Planning of Biogas Power Generating Systems In Sakai Tongonong Cattle Farm

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Abstract. The Sakai tribe is a tribe that originally lived in the interior of Riau. With the arrival of the oil and gas industry, this tribe began to live side by side with migrant communities. One of the Sakai tribes who are trying to meet their food needs is the Sakai tribe who are in Tongonong Perbathinan, located in the Tengganai village area, Tepi subdistrict, Duri. They have raised cattle, the number of cattle they breed is 22 cows. This group has 20 members, the cattle being bred are classified as fattened cattle or stable cattle. Cow dung has not been utilized, causing unpleasant odors and accumulation of cow dung. The potential of cow dung when used is quite extraordinary, such as processing cow dung into biogas and biogas into electrical energy. This research will carry out planning for the potential electrical energy that will be produced from 22 existing cattle as well as the need to make this happen as well as the design or placement of equipment that is appropriate and safe for farmers. Based on the calculation results, 22 cows will produce 20.68 m^3 of biogas and can produce 25.64 kW of electricity per day or 1.06 kWh.

Keywords: Cow Dung, Biogas, Electricity, Benefits, Savings

1 Introduction

Batin Tongonong is an area in the Batin 8 & 5 Sakai area that has tried raising cattle for fattening cattle to accelerate the economic recovery of the residents of Batin Tongonong District. The suburbs are affected by the Covid-19 pandemic and increase food security by cultivating and fattening cattle. One of the follow-ups to cattle fattening activities is the management of cattle manure waste into biogas which is more useful and abundant in energy [1][2].

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Figure 1. Condition and Location of Cattle

The use of electrical energy and gas for cooking, lighting and other things is something that cannot be eliminated in our current society so that people's living costs for energy have become high, especially during the past Covid-19 pandemic where the need for energy use has greatly increased due to learning. and work is done from home to reduce the spread of Covid-19. Even though the government's policy regarding converting kerosene to gas due to the lack of energy reserves and being more economical has been implemented for a long time, people sometimes have difficulty getting subsidized gas to use for cooking. If they buy non-subsidized gas, people feel that non-subsidized gas is quite expensive. To meet daily needs, a solution is needed, one of which is looking for alternative energy (biogas) based on a household scale that is environmentally friendly, especially for cattle farming communities. Various relevant research has been carried out to find new alternative energy sources that are cheap and environmentally friendly, including Biogas Power Plants.

Biogas Power Plant is a new alternative energy that is not only easy to operate and maintain but also environmentally friendly [3]. Based on the description above, we intend to propose research, namely Planning a Biogas Power Plant System at Sakai Tongonong Cattle Farmers, based on data we obtained from Batin Tongonong Cattle Farmers, they have 22 cows in one group, they have 20 members. The amount of cow dung produced is quite large, although some of it is used as fertilizer for palm oil plants, but the dung lying around is sometimes difficult to dispose of. Cattle are generally bred to be sold during the festival of sacrifice so that the dung produced is always there because the cows are always in the pen (fattening). If the cow dung is not processed, it can also pollute the environment in the form of an unpleasant odor carried by the wind into the air. Our hope is that in the future, Tongonong cattle breeders will be able to utilize cow dung into biogas for cooking and into electricity for the lighting system for the breeders themselves so that the cow dung becomes economically valuable and useful for saving costs on cooking and lighting systems [4][5].

Based on the description above, the problem faced by the community is how to use cow dung which has not yet been utilized into biogas or electricity. To realize this problem, it is necessary to study or plan the energy potential of cow dung waste as well as the appropriate costs and placement so that farmers can get a better picture and plan if they want to build a biogas power plant system [6][7].

2. Literature Review

Fermentation activity or anaerobic microorganisms from organic materials such as animal waste such as cows, organic waste will produce biogas [8]. Biogas formation occurs as a result of a series of processes including hydrolysis, acidogenesis, acetogenesis and methanogenesis. Biogas technology has quite promising prospects at present, because biogas raw materials are widely available in society, especially people who work as farmers or livestock breeders. The livestock manure produced can be used to produce biogas [9]

Each head of cattle or buffalo can produce 10 kg of manure or feces which is equivalent to + 2 m^3 of biogas per cycle (20-21 days). Of course, cow dung has enormous potential when processed like biogas[10] . This certainly helps the community in utilizing cow dung waste into biogas energy and even electricity. Biogas is the end product gas of anaerobic digestion or degradation of organic materials by anaerobic bacteria. The largest components (main constituent) of biogas are methane (CH_4, 50 - 70%) and carbon dioxide (CO_2, 30 - 40%) [11]

Table 1. Biogas Content

Component	Percentage %
Methane (CH_4)	50-70%
Carbon dioxide (CO_2)	30-40%
Water (H_2O)	0,3%
Hydrogen sulfide (H_2S)	Very little 1- 2%
Nitrogen (N_2)	5-10%

The energy contained in biogas depends on the concentration of methane (CH_4). The higher the methane content, the greater the energy content (heating value) of biogas, and conversely, the smaller the methane content, the smaller the heating value. Biogas quality can be improved by treating several parameters, namely removing sulfur hydrogen, water content and carbon dioxide (CO_2). Hydrogen sulfur contains toxins and substances that cause corrosion, if biogas contains this compound it will cause dangerous gas so the maximum permitted concentration is 5 ppm. If the gas is burned, hydrogen sulfur will be more dangerous because it will form new compounds together with oxygen, namely sulfur dioxide / sulfur trioxide (SO_2 / SO_3) [12]. This compound is more toxic.

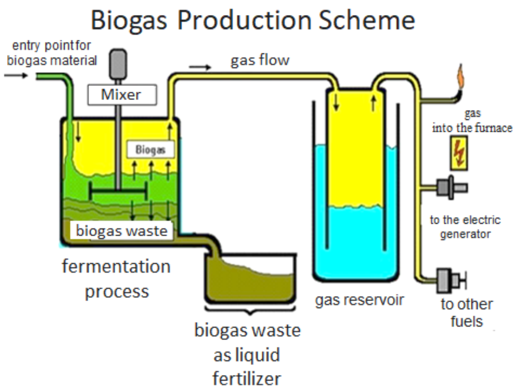

Figure 2. Biogas Production Scheme

3 Research Methods

The research method used in this research is:

a. Data collection methods
   In this research, the author uses field data, namely the potential for cow dung produced by livestock breeders as raw material to be used.
b. Data processing methods
   Calculation of the potential electrical energy that can be produced as well as calculating the capacity of the digiester tube to be built and its position and taking into account the existing impacts and potential.
c. Data analysis
   The analysis takes the form of calculations and efficiency as well as the placement of biogas processing equipment and how the energy produced is maximized so that results can be obtained that can illustrate the potential, obstacles and challenges in implementing biogas power plants for tongonong cattle breeders.

4 Results And Discussion

4.1 Biogas Potential in the Fajar Pagi Tongonong Livestock Group

The cow dung used as raw material for producing biogas in the Fajar Pagi Perbatinan Tongonong livestock group located on Jalan Lintas Duri-Pekanbaru, Tengganau Luar, Bengkalis Regency is cow dung which they have, namely 22 cows, if 1 cow can produce 25 kg of dung then 1 cow can produce 0.94 m3/day of biogas, so if calculated, the biogas produced from the cattle farm is 20.68 m^3/day.

It is known that 1 m^3 of biogas can generate 1.24 kWh of electrical power [13] so that 20.68 m^3 of biogas can generate energy of:

Energy amount = volume of biogas x energy generated per m^3
= 20.68 m^3 x 1.24 kW
= 25.64 kW per day

Power = 25.64 kWh : 24 Hours
= 1.06 kWh

So theoretically the amount of biogas energy in the Fajar Pagi Perbatinan Tongonong livestock group located on Jalan Lintas Duri-Pekanbaru, Tengganau Luar, Bengkalis Regency is 25.68 kW per day with the power produced being 1.06 kWh.

4.2. Biogas Generator

To generate electrical energy, a biogas fueled generator is used. The specifications for biogas generators that can be used are:

Figure 3. Biogas Generator Set

Table 2. Biogas Generator Set Specifications

Features	Single Cylinder
	4-Stroke
	OHV
	Force Air-Cooled
	Single Phase Ac Synchronization with Brush Alternator
AC Voltage	230V
AC Output/Max	Running Power : 1200 watt
	Peak Power :
Frequency	50/60 Hz
Starting System	Recoil Start/Electric Start
Fuel	Biogas
Fuel Capacity	0.55 Liter
Weight	65 Kg
Other	Min. Fuel Consumption : 1.46m^3/hour

Assuming the biogas generator will be operated 24 hours a day, the output energy from this biogas-based power plant is:

Energy = Power x Time
= 1200 watts x 24 hours
= 28,800 Wh.

The capacity of a digester with a power of 25.64 kWh or 25,643 watts is not sufficient for a generator with a capacity of 1200 Watts. If it is known that the generator engine has a capacity of 1,200 watts with a digester capacity of 25,643 watts, then the digester can hold gas for more than one day or for 1.23 days so that the power capacity produced is 25.64 kWh: 24 hours = 1.06 kW or 1,068 watt.

The biogas needed to run the generator for 24 hours based on the minimum biogas consumption stated in the generator specifications (1.46m3/hour) is = 24 hours x 1.46m3/hour = 35.04m3/day. Meanwhile, the gas produced by 22 cows was 20.68 m^3 in 24 hours. So the process of forming biogas to drive a generator of at least 35.04 m^3 for 24 hour use, takes 35.04 m^3 : 20.68 m^3 = 1.69 days so it is not sufficient for a full day's use. The length of time the generator operates for a biogas volume of 20.68 m^3 can be determined using the following calculation:

Biogas production volume: biogas for generator = 20.68: 1.46 = 14.16 days

4.3 Biogas Based Power Generation System Design

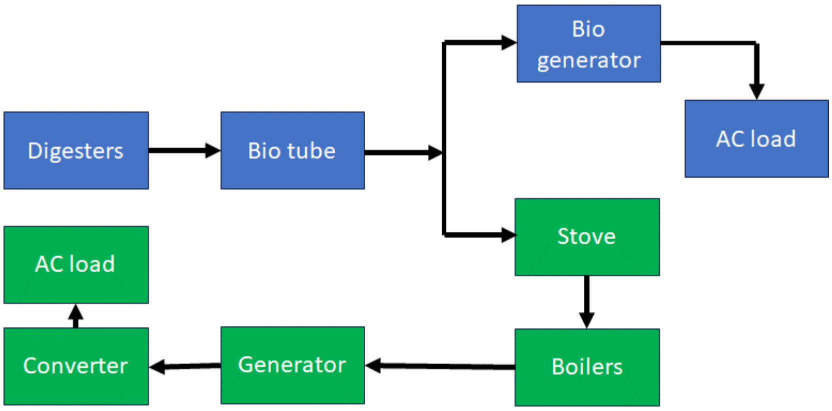

Figure 4. Scheme of Biogas Power Generation System

Based on Figure 4, it can be explained that the digester is a place for biogas production. The biogas is then directed to the biogas cylinder reservoir. Biogas can be used as fuel for 'Biogas Generators' which will then generate electricity for AC loads. And/or biogas from the biogas cylinder is used as energy to light the stove fire which will then heat the water in the boiler. Water that has been heated will create steam and pressure so that it can drive a generator. From the results of the generator rotation, it creates a DC current which will then be used as AC current by the converter and can then be distributed to the AC load (lights).

Table 3. The generator component specifications

No	Component	Specification	Volume	Price (Rp)
1	Digester	Type : *fixed-dome*/ 2.000kg (capacity) Materials: brick and cement mortar	4 units	6.000.000
2	Bio Tubes	Type: water reservoir (145m^3) Material: plastic	1 unit	3.000.000
3	Bio generator	AC voltage : 230 V AC out/max : 1,2 kW (running power), 1,3 Kw (peak power) Frek : 50/60 Hz Fuel : Biogas/0,55 liter (capacity)	1 unit	5.000.000

Investment costs are the initial costs incurred to complete the facilities and infrastructure to realize a project. When constructing a biogas installation, investment costs are incurred in full at the start of the project. In general, the economic life of a biogas installation is 15 years.

Table 4. Estimated Investment Costs for Installing a Biogas-Based Power Plant

No	Description	Volume	Unit	Price (Rp)
1	Biogas Installation	1	Unit	9.000.000
2	Generator Sets	1	Unit	5.000.000
	Total cost			14.000.000

Operational costs generally consist of labor costs and maintenance costs, which include, among other things:

a. Water to clean and mix dirt in the digester.
b. Supervision and maintenance.
c. Storage and disposal of dry waste.
d. Administration.

Table 5. Estimated Operational and Maintenance Costs for Biogas Plants

No	Description	Volume	Unit	Nominal/month (Rp)
1	Employee Salary	2	People	1.200.000
2	PAM Costs	1	Unit	500.000
	Total cost			1.700.000

5 Conclusions

From the research conducted, it can be concluded that:

a. The Fajar Pagi Perbatinan Tongonong livestock group located on Jalan Lintas Duri-Pekanbaru, Tengganau Luar, Bengkalis Regency has a population of 22 cows with the potential to produce 20.68 m3 of biogas with a potential of 25.64 kW per day of electrical energy and a power output of 25.64 kW per day. 1.06 kWh
b. The selection of a biogas generator set with a capacity of 1.2 kW is not suitable for use as a machine for converting biogas energy into electrical energy in simple generating systems but lower power is less effective
c. A simple generating system (Digester-biogas-1,200W-electric Biogas Generator) which is assumed to operate 24 hours a day can generate energy of 1.06 kWh

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