Planning of Garbage Power Plant (PLTSA): Case in Medan City

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Abstract:: Electricity crisis in Medan city causing serious problem and this problem can be overcome by building Waste Power Generation (PLTSa) in Medan City. Therefore this study aims to determine the feasibility of planning of Waste Power Generation (PLTSa) from the economic aspect conducted at TPA Terjun in Medan city by using incenerator type. The method used was the least cost method to calculate the economic aspect analysis by determining the value of NPV (Net Present Value), IRR (Internal Rate of Return), BCR (Benefit Cost Ratio), and PP (Payback Period). From the research results it can be seen that to build PLTSa in Medan city it required investment cost of Rp 70,268,968,000 from the production of electricity 22.90 MW. To determine the feasibility of this project planning is obtained NVP value = Rp 249.136.817.059, IRR = 54.6%, BCR = 13.71 and PP = 1.8 years, so from the results PLTSa development planning project in the city of Medan can meet the criteria feasibility to build.

1 INTRODUCTION

Waste into energy is a renewable energy source that can be converted into electrical energy through heat generated in combustion process above 850 ° C (Safrizal, 2014). Currently, power generation using waste power into the world's attention where garbage that usually becomes so disgusting for everyone now can be used as Power Plant (PTLSa).

In addition to electricity that has become a primary need in human life, it must have the power that available to meet the needs in the midst of society. The higher the desired demand than the existing power supply. So there was a blackout (byar pet) in various regions, especially in the city of Medan. Until now the Government and PLN are struggling to continue to meet the needs of the community supported by the Government's plan to create electrical power of 35,000 MW in Indonesia to remove pet byar from Indonesia.

The city of Medan, the capital of North Sumatra Province, is the 3rd largest city in Indonesia with a population of more than 2 million people with a population density of 7,657 inhabitants/km^2. The multitude of activities undertaken by millions of people in the city of Medan forces the existence of a quality and continuous plant to fulfill services and activities in government, education, industry, and many other things that must be met. But as we already know today, many of the existing generating units to meet the electric power of the city of Medan are getting old and unable to operate maximally, plus the difficulty of obtaining licenses to establish a generator either from the government or from the surrounding community.

Therefore, the choice of waste to be a renewable energy source is potential choice, which is where today many generating units depend on unstable and unstable fossil fuels and fossil fuels. While the waste is a thing that has been much wasted and like useless, but if the meticulous or in good use can make an important need such as making it a renewable power station in the city of Medan.

2 MATERIAL AND METHODS

2.1 Trash

Waste is the residual material in solid form from the end result of a process. In accordance with the Law No.18 Year 2008 on Waste Management, clearly

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stated in Article 4 it says "Waste processing aims to improve public health and environmental quality and make as a resource" (UU RI No 18, 2008). Making resources here means that waste can be used as a renewable power source for Indonesia.

There are 2 types of waste that is Organic Waste which consists of materials composing plants and animals taken from nature or produced from agricultural activities, fisheries or others. Inorganic waste originates from non-renewable natural resources such as minerals and petroleum, or from industrial processes. Judging from the composition of waste in major cities of Indonesia, organic waste reached 70% of the total of all waste, while inorganic 28% and the rest of B3 waste (Hazardous Materials Toxic) of 2% (Safrizal, 2014).

Geographical Location of TPA (Final Disposal Site) Namo Bintang, Pancur Batu Subdistrict, Deli Serdang Regency which has 16 Ha of land area. As shown in Figure 1.

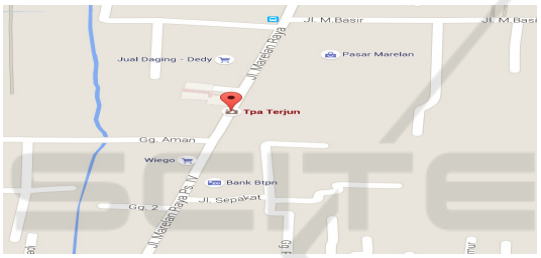

Figure 1. Geographic Map of TPA Terjun, Marelan

With the condition of garbage in TPA plunge can be seen in Figure 2.

Figure 2. Waste Condition at Landfill Terjun

2.2 Garbage Power Plant (PLTSa)

Electricity is an energy that is needed by society to live everyday life. Currently, the existing municipal waste in the TPA Terjun can be a source of energy if it can be managed and built Garbage Power Generation (PLTSa).

Renewable energy sources are energy sources that do not cause a variety of environmental problems such as environmental pollution and global warming (Indoenergi.com,2014). The working principle of PLTSa is shown in Figure 3.

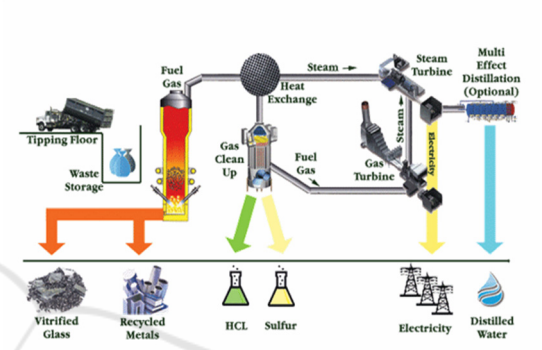

Figure 3. PLTSa Working Principles

2.3 Economic Accounting

a. NPV (Net Present Value)
NPV is the current value of the entire Dicounted Cash Flow or the total cost picture or total project revenue seen with the present value (the value at the start of the project). Mathematically the NPV value can be expressed as Equation 1.

$$NPV = \sum_{t=0}^{n} \frac{CIF_t}{(1+k)^t} - COF \qquad (1)$$

where :k = *Discount rate used, COF= Cash out flow / Investment, CIFt= Cash in flow in period t,* N = The last period of cash flow expected

b. IRR (Internal Rate Of Return)
IRR is the level of profit used to pay the amount borrowed in order to achieve a balance toward zero with the consideration of profit. IRR is shown in% / period and is usually positive (I> 0). To calculate the IRR can use Equation 2.

$$IRR = i_1 + \left(\frac{NPV_1}{NPV_1 - NPV_2} \right) \qquad (2)$$

where : *IRR = Internal Rate of Return* (%), NPV_1 = *Net Present Value* with low interest rate

(Rp), NPV_2 = *Net Present Value* with high interest rate (Rp), i_1 = First Interest Rate (%), i_2 = Second Level of Interest (%)

c. BCR (Benefit Cost Ratio)
Benefit Cost Ratio is the ratio of the ratio between total revenue over the time of the generator operation with the initial investment cost. Formulated in Equation 3.

$$BCR_t = \frac{\sum_{1}^{n} CIF_t}{Investment\ Cost} \quad (3)$$

d. PP (Payback Period)
Payback Period is the length of time it takes to recover the investment fund. Formulated in Equation 4

$$PP = \frac{Investment\ Cost}{Annual\ CIF} \quad (4)$$

2.4 Experimental Setup

The location of the research was conducted at TPA Terjun, Kec.Medan Marelan and in Sanitation Department of Medan City. It is hoped that with this research the achievement of PLTSa development and provide investment opportunity and make PLTSa become BUMD Medan City. The time for data collection starts from May 2016 to June 2016. It begins by searching the garbage data at the Sanitation Office of Medan City, then looking at the location of the TPA Terjun landfill, followed by processing the data and summarizing the research results.

The materials used in this study are the data collected from TPA Terjun, Sanitation Department of Medan City and research on the journal that has been done. For the equipment used is the Laptop by using Microsoft Excel Software. While the method used is the method of data collection and processing. Considering the absence of Waste Power Generation (PLTSa) in Medan City, one of the results of research on waste becomes a reference entitled "Analysis of Waste Business Feasibility to Waste Power Plant (PLTSa) in Bogor City" which is attached on appendix sheet (Siti, 2009). Since the data in this reference is used in 2009 with the effect of the Indonesian economy because inflation averages 5% each year then each data from this study multiplied 35% to obtain economic value in 2016.

a. TPA Terjun
By conducting a personal interview on the head of UPP TPA Terjun cpc. Sutikno then found that TPA Terjun which has a landfill area of 14 hectares with a population of 2,125,591 people and population density of 7,929.5 km^2 can produce garbage up to 7274 m^3/day equivalent to 1818 tons/day.

b. Sanitation Office of Medan City
Data collection at Sanitation Department of Medan City to get the cost of retribution and garbage transportation cost in Medan City and in Table 1 is the data obtained.

Table 1. Garbage Retribution Medan City

Year	Target Retribution (Rupiahs)	Realization Retribution (Rupiahs)
2011	27.000.000.000	16.152.471.550
2012	31.000.000.000	12.768.304.000
2013	21.300.000.000	18.134.728.282
2014	25.000.000.000	20.256.904.605
2015	27.500.000.000	20.534.958.850

Table 1 shows comparison of target city waste levy target value with the realization of garbage levy which has been running for the last 5 years.

2.5 Flow Chart

The sequence of this research procedure is represented in the flow diagram in Figure 4.

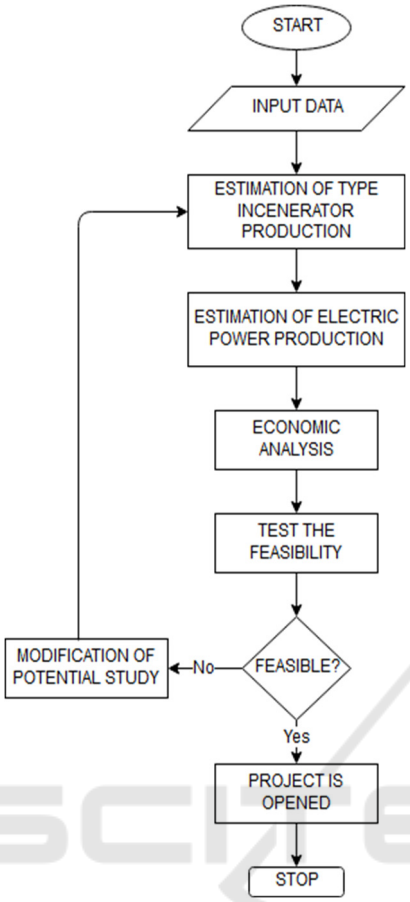

Figure 4. Flow Diagram of Research

3 RESULT

3.1 Estimated Production Type Incenerator

The burning of the organic waste which has been left to reduce the water content contained in the garbage to the moisture content of the garbage is only 50-60%, then burning with early fire triggers using kerosene and produce heat temperature above 850°C in the furnace burning and has a calorific value of 15500 kcal/ton (Ikhsan, 2014).

3.2 Estimated Power Production

Based on the results of the research from the Medan Landfill will continue to increase every year, as shown in Table 2.

Table 2. Potential of Garbage in Medan City

Year	Weight of Trash (Ton/day)	Organic (Ton/day)	Inorganic (Ton/day)
2010	1718	1202,6	515,4
2011	1735	1214,5	520,5
2012	1752	1226,4	525,6
2013	1768	1237,6	530,4
2014	1785	1249,5	535,5
2015	1807	1264,9	542,1
2016	1818	1272,6	545,4
2017	1835	1284,5	550,5
2018	1852	1296,4	555,6
2019	1868	1307,6	560,4
2020	1885	1319,5	565,5
2021	1902	1331,4	570,6
2022	1919	1343,3	575,7
2023	1935	1354,5	580,5
2024	1952	1366,4	585,6
2025	1969	1378,3	590,7

Table 2 shows in 2016 TPA Terjun accommodates 1818 tons of waste / day with specific inorganic waste of 545.4 tons / day and organic waste of 1272.6 tons / day. Based on TPA data from EBTKE (New Renewable Energy and Energy Conversion) that potential is calculated with the provision of 1 ton of waste / day equivalent to 18 kW it can be concluded that 1272.4 ton / day x 18 kW = 22.903.2 kW or 22.90 MW. While the electric energy generated in a year is 22,903.2 kW x 8760 hours / year = 200.637.032 kWh / year. So that the electric power generated from the Waste Power Plant (PLTSa) in Medan City with 20% efficiency assumption is 20% x 22,903.2 kW x 8,760 hours / year = 40.126.406,4 kWh / year.

3.3 Economic Analysis

a. Investment Cost

To obtain capital in the development of PLTSa in Medan city, it is necessary to detail the investment cost, where the investment cost incurred at the beginning of project age as a whole is shown in Table 3.

Table 3. Total Investment Cost of PLTSa in Medan City

No	Description	Total Investment (Rupiah)
1	Investment Cost of Machine and Operating System	44.093.700.000
2	Building Investment Cost	19.825.699.050
3	Pre-Investment Fee	4.050.000.000
4	Re-Investment Cost	2.299.568.950
	TOTAL INVESTMENTS	70.268.968.000

The total investment required is Rp 70,268,968,000,- with the biggest cost being the investment cost of machinery and information system.

b. Maintenance and Operational Cost

Operational costs are the overall costs associated with the operations (production) of the PLTSa business unit in Table 4.

For total maintenance and operational costs of Rp 19,641,972,585, -from the three parts to be calculated are fixed costs for labor, variable costs, office and vehicle factory overhead costs. The biggest cost is the variable cost.

Table 4. Total Cost of Maintenance and Operational PLTSa in Medan City.

No	Description	Total Investment (Rupiah)
1	Fixed Costs for Labor	6.624.180.000
2	Variable Cost	10.614.837.600
3	Factory Overhead, Office and Vehicle Expenses	2.402.954.985
	Total Cost of Maintenance and Operational	19.641.972.585

c Electricity sales

The value of electricity sales is obtained from the volume of electricity production multiplied by the selling price of electricity. Determination of electricity price based on the basic tariff price set by PLN. The production of electricity in PLTSa Medan City 2016 is 1272,4 ton/day x 18 kW = 22,903,2 kW or 22,90 MW. Assuming 20% power generation efficiency, 20% x 22,903.2 kW = 4,580,64 kW and 8760 hours/year x 4580,64 Kw = 40,126,406,4 kWh/year. Then the energy that can be sold to PLN from burning organic waste is 1,272.6 tons/day (464,499 tons/year) is 40,126,406,4 kWh/year.

PLN purchases electricity from PLTSa according to the Ministerial Regulation No.19 of 2013 has been fixed (zero waste: Rp 1,450 - 1798 /kWh; sanitary landfill: Rp1.250 - 1.598 /kWh; incenerator Rp/kWh 1.450 medium voltage). Acceptance of the cost of electricity sales PLTSa production of Medan city in 2016 is Rp 1.450 x 40.126.406,4 kWh/year = Rp 58.183.289.280.

3.4 Assessing Eligibility

With Discount Factor (DF) required to view the projected value of money for a certain period during the project, if the interest rate is determined at 15%, DF can be calculated by Equation 5.

$$DF = 1/(1+i)^n \quad (5)$$

Where i = *discount rate,* n= Year Period, DF= *Discount Factor*

Obtained present value operational and maintenance and present value of total income each during the project lasted 25 years is Rp 126.968.639.118 and Rp 376.105.456.177.

3.5 Investment Rating

To analyze the feasibility of a project it is necessary to evaluate the project investment by calculating NPV, IRR, BCR, and PP which can be seen in the following description (Ikhsan, 2014):

a. NPV (Net PresentValue)

After calculation using Equation 1 then the value of NPV obtained is Rp 249.136.817.059. After deducting the revenue from electricity sales with operational expenses, the NPV value is Rp 249,136,817,059, - or greater than zero, so the project can be considered feasible.

b. IRR (Internal Rate of Return)

After calculation using Equation 2 then the value of IRR obtained is 54.6%. Because the value of IRR obtained is 54.6% or greater than 0%, in

accordance with the terms of project feasibility on IRR that must be positive (I> 0) then the project is said feasible.

c. BCR (Benefit Cost Ratio)
After calculation using Equation 3 then the value of BCR obtained is 13,71. Because the value of BCR obtained is 13.71 or more than zero, the project is considered feasible.

d. PP (Payback Period)
After the calculation using Equation 4 then the value of PP obtained is 1.8 or (1 Year 9 months). Because the value of PP obtained for 1.8 years, with payback time for 1 year 9 months. The quick payback period makes investors interested in this project.

4 CONCLUSIONS

The amount of electric potential generated by using incenerator type in PLTSa business unit of Medan city with garbage capacity of 1272,2 ton / day can generate electricity equal to 40.126.406,4 kWh and electric power equal to 22,90 MW with sales Rp 1,450 for type incenerator with medium voltage.

Of the generated power of 22.90 MW it can provide input to the government in overcoming the electricity crisis in North Sumatra, especially Medan City.

Using the least cost method of NPV calculation is Rp 249.136.817.059 which means the project is profitable in accordance with the eligibility criteria of the NPV> 0 project and the payback period also exceeds the economic time of a power plant. Profit ratio between cost shown by BCR is positive number that is 13,71 and the payback period shown in PP is for 1 year 9 months and the last is IRR obtained equal to 54,6%. Therefore, based on the feasibility study, PLTSa development project in TPA Terjun Medan can be realized because it meets the criteria of feasibility study.

Economic feasibility PLTSa in the city of Medan has been tested feasibility, this will provide an opportunity for investment opportunities for energy and electricity development in the city of Medan.

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