.92 IDR. In order to improve waste management in the city, the government needs to increase the budget allocation for waste management. The city projection for direct expenditure in the year 2015 is 7,485,478,000 IDR. Currently, the ratio of the revenue to the waste management expenditure in the local Environmental Agency is 4.08%, which is relatively low.

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ANNEX

1. Cost of Electricity

Adjustment of Electricity Tariff

No.	Cost Category	Energy Limit	Regular		Pre-Paid (IDR/kWh)
			Costs (IDR/kVA/Month)	Usage Cost (IDR/kWh) and Cost kVArh (IDR/kVArh)	
1	R-1/TR	450 VA	11.000,00	415,00	415,00
2	R-1/TR	900 VA	20.000,00	605,00	605,00
3	R-1/TR	1.300 VA	*)	1.352,00	1.352,00
4	R-1/TR	2.200 VA	*)	1.352,00	1.352,00
5	R-2/TR	3.500 VA - 5.500 VA	*)	1.426,58	1.426,58
6	R-3/TR	> 6.600 VA	*)	1.426,58	1.426,58
7	B-2/TR	3.500 VA - 200 kVA	*)	1.426,58	
8	B-3/TM	> 200 kVA	**)	WBP Block = K x 1.027,16	
				LWBP Block = 1.027,16	
				kVArh = 1.105,47 ****)	
9	I-3/TM	> 200 kVA	**)	WBP Block = K x 1.027,16	
				LWBP Block = 1.027,16	
				kVArh = 1.105,47 ****)	
10	I-4/TT	> 30.000 kVA	***)	Block WBP dan LWBP Block = 965,00	
				kVArh = 965,00	
11	P-1/TR	6.600 VA - 200 kVA	*)	1.426,58	1.426,58
12	P-2/TM	> 200 kVA	**)	WBP Block = K x 1.027,16	
				LWBP Block = 1.027,16	
				kVArh = 1.105,47 ****)	
13	P-3/TR		*)	1.426,58	1.426,58
14	L/TR, TM, TT			1.501,46	

Source: www.pln.co.id

Note:

*) Minimum Account (RM) is applied.
RM 1 = 40 (hours used) x Installed Capacity (kVA) x Consumption Fee
**) Minimum Account (RM) is applied.
RM 2 = 40 (hours used) x Installed Capacity (kVA) x LWBP Consumption Fee.
Hours used : Monthly kWh divided by installed kVA
***) Minimum Account (RM) is applied.
RM 2 = 40 (hours used) x Installed Capacity (kVA) x WBP and LWBP Consumption Fee.
Hours used : Monthly kWh divided by installed kVA
****) Overused hour (kVArh) fee is charged in event where monthly average power is less than 0,85
K: Comparative factor between WBP and LWBP is in accordance to the local characteristic of electricity load ($1,4 \leq K \leq 2$), which is appointed by the Board of Director of State Electricity Company
WBP : Peak Hour
LWBP : Non peak hour

2. Costs of Water Consumption

No	Costumer Group	Consumption	Tariff		Increase	
		Progresive	Old tariff	New tariff	Nominal	Percent
1	2	3	4		5	
I	Social					
	a.Public	>20	1,040	1,300	260	25%
	b.Specific	0-10	1,040	1,300	260	25%
		21-30	1,600	2,000	400	25%
		>30	2,560	3,200	640	25%
II	Non Business					
	a. Household A	0-10	1,600	2,000	400	25%
		11-20	1,680	2,100	420	25%
		21-30	2,240	2,800	560	25%
		>30	2,880	3,600	720	25%
	b.Household B	0-10	1,600	2,100	500	31%
		11-20	1,760	2,200	440	25%
		21-30	2,800	3,500	700	25%
		>30	3,360	4,200	840	25%
	c.Institution	0-10	2,000	2,500	500	25%
		11-20	2,400	3,000	600	25%
		21-30	3,600	4,500	900	25%
		>30	4,400	5,500	1,100	25%
III	Business					
	a.Small Business	0-20	3,200	4,000	800	25%
		21-30	4,000	5,000	1,000	25%
		>30	4,800	6,000	1,240	25%
	b.large Business	0-20	4,000	5,000	1,640	25%
		21-30	4,800	6,000	1,200	25%
		>30	6,000	7,500	1,500	25%
IV	Industries					
	a.Small Industries	0-20	4,240	5,300	1060	25%
		21-30	4,960	6,200	1,240	25%
		>30	6,560	8,200	1,640	25%
	b.Large Industries	0-20	4,800	6,000	1,200	25%
		21-30	6,720	8,400	1,680	25%
		>30	8,800	11,000	2,200	25%

Source: PDAM probolinggo city