

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



Member of Indonesia Solid Waste Association

**Dini Tr**

*Dre*

Gedung IS Plaza, 5<sup>th</sup> Floor – Room 504  
JL Pramuka Raya Kav 150, Jakarta Timur 13120  
T: +62 21 29613933 F: +62 21 29613981  
[swi@sw-indo.com](mailto:swi@sw-indo.com), [www.sw-indo.com](http://www.sw-indo.com)

Hp : 0817867032  
Email : [dtrisyanti@sustainablewaste.co.id](mailto:dtrisyanti@sustainablewaste.co.id)  
Website : [sustainablewaste.co.id](http://sustainablewaste.co.id)

## Table of Contents

|  |           |
|--|-----------|
| <b>List of Abbreviation</b> .....  | <b>i</b>  |
| <b>Introduction</b> .....  | <b>ii</b> |
| <b>Part I – Context and Background</b> .....   | <b>1</b>  |
| 1.1 City Profile.....  | 1         |
| 1.2 Municipal Waste Collection Method .....  | 3         |
| 1.3 Formal Waste Collection: Organizational Waste Collection: Organizational<br>and Structure .....                      | 5         |
| 1.4 Waste Collection Tools .....   | 6         |
| 1.5 Waste Treatment Facilities .....   | 7         |
| 1.6 Existing Waste Separation Practices and 3R Initiatives.....  | 8         |
| 1.7 Final Disposal and Informal Sectors.....   | 11        |
| 1.8 Institutional Capacity and Key Policies, Law and Regulation at the<br>City/Provinces on Solid Waste Management ..... | 12        |
| <b>Part II – Empirical survey to support the development of<br/>        the waste-to-energy pilot</b> .....              | <b>14</b> |
| 2. Identification of the proposed locations of organic waste source and waste-<br>to energy plant in the city.....       | 14        |
| 3. Marketing of biogas and assessment of indicators for financial-economic<br>analysis.....                              | 22        |
| <b>Recommendation</b> .....  | <b>23</b> |
| <b>List of References</b>  |           |
| <b>ANNEX</b>   |           |

# List of Abbreviations

---

APBD = Regional Government Budget

BLH = Environmental Agency

DKP = Sanitation and Landscaping Agency

km = Kilometer

kWh = kilowatt-Hour

Ha = Hectare

m = Meter

RW = Community Group

TPA = Final Processing Site

TPS 3R = Material Recovery Facility

UCLG – ASPAC = United Cities and Local Government Asia Pacific

UN ESCAP = United Nations Economic and Social Commission for Asia and the Pacific

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 Malang 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 Malang City was conducted in February 16<sup>th</sup> 2015. In between a member of SWI field assistant was staying until February 20<sup>th</sup> 2015. A Fact Finding Mission by the representatives from UN ESCAP, UCLG ASPAC, and Waste Concern was conducted in March 5-6<sup>th</sup> 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 the feasible location that meets the criteria set forth by UN-ESCAP and Waste Concern. These requirements are designed to ensure the plant would operate optimally and sustainably when implemented.

Basically, baseline survey aims to identify and characterize the sources of organic waste and the potential locations for waste-to-energy plant. Both, the organic waste sources and potential locations for the plant have been proposed by the local government. 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 2-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 the waste generation rate, 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 were 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 did not require further analysis.

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 consists of identification of empirical survey to support the development of 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 produce 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 Malang City

### 1.1 City Profile

Malang City is the second largest city in East Java. The city is located 90 km away from Surabaya, the largest city in East Java. Malang City is well known as the city of education and the city of flowers. It lies between 112°06' – 112°07' East longitude and 7,06" - 8,02" South latitude, 440 – 667 m above sea level, and surrounded by mountains. The border city is District Karangploso and Singosari on the north part, District Dau and Wagir at the west part, District Pakis Haji and Tajinan on the South part and District Pakis and Tumpang at the east part.

Administratively the city is divided in to 5 parts, those are West Malang, North Malang, Central Malang, Southeast Malang, Northeast Malang and East Malang. Total number of population in Malang City is 862,335 inhabitants with 110.06 km<sup>2</sup> area which is distributed unevenly (Adipura 2014). The population density is ranging from 5,070 persons/km<sup>2</sup> at the lowest in East Malang City and 13,932 persons/km<sup>2</sup> at the highest in Central Malang (Master Plan Malang City, 2013).

The economic activities in Malang City consist of agriculture, processing industries, construction, trading, restaurant, hotel, transportation, warehousing, communication, mining, electricity, gas, water, finance and service.

Malang 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 of waste management during the respective year.

The city of Malang generates around 640 tons of waste per day. From this amount nearly 77% goes in to the landfill, whereas among it 9% goes to composting facilities, 0.5% goes to Recycle Bank, 14% goes to recycling activities outside the Recycle Bank, and the rest left untreated (Adipura Book, 2014)

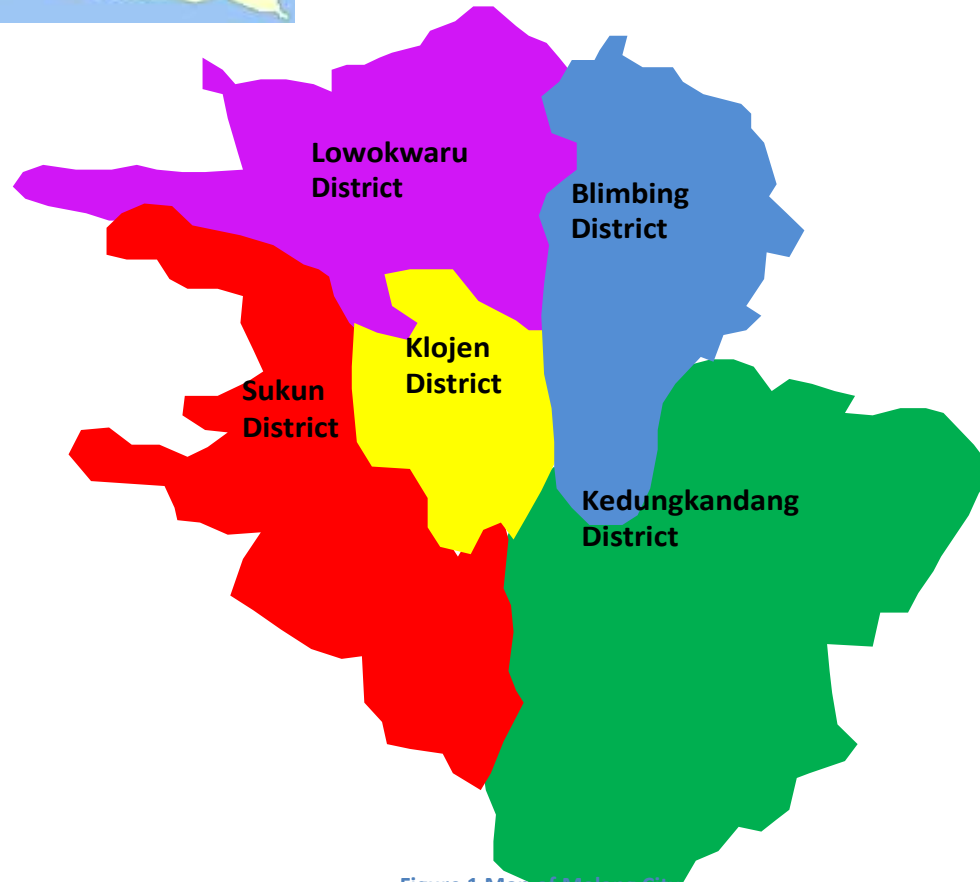
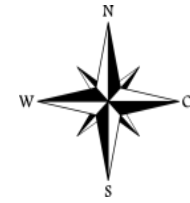


Figure 1 Map of Malang City

## Local Authority's Budget Allocation for waste management

In Malang City, the local authority who involve in the waste management related activities are mainly the Environmental Agency or *Badan Lingkungan Hidup* (BLH) and the Sanitation and Landscaping Agency or *Dinas Kebersihan dan Pertamanan* (DKP).

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 is direct expenditure for waste management development program. This items include waste management improvement program such as tools and operational infrastructures, waste management workshops through vermin-composting, concrete roads building in the Supit Urang landfill, maintenance of Manyar composting plant, rehabilitation and conventional temporary collection improvement, the improvement of community involvement program, waste bins and conventional handcart improvement, operational improvement and maintenance of supporting tools and equipment, improvement of the waste retribution services, and public campaign for waste management.

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 0.61% or equivalent to 10,347,498,463 IDR from the total regional expenditure that is worth 1,685,899,881,608.06 IDR. In detail, the amount of 330,016,063 IDR was allocated for BLH and 10,017,017,482.400 IDR was allocated for DKP. Please refer to Table 1 for the proportion ratio of direct expenditure for waste management to the total city expenditure in APBD.

Table 1. Local Authority's Budget Allocation for waste management in Malang City

| City/ Regency | Institution  | Budget Allocation For Waste Management Program 2014 (Rp) | Proportion To Regional Expenditure |
|---------------|--|--|------------------------------------|
| Malang City   | 1. Environmental Agency                                  | 330,016,063.00   | 0.61 %                             |
|               | 2. City Cleansing Agency (Sanitation, Gardening, Agency) | 10,017,482,400.00  |                                    |
|               | Total Expenditure  | 10,347,498,463.00  |                                    |
|               | Total Regional Expenditure                               | 1,685,899,881,609.06                                     |                                    |

## 1.2 Municipal Waste Collection Method

### Waste bin

There are different types of waste storage in Malang City and they are set-up based on housing settlement, commercial and public places purposes. At the housing



settlement, the community has their own individual waste bins from rubber and located in each houses. However there are also various types of waste storages such as plastic bags and sacks. For such storages, normally the communities provide their own plastics or waste sacks.

At the commercial area (market, shopping centers/stores, hotel, restaurant, theater), the waste is first stored in the plastic bags or directly brought to the communal waste bins. The Sanitation and Landscaping Agency (DKP) places one waste container in the market and purposed for market waste from the respective market.

At the shopping center/stores and industries the waste bins made from metal are preserved along the streets/roads. It is the same like at the offices building, but the waste bins are made from rubber.

In all cases in Malang City, no waste separation at source occurs except for the industrial waste and hospital waste. The waste in the industrial building is separated in to recyclables and non-recyclables. Another waste separation at source occurs at the hospital or other health facilities. Here the waste is separated in to medical and non-medical waste in different plastic bags.

### Collection

In general the waste collection activities are running with individual pattern. The waste at the housing settlements is picked-up door-to-door using handcart (capacity of 1 m<sup>3</sup>) and then brought in to the nearest temporary collection point with a maximums distance of 1000 m. The *pasukan kuning* or yellow troops, a well-known name of the Sanitation and Landscaping Agency employees who are responsible for the field of waste collection, normally they work from 5 AM in the mornings until 12 AM during the days. They collected the waste from household every day or every 2-days. The yellow troops also collect the waste from streets, and parks. Their schedules are divided in to 3 street sweeping shifts (early morning, day, and night).

According the city mayor regulation number 373 year 2012, the community is permitted to deliver their waste to the temporary collection point around 6.00 to 12.00. Outside of the hour, no waste is permitted to enter the facility.

In the industrial building, the non-recyclable waste will go then to the nearest temporary collection points, which is served for the waste that is coming from the respective industries. Meanwhile the recyclable waste is getting into the waste recyclable chain.

### Transfer Station

The local authority places 2 types of container in the temporary collection point or transfer station that is one big container (capacity of 8m<sup>3</sup>) and small container (capacity of 4-5 m<sup>3</sup>). The small containers are distributed within districts and sub-districts. All the collected waste from schools, offices building, parks and streets at the temporary collection points will be brought to the Supit Urang landfill by the Sanitation and Landscaping Agency, except for the medical waste from the hospital.

The waste is transferred with dump truck and arm roll truck, whereas the medical waste is treated in the hospital's incineration (capacity of 400 kg).

### **1.3 Formal Waste Collection: Organization and Structure**

Institutionally, the waste management related activities in Malang City are the responsibility of the Sanitation and Landscaping Agency. Figure 2 shows the organizational structures in the body of Malang City Cleansing Agency. The agency has 712 yellow troops and distributed with the 6 divisions in Malang City.

The head Agency who is supported by the Secretariat leads the Sanitation and Landscaping Agency. The Head of Agency supervises 4 sectors and those are Cleanliness Sector, Street Lighting and City Decoration Sector, Park Sector and Cemetery Sector. Each head sector supervises 2-3 sections. For example the Cleanliness sector is supervising Cleanliness and Retribution Section, Collection Section and Operational Transportation Maintenance Sections. Another sample, the Park Sector supervises the Garden and City Forest Section. Also the head agency supervises 3 Local technical Implementation Unit (UPTD).

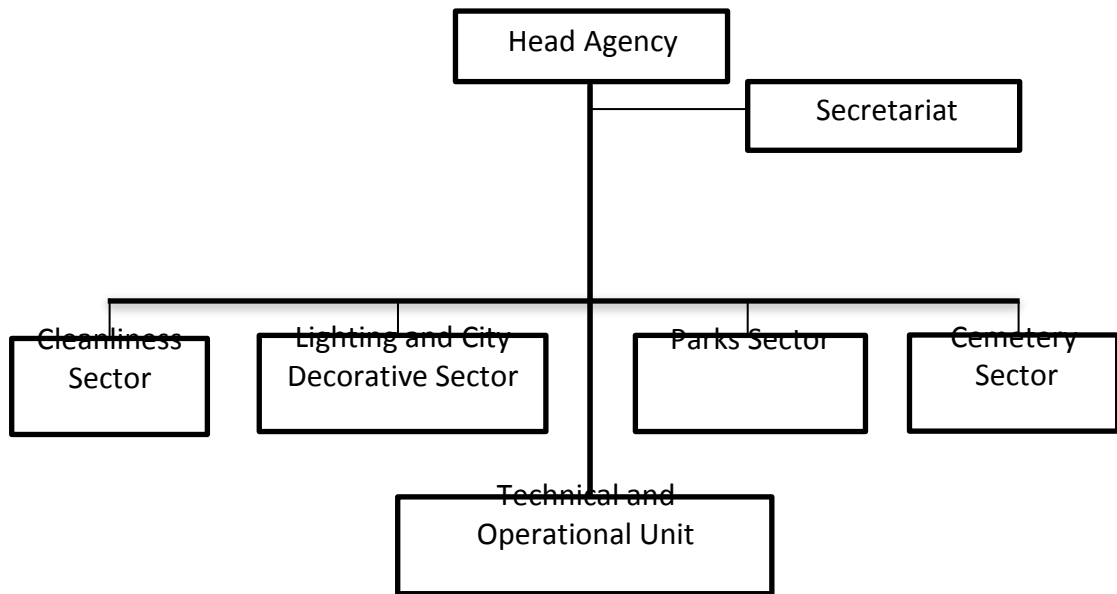


Figure 2 Organizational Structures of City Sanitation and Gardening Agency in Malang City

#### 1.4 Waste Collection Tools

The city uses conventional handcart and motorcycle handcart for the waste collection at source whereas dump truck and arm roll trucks are used for waste transfer from the collection points in to the landfill.

At the housing settlement level, the waste collection system in Malang City relies to a large extent on the use of a conventional handcart. Therefore the city has a large number of conventional handcarts, with an average capacity of 1 m<sup>3</sup>. At the housing settlement, waste is collected one to two times per day, whereas motorcycle handcarts collect waste 2-3 times a day.

In Malang City, the communal waste collection is done by a community-based organization at the household association level since year 1998. The City Mayor Regulation initiated this. The waste collection at the household level is in averaged done for 2 times a day. For this service, based on the household association agreement, the waste fee is between 5,000 to 15,000 IDR per month.

Malang City government has 1 compactor truck, 28 dump trucks and 18 arm roll trucks. Except for the compactor trucks, these trucks transport the waste form the city in average 1 to 5 times a day in to Supit Urang Landfill. Table 2 shows the waste collection infrastructure that is owned by the municipality.

**Table 1 waste collection vehicles owned by the municipality**

| No. | Infrastructure        | Total (Unit) | Capacity Per Unit (m <sup>3</sup> ) | Collection Frequency per day |
|-----|-----------------------|--------------|-------------------------------------|------------------------------|
| 1   | Conventional handcart | 1.993        | 1                                   | 1 – 2                        |
| 2   | Motorcycle Handcart   | 32           | 1                                   | 2 – 3                        |
| 3   | Compactor Truck       | 1            | 34                                  | 1                            |
| 4   | <i>Dump truck</i>     | 28           | 8                                   | 2 – 4                        |
| 5   | <i>Arm roll</i>       | 18           | 8.30                                | 2 – 5                        |

There is only one landfill in Malang City, the Supit Urang Landfill. The current waste municipal solid waste management system in the city shows that most of the waste is directed to this landfill. With the number of waste collection vehicles shown by Table 2, the municipal solid waste management service coverage in Malang City has reached 93% or equal to 107 km<sup>2</sup> (Adipura Book 2014).

## 1.5 Waste Treatment Facilities

### Waste Bank

Malang City is famous for its Bank Sampah Central. Malang city has been a pioneer and is a role model in Indonesia with regards to the implementation and operation of waste banks. There is only one Waste Bank in Malang City because the city owns the principle of centralized Waste Bank. In

2012, this waste Bank won a CSR funding from the State Electricity Company worth of 280,000,000 IDR.

Waste Bank in Malang City is one of the largest waste banks in Indonesia and it has been in operation since November 2011. This Waste Bank treats around 3.5 tons of non- organic waste and 0.6 ton organic waste per day. Only 2% of the incoming waste is transferred in to the landfill from this facility (Adipura Book 2014). This central Waste Bank has 24,000 members. It is located in Sukun District. With the number of employee reach 50 persons, this Waste bank earns revenue about 250,000,000 to 300,000,000 IDR per month. The average profit is 40,000,000 to 50,000,000 IDR per month. Please see table 3 for more detailed information.

**Table 2 Waste Bank in Malang City**

| <b>Name of Plant</b>            | <b>Capacity (ton/day)</b> | <b>Operational details</b>   |
|---------------------------------|---------------------------|--|
| <b>Bank Sampah Induk Malang</b> | 3.5                       | <ul style="list-style-type: none"> <li>• Located in Sukun sub-district, Sukun District.</li> <li>• Treated around 3.5 tons of non-organic waste and 0.6 ton of organic waste per day)</li> <li>• Has 24.000 members (consist of schools, waste collectors, CBO, Institutions and individuals).</li> <li>• Incoming revenue ~ 250 - 300 Mio IDR/month</li> <li>• Profit : ± 40 – 50 mio IDR/month</li> <li>• Number of employees is 50</li> </ul> |

### **Composting Facilities**

The city has more than 10 material recovery facilities (TPS 3R). Among them, one is located in Supit Urang landfill. The waste treatment capacity of each TPS is various, ranging from 1 to 5 ton of waste per day but mainly applied the same composting system, i.e the windrow method. In total these composting facilities treats around 90 tons of organic waste per day. The table 4 shows the list of the facility that mainly conducts the composting activities, as appeared on Figure 3.

**Table 3 Material Recovery Facility (TPS 3R)**

| <b>No</b> | <b>MRF</b>           | <b>Capacity (Ton/day)</b> |
|-----------|----------------------|---------------------------|
| 1         | Tlogomas             | 4                         |
| 2         | Brawijaya University | 5                         |
| 3         | Jatimulyo            | 2                         |
| 4         | Polowijen            | 1                         |
| 5         | Ariosari             | 2                         |
| 6         | Narotama             | 2                         |
| 7         | Pandanwangi          | 2                         |
| 8         | Malabar              | 4                         |
| 9         | Asahan               | 2                         |
| 10        | Sawojajar            | 2                         |
| 11        | Velodrome            | 4                         |
| 12        | Supiturang           | 5                         |
| 13        | Kebun bibit          | 3                         |
| 14        | Gadang               | 5                         |

### **1.6 Existing Waste Separation Practices and 3R Initiatives**

Although waste separation at source is mainly conducted a the industrial level and hospitals, some schools, offices building and housing settlements. Some of these have started their own composting activities using simple technology such as the Takakura

method and the composter drum. Then, the compost is usually used for parks/garden in the surroundings.

In general, the city members do not yet holistically practice waste separation activities. Currently such activities are conducted at the community level. Therefore the number of such activity and its product is considerably small.

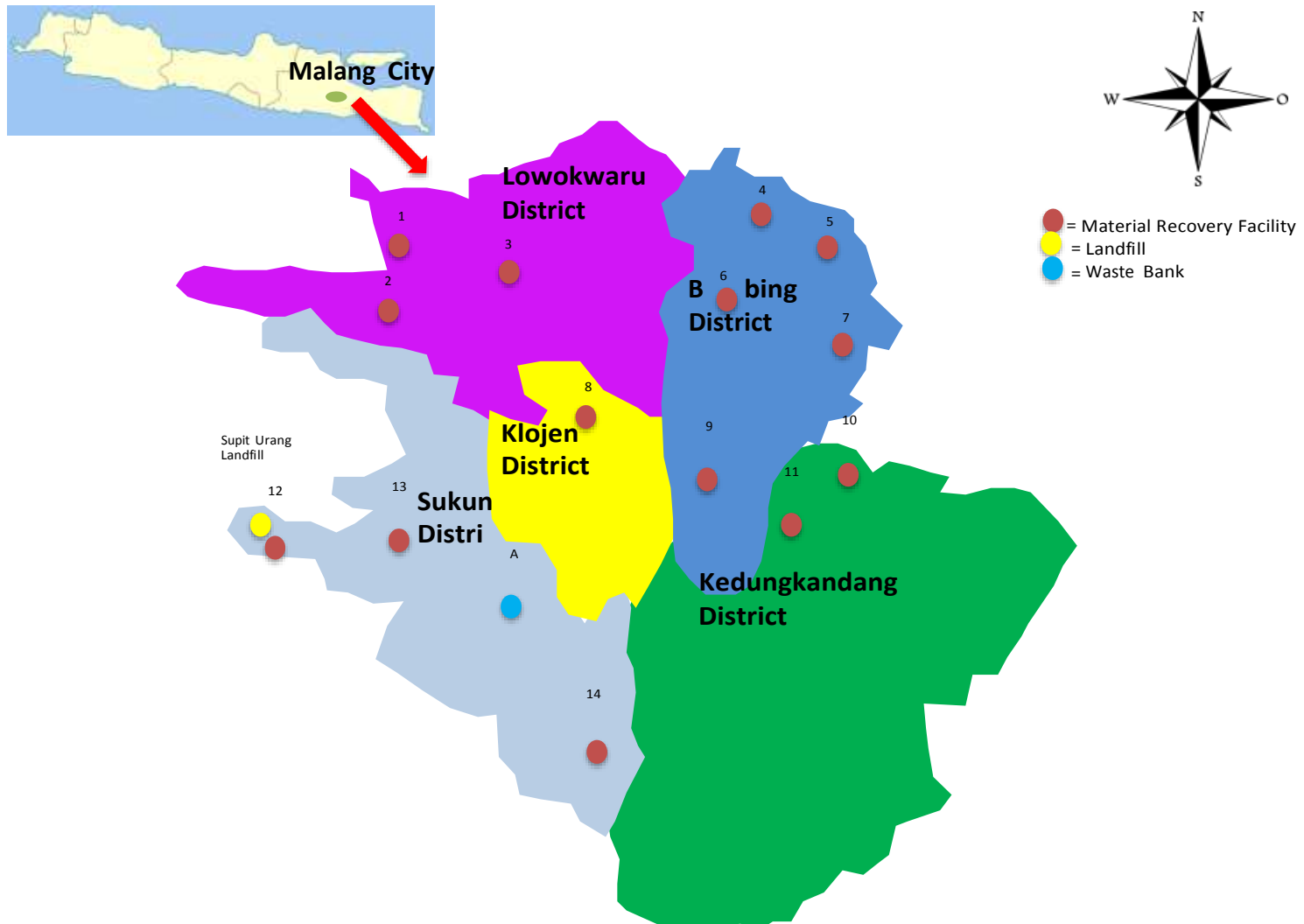


Figure 3 Location of waste treatment facility in Malang City

## 1.7 Final Disposal and Informal Sector

Since 1998, TPA Supit Urang applied the sanitary landfill system (Adipura Book 2014). This landfill can be used until year 2042. So far about 50% of the land is already used. At the moment the landfill depth is reaching an average depth of 24 m. The distance of the landfill to the nearest settlement is 0.7 km and to the farthest location is 30 km. Meanwhile the distance of the landfill to the nearest river/water body is 0.05 km. This landfill receives around 420 ton of waste per day. Please refer to table 5 for waste disposal characteristic at TPA Supit Urang.

Table 4 Final Disposal Characteristics

|   |          |
|---|----------|
| 1. Projected Landfill Area/ Existing Landfill Area      | 31.25 h  |
| a. Used area for landfill (December 2014)               | 15.2 ha  |
| b. Available area for landfill                          | 16.05 ha |
| 3. Distance from the landfill to the river/water body   | 0.05 km  |
| 4. Distance from the landfill to the nearest settlement | 0.7 km   |

Source: Adipura Book 2014-2015

As the Malang City is well organized with its system of centralized waste banks. The informal activities that are related to waste management are unfeasible in this city. The scavenger works out of the Waste Bank boundary. However, although Waste Bank in Malang City is the biggest in Indonesia, but still the biggest informal recycling activities in the city are done outside the Waste Bank System. The main actors of this recycling are industries that use waste as raw materials, home industries, plastic grinder industries, waste collectors (lapak) and the scavenger. Together these actors recycled around 90 tons of non-organic waste per day.

Scavengers are found at the Supit Urang Landfill. This people are registered at the official landfill management. They work from morning to the afternoon. Before the landfill gas utilization was installed and made operational, these scavengers are normally going home during the lunchtime to have lunch and coffee. But since the gas utilization is implemented, they don't need to go home during this time as they can cook their hot water at the landfill site.

The waste pickers at the transfer station separate the waste into recyclable and non-recyclables. These recyclables are then sold to a third party in the city and from this they earn around 1,000,000 per week. Mostly the recyclables are plastics and paper.

### Biogas

Apart from its central waste bank, Malang City is also known for its biogas utilization from the landfill. In average, the Supit Urang landfill generates 118,234m<sup>3</sup> gas per year. However, the landfill officer never measures the amount of gas production. Therefore, no reliable data related to the amount of gas produced is available.

Currently, there are about 400 gas connections linked to the community housing in the surrounding landfill. The gas produced from the landfill is utilized by the community for cooking purposes. In addition, the gas utilization is free of charge but



the community pays 10,000 IDR for each household per month, which is used for the gas piping maintenance cost.

Some of the collected information during the field visit was that in 2012 there were

300 house-connections for gas utilization in the surrounding settlements near Supit Urang. At that time, the methane used for these communities was around 0.708 m<sup>3</sup> per capita per day with gas flow rate reached approximately 44.22 m<sup>3</sup>/hour.

## 1.8 Institutional Capacity and Key Policies, Law and Regulation at the City/Provinces on Solid Waste Management

There are several regulations, which play role as key policies in Malang City. Among them some regulation in the forms of Local Regulations or *Peraturan Daerah* emphasizes about the sewerage and wastewater treatment and waste management in the city, public service and business retribution related to waste management, operational and technical issues at the landfill, and also about the scheduling for waste collection at the temporary collection points. The regulations related to waste management in Malang City are listed in Table 6 as follows.

Table 5 Institutional Capacity and Key Policies

| No. | Legal Form   | Documents Number and Dates | About   |
|-----|--|----------------------------|---|
| 1   | Malang City Local Reg. or Perda Kota Malang                | Number 1 Year 2008         | Sewerage and wastewater Treatment   |
| 2   | Malang City Local Reg. or Perda Kota Malang                | Number 10 Year 2010        | Waste Management  |
| 3   | Malang City Local Reg. or Perda Kota Malang                | Number 1 Year 2011         | Public Service Retribution  |
| 4   | Malang City Local Reg. or Perda Kota Malang                | Number 2 Year 2011         | Business Service Retribution  |
| 5   | Malang City Mayor Regulation or Peraturann Walikota Malang | 38 Tahun 2011              | Operational and Technical - Landfill  |
| 6   | Malang City Mayor Decision or Keputusan Walikota Malang    | 373 Tahun 2002             | Schedule for Incoming/picking waste at the conventional temporary collection point. |

The government enacted the main regulation for waste management in Indonesia by launching Indonesian Regulation no.18 year 2008. In addition to that the government also launched the Indonesian Act no. 81 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 Malang City, the local authority adds the support by launching local regulation no. 10 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 involved 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 10.

## **Observations and Conclusions**

As the city model for waste management in Indonesia, the Malang city owns a well-performed municipal solid waste system, especially at the Bank Sampah Induk or Central Waste Bank. The city applies MRF and Waste Bank system, and controlled landfill as one system to solid waste treatment. Another strongest value from the waste management in the city is the landfill gas utilization for the surrounding neighborhood. This should be a good sample to be replicated in other cities.

# 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<sup>2</sup>.

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<sup>2</sup>
- 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

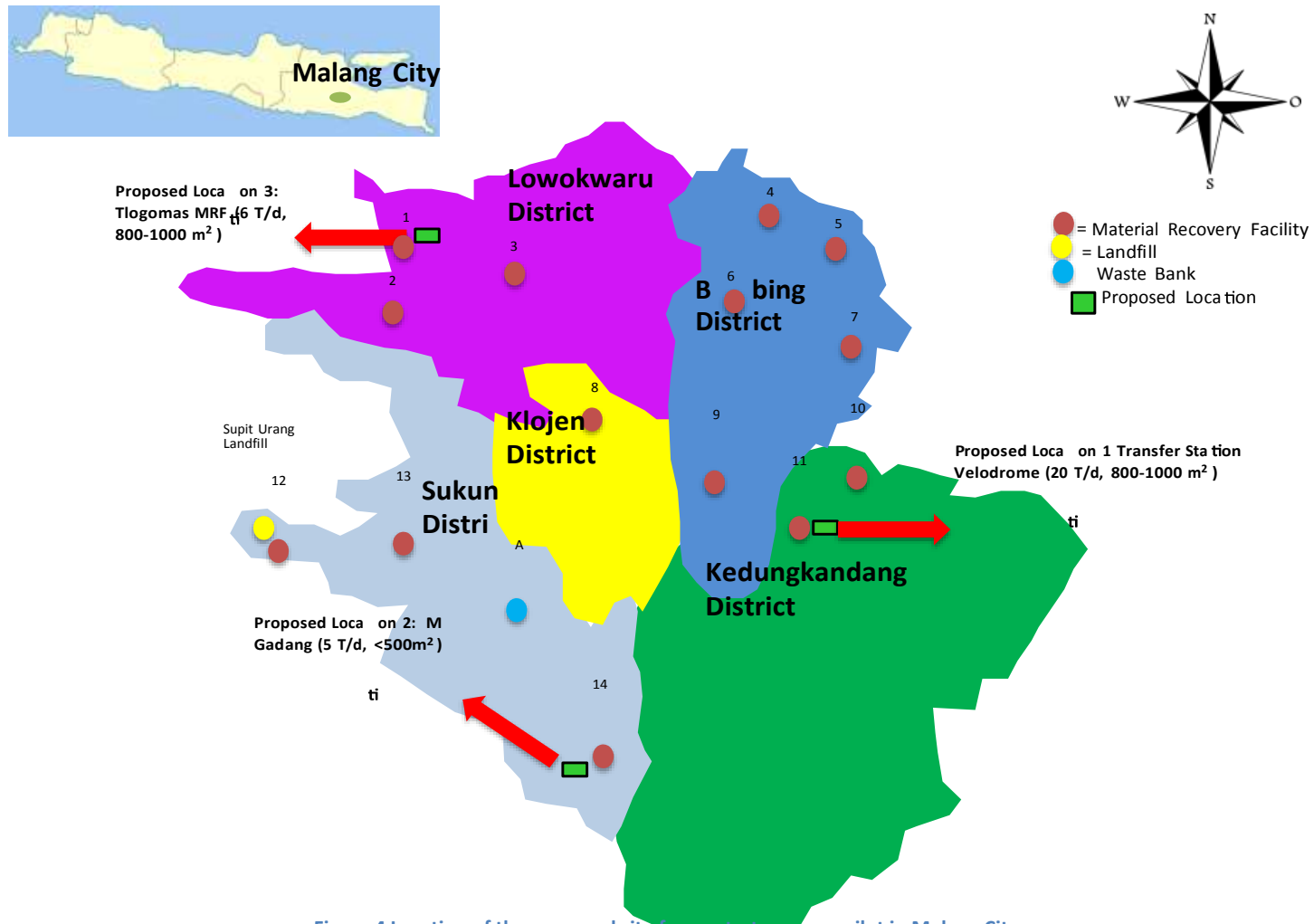
According to the given criteria, the team has conducted a survey to identify and characterize the potential locations proposed by the local government that could be

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

**Table 7 Proposed locations of organic waste source and waste to energy plant**

| No  | Parameter   | Location 1   | Location 2                              | Location 3                              |
|---|---|--|---|---|
| 1   | Potential Location for Waste to Energy Plant                            | Transfer Station - Velodrome                               | MRF - Gadang                            | MRF Tlogomas                            |
| 2   | Total waste collected (ton/day)   | 20   | 5                                       | 6                                       |
|   | Organic waste (ton/day)   | 13   | 3.25                                    | 3.9                                     |
| 3   | Other possibility of waste input (ton/day):                             | n/a  | Slaughterhouse =1 ton/day               | n/a                                     |
| 4   | Availability large portion of meat and fish waste                       | n/a  | n/a                                     | n/a                                     |
| 5   | Waste management:   |  |   |   |
|   | a. Waste collection   | Human Handcart 1 m <sup>3</sup>                            | Human Handcart 1 m <sup>3</sup>         | Human Handcart 1 m <sup>3</sup>         |
|   | b. Waste transportation   | Dump truck 8 m <sup>3</sup>                                | Dump truck 8 m <sup>3</sup>             | Dump truck 8 m <sup>3</sup>             |
|   | c. Waste disposal   | Residues transported to Landfill                           | Non compostable transported to Landfill | Non compostable transported to Landfill |
| 6   | Waste condition (segregated or mixed)                                   | mixed  | mixed                                   | mixed                                   |
| 7   | Energy consumed at the site   | 10,900 Watt (nearby market)                                | n/a                                     | n/a                                     |
| <b>Proposed Location for Waste-to Energy Plant:</b> |   |  |   |   |
| 1   | Waste to Energy proposed location:                                      |  |   |   |
|   | a. Area   | 800 - 1000 m <sup>2</sup>                                  | < 500 m <sup>2</sup>                    | 800 - 1000 m <sup>2</sup>               |
|   | b. Land Status  | owned by the local government                              | owned by the local government           | owned by the local government           |
|   | c. Location   | In front of the transfer station                           | On site the MRF Gadang                  | In front of the MRF Tlogomas            |
| 2   | Distance from waste generation points (km)                              | 15 - 200 m   | 20 m                                    | 50 m                                    |
| 3   | Distance of households/markets from the plant (also within 1 km radius) | Traditional market = 15 m                                  | Slaughterhouse = 500 m                  | Settlements = 50 m                      |
|   |   | Settlements = 200 - 300 m (middle - high income household) | Household = 20 m                        |   |
| 4   | Distance to access road   | 50 - 100 m   | 5 - 10 meter                            | 10 meter                                |

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



### Location 1: Transfer Station - Velodrome

The first proposed location is a Transfer Station, named “Velodrome” that serves the nearest traditional market “Madyopuro”, one office unit, two schools, and four residential in Gedung Kandang District. This district has 44,000 inhabitants. In Madyopuro market, there are 627 traders/166 stalls. They sell many different products, such as groceries, vegetables/fruits, etc.

The waste is collected from the source and separated at this facility. Then, the waste is compressed and transported to the landfill. Total waste collected reaches 20 ton/day in mixed condition while the organic waste is estimated around 13 ton/day. However, the data of waste composition at this transfer station is not available so the portion of meat and fish waste could not be identified.

At this facility, waste separation activity is conducted by the waste pickers with the average income per week approximately Rp 1,000,000.00. The separation activity is to segregate between recyclable and non-recyclable waste. The recyclable waste is usually sold to the recycling industries or other related stakeholders. Composting hall also available in this facility but the composting activity has not been practiced yet. Until now, the organic waste is compressed and transported to the landfill together along with any other residues.

The waste collection system applies at the source is door-to-door collection system. It uses human handcart of 1 m<sup>3</sup>. After waste separation and compression, the residues and non-recyclable waste is transported using dump truck capacity of 8 m<sup>3</sup> to Supit Urang Landfill.

The average energy consumption at Madyopuro market reached approximately 10,900 kWh, which could be one of the potential end user besides the waste-to-energy plant itself. The surrounding settlements are categorized as middle to high-income households and most of them are connected to the electricity network. Thus, the potential end users are Madyopuro market and the transfer station. The energy consumption at the market is used for lighting purposes while the energy consumption in the transfer station used to operate a compression machine.

The proposed site for the plant at this facility is located in front of the transfer station with a total area of 800 – 1000 m<sup>2</sup>. The distance from the waste source to the site is around 15 – 200 m. Madyopuro market is located approximately 15 m from the site. Approximately at 200 – 300 m distance, the middle to high-income households are found.

However, the proposed site is a green space full of trees (forest) with sturdy/large roots. So, some difficulties might arise when constructing the anaerobic digester that is usually designed for being placed underground. In this case, destroying green open space should be minimized. Also, the proposed site is considered as the green area in the city so its main purpose

should not be substituted with other functions, assuming that other locations are still available within the city.



Figure 5 Velodrome Transfer Station

### Location 2: MRF Gadang

In Malang city, the local government also proposed a site located at a material recovery facility site named Gadang that serves the surrounding settlements. At this MRF, the total waste coming in to the facility reaches 5 ton/day of mixed waste that consists of 3.25 ton/day organic waste. However, the data of waste composition at this MRF is not available so the portion of meat and fish waste could not be identified. In addition, MRF Gadang is located around 500 m to a slaughterhouse, which generates 1 ton/day of animal manure and could be the potential feedstock to the plant.

The waste management system applied at the source is similar to Velodrome transfer station. At the source, the waste is collected from door to door using handcart and delivered to this MRF. Then, the waste is separated at MRF Gadang into compostable waste and non-compostable waste. At this facility, the organic waste is composted with windrow system. After segregation the non-compostable waste and residues are transported to Supit Urang Landfill. A dump truck with the capacity of 8 m<sup>3</sup> collects and transports the waste to the landfill site

At MRF Gadang, there is quite small area of less than 500 m<sup>2</sup> and this area has been proposed by the local government to be the waste-to-energy plant. The distance from this proposed site to the closest waste generation point is pf only 20m. This is a middle-income area. Thus, the energy demand at the surrounding area might be relatively low since most of the settlements are already connected to the electricity. The energy consumption for cooking purpose might attract the nearby settlements. However the plant could replace the electricity that is already being supplied to these residents by PLN.



In addition, the proposed site used to be a landfill site. Therefore, it is very risky to locate and construct the waste-to-energy plant at an old landfill site. Since this could potentially endangered the nearby environment, particularly the unexpected explosion that might occur at the old landfill. Also, the anaerobic digesters that normally designed underground could potentially cause hazards when digging the old landfill during the construction. High amount of harmful gases might come out when digging the landfill. Therefore, it is recommended not to considering this site as the proposed location for the waste-to-energy pilot.



Figure 6 MRF Gadang

### Location 3: MRF Tlogomas

Similar to the second proposed site in Malang City, the third location also an MRF, named Tlogomas that serves the surrounding settlements. Total waste collected at the source that gets in to this MRF is 6 ton/day of mixed waste. It comprises of organic waste around 3.9 ton/day. However, the data of waste composition at this MRF is not available so the portion of meat and fish waste could not be identified.

The waste management system applied at the waste source is similar to the system applied in MRF Tlogomas. At the source, the waste is collected from door to door using human handcart with capacity of 1 m<sup>3</sup> and delivered to the MRF. At this MRF, the waste is separated in to compostable and non-compostable waste. Only organic waste is processed through composting using windrow system. Meanwhile the non-compostable waste is transported to Supit Urang Landfill by dump truck capacity of 8 m<sup>3</sup>, together with the residues from this MRF.

At this location, the proposed site for the plant is located in front of the MRF. This site is surrounded by middle-income settlements so the main potential end users are the nearby households. However, those settlements already have connection with the electricity even though the energy consumption for cooking purposes might still attract the surrounding households. Also, the



settlement in this area is scattered and not too populous. The surrounding energy demand is relatively low, since there is no other potential end user, apart from the settlements.

On the occasion of the field visit in March, the Local Government Authorities representatives did not take the ESCAP/UCLG/WC teams to location 3, which would have been an important aspect for considering it as one of the strongest candidates to host the pilot.



Figure 7 MRF Tlogomas

### Observations and Conclusions

Based on the above findings, the proposed locations partly meet the criteria of ESCAP and Waste Concern for selecting the site due to the large availability of organic waste quantities in location 1. However the site that is proposed for the waste-to-energy plant, could not satisfy the appropriate design of the anaerobic digestion due to several important reasons as previously mentioned. This is, particularly the case for the proposed location 1 and 2. Location 1 has the land utilization issues. It will be changed if the plant is constructed in here. On the contrary, this greening space should be preserved so the function should remain. Meanwhile, the main issue in the proposed location 2 is the fact that this site is an old landfill site. Thus, many hazards that possibly endanger the nearby environment might on risks. Thus, it is highly not recommended to consider this site as the feasible location for the waste-to-energy pilot.

Another parameter to be considered is the utilization of the produced energy from the plant to the surroundings area. It needs to be emphasized that the energy produced would be principally utilized to support the waste-to-energy facility before it is distributed to the surrounding consumer.

Related to the potential end users, most of the proposed locations are generally have the same potential end users. Since all of the proposed sites are surrounded by the settlements, it makes the nearby households become the potential end users of the energy that would be generated by the plant. However, other potential end users at the first proposed location are available which includes the Madyopuro market and the transfer station.

Generally, most of the settlements are the middle to high-income households and most of them are already connected with the electricity. However, the energy consumption for cooking purposes might attract the nearby settlements. Also, the surrounding households are not considered to be highly populous. Thus, the energy demand is relatively low, particularly in the third proposed location.

The surveyed locations offer some potential to host a waste-to-energy pilot, however they “score” modestly on some of the key criteria set by ESCAP and Waste Concern. The main issue with all of them is difficulties in ensuring demand for the energy produced by the plant. Two of the sites are also not ideal for civil construction works, with one of them, location 2, having a small area.

Furthermore, UN ESCAP’s representatives visited the proposed sites location 1 and 2 during fact-finding mission. This mission is related to the organic waste sources and the potential location for waste-to-energy plant. After UN ESCAP’s representatives 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 collects information related to the biogas and assessment of indicators for financial-economic analysis. Unfortunately the team was unable to obtain information on the price of land at the surrounding of SPA Velodrome transfer station, Tlogomas MRF and Gadang MRF.

The fuel consumption of the waste dump truck that goes from the temporary collection point to the landfill is around 0.375 l/km. The distance to the landfill from Gadang MRF is 9 km; from Tlogomas MRF is 12 km; and from SPA Velodrome transfer station is 14 km. In Malang 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 138,000 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 customer is different by the type of customers. For example the government institutions in Malang City is charged by the State Drinking Water Company (PDAM), worth of 4,000/m<sup>3</sup> of water, for maximum of 10 m<sup>3</sup> water. For more than 10 m<sup>3</sup> of water use, the price is 6,200 IDR. Additionally, the minimum charge for regular customer is 26,000 IDR. Please refer to annex 2 for more information.

In 2015, the State Drinking Water Company gives a promotional price to the new water customer. Normally the installation price is 1,250,000 IDR and now it is 550,000 IDR for the new connection.

# Recommendation

---

1. Malang City has already a well-established non-organic waste management system in place. It is proven by the centralized Waste Bank system in Bank Sampah Induk Malang. It is need to be mentioned that such system is necessary to be adapted by other cities in Indonesia. Since the impacts are not only increasing the people's income in Bank Sampah but also improving the informal sector. As further suggestions, we encourage Bank Sampah to have more established management, particularly in terms of waste collection and distribution to the third parties, such as recycling industries.
2. In terms of infrastructure/supporting tools for waste collection, transportation and disposal system, the SWI Team found that Malang City is slightly behind in comparison to other cities in Indonesia. It is shown by, the high proportion of the conventional handcarts compared to motorized handcarts, the absence of the weighing bridge, and the landfill gas measurement. This influences the data quality, which is actually necessary to be analyzed in meeting the designed parameter of the waste-to-energy pilot. The dominance of conventional infrastructure in waste collection and transportation influence the effectivity and efficiency.
3. As a conclusion, the UCLG ASPAC and UN ESCAP have decided not to further be analyzed the proposed locations in Malang City due to the existing conditions of the proposed locations. Based on the team analysis, it is found that the waste characteristics in the proposed location 2 and 3 are not suitable for waste-to-energy pilot that requires high content of organic waste. On the other hand, the proposed location 1 has land utilization issue. This city is already has an excellence sample of non-organic waste management that is potentially to be further developed including its local regulation.
4. For general improvement of the waste management in the city, it is recommended to evaluate and improve the community-based facilities that are already working well in order to optimize the reduction of waste to the landfill. In addition, it is suggested to develop MRF that combines the technology activities, especially anaerobic biological treatment technology that generates electricity at Supit Urang landfill.
5. Ratio of the waste management expenditure to the Regional Government Budget is 0.61%. It is equivalent to 10,347,498,463 IDR from the total regional expenditure that is worth 1,685,899,881,609.06 IDR. In order to improve waste management in the city, the government needs to increase

the budget allocation for waste management. Unfortunately the SWI Team could not obtain the city projection for direct expenditure in the year 2015. Currently, the ratio of the revenue to the waste management expenditure in the Sanitation and Landscaping Agency is 68.86%, which is considerably high.

6. Among other cities and regency surveyed by the team, Malang City has great potential in terms of organic waste generation and consumption, waste management system, institutional capacity, as well as the human resources. This city has many collaboration experiences and has been awarded by different organizations on its achievement in environment cleanliness, such as Adipura Kencana, United Kingdom Royal Appreciation for Waste Insurance Innovation, etc. However the main constraint is the land issues for having the waste facility in proximity to the organic waste sources. In the future, it is valuable to re-consider this city for other implementation projects.

# List of References

---

BAPPEDA Pemerintahan kota Malang.2009.Buku Putih Sanitasi 2009

Pemerintah Kota Malang,2013.Masterplan Kota Malang 2013

Pemerintahan Daerah Kota Malang.2013.Rencana Pembangunan Jangka Menengah Daerah Kota Malang 2013-2018

Pemertintah Kota Malang.2013.Analisis Anggaran Pendapatan dan Belanja Daerah 2013-2014

Walikota Kota Malang.2014.Buku Non Fisik Adipura kota Malang 2014-2015

# ANNEX

## 1. Cost of Electricity Tariff

### 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 = $K \times 1.027,16$<br>LWBP Block = 1.027,16<br>kVArh = 1.105,47 ****) |                    |
| 9   | I-3/TM        | > 200 kVA           | **)                   | WBP Block = $K \times 1.027,16$<br>LWBP Block = 1.027,16<br>kVArh = 1.105,47 ****) |                    |
| 10  | I-4/TT        | > 30.000 kVA        | ***)                  | Block WBP dan LWBP Block = 965,00<br>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 = $K \times 1.027,16$<br>LWBP Block = 1.027,16<br>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.

$RM\ 1 = 40 \text{ (hours used)} \times \text{Installed Capacity (kVA)} \times \text{Consumption Fee}$

\*\*\*) Minimum Account (RM) is applied.

$RM\ 2 = 40 \text{ (hours used)} \times \text{Installed Capacity (kVA)} \times \text{LWBP Consumption Fee.}$

Hours used : Monthly kWh divided by installed kVA

\*\*\*\*) Minimum Account (RM) is applied.

$RM\ 2 = 40 \text{ (hours used)} \times \text{Installed Capacity (kVA)} \times \text{WBP and LWBP Consumption Fee.}$

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





|    |                     |  |         |        |                      |         |        |                      |         |        |  |
|----|---------------------|--|---------|--------|----------------------|---------|--------|----------------------|---------|--------|--|
|    | Business A (IV A)   | 5,900  | 9,000   | 30,000 | 6,200                | 9,900   | 32,000 | 6,500                | 10,400  | 32,000 |  |
|    | Business B (IV B)   | 9,300  | 12,000  | 32,000 | 9,800                | 13,200  | 34,000 | 10,100               | 13,800  | 34,000 |  |
|    | Business C (IV C)   | 10,900   | 14,000  | 35,000 | 11,400               | 15,000  | 37,000 | 11,900               | 16,800  | 37,000 |  |
|    | Commercial D (IV D) | 12,100   | 15,000  | 38,000 | 12,700               | 16,500  | 40,000 | 13,100               | 17,300  | 40,000 |  |
| d. | Industries          |  |         |        |                      |         |        |                      |         |        |  |
|    | Industries A (V A)  | 13,200   | 17,000  | 39,000 | 13,800               | 17,700  | 42,000 | 14,300               | 18,600  | 42,000 |  |
|    | Industries B (V B)  | 14,900   | 19,000  | 42,000 | 15,600               | 21,000  | 45,000 | 45,000               | 22,100  | 45,000 |  |
| 4  | Group IV            |  |         |        |                      |         |        |                      |         |        |  |
| a. | Specific Groups     | drinking water rates will be adjusted by agreement |         |        |                      |         |        |                      |         |        |  |
| b. | Water Tank          | Distance of Services                               |         |        | Distance of Services |         |        | Distance of Services |         |        |  |
|    |                     | 1-10 km  | >10 km  |        | 1-10 km              | >10 km  |        | 1-10 km              | >10 km  |        |  |
|    | Group I             | 95,000   | 140,000 |        | 100,000              | 150,000 |        | 110,000              | 165,000 |        |  |
|    | Group II            | 130,000  | 195,000 |        | 140,000              | 210,000 |        | 150,000              | 225,000 |        |  |
|    | Group III           | 160,000  | 270,000 |        | 170,000              | 290,000 |        | 190,000              | 320,000 |        |  |

Source: Leaflet PDAM Malang city