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Abstract. The purpose of this study is to analyze the factors that influence the use of dairy cow dung as a source of biogas energy in Gogik Village, West Ungaran District. In this study, the method used is a qualitative method by conducting in-depth interviews, observation, and documentation. The results of this study indicate that the factors that influence the use of biogas energy sources can be viewed from technical factors, social factors, and economic factors. In terms of the availability of livestock and manure produced by Gogik Village, it is feasible to implement biogas technology on a household scale. In terms of livestock raising, Gogik Village has indeed met the eligibility requirements for the implementation of biogas. The community using biogas in Gogik Village has provided a land area according to the provisions of about 20 m^2. In terms of social factors, the application of biogas technology in the community must be adjusted to the habits or culture of the community groups. On the other hand, the labor required to manage biogas in Gogik Village ranges from one to two people. In terms of economic factors, the effect of biogas use on community needs has not been fully felt by the biogas user community.

1. Introduction

Petroleum fuel is currently still the main energy source in meeting the needs of people in Indonesia. Consumption of LPG (Liquid Petroleum Gas) is also increasing from year to year. This is evidenced by the amount of national LPG consumption from 2007 to 2016 where around one metric ton increased to nearly seven million metric tons [1,2]. During the nine years this figure increased by 700 percent. The government has issued Presidential Regulation No. 5/2006 on national energy policies to develop alternative energy sources as a substitute for fuel oil. This was done as an effort to reduce dependence on fuel oil. This policy emphasizes on renewable resources as an alternative to fuel oil [3].

Alternative energy sources should be able to be an efficient, effective and environmentally friendly substitute fuel that can be accessed by all people. Ideally, alternative energy sources are renewable energy sources [4,5]. Biogas is an alternative energy which is currently being developed. Biogas is a form of alternative energy that is cheap and environmentally friendly. Making biogas is very simple, namely by inserting a substrate in the form of cow dung or organic waste into a tightly closed digester container, in some time it will produce gas as an energy source [6]. The gas produced by anaerobic

methanogenic bacteria (methane gas-producing bacteria that can only live in oxygen-free conditions) from the process of overhauling organic materials such as cow, pig, and even human waste. Naturally, there is a lot of biogas in rice fields or swamps. Biogas is mainly composed of methane gas (55-75%) and carbon dioxide (25-45%). Because of the flammable nature of methane gas, biogas can be used as an alternative energy source for the community [7].

Livestock manure that is not managed and used properly will cause environmental degradation. Accumulated and scattered livestock manure will be carried away by the flow of rainwater to lower areas. This will result in contamination of groundwater and river water. The accumulated dirt can produce methane gas naturally. Methane gas is the largest contributor to the greenhouse effect, the amount of gas produced exceeds the amount of oxygen in the atmosphere [8].

The Energy Independent Village Program is a government program that aims to overcome the energy crisis in the community, especially in rural areas. The Indonesian government has implemented several programs to increase the use of biogas technology, such as demonstrations and training in operating digesters for the community. This government program can be managed individually or in groups [9,10]. The success factors that influence the development of biogas can be based on five parameters, namely technical, environmental, socio-economic and management parameters [11].

Gogik Village, West Ungaran Subdistrict, Semarang Regency implements a government program towards the Energy Independent Village (DME) by utilizing cow dung waste to become biogas energy. In 2000 this program was started with the provision of 7 installations given to the community which were managed individually. In implementing the program, some communities have succeeded, but there are also those who have not succeeded in implementing it. Starting from this situation, the researcher is interested in examining the factors that influence the implementation of the livestock waste utilization program which is based on three parameters, namely technical, social and economic.

2. Method

This research was conducted in Gogik Village, West Ungaran District. The selection of this location is based on the use of alternative biogas energy by the community which has been started since 2000. The results of preliminary observations made by the researchers found that the condition of the biogas installation was partly damaged.

The approach used in this research is descriptive qualitative where the research is described systematically, factually and accurately to the conditions and phenomena that occur based on the data and information obtained in the study [12]. The method used in primary data collection is through observation, in-depth interview and documentation. Secondary data were obtained from literature, the Animal Husbandry Services and the Semarang District BLH.

Descriptive qualitative analysis method is a method used in this research because this research requires accuracy in exploring information and the desire of researchers to understand the social situation in depth. In this analysis method, there are three activities, namely data reduction, data presentation and drawing conclusions. This study focuses on analyzing three parameters that affect the implementation of biogas utilization in Gogik Village. The technique of determining key informants uses purposive sampling, which is selected with certain considerations and goals [13]. In this study, the key informants were two community leaders consisting of the village head and the village secretary, as well as 7 people / family members using the biogas installation.

3. Result and Discussion

Gogik Village is one of the villages located in West Ungaran District, Semarang Regency, Central Java Province. This village is located on the slopes of Mount Ungaran with an altitude ranging from ± 500-600 meters above sea level and has an area of ± 149.024 hectares. Gogik village area consists of two hamlets, namely Dusun Gogik and Dusun Gintungan.

Most of the people's livelihoods in Gogik Village are farmers and breeders. Gogik Village in 2000 received assistance in the form of seven units of household-scale biogas installations from the Livestock Service Office and the Regional Government of Semarang City. This biogas installation was provided

to seven heads of families who owned dairy cattle as the main ingredient in making biogas from livestock manure. In the process of selecting people who get the biogas installation, it is based on three factors, namely livestock ownership, land ownership and the desire of the community to use biogas as an energy source to meet their daily energy needs. In the implementation process, there are several factors that influence the success of the community in terms of technical, social and economic factors which will be described in the following analysis.

3.1. Technical Factors

3.1.1. Availability of livestock. Based on the results of interviews with four respondents, it was found that the average number of cows they owned was 4-6 cows, while the other three respondents only had 2-3 cows. The average cow dung produced is around 15-20 kg / head / day. Based on the results of the interview, it was concluded that the users of the biogas installation in Gogik Village had not met the main requirements in the implementation of biogas technology on an individual or household scale, so that some users found it difficult to meet the needs of the main raw material. In principle, by reducing the amounts of raw materials available, it can affect the ongoing biogas production process. If the main raw materials available cannot meet the existing digester capacity, the resulting biogas production is not optimal. Another impact that will arise from the lack of available main raw materials can affect the slurry / sludge produced from the production process cannot come out perfectly through the outlet channel, so that the slurry will mix with the production of gas produced in the main digester. This of course will disrupt the work function of the main digester and the supporting components in the biogas production process. In general, the minimum number of cattle that must be fulfilled by the community in the application of this biogas technology is 2-3 cows / family, which is sufficient for the main material for individual scale biogas. The number of livestock must be adjusted to the digester capacity that has been provided, so that the biogas production process can run optimally. In the implementation of biogas, continuity in the availability of cattle is the most important part. The implementation of biogas will run continuously if the availability of cattle every day with the appropriate number can be guaranteed. This was stated by [14,15] where the availability of livestock manure is a must-have requirement. This means that the availability in this case is not only in sufficient quantities, but also its continuity (continuity). In livestock areas, this will not be a serious problem as manure is easily available in sufficient quantities. Judging from the availability of livestock and manure produced, it can be concluded that Gogik Village is conditional on the implementation of biogas technology on a household scale. This means that the requirements will be feasible, efforts are needed for non-active user communities to provide cattle according to the digester capacity that has been provided and maintain the continuity of livestock so that the implementation of biogas can run optimally.

3.1.2. Livestock maintenance. The implementation of biogas technology in Gogik Village uses the main raw material of livestock manure, namely dairy cow dung. Therefore, to maintain optimal biogas production, the availability of livestock manure, especially dairy cow dung, needs to be maintained. In principle, how to raise livestock by being penned will be easier to get continuous manure compared to being shepherded. Another positive impact of keeping in captivity is that it can reduce the unpleasant odor of dairy cattle manure and make the environment look cleaner. Based on the results of the interview, it was found that the community in Gogik Village carried out the maintenance of livestock by being kept in captivity. Most of the people who use biogas build simple pens, but the conditions of the stables are plastered or cemented so that it can make it easier for farmers to harvest their dairy cattle dung. The cage facility is also equipped with a drain in the form of a small, elongated ditch behind the cow which aims to make it easier to clean the drums carried out by the user community. Other facilities available are the animal feed area in front of the cows. This aims to minimize the mixing of the remaining animal feed with the manure produced every day, making it easier to mix raw materials with water. Another positive impact is the smooth running of the biogas production process because the entry of foreign objects such as leftover animal feed into the main installation can be minimized. This is as explained in

the research of [16] that the system of raising cattle for the Palopo City farmer community can be changed by implementing a biogas program where the way of being grazed is turned into a cage or an intensive system. This means that the implementation of biogas technology can change people's daily positive habits in raising livestock. If viewed from the aspect of raising livestock, the eligibility requirements for the implementation of biogas in Gogik Village have been fulfilled. This can be seen from the ease in collecting raw materials in the form of dairy cow dung by the user community in making biogas. In [14,17] states that the housing system is closely related to the method of collecting livestock manure. In principle, a good cage has a good sewage system too. The sewage channel in the form of a small, elongated ditch equipped with a place for feeding is usually available on the drums for dairy cows.

3.1.3. Distance. One of the first steps in building a biogas installation is determining the right location so that the resulting biogas production can be optimal. There are several things that must be considered in determining the location of the biogas installation, including the distance between water sources, the source of raw materials (cow manure) and the user community must be close. The goal is that the procurement of raw material sources can be carried out easily and continuously, namely the entry of dairy cow manure into the biogas installation. In addition, to minimize the occurrence of gas leaks in pipes and the use of gas to run optimally, the biogas installation should be located close to the location of the biogas stove (home kitchen). Based on the results of the interview, it was found that the area of land had been provided in accordance with the provisions of about 20 m^2 by the community who used Gogik Village. In addition, the distance between the house kitchen, the cow drum and the biogas installation is still quite affordable. The positive impact that can be felt by the user community is that it facilitates the processing of cow dung, especially in the procurement of the main raw material in the form of manure from the biogas installation into the installation and gas distribution for daily needs, especially cooking activities. This is in accordance with [18-20] where to build a biogas installation, a minimum area of 18 m^2 is required. Meanwhile, the distance between the location of the stove in the kitchen and the biogas installation should be approximately 20 m. The purpose of placing this standard is to reduce the risk of gas leakage and minimize the cost of installing high pipes.

3.2. Social Factors

3.2.1. Availability of labor. In the implementation of biogas, workers who can manage it well are needed. Managing biogas technology on a household scale using a capacity of four to six cows takes about one to one half an hour per day and a considerable amount of energy is exerted. Routine activities that are carried out every day start from cleaning cow dung which is then carried out first collection in front of the installation entrance, then stirring between water and cow dung so that it is mixed homogeneously, after that it is put into the digester. Activities like this are carried out routinely by biogas users every morning and evening. Managing biogas in Gogik Village requires a workforce of between one and two people. Most of the family heads in Gogik Village work as farmers, so in their daily activities managing the biogas user community is assisted by family members, namely their wives and children. The positive impact that is felt, apart from being more practical, of course, is more economical because there is no need to spend money to pay for other people's labor, because the benefits of biogas can be felt by family members, although indirectly. This is according to what [21,22] stated, where the amount of labor devoted to farming is 66 percent of the total available workforce.

3.2.2. Potential conflict between communities. From the results of interviews with village officials, it was found that conflicts that occurred in the community did not exist during the implementation of the use of livestock manure into biogas in Gogik Village. This is justified by non-active and active biogas users where in the community there has not been any conflict during the implementation of biogas until now. The local community did not complain about anything even though at this time some installations were no longer active. This is because most of the people work as breeders and indeed people are used

to the unpleasant smell of cow dung. In Gogik Village, the implementation of biogas has a positive influence on the social life of the community there. The high enthusiasm for biogas technology is shown by the community around biogas users. In orders to process livestock waste into biogas, they want to get assistance from the government in the form of a biogas installation. This cannot be realized properly because the land required to make the installation does not meet the predetermined standards.

3.2.3. Conformity to culture / habits. In principle, the way of raising livestock carried out by the community and the use of other energy by the community such as firewood, kerosene, LPG gas in fulfilling daily energy needs is closely related to the principle of using livestock manure to become biogas. The intensive care for dairy cattle has been carried out by the biogas user community in Gogik Village. Incarcerated is a way that user communities maintain their livestock. In addition, to make it easier for the user community to collect livestock manure, the conditions for the stables are made simple but the floor has been plastered / cemented. In addition, in orders for the implementation of biogas to run optimally, the construction of an integrated livestock waste treatment plant will be carried out. The application of biogas technology in the habitual or cultural communities of the community is one of the keys to success in the program. The basic foundation for biogas technology to be accepted by society is the ease and practicality of using this technology. In addition, the main motivation for people to want to use this technology is the economic benefits that people get from the program. Changing certain conditions or habits of society for the better can be done by applying this biogas technology. However, it depends on the will and motivation of the community itself. To change the habits of the people that they have been doing so far, it will certainly take a long time. As stated by [23,24] there are several causes that make people less interested in applying biogas technology, including the availability of other energy in meeting people's daily energy needs, practical problems and habitual problems (people are accustomed to using firewood). Overall, the biogas technology has not been fully accepted by the community. This can be seen from the active and non-active biogas users in Gogik Village who have a habit of using other energies such as LPG gas and firewood in meeting their energy needs. Biogas technology emphasizes ease of operation, is more practical and economical in use than other energies, so that the user community will be more interested in using biogas than other energies.

3.3. Economic Factors

3.3.1. The influence of biogas on community needs. In principle, the application of biogas has a big impact on the user community. From an economic perspective, the application of biogas can reduce the cost of daily necessities, especially in energy use. In the development stage, biogas does require a high initial investment. However, the community got a sizeable advantage. Economic benefits greatly affect the user community in applying biogas technology in addition to environmental and social benefits. Community active biogas users in Gogik Village can make savings of 35 thousand to 50 thousand per month. These funds are allocated by the community for other needs so that it helps the community in managing their finances even though the amount is not too large. As stated by [25-27], household fuel needs can be reduced by 42 thousand / month by using biogas as an alternative energy. Overall, the effect of biogas on community needs has not been fully felt by all of the biogas users in Gogik Village. This is because some of the user communities in Gogik Village are no longer actively using biogas as an alternative energy source to meet their daily energy needs. This is very unfortunate because although it is not very big, it can help the community to reduce the cost of buying LPG gas and firewood as their energy source.

3.3.2. Increase community income. In principle, the utilization of livestock manure into biogas by the user community can provide significant benefits both from an environmental and economic perspective. From an economic perspective, the optimal use of by-products can increase people's income, especially active users of biogas. Solid organic fertilizers and liquid organic fertilizers can be produced from the biogas by-product in the form of sludge. From the results of these two preparations, the user community

individually in the agricultural sector can be used as well as sales to third parties so that from the sale the community gets a profit. The use of biogas by-products by the active users of biogas in Gogik Village has not been carried out optimally, so that the effect of increasing community income has not been maximally felt. To be able to increase the maximum income it is better if the processing of by-products in the form of sludge into liquid organic fertilizer can be maximally utilized by the active users of biogas in Gogik Village. In general, liquid fertilizer that is produced from the residual biogas production has several advantages, including saving energy, being more practical and equalizing its use so that liquid fertilizer is the main choice in its use compared to solid fertilizers. From the sale of solid organic fertilizers, the user community gets a profit of around 100 to 200 thousand in one month, so that the profit is used by the community for additional income in meeting their daily needs. As stated by [15,25,27,28], the by-products in the form of organic solid and liquid fertilizers also obtained a high selling value. On average, in one month with a source of livestock manure from 3-4 cows, 50 liters of liquid organic fertilizer and 140 kg of solid organic fertilizer are produced with a selling value of 190 thousand / month.

4. Conclusion

The management of cattle waste into biogas in Gogik Village has not been going well. This can be described in three influencing factors, namely:

a. Engineering Factors
   Overall, the community has not fully met the technical requirements for the implementation of biogas. From the availability of livestock, some user communities have not met the main requirements. Where a small part of the community has sold some of their livestock so that the number of livestocks they have does not meet the existing digester capacity. The maintenance of cattle by the community has been carried out intensively, namely in cages. This makes it easier for the community to harvest raw materials, namely cow livestock waste. The area of land has been provided in accordance with the provisions of about 20 m^2 by the community who use the Gogik Village. In addition, the distance between the house kitchen, the cow drum and the biogas installation is still quite affordable.
b. Social Factors
   From a social perspective, the implementation of biogas does not experience any obstacles. In conformity to the culture / habits of the community, users able to adapt to the changes they make in their daily activities. However, the user community has not been able to change their habits to use other energy such as firewood and LPG gas to meet their daily energy needs. There is no potential for conflict in the community. In fact, there is a positive influence that occurs in the surrounding community. The kinship between the people is getting closer. In addition, the relationship between family members is also getting closer.
c. Economic Factors
   Basically, the effect of biogas on community needs has not been fully felt by the people who use biogas. This is because some of the users of society no longer use biogas energy as a daily energy source. In addition, the utilization of biogas byproducts in Gogik Village by the user community has not been carried out optimally, thus affecting the increase in community income which has not been maximized.

Reference

[1] Dewi R P & Kholik M 2018 *J. Mech. Eng.* **2**(1)
[2] Thoday K, Benjamin P, Gan M, & Puzzolo E 2018 *Energy Sustain. Dev.* **46** 71-81.
[3] Sulistiyanto Y 2016 *J. Udayana Mengabdi* **15**(2)
[4] Putri A A I K 2014 *J. Kesehat. Lingkung.* **4** (1) 45-49.
[5] Omer A M 2008 *Renew. Sustain. Energy Rev.* **12**(9) 2265-2300.
[6] Ritonga A M & Masrukh 2017 *J. Rona Tek. Pertan.* **10**(2).
[7] Renosori P 2012 *Buana Sains* **12**(1) 109-116.

[8] Hastuti D 2009 *Mediagro* **5**(1).
[9] Haryati T 2006 *J.Wartazoa* **16**(3) 160-169
[10] Singh R & Setiawan A D 2013 *Renew. Sustain. Energy Rev.* **22** 332-345.
[11] Ariani E 2011 *J. Ketransmigrasian* **28**(1) 34-44.
[12] Santoso G 2007 *Metodologi Penelitian* (Jakarta : Prestasi Pustaka)
[13] Sugiyono 2010 *Memahami Penelitian Kualitatif* (Bandung : Penerbit CV. Alfabeta)
[14] Setiawan A I 2007 *Memanfaatkan Kotoran Ternak* (Bogor : Penebar Swadaya)
[15] Putri A, Purwanto P & Purnaweni H 2019 *E3S Web Conf.* 125 14014
[16] Syamsuddin, Mappangaja A R, Asmuddi 2011 Analisis Manfaat Program Biogas Asal Ternak Bersama Masyarakat (BATAMAS) Kota Palopo (Studi kasus Kelompok Tani Kampulang Kecamatan Wara Selatan Kota Palopo). Retrieved from http://pasca.unhas.ac.id/jurnal/files/0c04ca421fe5987945c80a6200487781.pdf
[17] Maton A, Daelemans J, & Lambrecht J 2012 *Housing of animals: Construction and equipment of animal house* (New York: Elsevier)
[18] Wahyuni S 2011 *Menghasilkan Biogas dari Aneka Limbah* (Jakarta : Agro Media Pustaka)
[19] Bansal M, Saini R P & Khatod D K 2013 *Renew. Sustain. Energy Rev.* **17** 44-53.
[20] Deng L, Liu Y, & Wang W 2020 *Biogas Technology* (Singapore: Springer) pp. 109-156
[21] Najiyati S 2000 *Studi Kelayakan Pemantaatan Bioteknologi untuk Peningkatan Produksi di UPT* (Jakarta: Puslitbang BAKMP)
[22] MacDonald J M, Korb P, & Hoppe R A 2013 *Farm size and the organization of US crop farming* (New York: United States Department of Agriculture)
[23] Hamni A 2008 *Pros. Semin. Has. Penelit. dan Pengabdi. kpd. Masy. Unila* 18-24.
[24] Huan F, Liu J, Wang Z, Shuai C, & Li W 2020 *Energy Res. Soc. Sci.* **67** 101517.
[25] Sariubang M A, Syam A, & Nurhayu A 2007 *Sistem usaha tani tanaman ternak pada lahan kering dataran rendah di Kabupaten Takalar, Sulawesi Selatan* (Makassar: Balai Pengkajian Teknologi Pertanian (BPTP) Sulawesi Selatan)
[26] Yevdokymov Y, Chyhryn O Y, Pimonenko T V, & Liulov O V 2018 *Innov. Mark.* **14**(2) 7-15.
[27] Raheem A, Abbasi S A, Memon A, Samo S R, Taufiq-Yap Y H, Danquah M K, & Harun R 2016 *Energy Sustain. Soc.* **6**(1) 1-13.
[28] Putri A, & Purnaweni H 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **481**(1) 012045.