CSID Journal of Sustainable City and Urban Development (2018) 1:31-38
ISSN: 2614-8161

FINANCIAL PROSPECT OF THE WASTE TO ENERGY APPLICATION FOR SOLID WASTE MANAGEMENT IN INDONESIA

Mohajit*

Institut Teknologi Bandung, Bandung

ABSTRACT

Solid waste generation rate in big cities in Indonesia is recorded at 500-7000 tons/day. Waste management by the application of sanitary land fill technology cannot solve the waste problem and tends to create new problems in the increasingly difficult and expensive land procurement in recent years. The practice of sanitary land fill technology with a very large volume of solid waste tends to become more complex and becomes difficult in controlling the impact of the resulting environmental pollution.
Incineration technology has been proven its implementation in some developed and developing countries. Study on the extent of incineration technology in the application for waste management in Indonesia is carried out. The purpose of this study is to look at the financial prospects of incinerator technology applications for solid waste management in Indonesia. The application of incineration technology seems interesting in respect to the technical aspects in reducing significantly the volume of solid waste and as well as in producing a very useful source of electrical energy. On the other hand the financial prospect is also very attractive where the breakeven point, net present value and internal rate of return seem to be bankable on the basis of reasonable tipping fee that is quite affordable for the house hold served.

Keywords: solid waste, incineration, financial model, waste to energy,

1. INTRODUCTION

Solid waste generation rate in big cities in Indonesia is recorded at 500-7000 tons/day. At least 20 cities had been identified to have such that a huge amount of solid waste generation rate. For example, Jakarta has a waste generation of approximately 7000 tons/day, Surabaya records a waste generation of approximately 2000 tons/day, Bandung, Bekasi, and Medan produce approximately 1500 ton/day of municipal solid waste. Six other cities recorded a production rate of about 1000 tons/day of solid waste, including the city of Tangerang, Depok, Semarang, Palembang, Makassar, and Tangerang Selatan. Other large cities with population less than one million people are predicted to produce waste generation of about 500 tons/day, for example, Bogor, Batam, Pekan Baru, Bandar Lampung, Malang, Denpasar, etc.

Solid waste management by the application of sanitary land fill technology cannot solve the waste problem and tends to create new problems in the increasingly difficult and expensive land procurement in recent years. The availability of land for the development of sanitary land fill within the city is no longer possible, while looking for locations outside the city often arise conflict of interest between the cities. Furthermore, the practice of sanitary land fill technology with a very large volume of solid waste tends to become more complex and becomes difficult in controlling the impact of the resulting environmental pollution.

*Corresponding author: E-mail: mohajito@hotmail.com

Based on the considerations and background as described above, it is necessary to adapt efficient and effective technology by applying the technology of waste to energy in order to solve the problem of waste management in Indonesia. Incineration technology has been proven its implementation in some developed and developing countries. Meanwhile gasification/plasma technology and pyrolysis technology are still limited in the application and are still under development process.

In various literatures explained that waste to energy technology can be developed through two processes, namely biochemical processes and thermal processes. The biochemical process is divided into two processes: anaerobic digestion process to produce methane fuel and fermentation process to produce ethanol fuel. While the thermal process is divided into three types, namely, combustion process, pyrolysis process, and gasification process/plasma.

The combustion process, known as incineration technology, is a combustion process at temperature of around 1200ºC with excessive oxygen supply using a burning furnace to generate heat which then the heat can be converted into electrical energy through boilers and turbines. The solid waste burned through the incinerator will be converted into heat and electrical energy or a combination of heat and energy (Combined Heat and Power, CHP).

While pyrolysis process, is a combustion process at temperature of around 1000 oC with no oxygen supply using a combustion chamber to produce char and synthetic gas which then can be used as fuel to generate electricity through boilers and or generator sets.

The gasification process/plasma is a combustion process at temperature of around 3000 oC with partial oxygen supply using a plasma reactor to converts organic matter into a syngas (synthesis gas) which is primarily made up of hydrogen and carbon monoxide. A plasma torch powered by an electric arc, is used to ionize gas and catalyze organic matter into syngas with slag remaining as a byproduct. The synthesis gas can then be used as fuel for turbine engine or heater.

Study on the extent of incineration technology in the application for waste management in Indonesia is carried out. The purpose of this study is to look at the financial prospects of incinerator technology applications for solid waste management in Indonesia. The application of incineration technology seems interesting in respect to the technical aspects in reducing significantly the volume of solid waste and as well as in producing a very useful source of electrical energy.

2. METHODOLOGY/ EXPERIMENTAL

An incinerator with a capacity of 1000 tons/day is a typical waste to energy system that is generally applied to generate electricity of about 12 Mega Watt. The system consists of Incineration Unit, Steam Boiler Unit, Turbin Unit, Generator Set, Cooling Unit, Air Pollution Control System, Wastewater Treatment Unit, Sludge Treatment Unit, Water Supply Sistem, Control System, Trash Storage Bunker, Building and Operation Room, Electricity Transformator, Dump Truck, Heavy Vehicle, and Workshop.

This study will use this type of incinerator where necessary investments include Access Road and Landscaping, Houses, Cars, and Motor Cycles for Officials, and Land Acquisition.

Engineering cost estimates was made to predict investment cost of the incinerator system as well as their operational cost. Income is expectedly generated from the tipping fee and the sale of electrical energy generated. Financial analysis was then developed by using a mathematical models to look at a bankability of the investment.

A mathematical modelling for the financial analysis was developed to simulate any condition of the financial aspect in respect to the application and implementation of the incinerator system [1, 2]. Important parameters and criteria for the financial analysis in the model include: Capacity of solid waste input (tons/day), In-plant Losses (%), Tipping fee for solid waste input (Rp/ton), Operation Cost (Rp/ton), Maintenance Cost (Rp/year), Investment including VAT (Rp), Investment, VAT and IDC (interest rate during construction) (Rp), Construction Periods (months), Tax after BEP (%), Interest Rate or Discount Rate (%), Equivalent Household served (HH/day), Equivalent Tipping Fee per Household (Rp/month), Energy Tariff from Waste to Energy (WtoE) Turbine (Rp/kWH), IRR gues (%), Targeted Period of Investment (years), Targeted IRR (%), Inflation Rate/Fee and Tariff Increase (%), Standby Cash for Operation & Maintenance (months), Tipping Fee Payment Efficiency (%), Maximum Extended Period of Payment (months), etc. The output parameters of the financial analysis includes: BEP (break even point), IRR (internal rate of return), NPV (net present value), and DCR (debt coverage ratio).

3. RESULTS AND DISCUSSION

The investment cost as well as the operational cost for the application and implementation of the incinerator system was estimated based on the standard price of the Ministry of Public Work, the Government of Republic Indonesia, No. 03/PRT/M/2013, as depicted in Table 1 and Table 2 [3]. Others cost include water consumption; fuel subsidy for operational activities; allowance for new year, eidul fitri, and bonus; out station allowance (OSA), and alocation for research and development.

The cost for maintenance is estimated at around Rp 66.357.000.000,00 per year including the civil building for around Rp 8.124.500.000,00 per year as well as electrical and mechanical equipment at around Rp 58.232.500.000,00 per year, respectively.

Table 1. Summary of Investment Cost

Parameter	Cost (Rp)
Investment Cost	1.477.100.000.000,00
Engineering Cost	22.156.500.000,00
Unpredictable Cost	73.855.000.000,00
Total Cost	1.573.111.500.000,00
Value Added Tax 10%	157.311.150.000,00
Grand Total	1.826.434.150.000,00

Table 2. Summary of Operation Cost

Parameter	(Rp/ton waste)
Remuneration	35.000,00
Chemicals	199.000,00
Electrical Energy	156.000,00
Fuel for Extra Heating	140.350,88
Others	23.421,11
Total	553.771,99

The financial analysis for the application of incinerator system is simulated under the following data and assumptions:

Capacity of waste input = 1000 tons/day, In-plant Losses = 2%, Tipping fee for solid waste input = Rp. 1.553.772 per ton, Operation Cost = Rp. 553.772 per ton, Maintenance Cost = Rp. 66.357.000.000 per year, Investment including VAT = Rp. 1.826.434.150.000, Investment, VAT and IDC (interest rate during construction) = Rp. 2.035.623.000.000, Construction Periods = 36 months, Tax after BEP = 15%, Interest Rate or Discount Rate = 12%, Equivalent Household served = 294.118 HH/day, Energy Tariff from Waste to Energy Turbine = Rp. 1000 per kWH, Inflation Rate/Fee and Tariff Increase = 6%, Standby Cash for Operation & Maintenance = 3 months, Tipping Fee Payment Efficiency = 97%, Maximum Extended Period of Payment = 3 months, Loan component = 70% and equity = 30%, VGF (viability gab funding) component = 49%. Typical solid waste chracteristics is presented in the following Table 3.

Due to a lower heat value of the solid waste (3000 kJ/kg) it is necessary to increase the heat value to around 3800 kJ/kg as required by the incinerator. In this case diesel is used to increase the heat value of the solid waste from 3000 kJ/kg to more or less 3800 kJ/kg. By this fuel for extra heating is required and it will cost around Rp 140.350,88/ton solid waste.

Simulation of the financial model results as depicted in the following Table 4 and Figure 1.

Table 3. The typical characteristics of the solid waste in some cities in Indonesia

Parameter	Value
Generation rate (L/HH/day)	17
Organic content (%)	54
Inorganic content (%)	46
Density (kg/L)	0.20
Water content (moisture) in %	70
Ash (%)	15
Heat value (kJ/kg)	3000
Heat value required for incinerator	3800

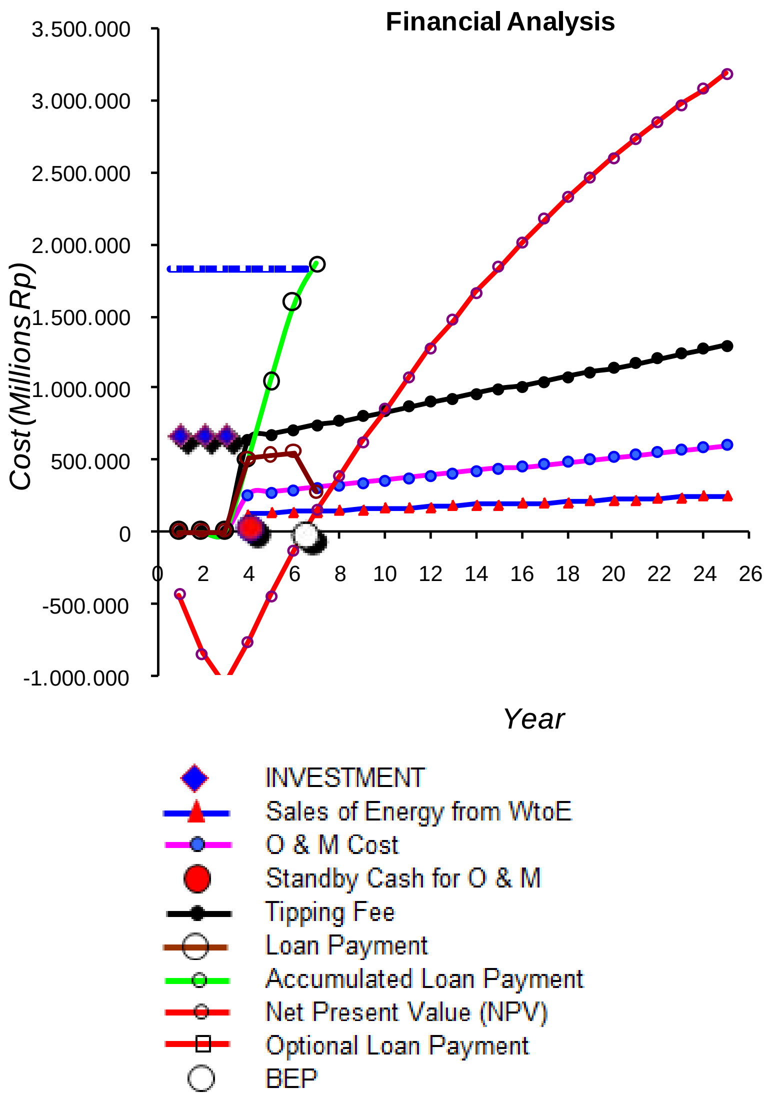

Figure 1. Result of the Financial Analysis
In case VGF = 49%

Table 4. Resume of the financial analysis
(in case VGF = 49%)

Parameter	Value
Year period	10th
DCR	2,15
NPV (Rp)	852.311.821.983,24
IRR	24,18%
Year period	25th
DCR	8,6
NPV (Rp)	3.185.900.558.965,05
IRR	30,40%
Break even point (years)	6,5
VGF	49%

From the financial analysis model as depicted in Figure 1, and Table 4, it can be seen that the investment for the implementation of incinerator system could be paid back within 6,5 years period and its Net Present Value is quite attractive at around Rp 3.185.900.558.965, with Internal Rate of Return of 30,40% in the year of 25th. This financial prospect which looks very good and bankable is mainly due to the support of the 49% VGF (viability gab funding) intervention [4, 5, 6], as well as the tipping fee which seems affordable to the house hold served. In this case the house hold served have to pay monthly of equivalent to Rp 158.485 based on the generation rate of the solid waste around 17 L/household/day.

Further more, simulation of financial analysis model without intervention of VFG, it seems likely that application of incinerator system for the solid waste management in Indonesia is still feasible as can be seen in Table 5 and Figure 2.

Table 5. Resume of the financial analysis
(in case VGF = 0%)

Parameter	Value
Year period	10th
DCR	1,23
NPV (Rp)	280.007.472.551,62
IRR	12,31%
Year period	25th
DCR	4,93
NPV (Rp)	2.613.596.209.533,43
IRR	21,58%
Break even point (years)	8,8
VGF	0%

The break even point is 8,8 years and its NPV is 2.613.596.209.533,43 with Internal Rate of Return of 21,58% in the year of 25th. By this option the investment is also still bankable.

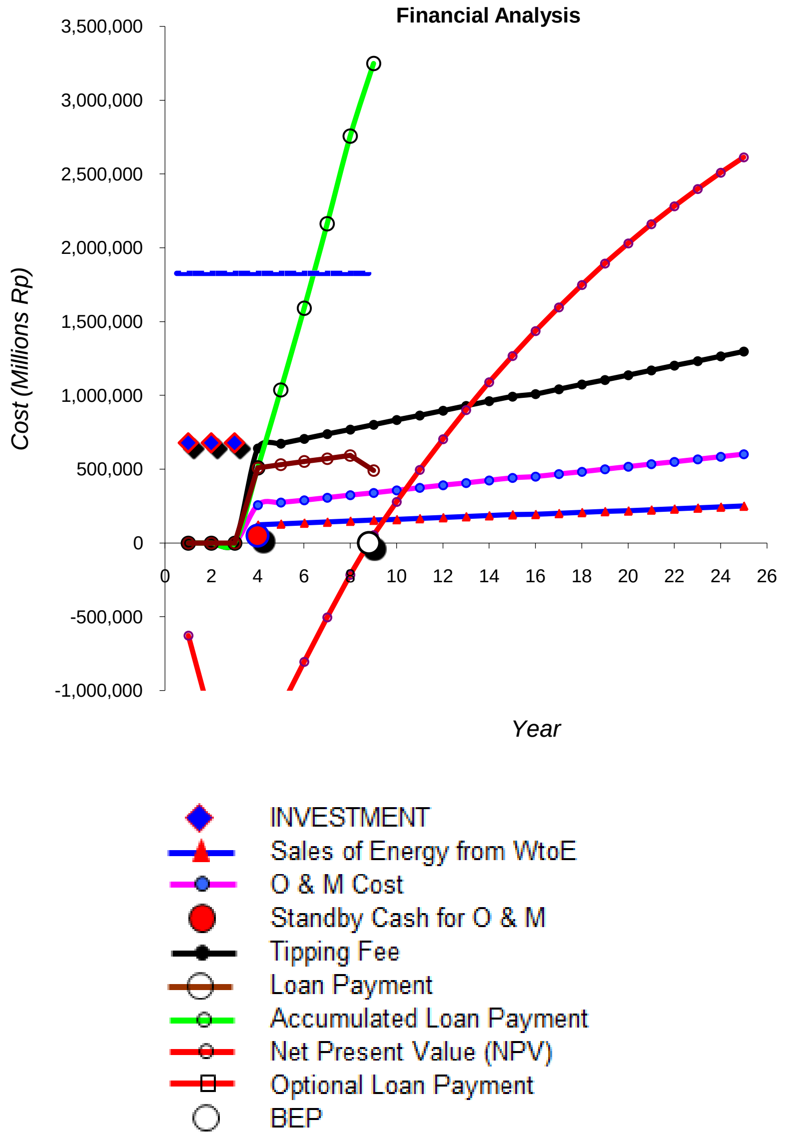

Figure 2. Result of the Financial Analysis
In case VGF = 0%

4. CONCLUSION

This study has clearly shown that the application and implementation of waste to energy of the incinerator system for the solid waste management in Indonesia is actually inexpensive. The investment cost of Rp 2.035.623.000.000 is equivalent to Rp. 6.921.118 per house hold served.

With a reasonable and affordable tipping fee it appears that the application of waste to energy of the incineration system for the solid waste management in Indonesia is financially prospective and bankable to solve the the most problematic solid waste management in Indonesia.

5. ACKNOWLEDGEMENT

The author would like to thank to PT. PRATAMA GROUP Jakarta and PT. LAPI ITB – GANESHATAMA CONSULTING Bandung for their initiative effort and support in this study on the application and implementation of waste to energy of the incineration system for the solid waste management in Indonesia. Special thank is also directed to Dr. Subekti, SE, MM, the president director of PT. PAL Jaya Jakarta, who invited the author for meaningfull discussion in wastewater and solid waste management in Jakarta.

REFERENCES

Mohajit, (2011), Financial Prospect to the Application of High Rate Water Treatment Plant System, in Seminar Proceedings: Humboldt Kolleg: Synergy, networking, and the role of fundamental research development in Asean, In conjunction with: International Conference on natural sciences, Malang Indonesia. July 9-11, 2011.

Ogata, K, (1998), System dynamics, Prentice Hall International Inc., New Jersey, USA

Peraturan Menteri Pekerjaan Umum, 2013, No. 03/PRT/M/2013 tentang Penyelenggaraan Prasarana dan Sarana Persampahan dalam Penanganan Sampah Rumah Tangga dan Sampah Sejenis Sampah Rumah Tangga.

Undang-undang No. 18 Tahun 2008 tentang Pengelolaan Sampah.

Peraturan Pemerintah No. 81 Tahun 2012 tentang Pengelolaan Sampah Rumah Tangga dan Sampah Sejenis Sampah Rumah Tangga.

Peraturan Presiden No. 18 Tahun 2016 tentang Percepatan Pembangunan Pembangkit Listrik Berbasis Sampah untuk 7 Kota Besar.

Peraturan Presiden Republik Indonesia Nomor 58 Tahun 2017.