Eco-Biger (Ecopreneur Biodigester) is Right Digester Innovation for Household to Increase People’s Welfare in Indonesia

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Abstract. Indonesia could produce 13 million organic waste, even this makes the potential of methane gas can be biogas and even its slurry can be composted too, people who are indifferent to it. Therefore, Eco-Biger innovation is required that maximizes the potential of organic waste even Eco-Biger is able to educate people to reduce the use of fossil energy and technology-based. The purpose of writing this scientific paper is (1) to find out how Eco-Biger works, (2) to know the strategy of realizing SDG's appropriately through Eco-Biger, and (3) to know Eco-Biger implementation technique. The method used is research R&D (research development) with data collection techniques that is, observation, literature study and interview with recipient kalpataru in Pasuruan. The results is; (1) organic waste is fed through the input hose on Eco-Biger, then the waste will be fermented and produce methane gas and the gas will be piped through the installation pipe for use; (2) Eco-Biger transforms organic waste into biogas. It supports the 7th and 13th goals of SDG's on clean and affordable Energy and climate change mitigation. and (3) Implementation, production, testing, cooperation with stakeholder and distribution, socialization, training user, and evaluation.

Keywords. Biodigester; GDP, SDGs

1. Introduction

Indonesia is the second largest garbage producing country in the world [1]. Garbage is divided into two, namely organic waste and inorganic waste. Both cause enormous environmental problems. Organic waste can rot and produce methane (CH4), carbon dioxide (CO2), etc. These gases can pollute the air and even methane gas can damage ozone 25 times stronger than carbon dioxide [2]. However, behind the impact of organic waste also has enormous potential in realizing sustainable energy security and climate change handling, namely by biogas.

Java Island is the smallest island among the five major islands in Indonesia as the highest producer of waste [3]. Overall, Indonesia produces 65 million tons of garbage per year with organic waste
composition having 60 percent of total waste in Indonesia or worth 39 million tons per year [4]. Organic garbage such as rotten fruits, rotten vegetables, stale rice and so on are not widely utilized, but left to accumulate and decompose to disturb the landscape and pollute the environment, especially in urban areas. In fact, some people in Jakarta are cultured to buy food for disposal [4]. Scientifically organic waste produces flammable methane gas, and waste material from the use of biogas (slurry) can be used as a fertilizer that is useful to fertilize plants, in addition to bioslurry does not contain odor and not inviting flies. During this time, biogas utilization using biodigester is limited to large scale breeders because the manure from livestock produces quite a lot of methane gas as a biogas producer and occupies a large space and is only available in rural areas this makes its use limited to large installations. The use of biogas in urban areas is still difficult to realize because of the limited space in urban areas, for that in this issue obtained the idea for the use of biogas that can be used in urban areas using organic waste generated houses in urban areas by mini-tube reactor method which can be placed in a fairly narrow space such as in urban areas. Its application is directed to the entire community in order to benefit from renewable energy and support the increase of renewable energy and reduce the use of natural gas that is a component supporting Green GDP in Indonesia that care for the environment.

Nowadays, biogas has been realized on a large scale, but in urban areas it is difficult to develop whereas urban areas have tremendous potential of waste. Therefore, it is necessary to have "Eco-Biger (Ecopreneur Biodigester) is Right Digester Innovation for Household to Increase People’s Welfare in Indonesia”.

2. Data and Method

This research is a type of research and development or Research and Development (R&D). According to [5] research and development is a research method used to produce a particular product and test the effectiveness of the product. The research entitled "Eco-Biger (Ecopreneur Biodigester) is Right Digester Innovation for Household to Increase People’s Welfare in Indonesia" is a research development because researchers produce a product in the form of Eco-Biger design. Making this design by way of making models and excavations from various literature.

The focus in this research is Eco-Biger innovation. In order to deepen the focus of this research will use qualitative and quantitative methods. Qualitative and quantitative research was chosen because this research is a design in the form of an idea model and the calculation of the energy produced. Qualitative research has a purpose to explore in detail about how the relationship of ideas with the basic theory and existing data. In the context of the research to be studied, the main focus of this research is the form, function and effectiveness of Eco-Biger.

Data collection techniques in this study include the following.

a. Observation Technique, this technique is used to see the conditions of digester that can be applied in the field at this time. This technique was carried out on July 2017 in Gendro Village, Nongkojajar Subdistrict, Pasuruan Regency with guidance by Mr. H. Hariyanto as environmentalist and recipient of Kalpataru in environmental saver.

b. Literature study, this technique is used to search various theories about waste, renewable energy, biogas, and SDG’s. The theory used in this research is taken by searching the journal, books, as well as other literacy sources about piezoelectric modules, bags, and how to stretcher efficiency.

c. Interview technique, this technique is used to extract information from several experts, for example experts in the field of renewable energy, especially biogas. Person data collection techniques are used for the addition of literature through interviews with recipients of Kalpataru for their services in saving the environment through biogas, namely H. Harianto on how to make biogas and biodigester efficiency.

Analysis is the process of investigating an event to find out the real situation, or the problem-solving activity that begins with its alleged hyperbole. The analytical method used in this paper is descriptive analytic, which is descriptive-oriented problem-solving. Analysis of problems obtained from literacy and identification results is based on a theory or relevant scientific concept. The author raises
environmental issues and sustainable energy resource and provides new ideas of biodigester technology with innovation and efficiency.

3. Result and Discussion
The results of data mining with interview technique and literature study by writer do obtained Eco-Biger design seen in Figure 1.

![Eco-Biger with its dimensions](image)

The design of Eco-Biger is based on its efficiency so that the resulting gas is not wasted and can function optimally. Characteristics of Eco-Biger has a shape almost like a tube but there is a dome above it, Eco-Biger has an overall height of 850 mm with a diameter of base of 500 mm and diameter and dome height of 700 mm and 200 mm. With a height of less than one meter and a diameter of 500mm dung shelter that can accommodate as much as 98 liters of dirt or 74 kilograms of impurities. Eco-Biger has two doors where the doors are used to insert the dirt and remove any residual waste that the CH₄ compound has lost out of Eco-Biger (output). In this Eco-Biger design has a dome to accommodate CH₄ methane gas resulting from the fermentation of dirt present in the base of Eco-Biger. This dome is semicircular with a height of 200 mm and a width of 700 mm or bias is expected to accommodate 100 liters. At the top of the dome the Eco-Biger design has a pipe that serves as an outlet of CH₄ methane gas formed from the fermentation process at the base of Eco-Biger.
Figure 2. Design of Eco-Biger according to its parts

Based on the order of use, the design of the digester above has the following functions:

1. **Input**, the input door in the picture above serves as an entrance hole from the previously collected organic waste.
2. The room digestion & sludge sediment, has a function as an organic waste container that was previously incorporated and the waste that has been processed into biogas.
3. **Sludge channel (output)**, the output door on the picture serves as a hole out of the processed organic waste.
4. **Dome** The dome of the digester has a function as a biogas reservoir, and the dome is made somewhat wide in order to make the biogas produced more and avoid the waste gas passing through the input or output.
5. **Gas Outlet & Access**, is a gas outlet which is then connected to a hose to be supplied to the stove.

Instructions for using Eco-Biger by preparing all tools and materials and following these instructions:

a. Tool
   Eco-Biger

b. Material
   Organic waste and water in a ratio of 1:1. Organic waste in question is waste that can be decomposed or easily decomposed by bacteria. Organic household waste is very rich in water content, so that biogas can be optimized so that the soil type of soup or non soup first dumped water and then can be incorporated into Eco-Biger. Trashes that can be put into Eco-Biger include animal bone waste, household waste such as vegetables, rice, meat, etc. either that have been decomposed or that have not been eaten.

c. Steps for using Eco-Biger:
   1. Flow the hose according to the gas burning installation.
   2. Solid organic waste with inorganic waste, if organic waste does not contain water then given water according to the weight ratio of 1:1.
   3. Enter the organic waste along with the water (if necessary) through the input hole. For the first entry, 50 kg of garbage is needed.
   4. After entering organic waste, wait up to 2-4 weeks.
   5. Within 2-4 weeks, organic waste can still be incorporated into Eco-Biger.
   6. Biogas can already be flowed in accordance with biogas burning installation.
7. Open the output to take the remaining or slurry and this slurry includes compost or organic fertilizer.

3.1. How Eco-Biger Works

The principle of Eco-Biger work is dirt that enter into it through the input will experience a heat reaction which will produce methane gas or biogas that we know. Basically, Eco-Biger has many outputs such as biogas and compost. The first result in biogas is methane gas then when a dirt has run out of methane gas it will become compost.

![Eco-Biger Workflow Design](image)

Biological process of biogas formation through three stages of hydrolysis stage, acidification stage, and stage of methane formation. The hydrolysis stage, organic materials containing cellulose, hemicellulose and extractives such as proteins, carbohydrates and lipids will be broken down into shorter chain compounds. As the polysaccharides harmonize into monosaccharides the proteins break down into peptides and amino acids. At the hydrolysis stage, microorganisms that play an extra cellular enzyme such as cellulose, amylase, protease, and lipase.

After going through the hydrolysis stage, it goes into the acidification stage where the bacteria will produce acids that will serve to convert the short compound of the hydrolysis product into acetic acid (CH₃COOH), H₂, and CO₂. This bacteria is an anaerobic bacteria can grow in acid state, ie with pH 5.5-6.5. These bacteria work optimum at temperatures around 30°C. In producing acetic acid, the bacterium requires oxygen and carbon obtained from dissolved oxygen in the solution. For evenly occurring metabolism, good mixing is needed with a water concentration of > 60%. In addition, the bacteria also convert low molecular compounds into alcohols, organic acids, amino acids, CO₂, H₂S, and a little methane gas. In this process will form methane gas. The formation of methane gas, where the bacteria that act is the bacteria methanogenesis. Methane bacteria include methanobacterium, methanobacillus, methanosacaria, and methanococcus. This bacterium requires a condition of digester that is completely airtight and dark. The temperature at which the bacteria works optimum is at 35 °C and is sensitive to temperature changes of about 2-3° C. The pH range is 6.5-7.5. At the end of metabolism is produced methane and CO₂ from H₂ gas, CO₂ and acetic acid produced at the acidification stage. Eco-Biger requires about 50 kg of organic waste in accordance with the ratio of organic and water waste, namely 1:1. This organic waste weighing 50 kg is needed for starter biogas, this is done with the aim to provide the number of biogas-producing bacteria ranging from bacterial fermentation to methanogenesis. If Eco-Biger has a large number of bacteria, then by re-entering the dirt it will speed up the process of forming methane. Slurry or the remaining dirt that has depleted its methane gas will have an odor that is not even like the previous waste. This slurry can be used as organic fertilizer. The process of removing the slurry in the presence of pressure from new dirt which is higher then pressed down and the bottom also pushes the garbage up in the gap so that the slurry can go out to the Eco-Biger output door [6].
3.2. The realization of SDG’s through Eco-Biger

Eco-Biger aims to reduce the amount of organic waste that is not utilized by the community, due to their busyness or unwillingness of urban and rural communities in processing waste. Most of the waste generated by the community is only discarded or burned, but this only eliminates the garbage effect at this time, people do not think about what will happen if they do it continuously. The garbage they waste will result in pollution in the form of odors and causes of floods, and the burning effects of waste can cause damage to the ozone layer. With Eco-Biger, people are expected to utilize the organic waste they produce by converting it into biogas by digestion process in Eco-Biger which then they can use the result of digestion in the form of biogas as fuel for cooking. The use of organic waste into biogas can reduce the volume of wasted waste which can indirectly reduce the amount of methane gas (CH$_4$) which causes the ozone layer to thin out. Biogas is economically able to reduce the cost of using LPG gas and waste output (slurry) can be used as a useful fertilizer for plants. The use of organic waste used as biogas material is also in accordance with the objectives of the seventh SDG Fact Sheet with Clean and Affordable Energy Objectives (Ministry of Energy and Mineral Resources).

Biogas can be used for various purposes, including:

a. Gas fuel sources are used for household stoves, lighting, water heaters, etc.
b. Fuel source gas to produce heat that can be used for various purposes eg water heater, air heater, and water heater.
c. Gas fuel source to drive combustion motor, turbine, and other then torque obtained can be used to move the pump or other machines.

Theoretically can be made a general prediction that [7]:

a. For cooking purposes, 1 person per day requires as much as 0.1 to 0.3 m$^3$.
b. For lighting (petromax lamps), the average requires 0.1 - 0.15 m$^3$ per hour. Another opinion says that 1 m$^3$ can be used for lighting that is comparable to a 60-100W lamp for 6 Hours.
c. To replace gasoline fuel required 0.7 kg as much as 1 m$^3$.

Based on the estimation of biogas production from the type of dirt to vegetables have biogas production of 0.03-0.04 m$^3$ per kilogram. If Eco-Biger performance is optimized with daily income of at least 1 kg then it can be a night light and there are some leftovers to become fuel for cooking, so Eco-Biger is optimum in realizing SDG’s.

Indonesia is committed to launching Green Economy concept, and Indonesia has started using Green GDP concept which is calculated based on environmental depletion and environmental degradation, with low depletion and environmental degradation level and high enough GDP level, so the development can be said optimally. The future of Indonesia's energy security and the role of renewable energy in its contribution to Indonesia's energy security is a great hope in supporting the availability of energy as the energy supply from the earth begins to fall. And the application of Eco-Biger supports the concept of Green Economy Development which takes into account the ecological aspect in it, because currently Indonesia needs a lot of green investment that needs to be applied in the market stimulation in society through government assistance and innovation from society.

3.3. Eco-Biger Implementation Technique

Eco-Biger is a container or digester that serves to store materials in the manufacture of biogas as well as a container of biogas that has been produced. The target audience of Eco-Biger is urban communities and small-scale livestock breeders.

The urban community is chosen for the purpose of educating the community to participate in the processing of waste 3R, the minimum result of the urban community that is obtained is able to sort the garbage to be further processed either by the institution that handles the garbage. Today, urban society
is considered very wasteful of energy both electricity, fuel, and tend to be lazy in processing waste generated. Eco-Biger can improve the culture of the people to pay more attention to the current nature and have the opportunity to preserve nature amid the busyness.

Farmers and rural residents are also being targeted by Eco-Biger, this is because the raw materials used by Eco-Biger are available there, just as animal dung is found in livestock areas that can be used for gas feedstocks. When a farmer is faced with a problem, namely the lack of energy supply, the community cuts down the trees even though their livestock products can also produce energy in the form of biogas. However, in the manufacture of biogas with large-scale installation requires even tens of millions. The small community also will not be able to make it because of lack of facilities. Eco-Biger price ranges from Rp. 525.000,-, with this price is very easy to reach by society either middle to middle economic aspect or middle upward. This price is detailed as follows; the price of materials starting from the frame, dome, input valve and output for Rp. 375.000,-, then the manufacture or installation of materials to become Eco-Biger charged Rp. 75.000,-, besides need registration fee of brand or patent Rp. 20.000,- and the remaining Rp. 55.000,- is used for socialization and training of Eco-Biger usage.

We direct this tool to be a sociopreneur because we assume that this tool is more concerned with the needs of the community and to educate the public to be more concerned, insightful, and cultured environment. Based on the objectives Eco-Biger goal will be implemented by the following techniques:

a. Producing is done by combining ideas and interview results, literature studies, and observation techniques. This is done to improve the efficiency of the tool and the quality of the implementation of this tool. Meanwhile, the results of research from Mr. Hariyanto are very helpful and support the implementation of this tool.

b. Product testing was conducted by the evaluation team of both lecturers and renewable energy experts. This is done with the aim to evaluate the performance results of biogas and compost making so that at the time of implementation there is no error.

c. Collaboration with relevant agencies for mass production of Eco-Biger This collaboration is carried out with the Ministry of Energy and Mineral Resources, Ministry of Environment, PT Indonesia Power, Tank Factory and Regional Government. This is done to create continuity in the implementation of this tool in order to be targeted and directed goal.

d. Product socialization in the targeted community is done to the society in urban by structured way from poster and banner installation both in housing and others, then conducted socialization about Eco-Biger and make policy to participate in the effort of saving the environment hence Eco-Biger work. Community organizations, both residential and others who have been trained, can then coordinate the use of Eco-Biger more optimally in other communities. Product socialization in rural communities is done by first approaching and then petrified some people who are very less able to use Eco-Biger and the people who are given this assistance serve as a reference and the driving force in the implementation of Eco-Biger because in principle the rural community more imitate or imitate something that became a trend at that time. So, hopefully Eco-Biger can be a large influence to educate rural communities while helping to equalize energy needs in Indonesia.

e. Community product training is provided by experts in the use of Eco-Biger as well as motivators to the community for more optimal use of the tool. This training is based on the smallest areas such as housing or village or hamlet so that the training can run smoothly and Eco-Biger users can optimize the performance of Eco-Biger.

f. Evaluation of the results of Eco-Biger use was done directly by the community after the using Eco-Biger. Our hopes cannot be used on communities such as useless tools, unusable, but we can accommodate by continually checking and monitoring and contributing to communities that maintain an environment that can benefit the people.
With this implementation technique, Eco-Biger can be well realized because many of the government and private companies have the same goals that can improve the welfare of their people and also increase community participation to maintain the environment.

4. Conclusions
Based on the above results and discussion can be concluded as follows; (1) Organic waste is fed through the input section of Eco-Biger, then the waste will be fermented and produce methane and compost out at the output, and the gas accumulated on the Eco-Biger dome will be piped through the installation pipe for use. Dirt in Eco-Biger reacts with the fermentation stage, hydrolysis stage, and methane gas formation stage; (2) Eco-Biger is a waste collection tool that can make the efficiency of biogas production, biogas is a renewable alternative energy source. SDG's has one goal of ensuring access to affordable, secure, sustainable and modern energy for everyone; and (3) Implementation technique that is, product production, product trial, product socialization and cooperation with company and government for mass production and its distribution. The goal of Eco-Biger is in urban and rural communities. People can use this tool because the cheap price is around Rp. 525.000, - so it can be used either society with middle to lower economy upwards.

References
[1] Aminah A N 2017 Wali Kota Palembang Resmikan Bank Sampah RS Mohammad Hoesin, (http://nasional.republika.co.id/berita/nasional/daerah/17/03/15/nasional/daerah/17/10/16/oxxag5384-wali-kota-palembang-resmikan-bank-sampah-rs-mohammad-hoesin)
[2] Russell G, Singer P and Brook B 2008 The Missing Link in The Garnaut Report (https://www.theage.com.au/politics/federal/the-missing-link-in-the-garnaut-report-20080709-3cjh.html?page=1)
[3] BPS-Statistics Indonesia 2017 Environment Statistics Indonesia (Jakarta: BPS-Statistics Indonesia)
[4] Kresna M 2017 DKI Hasilkan 4 Ribuan Ton Sampah Makanan Per Hari (https://tirto.id/dki-hasilkan-4-ribuan-ton-sampah-makanan-perhari-cjti)
[5] Sugiyono 2012 Metode Penelitian Kuantitatif Kualitatif dan R&D (Bandung: Alfabeta)
[6] Suyitno M N and Dharmanto 2012 Teknologi Biogas: Pembuatan, Operasional, dan Pemanfaatan (Yogyakarta: Graha Ilmu)
[7] Uli W, Ulrich S and Nicolai H 1989 Biogas Plants in Animal Husbandry (Germany: GTZ)

Appendix
Biodigester: Tank for organic waste, anaerob reaction, and gasses.
GDP: a monetary measure of the market value of all the final goods and services produced in a period (quarterly or yearly) of time
SDGs: Sustainable Development Goals