**International Journal of Electrical, Energy and Power System Engineering (IJEEPSE)**
**e-ISSN: 2654-4644**
**Vol. 4, No. 3, pp. 196-199, October 2021**
**Accredited by KEMENRISTEKBRIN, No. 200/M/KPT/2020**
**http://www.ijeepse.ejournal.unri.ac.id**

# Study on the Potential of Waste in Pangkalpinang as Fuel of Power Generation

Nada Fitsa Alfazumi
*Dept. of Electrical Engineering*
Universitas Bangka Belitung
Pangkalpinang, Indonesia
nadafitsalfazumi@gmail.com

Wahri Sunanda
*Dept. of Electrical Engineering*
Universitas Bangka Belitung
Pangkalpinang, Indonesia
wahrisunanda@ubb.ac.id

Welly Yandi*
*Dept. of Electrical Engineering*
Universitas Bangka Belitung
Pangkalpinang, Indonesia
wellyyandi@ubb.ac.id

**Corresponding author: welly yandi, wellyyandi@ubb.ac.id*

***Abstract— The Waste Power Plant is one of the power plants with a new renewable energy concept that utilizes waste as fuel. The processing of waste into electrical energy is carried out in two ways: the thermal conversion process and the biological conversion process to find the potential for waste that can be used as fuel to generate electricity. The analysis is needed, especially for Pangkalpinang, which currently has a lotof unprocessed waste. This research was conducted through calculations using several formulas that have been used in previous studies. From these results, the potential waste in 2015 is 97.25 tons/day and produces energy of 18548.10 MWh/year, and in 2020, it was about 186.57 tons/day and produced energy of 35547.18 MWh/year. The projection calculations are carried out to determine the potential for 2021 to 2030. Waste as much as 182523 tons/day in 2021 can produce energy of as much as 34776.11 MWh/year. And in 2030, the amountof waste as much as 218132 tons/day can generate an energy potential of 41560.69 MWh/year.***

***Keywords—electrical energy, power plant, waste, output power***

## I. INTRODUCTION

Indonesia is one of the developing countries with waste problems that often arise. This waste problem never stops because of the increase in the amount of waste and the volume of waste accompanied by population growth and residential areas[1]. The increasing demand for electrical energy and human growth and development encourages the government to provide a good electricity supply to meet the electricity needs of every citizen. This provision requires a power plant that can be used to generate electricity.

Many power plants have been established in Indonesia with different primary fuels, but most of them still use fossil fuels. Meanwhile, fossil fuels are non-renewable natural resources, and their reserves in the earth's bowels are running low. For this reason, it is necessary to have alternative renewable energy sources that can reduce dependence on the use of fossil fuels. There are already several power plants that utilize alternative renewable energy sources as a source of energy fuel that can reduce reliance on fossil fuels. One example of this energy comes from waste.

So far, waste has always been a problem, especially in urban areas. The amount of waste produced every day is increasing. However, some of the Final Disposal Sites have received less attention from the local government in some areas. One of them is the Province of the Bangka Belitung Islands, which has several Final Disposal Sites (TPA) scattered in every district/city, one of which is in Pangkalpinang City. Pangkalpinang is located in the eastern part of Bangka Island, one of the autonomous regions and the capital of the Province of the Bangka Belitung Islands. In Bangka Belitung, a waste power plant has been established, precisely on Pulau Tinggi, South Bangka Regency.

Based on data sourced from the Environmental Service of Pangkalpinang city, the waste generated in Pangkalpinang in 2015 was 295.01 m/day. In 2016 it was 343.7 $m^3$/day, in 2017 of 398 m/day; in 2018, it was 420 m/day. In 2019, it was 499 m/day, respectively. In 2020 it was 565.37 m/day[2]. This increasing amount of waste is accompanied by an increase in Population. This is because the city of Pangkalpinang is a city that is undergoing development into a big city with all the facilities it has.

Pangkalpinang City has an amount of waste that continues to increase every year without proper processing. The increasing number of residents in the city of Pangkalpinang causes the amount of waste production to increase. This massive amount of waste, if it does not treat properly, will result in environmental pollution. Many ways can reduce the amount and volume of waste in landfills, one of which is processing by using waste as fuel in a power plant.

Therefore, the waste can generate electrical energy, a more detailed calculation of the potential generated is needed[3]. With the research and analysis on the possibility of waste in Pangkalpinang city as a fuel for power plants, it is hoped that it can be an illustration in Pangkalpinang that a waste power plant is established[4].

## II. RESEARCH METHOD

### *A. Time and Place*

This research was conducted at the Environmental Service of Pangkalpinang City, Bangka Belitung Islands Province for ten days.

*Received: Sept 27, 2021 | Revised: Oct 24, 2021 | Accepted: Oct 31, 2021*

### B. *Research Implementation Method*

The method of carrying out the research was carried out qualitatively by conducting interviews for data collection. The analysis begins with a literature study, namely searching for literature studies and supporting references related to the topics discussed. Then, collecting information and data so that it can be used as a reference in writing. It analyzes the calculation of output power and electrical energy and forecasts the output power for 2021-2030.

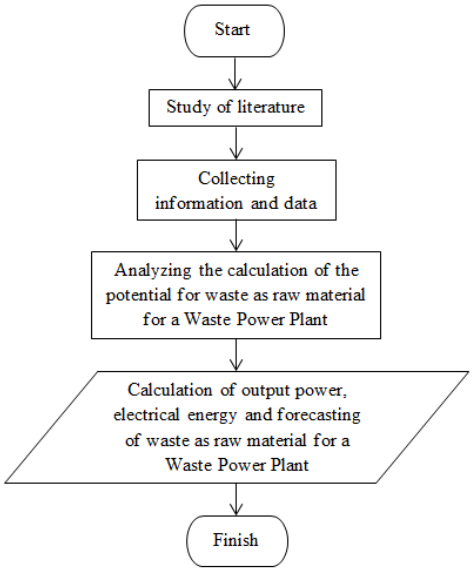


**Fig. 1** Flowchart

The explanation of the steps in processing data and analyzing data in Figure 1 about flow chart of research procedures are as follows;

1. Perform data processing of the amount and volume of waste generated to obtain the potential power and electrical energy generated from the waste power plant.

   The explanation of this point is that data processing is carried out using several equations. The first equation determines the number of calories produced per day by multiplying the volume of waste by the calorific value of the waste. The second equation determines the energy per day by multiplying the number of calories by 0.00116 kWh/day[5]. Furthermore, the third equation is used to find the thermal waste that enters the boiler by dividing the amount of energy by the number of hours per day. The boiler's output power is the result of multiplying the waste's thermal capacity by the boiler efficiency of 80%[6].

   Furthermore, the next step is to find the turbine's output power by multiplying the boiler's output power with a turbine efficiency of 25% then, the next step is To find the generator's output power by multiplying the turbine output power by the generator efficiency of 90%[7]. Then, to calculate the electrical energy produced, the generator's output power is multiplied by 24 hours to find the daily power, multiplied by 365 to get the power for the year[8].

2. Calculate the forecast population and the amount of waste consumed to determine the waste, output power, and electrical energy generated between 2021 and 2030.

   The method used to determine this forecasting uses the equation of the geometric method from the Central Statistics Agency [9].

3. Calculate the potential output power and electrical energy generated from waste power plants for 2021-2030.

   The amount of waste, output power, and electrical energy generated for this projection is calculated following the steps described in point 1.

4. Calculating the potential income from the purchase of electricity from the Waste Power Plant by PLN

   This potential income is calculated by multiplying the electrical energy produced by the electricity price of Rp. 1450/kWh for a waste power plant connected to a medium voltage network and multiplied by Rp. 1798/kWh for a waste power plant connected to a low-voltage network[10].

## III. RESEARCH RESULTS AND DISCUSSION

### A. *Field Observation and Initial Data Collection*

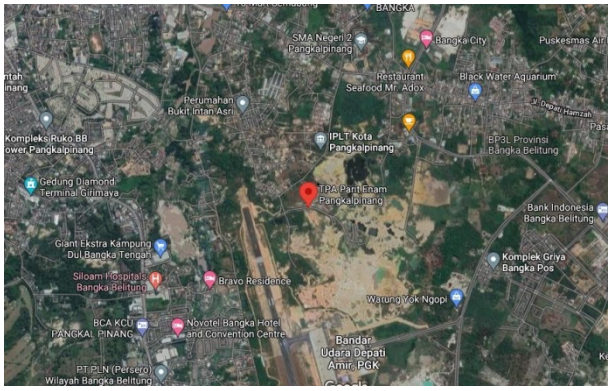


**Fig. 2** Pangkalpinang Trench Six Final Disposal Site Maps (Google Maps, 2021)

Figure 2 shows the location of the Trench Six Pangkalpinang Final Disposal Site (TPA). This location is precisely in Bacang Village, Bukit Intan District, Pangkalpinang City, Bangka Belitung Islands. Bukit Intan District is one of seven sub-districts in Pangkalpinang.

The data obtained and used in this study are data from the Department of the Environment, the Central Bureau of Statistics of the City of Pangkalpinang, and the Generation Implementation Unit (UPK) of Bangka Belitung.

This data is then processed to generate the output power and electrical energy using existing equations or formulas. Electrical power and energy calculation is carried out for 2015-2020 and for its potential in 2021-2030. For this reason, a population projection calculation is carried out to get the total Population in 2021-2030. Based on the results of the population projections obtained, measures can be made to determine the volume and pile of waste generated.

Then calculations are also carried out to obtain the output power and electrical energy generated for the next ten years. The output power and electrical energy analysis results will be multiplied by the purchase price of electricity from municipal waste-based power plants by the Regulation of the Minister of Energy and Mineral Resources of the Republic of Indonesia.

*Received: Sept 27, 2021 | Revised: Oct 24, 2021 | Accepted: Oct 31, 2021*

### B. *Calculation of Output Power and Electrical Energy Produced in 2015-2020*

In 2015, the amount of waste produced was 97.35 tons/day or 97.350 kg/day, assuming a calorific value of 2500 kcal/kg. Calculation of the number of calories is done by multiplying the amount of waste by the calorific value. After the number of calories is obtained, calculate the amount of energy by multiplying the number of calories by 0.00116 kWh/kcal so that the result is 282315 kWh/day.

Furthermore, the result of energy is divided by 24. The result is the amount of thermal waste that enters the boiler—then calculated the output power of the boiler, turbine, and generator. The boiler output power is obtained by multiplying the result of the amount of thermal waste that enters the boiler with a boiler efficiency of 80%, and the result is 9410.5 kW. Then to produce the turbine output power, multiplying the output power of the boiler with a turbine efficiency of 25% so that the results are 2352.625 kW.

The generator output power is obtained by multiplying the turbine output power with a generator efficiency of 90% so that the output power is 2117.624 kW. Based on the output power got, it can be said that for the year 2015 for 1 ton of waste can produce a power of 21.75 kW. The calculation of electrical energy produced is 50816.7 kWh/day or 18548.10 MWh/year.

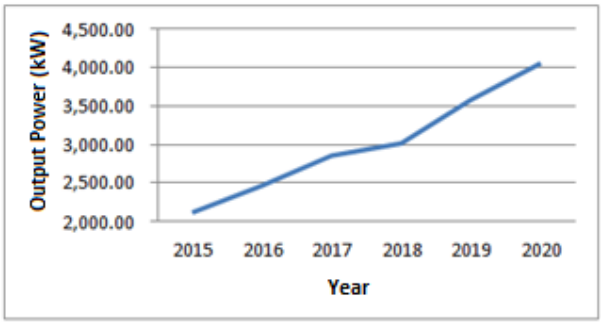


**Fig. 3** Results of Calculation of Potential Output Power

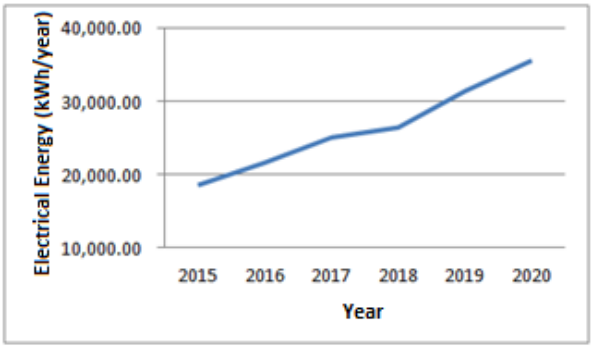


**Fig. 4** Results of Electrical Energy Potential

Based on Figures 3 and 4, it can be seen that the output power and electrical energy produced also increase as time goes on. This is influenced by the increase in the amount of waste and also population growth.

### C. *Forecasting Calculation Total Waste*

As the population increases, the volume of waste generated will also increase. To find out how much the increase in the amount of waste over the next ten years, namely from 2021 to 2030, it is necessary to do a forecasting calculation using an equation with the geometric method from the publication of the Central Statistics Agency, so that a population growth rate of 2% is obtained.

Forecasting the amount of waste for the year 2021-2030 can be calculated based on population prediction. According to the Ministry of Environment and Forestry records, the average Indonesian population produces 2.5 liters of waste per day. Assuming that the current Population of Indonesia reaches 268 million people, the total output of waste generated goes 670 million tons per day[11]. Forecasting the volume of waste and landfills for the next ten years continues to grow following the population, projected with the existing equation. So that the results of forecasting calculations for the amount of waste in 2021-2030 are shown in Table 1

**Table 1.** Forecasting Volume and Waste

| *Year* | *Total Population* | *Waste Volume ($m^3/day$)* | *Amount of Waste (tons/day)* |
|---|---|---|---|
| 2021 | 221241 | 553.102 | 182.523 |
| 2022 | 225666 | 564.165 | 186.174 |
| 2023 | 230179 | 575.448 | 189.898 |
| 2024 | 234783 | 586.958 | 193.696 |
| 2025 | 239478 | 598.695 | 197.569 |
| 2026 | 244268 | 610.67 | 201.521 |
| 2027 | 249153 | 622.882 | 205.551 |
| 2028 | 254136 | 635.34 | 209.662 |
| 2029 | 259219 | 648.047 | 213.856 |
| 2030 | 264403 | 661.007 | 218.132 |

### D. *Forecasting Calculation of Output Power and Electrical Energy Produced for the Next 10 Years*

Based on table 1, the results of forecasting the population, volume of waste, and the amount of waste is increasing every year. This shows that the potential for waste to generate electricity as a fuel for power generation will increase every year. Calculations are carried out using the existing equations as in the second discussion to find out the potential output power and the electrical energy produced. This calculation is done by considering the amount of waste and the calorific value to be used. The calorific value used is 2500 kcal/kg. The potential output power and electrical energy are generated for the next ten years from 2021 to 2030. The results obtained are shown in Table 2.

**Tabel 2**. The results of the calculation of the output power forecasting and electrical energy generated for the next ten years

| No. | Year | Output power (kW) | Energy (kWh/day) | Energy (MWh/day) |
|---|---|---|---|---|
| 1. | 2021 | 3969.875 | 95277006 | 34776.11 |
| 2. | 2022 | 4049.285 | 97182.828 | 35471.73 |
| 3. | 2023 | 4130.282 | 99126.756 | 36181.27 |
| 4. | 2024 | 4212.888 | 10110.931 | 36904.90 |
| 5. | 2025 | 4297.126 | 103131.018 | 37642.82 |
| 6. | 2026 | 4383.082 | 105193.96 | 38395.80 |
| 7. | 2027 | 4470.734 | 107297.62 | 39163.63 |
| 8. | 2028 | 4560.149 | 109443.56 | 39946.90 |
| 9. | 2029 | 4651.368 | 111632.83 | 40745.98 |
| 10. | 2030 | 4744371 | 113864.9 | 41560.69 |

### E. *Utilization of Waste as Raw Material for Power Generation*

The utilization of waste as fuel for electricity generation certainly requires a high cost. Because in processing waste, both as raw material to produce electricity, sophisticated technology is needed to maintain its quality as fuel and the machines. The processing technology used is incineration or direct combustion. Because the incineration process has advantages, such as reducing 70% of waste and the ash produced for building materials. However, this technology also has a weakness in which this technology requires high investment, operation, and maintenance costs and emissions that cause pollution[12].

Garbage as raw material for this plant is of course, only used as an alternative energy source. The technology available in waste power plants also varies. So, the techniques for processing waste for fuel also have differences in incineration technology. Waste will be sorted through cranes located at the plant. This waste will then be stored in a bunker within a few days to reduce its water content. After that, the waste will go into the combustion chamber and be processed to produce electrical energy[13].

Based on the Regulation of the Minister of Energy and Mineral Resources Number 19 of 2013, that the purchase price of electricity from a waste power plant connected to a medium voltage is Rp. 1450/kWh, and for a low voltage, it is Rp. 1798/kWh. To get the results of this cost is to multiply the electrical energy by the purchase price of electricity.

## IV. CONCLUSION

For the last six years (2015 – 2020), waste potential in Pangkalpinang was able to produce an output power of 21.173625 GW in 2015 to 40.578975 GW in 2020 as the potential for annual electrical energy generated during the last six years (2015-2020). 2020) of 18548.10 MWh/year in 2015 to the last in 2020, producing 35547.18 MWh/year. The results of forecasting (forecasting) the potential for waste for the next ten years (2021-2030) increase output power and electrical energy produced. In 2021 the output power generated is 3.939875 GW, and the electrical energy generated is 34776.11 MWh/year. Until 2030, the output power generated is 4744.371 kW, and the electrical energy produced is 41560.69 MWh/year. The calculation of the cost of purchasing electricity from waste power plants obtained by business entities connected to the medium-voltage or low-voltage network shows a significant income. The potential that will be accepted for medium-voltage in 2030 will reach 60.263 billion rupiahs - and for low-voltage to reach 76.726 billion- rupiahs.

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*Received: Sept 27, 2021 | Revised: Oct 24, 2021 | Accepted: Oct 31, 2021*