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1 Improvement of campus environment quality: the feasibility study of the University of Lampung integrated waste management

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Abstract. The University of Lampung is located 2 in the City of Bandar Lampung. Like many other cities in Indonesia, the city is still having difficulty in solving the waste problems. Meanwhile, the university generates waste of 14.7 tons per day (24.5 m³ per day). The waste produce at university commonly rich in organic content, which is has the potential to be processed into bio-methane. Answering the challenge of implementing a decentralization and zero waste policies, helping to ease the burden of government in handling waste as well as considering the potential of rich organic content of waste, the University of Lampung set up a plan to develop a campus community integrated waste management and carry out innovation in waste processing by utilizing a Biomass Power Plant (Pembangkit Listrik Tenaga Biomasa or PLTBM). The advantage of PLTBM is while converting organic waste into energy (electricity and gas), it produces solid and liquid fertilizer as its byproduct. This paper presents the feasibility study of the plan, specifically on technical aspect. The study was assessed by comparing the condition with and without project. The result of this study can be used by university stakeholders to take actions to make this plan work properly. The plan is expected to improve the campus environment quality, divert 80% of waste being dump into landfill as well as can be a pilot model for a wider communities.

1. Introduction

Municipal waste is a major problem due to volume increases over time as population and welfare increase. If the waste is not properly manage, it can be a calamity because it causes many problems including climate change. Despite there have been a number of initiatives, commitments and investments, policies and regulations are being implemented by the Local Government of Bandar Lampung to improve waste management, there are still many problems related to infrastructures, laws, level of service, etc. that need to be addressed immediately. In addition to this problem, the city municipal landfill – Bakung, also requires immediate improvement since it is still operated by utilizing an open dumping system, the location is not appropriate and may endanger the environment and society, inadequate buffer zones, and the capacity is approaching its limit.

On the other hand, Law No. 18 of 2008 on Waste Management requires community, industry, market, etc. to manage waste on the source. The law also mandates to abandon the open dumping method and adopting a decentralized-centralized management pattern (based on community or independent concept). The communal system is expected may solve waste problems thoroughly and sustainably.

In order to ease the government burden in handling waste problem as well as supporting the policy of independent waste processing at source, the University of Lampung is planning to develop a pilot for Campus Community Integrated Waste Management - The University of Lampung Recycling Center (hereinafter referred to as the University of Lampung Recycling Center). There a number of benefits of community-based waste management, the followings are the major benefits of implementing it at university level:

- Cultivate good ways of managing waste generates by the university.
- Utilize organic waste as raw material to generate energy (electricity and biogas) and to produce fertilizer (liquid and solid) as well as to divert waste of being disposed to landfill by up to 80%.
- Create a new business for the university.
- Thus, the objective of this study was to assess the feasibility and viability of the pilot project to be successfully implemented.

2. Research Methods

There are two approaches in the feasibility study, namely: before and after project method and with and without project method. To review the feasibility of the University of Lampung Recycling Center, the method utilized is to comparing the conditions with and without the project. Conditions with the project is the condition where the innovation/investment is done to improve the capacity of managing and processing of waste, while the condition without the project is the condition where no innovation/investment is implemented, except to only maintain the function of routine waste service. The scope of feasibility study includes: review on the existing condition of the study area, review on the campus infrastructure development planning policies, assessment on technical aspect, managerial, economy, marketing and environmental aspects. However for this paper, the discussion is limited to the existing condition, campus infrastructure development planning policies, and assessment on technical aspect.

3. Result and Discussion

This feasibility study of the University of Lampung Recycling Center was conducted in two months period (December 2017 to January 2018). The followings are the discussion of the findings:

3.1. The Existing Condition

The University of Lampung is the first and oldest state university in the Province of Lampung that currently is offering about 75 courses across 7 departments. The main campus of Gedong Meneng stands on an area of 62.8 hectares. Based on the latest census, the number of people attends the university every day is about 35,000 people. With the number, it is predicted that the waste produce is about 14.7 tons (24.5 m³) daily.

Currently there is no integrated waste management in the university. The management of waste is authorized by the General and Financial Bureau and daily waste handling is carried out by cleaners. All waste produced by the university is finally dumped to Bakung Landfill. The method of managing waste is still adopting the old paradigm of collect - transfer – dump. The existing waste infrastructure and facilities are inadequate and there is no special treatment of waste such as 3R (reduce – reuse – recycle). The awareness of campus community to separate and dispose waste in the correct bin is low as well as no rules established that may enforce it. This condition is exacerbate by the presence of illegal food hawkers that scatter all over the campus.

3.2. Infrastructure Development and Spatial Planning Policy

The University of Lampung realizes that infrastructure, facilities and utilities (hereinafter referred to as infrastructure) are major factors to ensure the university achieve its vision, mission and goals. The university also aims to be recognized as a sustainable green campus. In order to achieve those objectives, infrastructure needs to be developed continuously both in quantity and quality as well as

must be developed as a network system that integrate with each other, with the campus spatial planning, and with the city's network systems. The university also established a policy to maintain 60% of campus area as open spaces that consist of: green and blue (pools) spaces, sports fields and outdoor theater plazas. The following figures are campus map and aerial view:



Figure 1. Map and Aerial View of the University of Lampung Campus Spatial Planning [1]

In order for the infrastructure is developed properly, a new unit called the Office of Infrastructure Planning and Green Metrics (BPI and Green Metrics) is established. Since the university recognizes that sustainable green campus and waste management are closely link, waste infrastructures have been included in the infrastructure development agendas. The university is also considering to establish a sub-unit under the office that will manage day to day activities of the University of Lampung Recycling Center. Furthermore, the management of waste will also adopt the new paradigm of zero waste (destroyed - conversion of waste).

3.3. The Review on the Feasibility of Technical Aspects

Indonesia is a country that has the largest biomass potential in the world, however its potential has not been fully utilized by government and community. In fact, with proper processing, biomass can produce three things at once namely electrical energy, fuel, and organic fertilizer. One source of biomass is waste since it has a high organic content.

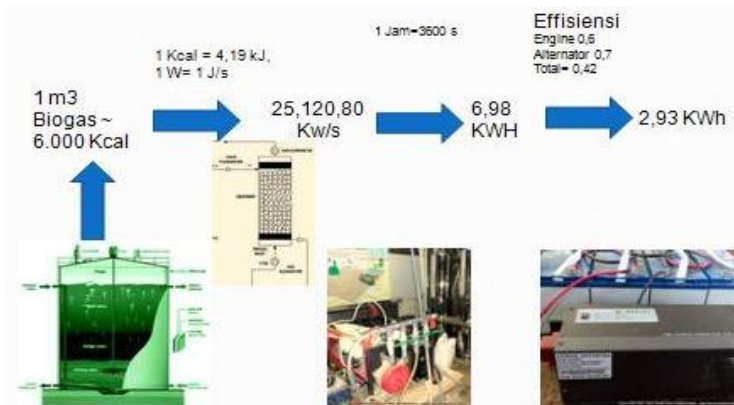


Figure 2. Conversion of Biogas into Electricity [2]

Based on the study carried out by Damanhuri and Padmi [3], the organic waste content of Jakarta and Bandung is about 74%. Since the City of Bandar Lampung has similarities in many aspects with Jakarta and Bandung, it can be assumed that the organic waste content of the city - in this case the

University of Lampung, is similar to those two cities. Assuming 60% of waste produce daily by the university to be organic matter, then the amount of organic waste per day is about 8.83 tons. With the potential calorific value of 1,000 – 1,300 k.cal/kg, the waste has a potential calorific value of 8,830,000 k.cal. which has the potential to generate electricity of 4,312 kWh. Figure 2 shows the process of converting biogas into energy.

3.3.1. The Biomass Power Plant (PLTBM) Technical Feasibility

Biomass or solar energy stored in biological material is a source of renewable energies. This solar energy can be revived and converted into bio-methane (pure biogas). Subsequently, biome-thane can be utilized as fuel to rotate generator or turbine to produce electricity. Bio-methane can also be used as gas fuel for stove. The biomass generation process on biological materials produce by product or waste of economic value in the form of solid and liquid organic fertilizer.

One method that can be used to process biological materials to generate biomass and produce bio-methane is PLTBM. It is the most profitable method comparing with other methods of generating new renewable energies since the investment cost of PLTBM divided by energy output unit is the cheapest and most profitable. This makes PLTBM favourable to be utilized as a part of the University of Lampung Recycling Center.

The utilization of a fiberglass digester material, the creation of methane-generating bacteria activators such as GP-7, and the utilization of biogas purification devices (to separate carbon dioxide, hydrogen sulfide (H₂S) and other gases that can decrease the quality of methane gas in biogas) produce pure biogas (bio-methane). This bio-methane then can be used as fuel substitution. A mini PLTBM can process 150 kg of biomass into 6 m³ of bio-methane and 300 liters of liquid organic fertilizer per day. Six m³ of bio-methane can fuel 6 kWh/6 KVA generator to produce electricity for 6 hours. When it is used to fuel gas stove, it is equivalent to energy of 2.88 kg of LPG gas. The university are planning to utilize the electricity and gas generated from the PLTBM for Students Dormitory Flat and the fertilizer for maintaining gardens throughout the university. The following figure depicts the process of converting organic waste with PLTBM.

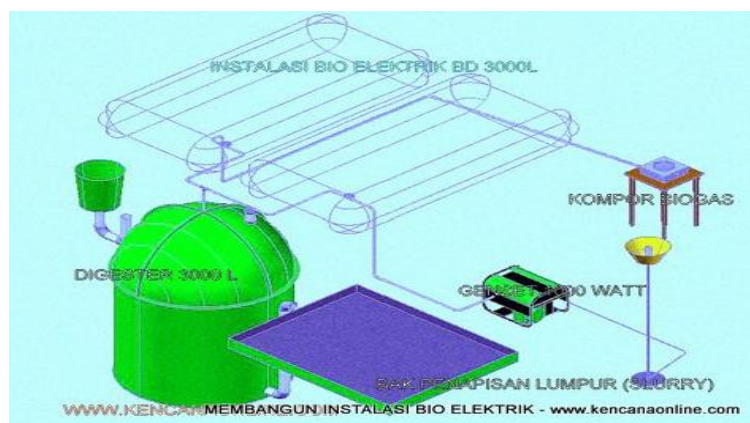


Figure 3. The Scheme of Processing Biomass into Electrical Energy [2]

3.3.2. The Review on Other Aspect

Other aspects assessed also showed positive results, among others are:

- Marketing: Since agriculture is one of major products of the Province of Lampung, market for fertilizer is promising. The fertilizers produced can be polished in aspects of quality, appearance, packaging and branding to increase its selling power.

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- Economics: The utilization of PLTBM unit is one alternative solution that is easy and cheap amid energy and natural resources crisis. It can save the cost of electricity and gas consumption as well as save the cost of dumping waste to the landfill.
 - Environmental: Methane (CH₄) is 21 times more harmful than CO₂ released by vehicles and factories. 40 m³ of methane gas releases 280,000 kcal. to the atmosphere that potentially increases the global temperature by one centigrade. By avoiding a considerable amount of methane gas per day releases to the environment is a great effort to improve the environment quality.

4. Conclusion and Recommendation

In brief, the feasibility study of the the University of Lampung Recycling Center has shown a potential to be successfully implemented. It is recommended that the followings program must be included in the pilot project: campaign of sorting waste as a 'lifestyle'; establish enforcing rules and monitoring system; improve the quality of staff responsible in managing and handling waste; organize activities (campaign, exhibition, competition, cooperative, etc.) to increase awareness, willingness, and participation of the campus community to actively involved in 5 R activities (reduce, reuse, recycle, recover and rest) and; inserting material about waste management into courses elements, etc.

It is expected this innovative solutions of the University of Lampung Recycling Center will successfully solve the waste problems at the University of Lampung. It is also expected in the future, this solution can back-up the power-gap supplied by the country power supply company. The campus community (civitas academica) also has a great potential as an agent of change that can be a role model for a wider community. Therefore, this pilot project of communal pattern or independent concept in waste management can be a great strategy. When the project is successful, it can be easily accepted by communities and can be replicated to a wider community.

2. Acknowledgement

The study was conducted with the grant supported by the University of Lampung.

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