ATLANTIS PRESS

Advances in Engineering Research, volume 156

18th International Conference on Sustainable Environment and Architecture (SENVAR 2018)

Waste to Energy (WTE) Putri Cempo As Urban Innovation: A Financial Analysis

Adhianti Roswulandari
Magister Economics and Development Studies, Faculty of Economic & Business
Sebelas Maret University
Surakarta, Indonesia
adhianti@staff.uns.ac.id

Ahmad Daerobi
Department of Development Economics Studies,
Faculty of Economic & Business
Sebelas Maret University
Surakarta, Indonesia
ad94784@gmail.com

Suryanto
Department of Development Economics Studies,
Faculty of Economic & Business
Sebelas Maret University
Surakarta, Indonesia
suryanto_feb@staff.uns.ac.id

Evi Gravitiani
Department of Development Economics Studies,
Faculty of Economic & Business
Sebelas Maret University
Surakarta, Indonesia
e_gravity2000@yahoo.com

***Abstract*—** The handling of waste problems in urban areas of Surakarta, Putri Cempo Final Disposal Site (TPA) has been overload since 2005. The limitness of land has made the Government of Surakarta to think of innovation by building Waste to Energy plant project. The analysis was done by using secondary data obtained from the Enviromental Departement of Surakarta and PT. Metro Plasma Power imagery as a consortium of contractors project, the calculation of NPV, IRR and B/C ratio to show the feasibility study of urban waste treatment innovation. The calculation results showed that the NPV is Rp 1,502,724,992,382 the IRR is 8,174 % and B/C ratio is 2,177. According to the results of the calculation, it can be concluded that the construction of PLTSa Putri Cempo in Surakarta is feasible and give return to the investment value within 15 year. Waste generation problems can eventually be solved by innovation that produce profitable by-product outputs. The innovation which is in the form of waste handling method will take Surakarta a step further in the development of sustainable and environmentally friendly urban infrastructure.

***Keywords*—** *Waste power plant, Financial Analysis, TPA Putri Cempo, Surakarta*

I. INTRODUCTION

Garbage is a consequence of human activities, since every human activity must produce waste or garbage. The amount or volume of waste is proportional to the level of consumption of goods or materials that people use everyday. Every day, every city citizen produces an average of 900 grams of garbage, with the composition of 70% of organic waste and 30% of inorganic waste. The increased of population and lifestyle greatly affect the volume of waste.

Waste becomes a serious problem, especially in urban areas along with the increase of population and changes in the lifestyle of its people. Although a Final Disposal Site (TPA) where all the garbage in an area can be collected has been provided, however this place can no longer be able to accommodate the increase of waste. Waste handling capacity is not able to adjust the rate of waste production, causing inequality between waste capacity and service needs.

Generaly, the waste management in Indonesia is still limited to the way to dispose of garbage, and not to process them. This far, the method that has been carried out to solve the problem includes finding vacant land some distance from the residential area to be used as a final disposal site, and then moving after it is full and is deemed unfit. Waste management is relatively simple by collecting, transporting, disposing and destroying garbage, therefore, those way do not make the garbage problem solved.

Garbage handling by means of transportation and disposal that accumulates into this area requires very large but effective operational costs in the short term. In the long run, it is very inefficient and insecure due to the limited carrying capacity of land and the increasingly narrow environment and this will lead to a disaster if it is no longer able to accommodate the garbage or waste.

Problems related to landfill also occur in Surakarta, where garbage that has accumulated in Putri Cempo landfill since 2005 has been overloaded due to the limited land. Surakarta is one of the cities designated by the central government as a pilot project for waste management into electricity along with DKI Jakarta, Tangerang, Tangerang Selatan, Bekasi, Bandung, Semarang, Surabaya, Makassar, Denpasar, Palembang and Manado. Through the Presidential Regulation Number 35 of 2018 concerning the Acceleration of the Construction of Waste Management Processes to be the Green Energy-Based Electric Energy, 12 municipal/ district governments are given the authority to determine the Waste to Energy Plant (PLTSa) development contractor.

The Government of Surakarta through an open auction process cooperates with PT Citra Metrojaya Putra and PT Pembangunan Perumahan (PP) one of the state-owned Enterprises (BUMN) hereinafter referred to as PT. Plasma Power Metro Image in PLTSa development. This company is also supported by a gas engine technology provider company from Austria, General Electric (GE) in realizing PLTSa. A total of 450 tons of waste can be processed into 10-12 MW of electricity. The investment value of this

project is IDR 417 billion and will last for 20 years. Plasma grasification technology where garbage either new or buried for decades can be processed into electrical energy, and this is expected to overcome the problem of waste and remain environmentally friendly.

Considering the large investment value and its important and urgent designation, a financial analysis is needed to find out whether this investment is profitable and feasible to be implemented. This calculation also can be used to find out whether the initial investment can be paid before the economic duration and period of the project ends.

II. LITERATURE REVIEW

Waste to Energy Power Plants (PLTSa) is a thermal power plants with supercritical steam and fueled by waste or waste gas methane. Waste or methane gas is burned to produce heat which heats up steam in supercritical steam boilers. High compression steam then drives the steam turbine and flywheel connected to the dynamo generator with an intermediate transmission gear or automatic transmission to produce electricity. The power generated in this plant varies between 500 KW to 10 MW.

There are two types of PLTSa Work Process, namely: the process of combustion and the process of methane fermentation technology. PLTSa with the combustion process uses a thermal conversion process in processing the waste into energy. The work process is carried out in several stages, they are: Waste sorting and storage, combustion, boiler heating, turbine drive and generator and results.

The utilization of Gas from Waste for Energy Plants with methane fermentation technology is carried out using the sanitary landfill method, namely, utilizing gas produced from waste (sanitary landfill gas/ LFG). Landfill Gas (LFG) is a byproduct of the decomposition process from landfills consisting of the elements of 50% of methane (CH4), 50% of carbon dioxide (CO2) and <1% of non-methane organic compounds (NMOCs). LFG must be controlled and managed properly since it is used he continuously, if it is not done, it will cause a smog (toxic gas fog), global warming and the possibility of a gas explosion, the sanitary landfill system is carried out by inserting garbage into the holes then leveled and compacted then closed it with loose soil and finally the layers are formed. To take advantage of the gas that has been formed, the next process is to install the distribution pipes to remove gas. The gas is then flowed to the purification tube before it is finally flowed to the generator to turn the turbine.

A. ECONOMIC VALUATION AND COST-BENEFIT ANALYSIS

Given the considerable investment costs of PLTSa construction, a comprehensive study is needed to determine the feasibility of PLTSa development through cost benefit analysis. By defining each of the costs and benefits that can be assessed with the money arising from the project, the feasibility of the PLTSa construction can be calculated.

Valuation estimates can be directly entered into a cost-benefit analysis of a project or policy (Economics Interactions With Other Disciplines – Vol. I - Economic Valuation and Cost-Benefit Analysis - K.G. Willis).

B. Previous Studies

Siti Ade Fatimah, 2009 conducted the research of Feasibility Analysis of Waste Processing Business into Waste to Energy Plant (PLTSa) in Bogor with Financial Analysis and Switching Value Analysis.

Dedy Afiliano, 2011, conducted the research of Assessing the feasibility of the construction project of the Waste to Energy Plant (PLTSa) in TPA Supit Urang Malang by using financial analysis

Murni Rahayu Purwaningsih, 2012 conducted the research of Social Benefit Cost Analysis of the existence of Gedebage Waste to Energy Plant for the people around Bandung.

III. METHODS

A. Calculation of Cost

Costs consist of investment cost, variable cost, indirect cost and miscellaneous cost.

- Investment cost consist of the cost of constructing a PLTSa installation in order that it can flow electricity to the PLN substation. The government, in this case the Surakarta Environmental Service, cooperates with investors PT. Solo Citra Plasma Power that won the PLTSa construction tender.
- Variable Cost consist of the cost of chemicals and the operation of heavy equipment to run this PLTSa installation.
- Indirect costs include the cost of charging electricity for the office and workers fee (1 for administration and finance, 10 for technicians and operators and 5 for drivers)
- Miscellaneous cost is the cost of annual maintenance and unexpected cost.

B. Calculation of Benefits

The benefit of Waste to Energt Plant can be devided into direct benefit and indirect benefit.

- Direct Benefit is a benefit that could be taken from Waste to Energy Plant where waste, both new and old waste is processed into electricity and purchased by PLN. Everyday, 450 tons of processed waste can produce 280 KwH per ton and PLN will buy for 2496 per KwH.
- Indirect Benefit are carbon reduction generated from waste where 1 ton of waste reduces 0.0152146389 tons of carbon, carbon prices = $ 36/ ton, $ 1 = Rp. 14,730, -

Cost-Benefit Analysis Methods used includes:

1. NET PRESENT VALUE (NPV)

NPV is the net benefit that has been cut/ reduced using the Social Opportunity Cost of Capital (SOCC) as the discount factor.

$$NPV = \sum_{i=1}^{n} NB_i (1+i)^{-n}$$

Or

$$NPV = \sum_{i=1}^{n} \frac{NB_i}{(1+i)^n}$$

Or

$$NPV = \sum_{i=1}^{n} \overline{B_i} - \overline{C_i} = \sum_{i=1}^{n} N\overline{B_i}$$

Where:

NB = Net benefit = Benefit - Cost

C = Investment cost + Operating costs = Reduced Benefit = Reduced Cost

i = reduced Factor

n = year (period)

Criteria:

NPV > 0 (zero) → business / project is feasible

NPV < 0 (zero) → business / project is not feasible

NPV = 0 (zero) → business/ project in a state where the BEP TR = TC in the form of present value.

To calculate the required data on the estimated NPV of investment costs, operating costs, and maintenance as well as the estimated benefits of the planned project.

2. Internal Rate of Return (IRR)

IRR is a reduced rate that results in NPV = 0 (zero).
If IRR> SOCC, therefore, the project is feasible
IRR = SOCC, therefore, the project is on BEP
IRR <SOCC, therefore, the project is not feasible.

To determine the value of IRR, NPV1 should be calculated at first and NPV2 for the trial and error. If the reduced factor of NPV1 is positive, therefore, the second one must be greater than SOCC, and otherwise.
According to these experiment, it is explained that the IRR value is between positive NPV and negative NPV, therefore, the NPV = 0.

$$IRR = i_1 + \frac{NPV_1}{(NPV_1 - NPV_2)}(i_2 - i_1)$$

where:
i_1 = reduced rate that produces NPV_1
i_2 = reduced rate that produces NPV_2

3. Net Benefit Cost Ratio (Net B/ C)

Net B/ C is the ratio between the reduced net benefit which is positive (+) with a negative net benefits, which has been reduced.

$$NetB/C = \frac{\sum_{i=1}^{n} N\overline{B_i}(+)}{\sum_{i=1}^{n} N\overline{B_i}(-)}$$

If:
Net B / C> 1 (one), therefore, the project (business) feasible
Net B / C <1 (one), therefore, the project is not feasible
Net B / C = 1 (one), therefore, cash in flows = cash out flows (BEP) or TR = TC

4. Pay Back Period (PBP)

PBP is a specific period of time indicating the occurrence of flows (cash in flows) are cumulatively equal to the amount of investment in the form of present value. PBP is used to determine the period of the project to be able to recover the investment.

$$PBP = T_{p-1} + \frac{\sum_{i=1}^{n}\overline{I_i} - \sum_{i=1}^{n}\overline{B_{icp-1}}}{\overline{B_p}}$$

Where:
PBP = Pay Back Period
Tp-1 = The year before PBP
Ii = The reduced investment amount
Bicp-1 = The number of benefits reduced before PBP
Bp = Number of benefit to the PBP

IV. RESULT

The results of calculation showed that the NPV is Rp 1,502,724,992,382 the IRR is 8,174 % and B/C ratio is 2,177. Based on the results of this calculation, it can be concluded that the construction of Waste to Energy Plant Putri Cempo in Surakarta is feasible and give return to the investment value within 15 year.

V. CONCLUSION

Based on the result of the study, it is concluded that the Waste to Energy Plant (PLTSa) Putri Cempo is feasible to do, so that fully attention is needed from the government and stakeholder in implementing this program. New innovations in handling this waste problem make Surakarta a step further in the development of environmentally friendly urban infrastructure. The existence of PLTSa can reduce the volume of waste and extend the operation period of the landfill, two things at the same time can be overcome. Surakarta can be an innovator in solving the urban waste problems as well as an example for other cities in Indonesia.

To further optimize the operation of PLTSa, more in-depth studies are necesarry to be conducted regardless to the economic and social aspects of the environment. In addition, stakeholders analysis is also needed so that the roles and responsibilities of each party can be involved, in this case PT Citra Metro Plasma Power, PLN, DLH and the community around PLTSa in order to support PLTSa for more optimal management .

REFERENCES

[1] D. Afiliano, Jurnal. "Kajian Kelayakan Proyek Pembangunan Pembangkit Listrik Tenaga Sampah (PLTSa) di TPA Supit Urang Kota Malang", 2011.

[2] Dinas Lingkungan Hidup Kota Surakarta, "Laporan Tahunan, Kantor DLH Surakarta", 2016.

[3] F. Akhmad, "Ekonomi Sumberdaya Alam dan Lingkungan, Teori dan Aplikasi", PT Gramedia Pusat Utama, Jakarta, 2004.

[4] M. R. Purwaningsih, Jurnal Perencanaan Wilayah dan Kota Vo. 23 No.3 "Analisis Biaya Manfaat Sosial Keberadaan Pembangkit Listrik Tenaga Sampah Gedebage bagi masyarakat sekitar Kota Bandung", 2012.

[5] S. A. Fatimah, Thesis. "Analisis Kelayakan Usaha Pengolahan Sampah Menjadi Pembangkit Listrik Tenaga Sampah (PLTSa) di Kota Bogor", 2009.

[6] Peraturan Pemerintah No. 35 Tahun 2018, "Tentang Percepatan Pembangunan Instalasi Pengolah Sampah Menjadi Energi Listrik Berbasis Teknologi Ramah Lingkungan".