p–ISSN: 2723 - 6609 e-ISSN: 2745-5254
Vol. 3, No. 12 December 2023 http://jist.publikasiindonesia.id/

UTILIZATION OF BIOGAS AS AN EFFORT TO MITIGATE & ADAPT TO CLIMATE CHANGE IN INDONESIA

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ARTICLE INFO

Accepted : 09-11-2022
Revised : 14-12-2022
Approved : 15-12-2022

Keywords: Uncertainty; Climate Change; Biogas.

ABSTRACT

The preparation of this paper is a form of implementation related to the paper entitled Navigating Amid Uncertainty in Spatial Planning by Zandvoort, M., and friends in 2017. The paper contains the form of uncertainty faced by planners in the planning process. Uncertainty is divided into 3 types, namely ontic uncertainty which does not know a phenomenon to a certain degree, while epistemic uncertainty is a phenomenon that can be known to a certain level, and ambiguity uncertainty is knowledge and different perceptions of a phenomenon. One form of uncertainty that occurs in planning is climate change. The phenomenon of climate change is a phenomenon caused by human activities either directly or indirectly. This activity triggers changes in the composition of gases in the atmosphere within a certain time. The countermeasures are in the form of mitigation and adaptation measures. One form of climate change mitigation and adaptation is the utilization of biogas. Biogas is a gas that comes from anaerobic activity (fermentation) from organic materials such as animal manure. The state of Indonesia has a large number of livestock and of course, produces manure. If left unchecked it will become pollution. For that, it needs processing to become something useful. Biogas has benefits as a new energy that can be utilized. Besides that, biogas can fight the greenhouse effect, which triggers climate change. In Indonesia, not all provinces where people process livestock manure into biogas for daily use.

Introduction

In the world of planning, planners are faced with several situations and conditions. One of them is the condition of uncertainty in planning (Christensen, 1985). One form of uncertainty faced by planners is the risk of climate change. Planners have a compulsion to assess the impacts of climate change to design spatial interventions for adaptation to climate change. Although in general climate change can change a local environment in unpredictable ways (Borron, 2006).

According to Law No. 31 of 2009, the definition of climate change is a change in climate conditions caused, either directly or indirectly, by human activities and activities that cause changes in the composition of gases in the atmosphere globally and changes in natural climate variability that can be observed in a certain time that can be compared.

While referring to the IPCC (2001), the phenomenon of climate change is a change that refers to the average variation of a climate condition in a particular place or its variability that can be statistically accounted for for a long period (usually within a decade or more).

To prevent and reduce the impact of change, a process of adaptation and mitigation of climate change is carried out (Misra, 2014) (Locatelli, Evans, Wardell, Andrade, & Vignola, 2011). One form of adaptation and mitigation efforts is the use of biogas. Biogas is a gas derived from anaerobic activities and activities or fermentation from organic materials such as human and animal waste, domestic (household) waste, biodegradable waste, or organic waste that is biodegradable under anaerobic conditions. The main content in biogas is carbon dioxide and methane. The use of biogas can be one of the efforts to adapt and mitigate climate change (Farghali, Osman, Umetsu, & Rooney, 2022). This is because biogas can provide resistance to the greenhouse effect. The greenhouse effect is the effect caused by the accumulation of greenhouse gases in the atmosphere (Mikhaylov, Moiseev, Aleshin, & Burkhardt, 2020). The gases that accumulate in the atmosphere can absorb longwave radiation emitted by the sun to the earth, triggering the phenomenon of global warming which has an impact on increasing the earth's temperature. Some of the gases included as greenhouse gases are carbon dioxide and methane.

Research Methods

This research uses a qualitative research design with a case study method on the use of biogas as a mitigating and adaptation factor to climate change in Indonesia. To collect hidden data, this study conducted surveys and questionnaires from various regions in Indonesia that already have biogas systems. The case study approach allows researchers to explore in detail the application of biogas technology, identify success factors, and provide its impact on reducing greenhouse gas emissions and environmental benefits. Therefore, this method provides comprehensive information on the use of biogas in the context of climate change mitigation and adjustment in Indonesia.

Result and Discussion

Climate change trends and impacts

The natural envelope of greenhouse gases in the atmosphere can keep the earth warm enough for the life of all living things today at a comfortable temperature of 150 C. The increasing amount of greenhouse gases is caused by daily activities carried out by humans. This results in a thickening of the envelope, which causes the trapping of thermal energy which triggers global warming on Earth. The average temperature of the earth has been quite stable in the last 10,000 years and varies less than 10C so that human civilization can develop rapidly with comfortable temperatures. However, the successful development of human civilization poses a risk to the balance of the earth's climate. The problem now faced by humans is that since the start of industrial revolution activities 250 years ago, greenhouse gas emissions have increased and thickened the veil of greenhouse gases in the atmosphere at a significant rate of increase. This resulted in the greatest change in the composition of the atmosphere in 650,000 years. The warming currently occurring in the Earth's climate system is felt, along with overwhelming evidence from observations of rising air and sea temperatures, melting snow and ice in various parts of the world, and rising global sea levels (IPCC 2007) (Singh & Singh, 2012).

The rate of warming of the Earth's surface temperature on average in the last 50 years is almost double the average in the last 100 years. Over the past 100 years, the Earth's surface temperature has increased by about 0.740C on average. If the concentration of dominant greenhouse gases in the atmosphere, such as carbon dioxide, were to double in pre-industrial times, this would indirectly trigger an average warming of 30C.

One of the biggest impacts of global warming is sea level rise. Sea levels rose by about 17 cm during the 20th century (Nicholls, 2011). Based on geological observations, there are indications that this sea level rise is much greater than the events 2,000 years ago. The global average sea level is projected to increase by 28-58 cm due to ocean expansion and glacier melt by the end of the 21st century (compared to sea level in 1989-1999). Meanwhile, in temperate regions, many glacier mountains begin to melt, and the more severe the snow cover decreases, especially in spring. During the 20th century, the maximum area covered by snow in winter/spring decreased by 7% in the Northern Hemisphere. As many as 20-30% of species will face a greater risk of extinction. There will be stronger heat wave events, new wind patterns, and droughts that will become more severe in some areas.

Climate change mitigation efforts

Climate change is the change of several climate elements towards a certain trend that comes out of the average climate conditions in the long term as a result of global warming (Research and Development Agency, 2007). Action to anticipate climate change by preparing directions and strategies, programs, and policies to face the threat of global warming/climate change. Climate change mitigation efforts are known as mitigation and adaptation actions.

a. Climate change mitigation efforts are an action that aims to reduce the intensity of radiation forces to reduce the potential for global warming phenomena. Climate change mitigation is an active form of action to prevent or slow down the phenomenon of climate change by reducing emissions and increasing the absorption of greenhouse gases (KP3I, Ministry of Agriculture, 2008).
b. Climate change adaptation efforts are the ability of systems such as ecosystems, socio-economic, and institutional, to adapt to the impacts of climate change that occur, minimize the amount of damage due to impacts that arise, take advantage of opportunities, and overcome all forms of consequences (IPCC, 2001). Climate change adaptation efforts are various actions as a form of self-adjustment both managerially, technological developments, and patterns in agriculture so that the impact of climate change can be suppressed and can even be used to increase agricultural production itself (KP3I-Ministry of Agriculture, 2010).

History of Biogas and Its Utilization in the World

According to LPLH SDA MUI (2015), Biogas is a collection of gases derived from anaerobic or fermentation activities and activities from organic materials such as human and animal waste, domestic (household) waste, garbage, or organic waste that is *biodegradable* and in an anaerobic state.

The history of methane gas has long been used by people in ancient Egypt, China, and Rome as a fuel for combustion and heat generation. The process of fermentation of methane gas was first carried out (Demirbas, 2009). Willam Henry in 1806 and Becham (1868), students of (Faugi & Ariffin, 2017), were the first to demonstrate the microbiological origin of methane formation.

In 1900 the first anaerobic biogas-producing device was built. At the end of the 19th century, research was carried out to convert methane gas into biogas conducted by Germany and France in the period between the 2 world wars. During World War II, several farmers in England and Europe made a small biogas-producing device. This tool is useful for driving the farmer's tractor engine. However, because it was easy to obtain fuel (Fuel Oil) at a low price in 1950, the use of biogas began to be abandoned.

Different conditions occur in developing countries. Developing countries need energy sources that are cheap and always available. Thus, in India, biogas production activities have continued since the 19th century. Developing countries such as China, the Philippines, Korea, Taiwan, and Papua New Guinea have conducted several research and development on biogas-producing equipment. In addition to developing countries, biogas utilization technology has also been used in developed countries, namely Germany.

Entering the 21st century, awareness about the need for energy as a substitute for fossil energy began to emerge, and various countries began searching for new renewable energy sources. One of them is the United States which openly pays special attention to the development of biogas utilization. The United States Department of Energy provided an injection of US $ 2.5 million to develop biogas in the California area.

Before discussing the use of biogas in Indonesia, it will be discussed related to biogas in its manufacture. The principle of how to make biogas is the decomposition of organic materials carried out anaerobically (closed from the entry of free air) which will produce gas, mostly in the form of methane and carbon dioxide gas. This gas has flammable properties. The decomposition process is assisted by microorganisms, especially in the form of methane bacteria. The preferred temperature to carry out this fermentation process is 300-550C, so microorganisms can change organic materials more optimally.

The following is the amount of manure produced by several types of livestock within 1 day:

Table 1

Types of cattle	Solid Manure (kg)	Liquid Manure (litres)
Cow	25,00	9,07
Riding	16,10	3,63
Pig	2,72	1,59
Sheep	1,13	0,68
Chicken	0,05	-

Source: Wahyuni, 2009

For manure produced by 1 cow in 1 day, 25 kg of solid manure is obtained. If this amount of manure is used in biogas, ± 2m3 of biogas is produced in 1 day, where the amount of 1 m3 of biogas is equivalent to 0.62 liters of kerosene:

Table 2

Types of Dirt	Gas production per Kg of Dirt

Cow	0.023 – 0.04 m3
Pig	0.04 – 0.0059 m3
Chicken	0.065 – 0.0116 m3
Human	0.02 – 0.028 m3

Source: Wahyuni, 2011

The following are the results of the conversion from livestock manure into biogas:

Table 3

Number of farm animals	Biogas yield (m3)	Conversion to oil (liters)
1 sapi	2	1,24
2 horses	2	1,24
8 pigs	2	1,24
20 sheep	2	1,24
620 chickens	2	1,24

Source: Said, 2007

The following is a comparison between the costs incurred for different types of fuel:

Table 4

Fuel Type	Sum	Unit	Unity Fee (Rp)	Cost Incurred (Rp)
Biogas	1,00	m3	1.620	1.620
Kerosene	0,62	Litre	8.000	4.960
LPG	0,46	12 Kg	75.000	2.872
Petrol	0,80	Litre	4.500	3.600
Firewood	3,50	medical history	3000	10.500

Source: Wahyuni, 2011.

In the process of biogas production, several livestock manure will be obtained that can be used as organic fertilizer for crops. Waste from processing into biogas is in the form of livestock manure that no longer has gas (slurry) is an organic fertilizer that is very rich in substances needed by plants. Such required substances in the form of protein, cellulose, lignin, and many others, these substances cannot be replaced by the use of chemical fertilizers.

The calorific value contained in 1 m3 of biogas is equivalent to ±6000watt hours or half a liter of diesel. So biogas is very suitable to be used as an alternative fuel with the advantage of being friendly to the environment as a substitute for the use of kerosene, LPG, butane, coal, and other fuels sourced from fossil processing.

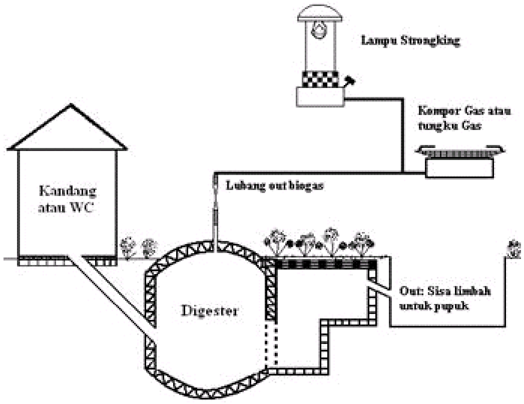

Figure 1: Unit for processing cow manure into biogas

If properly and correctly cleaning biogas from impurities is carried out, then this biogas will have similar characteristics to natural gas. If this happens, then biogas producers can sell the biogas directly to the gas distribution network. However, the gas must be in very clean condition to achieve *pipeline* quality, water (H2O), hydrogen sulfide (H2S), and particulates must be cleaned if they are still contained in large quantities of the gas. Carbon dioxide must also be removed to achieve pipeline-quality gas. If biogas is forced to be used without an extensive cleaning process, it will usually be mixed with natural gas which aims to increase combustion. Biogas that has gone through a cleaning process to achieve pipeline quality is also called renewable natural gas. In this form, the gas can be used just like natural gas. Its utilization can be used for distribution through gas networks, power plants, space heating, and water. Even if compression, the use of biogas can replace the function of compressed natural gas (CNG) used to run vehicles.

The use of biogas technology in Indonesia began to be introduced in the 1970s. This sewage treatment technique using biogas installations was originally developed in rural areas. The development of the times encourages the application of this biogas technology to be applied also in urban areas. In 1981, biogas installations in Indonesia were developed through a biogas development project supported by funding from the Food and Agriculture Organization (FAO) by building pilot biogas installations in several provinces. Then since the 2000s development has been carried out for biogas reactors on a small scale (household) using simple construction made of ready-to-install plastic at relatively cheap prices.

When fuel prices increased in 2006, government subsidy policies and energy scarcity became hot topics in Indonesia. The increase in fuel prices is certainly a burden for the community, especially the underprivileged. Currently, biogas is developed as an alternative energy source to replace fuel. Of course, this is especially beneficial for rural communities. The reason is, that people in rural areas mostly have livestock that have waste that can be utilized. So that the use of this waste can minimize the amount of environmental pollution and save expenses within the scope of households. For farming communities, biogas can produce output, namely in the form of organic fertilizer. This effort can reduce the use of chemical fertilizers to support organic agriculture (Kasem & Thapa, 2012).

The energy produced from biogas has the potential to be developed further. According to (Aggarangsi, Tippayawong, Moran, & Rerkkriangkrai, 2013), there are several reasons:

1. Biogas production derived from cow dung can be supported by a conducive cattle farming climate in Indonesia in recent years.
2. The existence of regulations in the energy sector such as increases in basic electricity tariffs increases in LPG prices, premiums, diesel oil, diesel oil, and fuel oil have encouraged the development of various alternative energy sources that are more affordable, sustainable, and friendly to the environment.
3. The increase in several types of organic fertilizer prices and the scarcity in the market began due to the ineffective marketing distribution process, causing farmers to start switching to using organic fertilizers.
4. Reduce the effects caused by greenhouse gases, reduce unpleasant odors, and prevent the spread of disease.
5. Implementing agriculture by carrying out the concept of *zero waste* is more friendly to the environment and can be sustainable.

The Government of the Republic of Indonesia started a biogas program under the name Home Biogas Program (BIRU) in 2009. This program received assistance from Hivos, which is an experienced non-governmental organization from the Netherlands. The Home Biogas Program is implemented by Yayasan Rumah Energi (YRE) in collaboration with the Ministry of Energy and Mineral Resources and has support from the Norwegian Embassy, EnDev (*Energizing Development*) program and partners tasked with promoting modern and sustainable forms of renewable energy for all people in Indonesia. The BIRU program strives to continuously promote the use of biogas reactors as a form of local energy source that can be sustainable by developing markets. This program will also work to develop the biogas sector commercially market-oriented and lead to the growth of new jobs. The BIRU program began in May 2009 and until November 2015 had built 16,015 biogas reactors in 9 provinces in Indonesia.

Many people in Indonesia have limited access to energy sources that are economical and convenient to use. While sustainable energy services will not address the underlying causes of poverty, limited energy availability will stand in the way of their path to prosperity.

In 2008, the Directorate General of Electricity and Energy and Mineral Resources Utilization, Government of Indonesia, requested the Dutch Embassy to examine biogas' potential in Indonesia more deeply. The results of the study show the potential of biogas in Indonesia can reach one million units and the favorable financial rate of return (FIRR) for farmers.

Based on the feasibility study that has been conducted by BIRU, Java Island, West Sumatra Province, and Bali are the initial focus of program implementation. This is because the area has a fairly large livestock population. Currently, BIRU operates in 10 provinces in Indonesia, namely Lampung, Banten, West Java, Central Java, Special Region of Yogyakarta, East Java, South Sulawesi, Bali, West Nusa Tenggara and East Nusa Tenggara.

The results of a BIRU survey in 2013, where BIRU users said their home environment became healthier. There is less smoke in the kitchen (79%), the kitchen is cleaner (72%) and the livestock shed is cleaner (69%). The smell is already reduced by 75-80%. villages in Indonesia have transitioned to using biogas energy:

a. Cabbeng Bone Village, South Sulawesi

Cabbeng Village has an area of 6.8 kilometers. This village has been utilizing biogas since 2013. This process began with information and assistance from the Environment Agency, Residents of Cabbeng Bone Village used biogas to become the main source of energy for their household needs.

Currently, there are 30 livestock chitosan waste processing devices in Cabbeng Village. According to the community, the existence of biogas is very helpful for them. The manure produced from 2 cows, is enough to help them to be able to cook up to 8 hours. In addition, the pulp from biogas processing is dried and used as organic fertilizer.

b. Bengan Village. Bali

Penyabengan Village in Bali has also moved to use biogas. 44 houses already use biogas. Before using biogas, Penyabengan Village used firewood for cooking. This village with the majority of the population as farmers started using biogas in 2011.

1) Medowo Village, Kediri

Medowo village is located at the foot of Mount Anjasmoro. The majority of Medowo Village people work as dairy farmers. Of course, people easily get livestock manure to be processed into biogas. After using biogas, villagers can reduce river water pollution by up to 90% in their environment which was previously polluted by livestock manure waste.

2) Argosari Village, Malang

In the past, the people of Argosari Village cut down trees to be used for cooking. The existence of biogas changes people's mindset. The forest that used to be cut down is now well cared for.

3) Pasuruan

Pasuruan is one example that has used biogas for a long time. There are 4 villages where 100% of the people use biogas as an energy source for daily cooking activities. The villages are Gunung Sari, Ngempiring, Cemoro and Kumbo. The community says they can save up to Rp 400,000 every month.

Conclusion

The main cause of climate change and its associated disasters is the increasing consumption of fossil fuels in Western countries. Developing countries are experiencing more severe impacts due to their increased sensitivity to climate-related changes, such as the increased use of levees to protect themselves from the threat of robbery. The use of biogas is the single best solution to mitigate and adapt to climate change. By replacing fossil fuels in the process of heating, cooking, cleaning, and cooling, biogas can reduce household gas emissions. The process of making biogas also converts methane gas which is the main cause of home impacts into carbon dioxide. In addition, biogas can increase forest vegetation and produce bio-slurry that harms long-term telecommunications networks. Indonesia can reduce carbon emissions, reduce energy needs, and help prevent climate change by using biogas effectively. The utilization of biogas is the only innovation currently used in the field of climate change that has the potential to reduce the rate of climate change and help create a more favorable future for the general public and the planet.

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