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Research Article

Potential Processing of Biogas Products for the Needs of Villagers in Jimbaran Village, Puspo District, Pasuruan Regency

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Abstract

The rise follows the increase in population in energy consumption that causes a decrease in the supply of non-renewable energy in the world. With its wealth in natural resources, Indonesia is even predicted to experience a decline in oil supply as renewable energy within 15 years. Therefore, energy transformation needs to be done slowly. This research emphasizes renewable energy utilization projects with high potential that have not been optimized, one of which is through cow manure processing into biogas products. The purpose of the research in Jimbaran Village, Puspo Subdistrict, Pasuruan Regency is to further explore the plan of processing cow manure into Jimbaran Village's biogas products. The method used in research activities is the descriptive research method. Data collection is done online through virtual calls between researchers and the Jimbaran village apparatus, the Village Secretariat. The data obtained were analyzed with PRA (Participatory Rural Appraisal) and RRA (Rapid Rural Appraisal) data analysis techniques. Based on the survey results and data analysis, a biodigester procurement project plan was obtained as a form of a program developed in the study area to utilize cow manure as input for renewable energy processing. Through the biodigester procurement plan, it is expected that biogas products can provide fuel to rural communities with their farms' potential.

Keywords: Renewable Energy, Cow Manure, Biogas

JEL Codes: O13, Q42, R12

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Araştırma Makalesi

Pasuruan Regency, Puspo İlçesi, Jimbaran Köyündeki Köylülerin İhtiyaçları için Biyogaz Ürünlerinin İşlenme Potansiyeli

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Öz

Dünyada yenilenemeyen enerji arzında bir azalmaya neden olan enerji tüketimindeki artış nüfus artışını takip ediyor. Doğal kaynaklardaki zenginliği ile bilinen Endonezya'nın, 15 yıl içinde yenilenemeyen bir enerji kaynağı olarak petrol arzında bir düşüş yaşayacağı tahmin ediliyor. Bu nedenle enerji dönüşümünün yavaş yavaş yapılması gerekiyor. Bu araştırma, inek gübresinin biyogaz ürünlerine dönüştürülmesi olan, yüksek potansiyele sahip, optimize edilmemiş bir yenilenebilir enerji kullanım projesi üzerinde durmaktadır. Araştırmanın amacı, Pasuruan Regency, Puspo Alt Bölgesi, Jimbaran Köyü'ndeki inek gübresinin Jimbaran Köyü'nün biyogaz ürünleri şeklinde işlenmesi planını daha fazla araştırmaktır. Araştırma faaliyetlerinde kullanılan yöntem betimsel araştırma yöntemidir. Veri toplama, araştırmacılar ve Jimbaran, Köy Sekreterliği arasındaki sanal telefon aramaları aracılığıyla çevrimiçi olarak yapılmıştır. Elde edilen veriler Katılımcı Kırsal Değerleme ve Hızlı Kırsal Değerleme veri analizi teknikleriyle analiz edilmiştir. İnek gübresini yenilenebilir enerji işlemede girdi olarak kullanmak için, anket sonuçlarına ve veri analizine dayanarak, çalışma alanında geliştirilen bir programın bir düzenlemesi olarak bir biyo-ayrıştırıcı tedarik proje planı elde edilmiştir. Biyoçözünür tedarik planı aracılığıyla, biyogaz ürünlerinin çiftliklerinin potansiyeli vasıtasıyla kırsal topluluklara yakıt sağlayabilmesi beklenmektedir.

Anahtar Kelimeler: Yenilenebilir Enerji, İnek Gübresi, Biyogaz

JEL Kodlar: O13, Q42, R12

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1.Introduction

An increase follows the higher rate of global population growth in the quantity of energy consumption to meet life needs. Increasing the amount of world energy consumption is one of the leading causes of the decline in the world's oil reserves. Indonesia is even predicted to decrease oil *supply* within 15 years with its wealth in natural resources, while natural gas will run out in 60 years. If continued consumption without discovering new reserves, it is estimated that this fuel reserve will run out in the next two decades (Farahdiba et al., 2014). One of the natural treasures of value for sustainable national development is energy (B.Satata, 2016). Indonesia has a considerable amount of fossil and non-fossil energy. Therefore, Research & Development in renewable energy will manifest the world's sustainable energy consumption. Biogas is one form of renewable energy from a variety of organic waste such as waste, human waste, and animal excrement (Prayitno et al., 2021). The utilization of waste in biogas becomes an opportunity to produce alternative energy to reduce the impact of fossil fuel use (Caraka, 2017).

Indonesia has considerable potential in the processing of biogas products. Mainly biogas products that use cow manure *input* as the primary raw material (Zalizar et al., 2013). Recorded from 2014-2018, the livestock sector that belongs to the sub-sector of agriculture, livestock, hunting, and agricultural services is the sector that contributes the most considerable contribution to GDP in Indonesia. Sub-sectors of agriculture, livestock, hunting, and farming services play a role in achieving a GDP of 75-77% of the types of farming, forestry, and fishery businesses (Direktorat Jenderal Peternakan dan Kesehatan Hewan, 2019) Commodities that enter the livestock sector and successfully contribute to GDP (Gross Domestic Product) include cattle and buffalo.

There was an increase in cattle and buffalo population by 4.5% in the period 2014-2017 there (Kementerian Pertanian Republik Indonesia, 2021) Commodities that enter the livestock sector and successfully contribute to GDP (Gross Domestic Product) include cattle and buffalo. Moreover, in 2014-2017, there was an increase in cattle and buffalo population by 4.5%(Kementerian Pertanian Republik Indonesia, 2021)

The dairy cows' population in East Java amounts to 259.57 thousand head or about 49% of the total dairy population. Almost 50% of the dairy population in Indonesia is located in East Java Province. Based on this, the manure produced by dairy cows will also increase. If not appropriately managed, this sewage will have a lot of negative impacts on the environment. The dirt is solid dirt and *urine* and gas that smells bad. Farmers generally dump dairy manure into waterways (Dianawati & Mulijanti, 2016) The Government of East Java Province has a work program to support the agricultural and livestock sector by running the Bhakti-6 Jatim Agro Work Program listed in the RPJMD of East Java Province in 2019-2024. This work program is a development commitment-oriented to improve the welfare of the community (Prayitno et al., 2020). This work program aims to advance the sector of agriculture, livestock, fisheries, forestry, and community-based plantations.

One of the commodities of dairy farming in East Java is in Pasuruan Regency. Pasuruan regency has a mission that supports the ESDM program of East Java Province, namely, "Realizing the economic welfare of the people through the revitalization of villages and increasing productivity in the agricultural, plantation, fishery and livestock sectors." To help develop the village, Pasuruan District issued a budget of 233.8 billion (Pasuruan Regency, 2017). One of the towns that can be grown under government regulations is Jimbaran Village. Jimbaran Village is one of the villages located in Puspo Subdistrict, Pasuruan Regency. Jimbaran Village area is dominated by hills, with plantations. One of the most dominant livelihoods in Jimbaran

Village is farmers, with 70% of all residents. A total of 1,633 households in Jimbaran Village are dairy farmers with 5,976 cows (Village Planning Studio, 2020).

The livestock sector has a high opportunity to reduce non-renewable energy in daily life and the processing of livestock products (Sims et al., 2016). Although, the Jimbaran Village people are not yet aware of any other potential of livestock waste that can be processed into biogas. Livestock waste in Jimbaran Village is left without further processing. In fact, in the rainy season, farmers tend to dump cow waste into drainage channels. It causes drainage network problems, but the community has also disposed of livestock waste potential into biogas.

Whereas if this livestock manure can be appropriately processed, it will be alternative energy to support other sectors' development (Wahyudi et al., 2015). This issue is expected to be a solution to Jimbaran village to improve the economy of Jimbaran Village. The purpose of our research is to further explore the plan of processing cow manure into biogas products in Jimbaran Village. The plan to process cow manure into biogas products will be encouraged to be a source of stimulus for community participation in rural development planning.

2. Literature Study

Biogas is a renewable energy source that can answer alternative energy needs (Afrian et al., 2017). Biogas is obtained through the decomposition of organic matter by bacteria anaerobic so that it is renewable *(Haryanto* et al., 2019). Biogas' composition mostly includes methane gas (CH4) amounting to 55-60% and carbon dioxide (CO2) of 35-40% (Sawyerr et al., 2019). Other gas components also contained in biogas with less quantity are ammonia (NH3), hydrogen sulfide (H2S), hydrogen (H2), oxygen (O2), nitrogen (N2), and carbon monoxide (CO). The content of CH4 and CO2 in biogas production will improve air quality because CH4 and CO2 as triggers of greenhouse effects can be reduced through biogas production. Biodigester biogas project is carried out gradually by considering several things so that its operations will not cause losses, including (Village Planning Studio, 2020):

1. Priority *biodigester* units are held for adjacent farmer's house groups with a maximum distance of 20 meters from the *biodigester* unit.
2. The number of cows owned by farmers is at least four so that *biodigester* can always operate every day.
3. The total number of adjacent houses should be more than equal to 20 homes.
4. Suppose the biodigester unit held is less than proposed. In that case, the *biodigester* will be prioritized in the group of houses that still use firewood as an energy source for cooking with the aim that the use of firewood as cooking fuel is minimized.

Dairy farming businesses can also have a positive impact on development. Livestock waste can be used as an energy source when energy fuel is limited—the need for fuel oil for industrial, transportation, and household needs. Utilization of biogas energy provides several advantages, namely reducing the smell of unpleasant livestock manure, preventing the spread of disease, reducing the effects of greenhouse gases, generating heat, and providing side products in the form of solid or liquid fertilizers. Biogas can be used mainly for cooking, lighting, and water pumping power. The utilization of waste into biogas will be advantageous to overcome the increase in fuel prices. Thus, farm waste produced is no longer a burden. Still, a driving result with high economic value is useful for developing biodigester dairy cattle biogas in the countryside (Dianawati & Mulijanti, 2016).

Measurement of waste potential from 16 mother cows weighing between 225 kg-250 kg produces the amount of waste directly proportional to the feed's consumption and the quality of

feed provided. The average fresh solid waste and urine produced is 14.87 kg and 5.94 liters of the average consumption of feed and drinking water, 17.91 kg and 7.39 liters per day. The ratio of feed consumption given averages 7.96%-7.16%, fresh stable waste yield 5.95%-6.61%, urine 2.38%-2.64%, and average water content compost yield of 20% 1.09%-1.21% compared to the weight of the mother cow (Adijaya & Yasa, 2012). Unsavory methane gas can cause greenhouse effects that cause global warming. This indicates the need for proper management of dairy cow manure waste (Muller, 2015).

3. Methodology

The research was conducted in the form of a descriptive study. A descriptive analysis is a research method that describes and interprets research objects according to what they are (Pertiwi, 2016). Data is collected by online interview data collection method with virtual media call. Researchers' data analysis techniques are combined data analysis techniques between PRA (Participatory Rural Appraisal) and RRA (Rapid Rural Appraisal) (Prayitno & Subagiyo, 2018). The merger of these two analytical techniques was conducted because the research was conducted at the time of the spread of the COVID-19 pandemic. Thus, some research activities are hindered by covid-19 health protocol policies. The survey was conducted online using virtual media calls between the author and the village officials represented by the Jimbaran Village Secretariat.

4.Result and Discussion

4.1 Survey Result

Data were obtained in an online survey on the decrease in the number of cows in Jimbaran Village from 2018 to 2020. The survey was conducted *online* using virtual *media calls* between the author and the village officials represented by the Jimbaran Village Secretariat. It is recorded that the number of cows in Jimbaran Village in 2018 is 5,976, and the number of cows in Jimbaran Village in 2020 is 3,595. Through the differences in existing data, then the author conducted a comparison of the conversion of cow manure into biogas as an energy source of the Jimbaran village community as a form of *supply* analysis (Table 1). Supply *analysis* is an analysis used to offer various commodities related to the strategy and calculation of offers in Jimbaran Village. Here is the formula *of supply* analysis (Arif, 2018):

$$St = (\text{Number of Commodities} \times \text{Total Commodity Production}) \times Yt$$

Description:
St: Total availability of commodities
Yt: Potential generated

Table 1. Comparison of Conversion of Cow Manure Produced into Biogas Products in Jimbaran Village

Year	Total cow of the year (tail)	Total impurities produced (kg/month)	Dry ingredient content of BK (cow manure=20%)	Biogas produced (cow manure= 0.023 m³/kg. BK)
018	5.976	4.482.000	896.400	20.617,2
020	3.595	2.696.250	539.250	12.402,75

Source: Results Analysis, 2020.

Biogas use calculation is a guideline for the biogas management plan in Jimbaran Village. The need for biogas in question is the community's need for cooking activities where the

community is divided into two groups, namely the family of farmers and non-farmer families. Calculation of the needs of biogas is a form of *demand* analysis (Table 2). Calculation of the conditions of the use of biogas is done using *demand* analysis. *Demand* is a tool used to know how much desire or need for a specific product is supported by the capabilities and willingness that are in the region (Sriastuti, 2017).

Table 2. *Calculation of* Demand for *Biogas Products for Jimbaran Villagers*

Family	Types of Energy Used	Number of HOUSEHOLDS	Energy Consumption (per month)	Energy Source Comparison (kg)	*Demand* (KE/PSE X Number of KK)
Breeder	LPG	783	3 LPG tubes 3 kg	0,46	15.319,56
	Firewood	830	150 kg	3,5	34.583,33
Non-Breeders	LPG	135	3 LPG tubes 3 kg	0,46	3.228,26
	Firewood	164	150 kg	3,5	6.833,33
Total					**59.964,49**

Source: Analysis Results, 2018.

After knowing the supply and demand of biogas products, researchers calculated the energy needs, cow waste per month, and the number of cows per day to develop the biogas utilization plan in Jimbaran Village. From the observation of the distribution of farmer's houses in Jimbaran Village, which is sourced from the 2018 Village Planning Studio Survey Report, information was obtained that there are 38 locations where at least 20 farmer's houses are close to each other with the distance of each home to that point is a maximum of 20 meters. The amount of 20 households taken to procure biodigester will be prioritized for as many beneficiaries as possible with the lowest budget likely. It is assumed to use firewood for cooking because of firewood's energy. The energy required for at least one cooking in 1 day for one meal by a family of ±6 family members by one household is obtained from the following calculations (Village Planning Studio 2020):

A. Energy Needs

$$\text{Energy Requirements} = \text{Number of Household} \times \frac{\text{Mass energy consumption at one time (kg)}}{\text{Comparison of fuelwood and biogas energy sources (kg)}}$$

$$\text{Energy Requirements} = 20 \times \frac{50\ \text{kg}}{3{,}5\ \text{kg}}$$

$$\text{Energy Requirements} = 285{,}71\ \text{m}^3$$

Found the energy needs of Jimbaran villagers in 1 day is 285.71 m^3. The calculation is continued by finding out many cattle waste per month and the total cattle per day needed to produce these energy needs.

B. Cow Waste Needs Per Month

$$\text{The need for cattle waste per month} = \frac{\text{Energy requirements}}{\text{Methane gas coefficient on cow manure}} \times \text{Cow manure multiplier}$$

$$\text{The need for cattle waste per month} = \frac{285{,}71\ m^3}{0{,}023\ m^3/kg} \times 5$$

$$\text{The need for cattle waste per month} = 62.110{,}86\ kg$$

C. **Total Needs of Cows Per Day**

$$\text{Total demand for cattle per day} = \frac{\text{Waste requirements per month (kg)}}{30\ \text{days}} \times \frac{1}{\text{Total excrement per day (kg)}}$$

$$\text{Total demand for cattle per day} = \frac{62.110{,}86\ kg}{30\ \text{days}} \times \frac{1}{25\ kg}$$

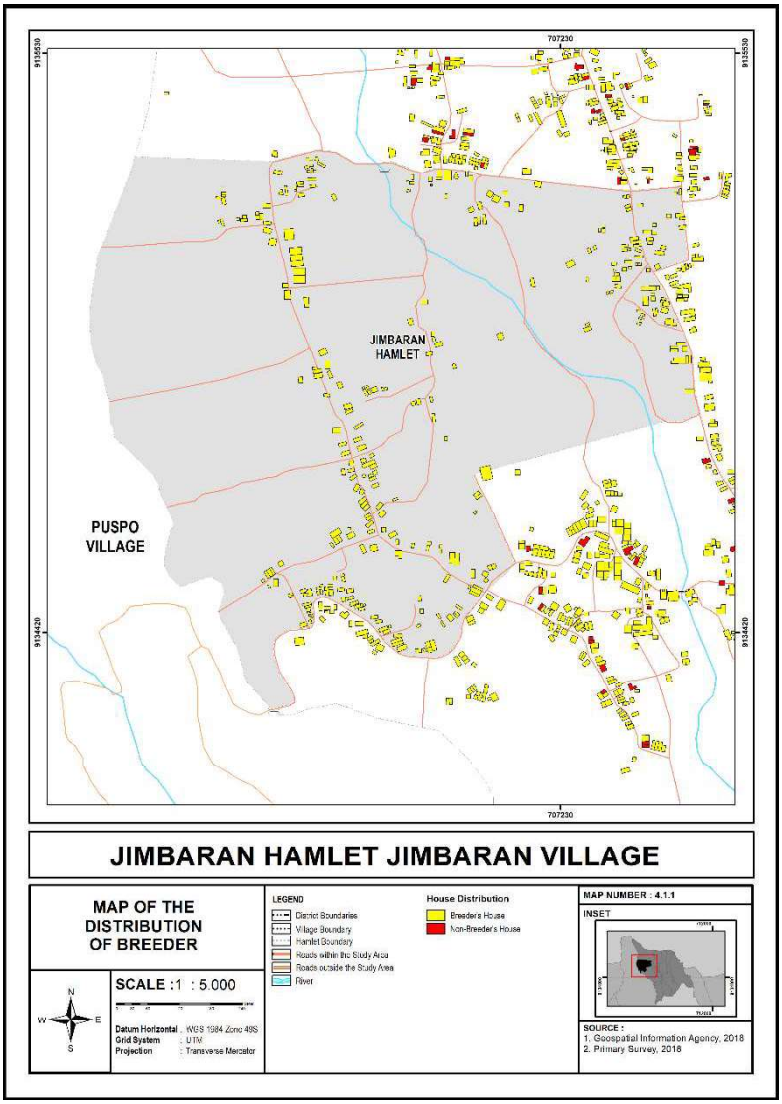
$$\text{Total demand for cattle per day} = 83\ \text{cows}$$

The calculation above shows that to support a minimum of one meal in one day by 20 families needed a supply of cattle waste 83 heads. If divided equally by the total beneficiary's house, each house donates four cows to be taken feces as raw materials for biogas processing. The observations of the distribution of Jimbaran village farmers' houses show 38 potential locations for efficient biodigester placement. So, the total needs of cows to supply 38 biodigesters in Jimbaran Village are:

$$38\ \text{biodigester} \times 83\ \text{cows} = 3.154\ \text{cows}$$

To meet Jimbaran villagers' energy needs, they needed 3,154 cows to input livestock biogas products.

Figure 1. Map of The Distribution of Breeder, Jimbaran Village, Puspo District, Pasuruan Regency



4.2 Analysis Result

The majority of Jimbaran villagers have a livelihood as farmers. It is recorded that 4,924 people have a livelihood as farmers in Jimbaran Village. In general, each farmer in 1 house has a minimum of 2 dairy cows. The condition can then describe the potential of cow manure management that is sufficient to be an input for biogas products' processing. Farmers in Jimbaran Village are scattered throughout the hamlet, but Jimbaran Hamlet becomes one of the hamlets with the largest number of breeders in Jimbaran Village. From the results of *the calculation* of supply and *demand* in Table 1 and Table 2, it can be known that the potential of biogas energy can not meet the total cooking energy needs of Jimbaran villagers. Therefore, researchers suggest that the treatment of livestock waste done by the community before that is still straightforward is directed to switch to a more optimal management way so that the community's profits are obtained more. Because the total cattle in Jimbaran Village in 2020 decreased compared to 2018, then in 2020, the Jimbaran village plan's direction to become Mandiri Energi (Sufficient Energy Supply) in Jimbaran village can not be applied anymore. This is due to the potential for livestock waste to be used as biogas, although it still exists but with a narrower scope of utilization. All

Jimbaran Village residents can no longer feel biogas' utilization because of insufficient *supply* for all houses. However, there are still opportunities to utilize the collection of biogas for livestock family groups. This utilization is expected to be a good start for transforming energy from renewable energy to renewable energy in Jimbaran Village.

4.3 Planning Program

Based on the study results, researchers developed an activity plan to encourage biogas in Jimbaran Village, namely the *biodigester* biogas procurement project plan. *Biodigester* biogas procurement project is a project that aims to optimize biogas in Jimbaran Village to help *supply* the fuel needs of the community to cook and encourage energy transformation towards renewable energy in Jimbaran Village.

Regarding the procurement of biodigester itself, the plan will be submitted a proposal for a request for 38-unit biodigester to the Livestock Service and or The Agriculture Office of Pasuruan Regency with consideration of biodigester biogas procurement will reduce the environmental impact caused by cow manure waste, be more environmentally friendly and save the expenditure of Jimbaran villagers whose economic conditions are inadequate. Here is a table of the distribution of houses per hamlet in Jimbaran Village with the procurement plan of biodigester per-hamlet with visualization of magnification displayed on the map of the project of distribution of biogas biodigester installation (Figure 1):

Table 3. **Biodigester Distribution Plan per Hamlet with Predicted Number of Houses Distributed Biogas**

Hamlet	Number of Houses	*Biodigester* Number Plan
Jurang Kecambah	≥140	7
Jimbaran	≥80	4
Guava	≥20	1
Kebonsari	≥80	4
Setro	≥40	2
Tanjek wetan	≥100	5
Tanjek Kulon	≥140	7
Rejosari	≥160	8
Total	**≥760**	**38**

Source: Planning Program, 2020

Figure 2. Land Suitability Map of Jimbaran Village, Puspo District, Pasuruan Regency

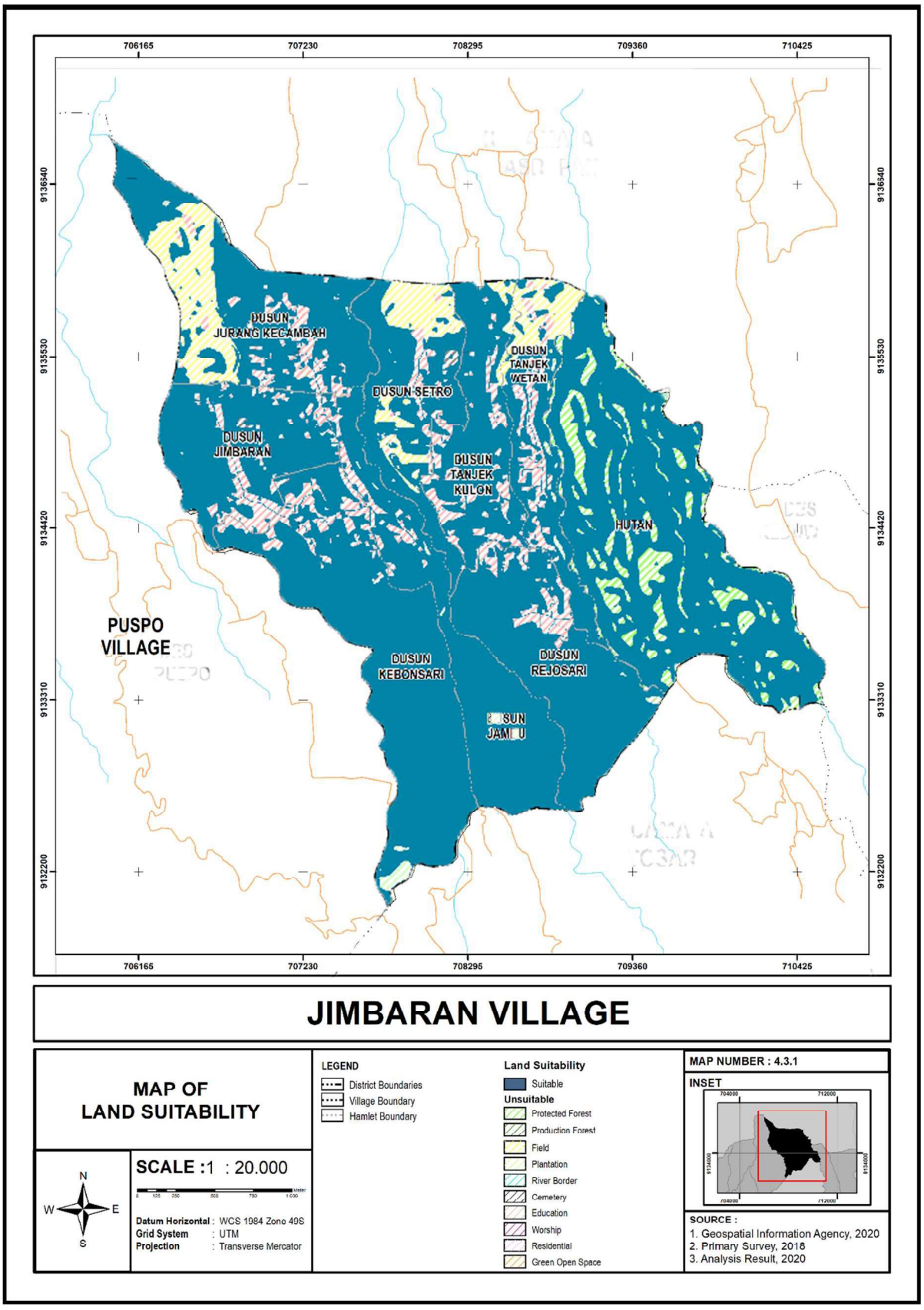
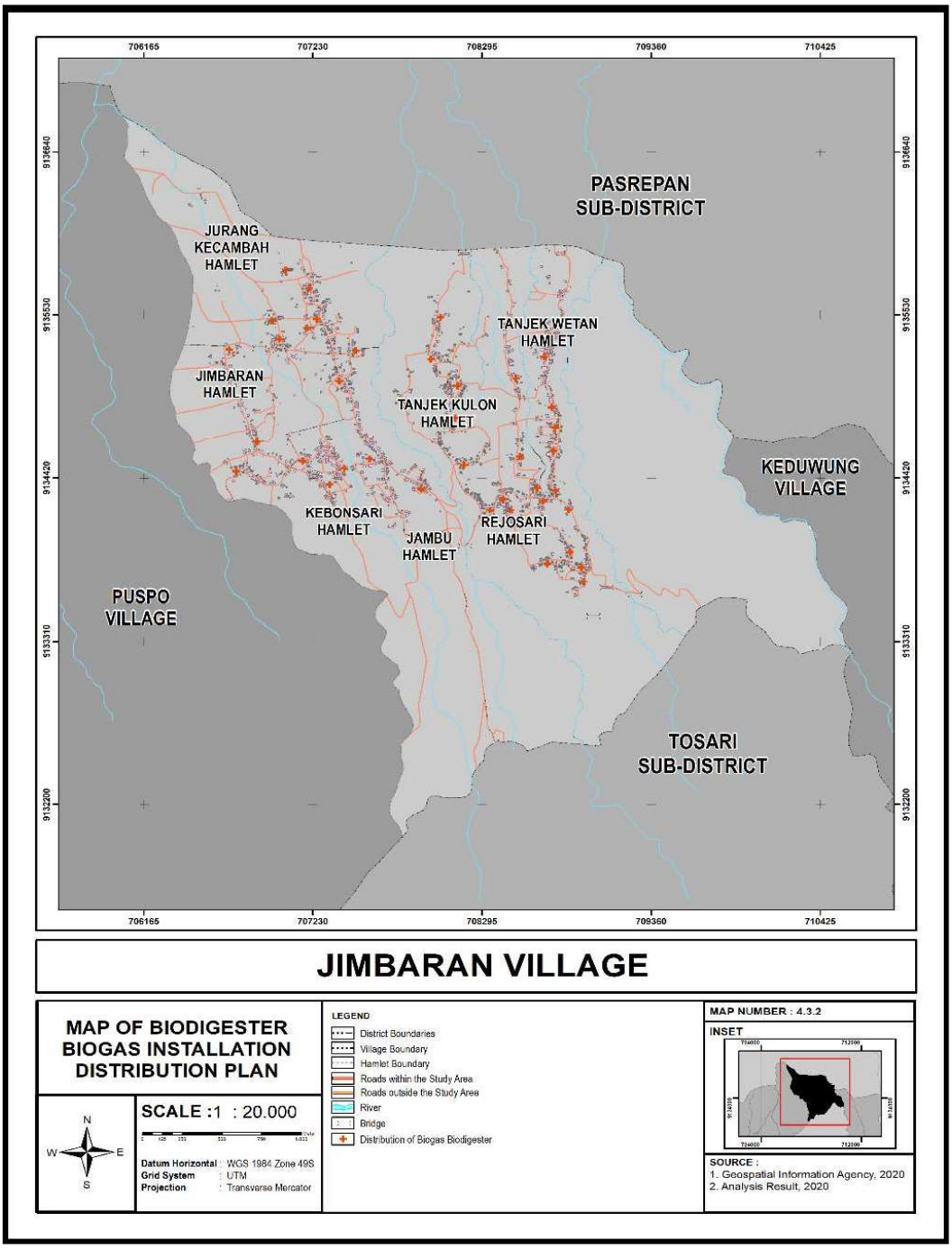


Figure 3. Map of Biodigester Biogas Installation Distribution Plan in Jimbaran Village



Based on Figure 3, it can be seen that the plan of biodigester biogas distribution is carried out in every hamlet in Jimbaran Village. The placement of biodigester distribution points is carried out based on consideration of the land suitability analysis of Jimbaran Village. Besides, biodigester's distribution is also carried out concerning cow manure supply that varies with each hamlet. Thus, hamlets with more biogas production can channel their advantages to other hamlets that have not met biogas' needs for community cooking activities.

5.Possible Solutions

In this study, we were able to find out how cow waste can benefit the environment and economy of Jimbaran villagers. Utilization of biogas to meet the energy needs in cooking for the Jimbaran Village people can shift the position of LPG or firewood that is commonly used by the community for cooking. People do not need to spend money buying LPG or spending time looking for firewood every month as their cooking energy source through biogas utilization. People who have enough cows are guided to process their livestock waste into biogas products. Thus, people help support the distribution of renewable energy and satisfy themselves in economic aspects.

This research was conducted with some limitations. Our research has not considered the processing costs that communities and villages must incur in producing biogas. The boundaries of the survey are enough to provide access to data that is quite difficult for researchers. In the future, the explanation of processing cost considerations will be very able to help consider whether the procurement of biodigester biogas projects is relevant to be applied in Jimbaran village or not. However, this research has met the study's purpose to further explore the plan of processing cow manure into biogas products in Jimbaran Village. In this case, researchers have successfully suggested a project plan for processing cow manure into biogas through a biogas biodigester procurement project plan.

6.Conclusion

Biogas is an alternative to renewable natural resources that comes from the decomposition of organic materials in the form of cow manure. The livestock sector is not the only sector that can provide benefits for farmers in terms of livestock production. However, the resulting manure is also one of the advantages that can be obtained if livestock manure can be processed. One of the things that can be done to get the benefits of livestock manure is through processing livestock manure into biogas. In our study area, namely Jimbaran Village, Pasuruan Regency, East Java, Indonesia, cow manure is one of the potential sources of biogas utilization and processing. The biogas produced can be a source of fulfillment of benefits for cooking needs or a source of electricity for the community.

The research that has been carried out can describe how the potential of a well-managed village will provide sustainable benefits. Not only for the village economy but also for the community's economy and environmental health conditions. One example is research conducted in the study area of Jimbaran Village, Pasuruan, Indonesia. Our research shows how the existence of cow manure that was previously discarded can now be processed to meet community needs. Existing cow manure is collected to be processed into a biogas source. The resulting biogas will be distributed to each biodigester. The biogas in the biodigester will then be distributed to breeders' houses. Biogas can be used as a gas fuel source to replace LPG gas fuel derived from fossil fuels. The utilization of biogas is one of the good steps in transforming from non-renewable natural resources to sustainable renewable natural resources.

Biogas development is one way to support the economy of the village and the people in it. There needs to be careful planning in developing a biodigester for biogas. The step that needs to be done in the preparation of a biogas biodigester development plan is the calculation analysis stage. First, researchers need to calculate the comparative results of cow dung each year as a benchmark for planning. Second, it is necessary to calculate the need for cow dung which will later be used as a source of biogas processing. The calculation of this need can be seen by taking into account the number of people who use LPG fuel and firewood as gas fuel for cooking. The data will then become data that summarizes the amount of gas fuel needed for cooking by the community. Third, it is necessary to calculate the energy requirements, the weight of cow dung

required for biogas processing, and the total number of cattle needed to produce manure as the basic material for biogas. The three calculations are carried out sequentially.

First, the calculation of energy needs is carried out to determine the volume of energy needs of rural communities in 1 day. After calculating the energy requirements, the calculation is continued by calculating the amount of cow dung that needs to be produced in 1 month. This needs to be taken into account because it will be a consideration whether the energy needs of the community can be met by the amount of cow dung in the study area. Finally, it is necessary to calculate the total cows that need to be available to produce manure in 1 day.

Based on the analysis results, it was found that 3,154 cows could meet the people of Jimbaran Village's energy needs. The existence of 3,154 cows can provide input for biogas production as a source of energy to replace LPG or gas fuel. Through 3,154 cows, biogas products' distribution will be evenly distributed throughout the farmers' community in Jimbaran Village. The biogas distribution is carried out through 38 biogas biodigester points planned to be built in each hamlet in Jimbaran Village.

Thank You

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