



Potential of Electric Energy from Organic Waste at TPA Bukit Pinang, Samarinda by Using Gasification Method

Muslimin¹(✉), Tantra Diwa Larasati², Nur Rani Alham¹,
Vicko Ghulam Fathurrohman¹, and Siska Mayra Andini¹

¹ Electrical Engineering Department, Mulawarman University, Jalan Sambaliung No. 9, Samarinda, East Kalimantan, Indonesia

musculi@gmail.com

² Chemical Engineering Department, Mulawarman University, Jalan Sambaliung No. 9, Samarinda, East Kalimantan, Indonesia

Abstract. The energy sector in Indonesia is a problem that the government must consider. Indonesia still relies on fossil energy as the main energy for power generation. However, the use of fossil energy that is carried out continuously will make Indonesia's energy reserves in the future will experience a crisis. So new renewable energy is needed as an alternative to help meet energy needs. The problem of waste that continues to increase in volume of production makes waste a big problem if the government and the community can not manage properly it. Therefore, we need to reduce waste in Samarinda, namely by managing the waste into new renewable energy through the Waste Power Plant (PLTSa). This study aims to determine the potential utilization of organic waste into electricity from the waste that enters the TPA Bukit Pinang Samarinda by using gasification method. From the results of the study, it is known that the percentage of organic waste is 60% with the amount of waste generated at the Bukit Pinang Samarinda TPA in 2021–2037 assuming the annual increase in waste is 3.39%, then the potential for PLTSa using the gasification method of 16.27 MW/year. The electricity produced per KWh will later be sold to PT. PLN of Rp. 1,922,- so that the income from the sale of electrical energy using the gasification method of Rp. 112.619.095.469,4 /year.

Keywords: Organic Waste · Gasification Method · PLTSa and Electrical Energy

1 Introduction

There are various main energy sources, and they are classified into two major groups: conventional energy and non-conventional energy. Santoso stated that conventional energy is non-renewable fossil energy. This is due to its consumption running out faster than its formation [1]. These unlimited energy sources consist of Crude Oil and Coal. Non-conventional energy is a new renewable energy resource that is always available and does not cause pollution [2]. These renewable energy sources include biomass, Sun, Water,

Geothermal, Wind, Tidal, and Nuclear. Indonesia itself has a big electricity challenge. As of March 2017, new EBT power plants had an installed capacity of 8.80 GW, only 2% of Indonesia's EBT potential of 443 GW [3]. In rural areas, they still rely on kerosene and firewood. That boosts biogas and biomass power plants [3].

Waste powered plant (PLTSa) is a power plant that utilizes both organic waste and inorganic waste as the primary material to generate electricity. Mainly, in terms of the mechanism, this generation can be carried out in two ways: thermal conversion technology and sanitary landfill technology (gasification) [4]. Furthermore, the waste power plant is a solution for waste management. Utilization of Biomass in particular, the Government through RUEN aims to build biomass-based power plants and it's expected to reach about 5.500 MW by 2025 and 26.000 MW by 2050, out of a total capacity of around 32,653 MW [5].

In Samarinda, the volume of waste produced every year tends to increase based on the East Kalimantan Province Environmental Office in 2021, the data obtained shows that there has been an increase in waste production in the last five years. The waste in Samarinda are divided into 2 types, they are organic waste and inorganic waste. The utilization of waste is used for electricity needs in Samarinda which can assist the Samarinda city government in dealing with environmental pollution and raising renewable electrical energy from organic waste because sources of electrical energy from petroleum and fossils are explored and consumed every day will gradually run out. While the process of formation takes millions of years, and the waste in Samarinda is increasing daily, so utilizing waste as an energy source from waste power plants can increase the supply of electrical energy and help keep the environment clean.

Based on the explanation above, an analysis was carried out on the potential of organic waste as an energy source for a waste power plant (PLTSA) in Samarinda. Data collection on the potential for waste power plants with organic waste is carried out by calculating the forecast for the average increase of waste in Samarinda from 2021 to 2037 and calculating the amount of power generated from 2021 to 2037 in Samarinda from processing waste as an energy source for power plants.

2 Methods

2.1 Research Location

To start this research, it is necessary to determine the place or location where the research will be carried out. The research location and data collection will be conducted at the Bukit Pinang TPA, Bukit Pinang, Samarinda Ulu, Samarinda City, East Kalimantan 75131.

2.2 Research Procedures

The problem to be raised in this research occurs according to PP No. 79 of 2014 concerning the National Energy Policy, the target for renewable energy by 2025 is at least 23% and 31% by 2050. Then the waste problem tends to increase every year. Based on the data collection results from the Environmental office in Samarinda for TPA for 2021 waste data in Samarinda is shown in Table 1.

Table 1. The Data of Waste Volume [5]

No	Year	Waste Volume (Ton)
1	2016	305.818,73
2	2017	250.611,11
3	2018	219.456,96
4	2019	222.992,00
5	2020	227.199,70

2.3 Data Analysis

From this research, the data analysis could be done by qualitative analysis. Qualitative analysis is for calculating the waste heap at TPA, which could be used for the resource of the waste-powered plant, calculating the power generated by a waste power plant, and calculating a profit from the energy sales. Some of the calculations that will be carried out include the following:

1. Calculating the Average Addition of Organic Waste

The forecast of the amount of waste is an estimate of the amount of waste in the coming year regarding the addition of the amount of waste in the previous year using the geometric sales method [4]:

$$\text{difference (\%)} = \frac{Ta - Tb}{Ta} \times 100\% \quad (3.1)$$

where:

Ta = the amount of waste in the first year

Tb = the amount of waste in the next year

Calculate the forecasting of waste volume by 2022 to 2037, using the formula:

$$Tb = Ta + (Ta \times r) \quad (3.2)$$

where:

Ta = The amount of waste in early year

r = The average of increasing waste (%)

2. Calculating Energy Utilization Potential with Gasification Technology

The calculation of energy recovery potential can be known through the following approach [6]:

The total amount of waste = W ton.

The total amount of waste per day = W.

$$W = \frac{\text{The Total of Waste Forecast}}{\text{Number of years} \times 365} \quad (3.3)$$

Total of Organic/Volatile Solids = TO %

Unreveled Organic Fraction (FO), around 66% of total organic,

$$\text{Then FO} = 66\% \times \text{TO}\% \times W \quad (3.4)$$

a. Calculating Biogas Produced

This system produced 95% natural gas contains methane (CH₄) from the purification process [6]:

The best results obtained from the purification process to produce methane gas contained in the biogas produced by the anaerobic digester is around 50% to 70%.

$$= \text{methane levels in biogas} \times 0,95 \times \text{Produced of Biogas} \quad (3.5)$$

b. Calculating Annual Energy Potential (kWh) [6]

$$\text{Energy potential per year (kWh)} = \text{Energy recovery potential} \times 365 \quad (3.6)$$

c. Calculating Potential Electrical Energy (kWh)

The amount of *electrical conversion efficiency* for each technology used for generating equipment can be seen in Table 2.

The potential of electric energy (kWh) [6]:

$$\text{The potential of electric energy (kWh)} = \text{The conversion of efficiency} \times \text{energy potential} \quad (3.7)$$

3. Calculating Incomes

The data from electric energy of PLTSA can be used to calculate the income generated through the following equation [4]:

$$\text{income} = w \times \text{Price} \quad (3.8)$$

where:

Tabel 2. Electrical Conversion Efficiency [3]

Technology	Preferred Plant Size (MW)	Electrical Conversion Efficiency (%)
Internal Combustion Engines/Gas Engines Generator Set	0,8–3	30–40
Gas Turbine Generator Set	>3	20–28
Microturbines Generator Set	0,03–0,25	25–50

W = The electric energy (kWh).

Price = 1 kWh of Rp 1.922. The data obtained from presidential regulation No. 35 of 2018 in article 11 which regulates the purchase price of electricity by PT. PLN as stated in article 10 paragraph (3) letter (b) is determined to be sold to PT. PLN with conditions of USD 13.35 cents/kwh and with an exchange rate of 1 USD = IDR 14.400⁷.

3 Result and Discussion

This section presents and discusses in detail the results obtained from the gasification method and the income obtained by assuming the price of electricity per kWh. Based on the data collection results from the Environmental office in Samarinda for TPA Bukit Pinang Samarinda. It can show in Fig. 1, that organic waste has the biggest percentage of all. The composition of organic waste is 60% from the amount of waste volume. Organic waste is often processed into energy sources, especially electricity.

Figure 2 shows the waste volume increasing yearly, and in 2037 the organic waste can reach 240.000 Tons.

The total amount of waste per day from the formula in 3.3 is 851.527 Tons/year. The result from decomposed organic fraction is 337.210 Tons. The total of biogas Produce is along 161.860 m³. Potential of electrical energy per year = 58.594,743 MWh/year. Potential Power generated by PLTSa per year = 16,276 MW/year. Therefore, the income obtained by assuming the price of electricity per kWh is Rp. 1,922 with a total profit from 2021 to 2037 using gasification method is Rp. 112.619.095.469 per year from energy sales.

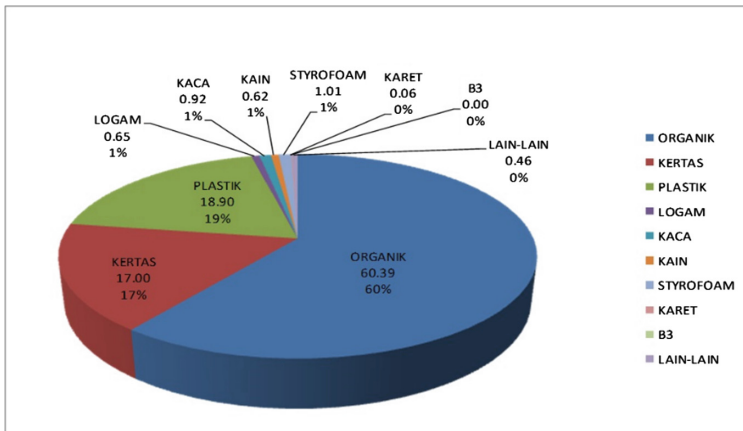


Fig. 1. Waste composition in Samarinda

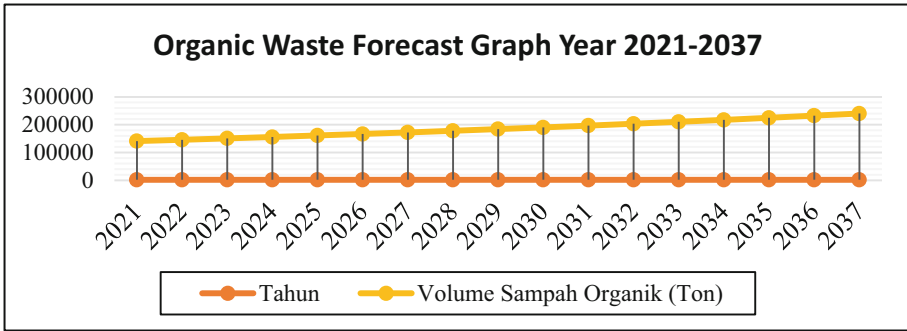


Fig. 2. Organic waste forecast

4 Conclusions

The research results obtained that the total volume of waste at TPA Bukit Pinang from 2021 to 2037 is 5.283.725,53 tons, the amount of organic waste is 60% of the total waste volume, so the amount of organic waste from 2021 to 2037 is 3.170.235,32 tons, the potential for waste in Samarinda that can be used as an energy source for waste power plants (PLTSa) is around 186,484,431 tons per year. The potential for electrical energy generated from processing organic waste at TPA Bukit Pinang Samarinda using the gasification method from 2021 to 2037 is 16,276 MW/year, along with a profit of Rp. 112.619.095.469 per year from energy sales. So it can be concluded that organic waste in Samarinda has the potential to be a source of energy for a waste power plant (PLTSa).

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