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RESEARCH PAPER

The acceptance of biogas in Islamic Boarding School Surakarta

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Abstract. The rapid population growth in Indonesia is leading to increased energy demands and the depletion of global energy sources. One promising to meet these escalating energy needs in the adoption of renewable energy sources like biogas. This study employs qualitative research methods to measure the response of the Islamic boarding school community in Central Java towards biogas utilization. Data analysis was conducted interactively, narratively describing insights gleaned from questionnaires completed by respondents. The findings reveal a varied response within Central Java Islamic Boarding School Community towards embracing biogas as part of efforts to enhance the national renewable energy mix. However, there is a consensus on certain aspects: respondents generally support biogas utilization as long as it is safe, sourced from clean materials, and developed in suitable locations. The exploration among ten boarding schools suggests that the government's renewable energy initiatives require further optimization in terms of socialization and engagement with Islamic boarding schools.

Keywords: biogas acceptance; renewable energy; biogas; Islamic boarding school;

1. Introduction

The increasing world population growth has a significant impact on rising energy demands and depletion of energy resources (Khalil et al., 2019). This trend is also evident in Indonesia, with data showing a population growth rate of 0.98% in 2021 (BPS, 2021) and a corresponding an annual increase in total energy demand of 3.5% (Hilmawan et al., 2021). Consequently, various energy resources, particularly fossil fuels, which are the primary energy source in Indonesia (Zuas et al., 2021), are experiencing a decline. Hilmawan et al., (2001) reported that fossil resources in Indonesia are projected to decline by 2.7% in 2021 due to their intensive use.

The extensive use of fossil fuels has detrimental impacts on the environment (Meidiana et al., 2020), primarily contributing to global warming (Kandpal & Broman, 2014; Francois, 2020; Paolini et al., 2018), which in turn leads to various other disasters such as climate change, extreme weather events, and rising sea levels (Kweku et al., 2018). As a result, there is a growing need to

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expand energy production to meet increasing demands, which can ultimately boost the economy and improve human quality (Kandpal & Broman, 2014).

The pursuit of global energy sustainability can be pursued through the utilization of renewable energy, such as biogas (Dobers, 2019). Biogas serves as a viable alternative to fossil fuels, offering renewable energy sources that mitigate global warming (Asai et al., 2019). It is environmentally friendly, enhances sanitation systems, improve air quality, functions as a biological fertilizer, contributes to reforestation efforts, reduces greenhouse gas emissions, and generates employment opportunities (Amigun & Von Blottnitz, 2010). Among the various benefits of biogas technology, the primary objective is to establish renewable energy sources, making it a focal point for implementation in countries like Indonesia.

The adoption of biogas technology in Indonesia is a key initiative aligned with the government's National Energy Police (NEP), which aims to achieve a renewable energy target of 23% in the national energy mix by 2025 (Yudha & Tjahjono, 2019). However, as of 2020, the renewable energy share in Indonesia stood at only 11.20% (Hilmawan et al., 2021), falling short of the desired target. Despite this, biogas has emerged as a proven renewable energy technology capable of providing heating, electricity, and vehicle fuel (Zuas et al., 2021), underscoring the need for its widespread implementation and optimization.

Biogas implementation in Indonesia utilizes variety of energy-producing materials, such as household waste (Amir et al., 2016), plant and animal biomass (Mahidin et al., 2020), livestock manure (Putra et al., 2017; Agustian, 2014; Alam & Pratiwi, 2013; Khalil et al., 2019; Widodo et al., 2015) and human waste (Andriani et al., 2015). Previous research indicates that Indonesia has strong potential for biogas technology development, although optimal outcomes have not yet been achieved.

In many countries worldwide, the analysis of biogas technology begins with assessing societal acceptance across various sectors. For instance, farmers' acceptance of biogas in Germany is influenced by concerns such as monoculture dominance, odor disturbance, agricultural impact, environmental harm, and competition with food production (Dobers, 2019). Emmann et al., (2013) emphasized that farmer acceptance in Germany is also influenced by innovative capacity, externalities, waste management aspects, and operational facility conditions. Health risks, identified by Francois, (2020), are primary influence on biogas acceptance in Taiwan. Additionally, Meidiana et al., (2020) highlight that the rural Indonesia, acceptance is shaped by family size, land availability, and knowledge of biogas technologies. Meanwhile, according to Amir et al., (2016), operational technical factors are paramount among Indonesian communities.

The acceptance of biogas from a religious perspective has been relatively underexplored area in various studies. Osei-Marfo et al., (2022) highlighted the influence of religious background, primarily Christians, on biogas acceptance, yet the remains a lack of comprehensive research on how fundamental religious beliefs affects this acceptance. In Indonesia, there is a critical need to investigate religious perspectives, especially concerning biogas derived from animal or human waste, considering that such materials are deemed unclean.

In Islam, different schools or thought offer varying views on the cleanliness of animal dung. According to the Shafi'i school, animal dung is considered unclean irrespective of whether the animal's meat is halal or haram. Conversely, the Maliki and Hambali schools do not deem dung from animals with lawful meat as *najis* (unclean). These differing opinions underscore the necessity of research on biogas acceptance from a religious standpoint, endorsed by Islamic religious leaders.

Furthermore, the predominance of Muslims in Indonesia adds to significance of such research. As of 2024, Muslims constituted 244,410,757 or 87.45% of Indonesia's population, as per Population Administration data (Kemendagri, 2021). The substantial Muslim population is seen as a pivotal driver of change.

Given the existing research gaps, it is imperative to explore the acceptance of biogas within the framework of religious teaching by Islamic religious leaders. Insights garnered, including their decisions and rationale for accepting biogas, can serve a guidance for Indonesians, aiding the successful adoption of government initiatives such as advancing the national renewable energy mix through biogas technology. This approach aligns with accelerating sustainable energy goals and fostering community acceptance.

2. Literature review

Several studies worldwide have extensively explored biogas applications. Tabatabaei et al., (2020) investigated the use of various materials, including fungi, bacteria, microbes, and enzymes, in biogas production. They also outlined biological methods like composting, micro aeration, and container closure to optimize biogas production. Grando et al (2017) surveyed raw materials commonly used for biogas production, such as sludge, biological waste, wastewater, livestock waste, and agricultural waste. Awe et al., (2017) demonstrated that is an effective renewable energy sources for fuel and chemicals production, including hydrogen and synthetic gas. Additionally, Ionescu et al. (2019) reported significant revenue growth (37.96%) and profit (53.175) in Romania from the application of biogas, underscoring its environmental and economic benefits. Further research has explored societal, cultural, and economic aspects of biogas adoption, particularly among farmers (Dobers, 2019; Emmann et al., 2013; Francois, 2020). Indonesia, like many other countries, has also conducted various studies on biogas applications.

One study conducted in Indonesia focus on identify various raw materials used in biogas production. These materials include cow dung (Hariansyah, 2009), buffalo and horses (Umam, 2019), activated sludge, kitchen waste (Widyastuti & Mulyani, 2018), tapioca flour waste (Sensih & Prayitno, 2020), carp pond waste (Irawan & Khudori, 2015), quail feces (Sudarman, 2018), human feces (Arnando et al., 2015), and even waste water hyacinth (Darnegsih, 2016) have been explored for biogas production. In addition to the raw materials, other research in Indonesia has examined the effectiveness of using effective microorganisms-4 (EM-4) in biogas production (Tira & Umbara, 2018). This study revealed that incorporating EM-4 can enhance biogas yields. Furthermore, Santosa et al., (2012) investigated the economic impact of using cow dung for biogas as fuel source, demonstrating cost savings compared to diesel fuel, thereby reducing production costs in a tea factory.

Research on the biogas acceptance in Indonesian society remains limited. One notable study in this area was conducted by Alam and Pratiwi (2013). Their research showed that many individuals are hesitant to adopt biogas due to lack of interest in household matters and preference for using animal manure as organic fertilizer. However, some respondents acknowledged the benefits of biogas in terms of increasing profits and supporting local government initiatives. Furthermore, the study identified several barriers to biogas adoption. Many users were not involved in the initial design process, lack ongoing training, and faced financial constraints when attempting to enhance the quality of biogas production. Overall, this study sheds light on the challenges and considerations that impact the acceptance and utilization of biogas technology within Indonesia communities.

Based on the comprehensive literature review described, the decision to explore the acceptance of biogas within Islamic boarding school community, as part of advancing the national renewable energy mix, is grounded in the following consideration. First of all, previous research on biogas, both global and in Indonesia, has covered a range of scientific aspects. This includes investigations into various types of raw materials used for biogas production and the effectiveness of each raw material, as well as biological methods such as composting. Additionally, economic studies have examined the income and profits generated from biogas applications. Secondly, studies on biogas acceptance, particularly in social and cultural contexts, have been conducted across multiple countries, including Indonesia with previous research conducted in Yogyakarta.

The findings from these studies indicate that a majority of people tend to reject the adoption of biogas technology.

In summary, these insights provide a strong foundation for focusing on biogas acceptance within the Islamic boarding school community, aiming to address key societal and technological challenges in advancing renewable energy adoption.

3. Data and methodology

3.1. Research method and location

This research employs a mixed methods approach, combining non-positivistic and positivistic paradigms. The sample of this study was selected from the category of large Islamic boarding schools with than 500 students, specifically in Surakarta. The research was conducted within a boarding school setting in Surakarta, focusing on the families of students and administrators from several Islamic boarding schools in the area. The Islamic boarding school involved in this research are Al Muayyad Islamic Boarding School Surakarta, Pondok Pesantren Daarul Qur'an Karanganyar, Walisongo Islamic Boarding School in Sragen, Daarul Hidayah Islamic Boarding School Sukoharjo, and Al Mansur Popongan Islamic Boarding School in Klaten.

3.2. Data collection

The data in this study consists of primary data obtained through direct interviews and questionnaire with various individuals associated with the Islami boarding schools, including the families of students, founders of the Islamic boarding school, managers, and teachers. The Islamic boarding schools were selected purposively from among these existing in Surakarta. Furthermore, interviews were conducted with these key stakeholders - families of student, founders of the Islamic boarding school, and the managers and teachers within the Islamic boarding school environment - who were identified as research objects.

Table 1. Questionnaire

No.	Question
1	Biogas is renewable energy and green energy
2	Biogas is used for vehicle and electricity
3	Methane, hydrogen, carbon monoxide from biogas is sources of energy
4	Energy from biogas can be used for cooking and generating electricity
5	Biogas is an alternative energy that can replace kerosene, LPG, butane, coal or other fossil fuels
6	Biogas can replace LPG for cooking, reducing dependence on non-renewable energy sources.
7	Slurry is by-product of biogas that can be used as organic fertilizer of plants containing essential chemical elements
8	Biogas is similar to natural gas and can be used for electricity, heating, and water heating.
9	Biogas is produced through anaerobic digestion and can process non-degradable organic waste
10	During the biogas production process, pathogenic bacteria from waste can be destroyed, reducing waste volume.
11	Several countries have increased the use of biogas from liquid or solid waste treatment
12	Governments should increase the development of biogas to reduce reliance on fossil fuels
13	Islamic boarding schools are the main target for communal biogas plant development due to higher production of feces, a key biogas source.
14	All management and teachers in Islamic boarding school should support national programs to develop energy mixes through biogas
15	Biogas development should be encouraged in Islamic boarding schools

The data collection process begins with measuring the initial knowledge of the informants on biogas through an online questionnaire. Additionally, the informants were queried about their inclination towards using biogas and the reasons behind the choices. The subsequent step involves conducting a focus discussion (FGD) with the following sequences. First, initiating with the presentation of scientific explanations related to biogas. Secondly, enquiring about acceptance

or rejection of biogas adoption and reasons. Thirdly, presenting various perspectives from scholars and finding from relevant studies regarding community acceptance of biogas (both acceptance and rejection). Fourthly, re-engaging informants to confirm which viewpoint resonated with them. Finally, ultimately, the participants were tasked with collectively deciding on whether to embrace biogas applications in their daily lives. Upon completion of data collection, then analysis phase ensues. The questionnaire contains of 15 closed questions, which are detailed in Table 1.

3.3. Data analysis

The analysis of research data involves several keys aspects. Firstly, it aims to document changes in individuals' decisions regarding the acceptance and the use of biogas. This includes understanding why individuals choose to accept or reject the application of biogas and investigating into their underlying reasons. In this part, the percentages of individuals are presented in a table showing the distribution of frequency, along with accompanying graphics. The calculations and graphical procedures are conducted using the Microsoft Excell. Additionally, the analysis involves mapping respondents based on their willingness or unwillingness to use biogas. Lastly, the data obtained from FGD is thoroughly analyzed to gain insights into why informants either to use biogas or choose not to, and understand the criteria influencing their decisions. The comprehensive approach to data analysis helps to elucidate the factors driving acceptance or rejection of biogas application among the research participants.

4. Result and Discussion

4.1. Result

The data collection stage was carried out using the FGD method at the Sharia hotel hall on the designated day of the boarding school board meeting. The FGD program was structured to opening remarks by the research team representatives, completion of initial questionnaire (attached), presentation of materials by resource persons, and the FGD session itself. Five groups were formed based on their respective Islamic boarding schools, each accompanied by a facilitator responsible for guiding the discussion using prepared FGD guidelines (also attached). The following section describes the responses received regarding. the acceptance of biogas from representatives five Islamic boarding schools in the Surakarta residency.

Table 1. Frequency distribution of Surakarta Islamic Boarding School response to biogas

Interval	Frequency	Percentage	Category
14-24	1	4.76	Disagree
25-35	4	19.05	Neutral
36-46	16	76.19	Agree
	21	100	

Based on the initial questionnaire distributed to 21 representatives from five Islamic boarding schools in the Residency of Surakarta, it was observed that 16 individuals (76.19%) agreed and accepted biogas as a government policy aimed at exploring new alternative energy sources in Indonesia (Table 1). However, further exploration and analysis are needed to better understand the perspective of Islamic boarding schools. As the result, discussion groups were formed representing each of the five Islamic boarding schools. The following section presents the FGD results from each group, highlighting the profile of biogas acceptance within each Islamic boarding school.

a. Daarul Qur'an Karanganyar Islamic Boarding School

Based on the initial questionnaire distributed to and completed by four representatives of Islamic boarding schools, the data in Table 2 were obtained.

Table 2. Frequency distribution of Daarul Quran Boarding School to biogas acceptance

Interval	Frequency	Percentage	Category
4-6	2	13.33	Disagree
7-9	8	53.33	Neutral
10-12	5	33.33	Agree
	15	100	

It can be observed that out of the 15 statement items in the questionnaire, 8 items (53.33%) indicated disagreement or hesitation in accepting biogas as an alternative energy source, with only 5 items showing agreement. This contrasts with the overall data which indicates that the majority of the five Islamic boarding schools (76.19%) are in favor of biogas as an alternative energy.

Regarding the FGD results, it was found that Daarul Qur'an Islamic boarding school relies on electricity supplied by Perusahan Listrik Negara (PLN), the state electricity enterprise, and uses Liquefied Petroleum Gas (LPG) for cooking purposes. Electricity powers lights, computers, WIFI, and the production of clean water. The total monthly cost for electricity amounts to approximately six to seven million rupiah, funded through student tuition fees and other sources.

In general, subscribing to electricity from PLN presents minimal obstacles, although occasional power outages occur, they are infrequent and manageable with a generator. Similarly, using LPG for cooking to meet the boarding school's needs is relatively safe, feasible, and adequately funded. This situation provides a comfortable environment for the school manager as there are few significant challenges related to the availability of the chosen energy sources.

When asked about the possibility of switching to biogas energy sources, an interesting fact emerged: the manager of the cottage had never considered or desired to adopt biogas as an energy source. Furthermore, this Islamic boarding school has never received information or outreach about biogas from any source. When asked about their opinion on biogas, some respondents stated that biogas is derived from waste and serves as an environmentally friendly fuel source. Additionally, other mentioned that biogas is a substitute for petroleum, contributing to waste reduction and air pollution mitigation.

Regarding the response of Islamic boarding schools to offers for biogas development, they generally express agreement, under the condition that the raw materials used are organic waste and kitchen scraps, excluding cow dung and especially human waste. Despite the abundance of human waste produced by the boarding school, obtained from the ninety toilet facilities in each Islamic boarding school's bathroom, it is deemed unclean. There is an assumption that using such waste as raw material for biogas production would result in gas being unclean, affecting both in the air quality and the perception of food prepared using biogas.

When asked about the obstacles to implementing biogas in Islamic boarding school, they simultaneously identified the location as a major challenge. This is because the Islamic boarding school is situated within a community area, adjacent to residential houses. While generally accepting the religious scholars' fatwa endorsing biogas as an alternative energy source, the four representatives expressed neutrality regarding the construction of communal biogas facilities in the Islamic boarding school. They indicated that their stance would depend on the decisions made by the boarding school's board of directors and the local community.

b. Al Muayyad Surakarta Islamic Boarding School

This boarding school is situated in Surakarta, a city renowned as a hub for batik and other textile trading, education, Javanese culture, and as the birthplace of prominent figures and organizations in the national movement. Geographically, it holds significance as a crucial intercity crossing area in Java. Its modern history traces back to 1945 when the Kartasura Palace relocated to the village of Sala, which later evolve into Surakarta. The initial questionnaires were completed by four representatives of Islamic boarding schools, yielding the data descriptions in Table 3.

Tabel 3. Frequency distribution of Al Muayyad Surakarta Islamic Boarding School to biogas acceptance

Interval	Frequency	Percentage	Category
4-6	0	0	Disagree
7-9	1	6.67	Neutral
10-12	14	93.33	Agree
	15	100	

It can be observed that of the 15 statements in the questionnaire, 14 (93.33%) responded agreed or accepted biogas as an alternative energy source. This finding is consistent with the overall data. indicating that the majority of the five Islamic boarding schools (76.19%) endorse biogas as an alternative energy.

In the FGD results, it was noted that Al Muayyad Islamic boarding school in Surakarta relies on electricity supplied by PLN. For cooking purposes, the school uses LPG. Electricity is primarily utilized for lighting, computers, speakers, and water pump. The total monthly expenditure to meet electricity needs exceeds ten million rupiah, sources for student tuition fees.

Overall, there are no significant issues with subscribing to electricity from PLN, it is relatively stable. Similarly, using LPG for cooking to fulfil the cottage's needs is deemed safe and manageable, with sufficient funds available. This stability provides comfort zone for the manager of the Islamic boarding school, as there are no major obstacles related to the availability of the chosen energy source.

When asked about the possibility of transition to biogas as an energy source, an interesting revelation emerged: the cottage manager had never considered to adopt biogas. Additionally, the Islamic boarding school has not received any information or education about biogas from external sources apart from television. Their understanding of biogas is limited to its use as an energy source derived from animal or human waste for cooking purposes.

Regarding the response of Islamic boarding schools to offer biogas development, they generally express acceptance it, except for the Al Muayyad school at this time. It is acknowledged that the human waste generated by the school is substantial due to the large student population. However, there is a prevailing assumption that this waste is impure, and if used as raw material for biogas, the resulting is also considered impure. Therefore, inhaling air or cooking food using biogas is viewed as unclean.

When asked about the obstacles to implementing biogas at Islamic boarding school, the response from representatives highlighted the location as a primary concern. The Islamic boarding school occupies an area of 2050 m^2 situated within a residential community. Consequently, despite their acceptance of the ulama's fatwa supporting biogas as an alternative energy source, the four representatives expressed disagreement with constructing a communal biogas system at the Islamic boarding school due to its proximity to residential homes.

c. Walisongo Sragen Boarding School

Walisongo Islamic Boarding School is not only a traditional Salafiyah model with its focus on yellow books and Fiqh Sciences, but it also incorporates modern approaches through various advanced programs. These include extracurricular activities, Arabic and English conversation

classes, methods of Quranic recitation (Qiroati and Tilawati), the ISWA organization, Quran memorization (Tahfidul Quran), and Al-Miftah lil Ulum fast book reading method. Additionally, the school features the Walisongo Islamic Football Academy (WIFA) among other initiatives. Based on the initial questionnaire completed by four representatives of Islamic boarding schools, the data descriptions were revealed in Table 4.

Table 4. Frequency distribution of Walisongo Sragen Boarding School to biogas acceptance

Interval	Frequency	Percentage	Category
4-6	0	0	Disagree
7-9	2	13.33	Neutral
10-12	13	86.67	Agree
	15	100	

Out of the 15 statement items in the questionnaire, 13 items (86.66%) indicated agreement or acceptance of biogas as an alternative energy source. This aligns with the overall data, which shows that the majority of the five Islamic boarding schools (76.19%) support biogas as an alternative energy.

In description the results of the FGD, it was found that Walisongo Islamic Boarding School in Sragen relies on electricity from PLN for its power needs. For cooking, the school uses approximately one truck of firewood per month along with gas. Electricity is primarily used for powering water pumps (flow water flow), lights, computers, and air conditioners. The total monthly expenditure for electricity amounts to around seven million rupiahs, sources from student fees and other funding channels.

Generally, the obstacles experienced with subscribing to electricity from PLN include power outages and insufficient power strength. Similarly, using firewood for cooking to fulfil the cottage's needs is considered safe and manageable, with sufficient funds available. This situation provides a comfort zone for the manager of the Islamic boarding school, as there are few significant obstacles related to the availability of the chosen energy source.

When asked about the possibility of switching to biogas as an energy source, an interesting fact emerged: the cottage manager had never considered or desired to adopt biogas. Additionally, this Islamic boarding school has never received information or education about biogas from any source. When asked about their opinion on biogas, some respondents mentioned that biogas is derived from waste, while others described it as a fuel source using natural materials that produce renewable methane gas. It appears that their knowledge about biogas is still limited.

The response of Islamic boarding schools to offers biogas development generally indicate acceptance, with flexibility regarding the raw materials used whether organic waste, kitchen waste, cow dung, or even human waste. They argue that using human waste from the boarding school could be more effective and efficient due to its abundance, sourced from 850 students and 110 bathrooms.

When asked about the obstacles to implementing biogas in the boarding school, representatives cited location as a primary concern. The boarding school, occupying a 1500 m^2 area, situated within a residential community, alongside people's homes. Consequently, although they accept biogas as alternative energy source, only one out of the four representatives expressed agreement with constructing a communal biogas system at the Islamic boarding school, while the other three disagreed due to location constraints.

d. Daarul Hidayah Sukoharjo Islamic Boarding School

This Islamic boarding school follows a typical Ahlus Sunnah waljama'ah education model, offering Diniyah teaching alongside formal education programs including MTs, MA, and SMK. Based on the initial questionnaire completed by four representatives of Islamic boarding schools, the data descriptions were presented in Table 5.

It can be observed that out of the 15 statement items in the questionnaire, 13 items (86.66%) indicating disagreement or less willingness to accept biogas as an alternative energy source. This contrasts with overall data, which shows that the majority of the five Islamic boarding schools (76.19%) support biogas as an alternative energy

Table 5. Frequency distribution of Daarul Hidayah Sukoharjo Islamic Boarding School to biogas acceptance

Interval	Frequency	Percentage	Category
4-6	1	6.67	Disagree
7-9	13	86.67	Neutral
10-12	1	6.67	Agree
	15	100	

Regarding the results of the FGD, the Daarul Hidayah Sukoharjo Islamic boarding school relies on electricity from PLN for its power needs, for cooking, the school uses LPG. Electricity is used to power lights, computers, and various electrical appliances. The total monthly expenditure for electricity amount to around five million rupiah, while the cost for LPG is approximately two million rupiah per month, which is obtained from student tuition fees and other funding channels.

In general, subscribing to electricity from PLN poses no significant obstacles, although occasional power outages do occur. These are infrequent and can usually be managed using a generator. Similarly, using LPG for cooking to meet the cottage's needs is considered safe, feasible, and adequately funded. This provide a comfort zone for the manager of the Islamic boarding school, as there are few significant obstacles related to the availability of the chosen energy source.

When asked about the possibility of switching to biogas energy sources, an interesting revelation emerged: the cottage manager had never considered or desired use biogas as an energy source. Additionally, this Islamic boarding school has never received information or education about biogas from any source. Their opinion on biogas was that it involves processing energy from waste, which they perceive as potentially emitting unpleasant odors and disrupting the surrounding environment.

Regarding the response of Islamic boarding schools to offer biogas development, in general, they expressed disagreement. Tt is acknowledged that the human waste produced by the lodge is abundant. However, it is considered unclean, leading to concerns about the potential for producing unclean smoke if used as raw material for biogas. This perception extends to concerns about inhaling contaminated air and cooking food with biogas. In terms of construction communal biogas facilities in Islamic boarding school, they indicated that they are still considering it but need to find a solution to eliminate the potential impact of unpleasant odors.

e. Al Mansur Popongan Klaten Islamic Boarding School

Initially, the name of the boarding school was Pondok Pesantren Popongan, derived from the name of the hamlet where the boarding school is located. Popongan is a hamlet in Tegalgondo Village, Wonosari District, Klaten Regency, situated along Jalan Solo-Yogya, KM 8 Delanggu. It is a small agricultural community. The formal education offered include Madrasah Tsanawiyah Al Manshur, Madrasah Alyah Al Manshur, Islamic kindergarten. Non-formal education is also provided through Madrasah Diniah. Based on the initial questionnaire completed by four representatives of Islamic boarding schools, the data descriptions is shown in Table 6.

It can be observed that out of the 15 statements in the questionnaire, 9 items (60%) indicating agreement with biogas as an alternative energy source, while 6 items (40%) did not agree or were less able to accept it. This finding somewhat aligns with the overall data, which indicates that the majority of the five Islamic boarding schools (76.19%) support biogas as an alternative energy.

Regarding the results of the FGD, the Al Mansur Popongan Islamic boarding school in Klaten utilizes electricity from PLN for its power needs. For cooking, the school uses 3 kg LPG and

firewood during special event. Electricity is used for lighting, cooking rice, operating water pumps, charging cell phones, office equipment, and fans. The total monthly expenditure for electricity ampunts to over five hundred thousand rupiahs, sourced from Islamic students' contributions (Rp. 55,000 per student) and meal fees (Rp.220,000 per student).

Table 6. Frequency distribution of Al Mansur Popongan Klaten Islamic Boarding School to biogas acceptance

Interval	Frequency	Percentage	Category
4-6	1	6.67	Disagree
7-9	5	33.33	Neutral
10-12	9	60	Agree
	15	100	

In general, there are no significant issues with subscribing to electricity from PLN, it runs smoothly. Similarly, using LPG for cooking to meet the cottage's needs is considered safe, feasible, and adequately funded. This provides a comfort zone for the manager of the Islamic boarding school, as there are no significant obstacles related to the availability of these energy sources.

When asked about the possibility of switching to biogas energy sources, it was revealed that cottage manager had never considered or desired to apply biogas as an energy source. However, the Islamic boarding school received information and socialization about biogas from the Ministry of Information in 2018 in Semarang. When asked for their opinion on biogas, they expressed agreement with its benefits, but emphasized the importance of safety.

Regarding the response of Islamic boarding schools to offers biogas development, opinions vary. Some agreed, while others expressed disinterest. Some stated that community agreement was crucial, highlighting the need for no smoke, no smell, and safe installation that does not disrupt cottage life.

When asked about obstacles if biogas is applied in the Islamic boarding school, the location was cited as a primary challenge. Islamic boarding schools are situated within community complexes, adjacent to people's houses. Therefore, for the construction of communal biogas facilities in Islamic boarding School, they are still considering it and need to evaluate community feedback first.

4.2. Discussion

Biogas is gas produce through anaerobic digestion or fermentation of organic materials, such as animal waste, domestic waste, biodegradable waste or any organic material that can decompose in anaerobic conditions. The primary component of biogas are methane and carbon dioxide. Biogas is a renewable alternative energy source expected to replace fossil fuels, which are becoming increasingly scarce.

As part of efforts to accelerate the development of renewable energy, the government faces several challenges and opportunities in biogas development. The utilization of biogas is a key for advancing bioenergy-based renewable energy, as outlined in the General National Energy Plan (RUEN). However, current progress in biogas utilization falls short of the 2025 RUEN target. Various aspects such as access to funding, technology, coordination, sustainable development, governance, investment, and policies present both challenges and opportunities for the government in implementing biogas development. The Ministry of Energy and Mineral Resources is actively seeking strategies to address these challenges, emphasizing the need for support from all stakeholders.

One of the challenges in biogas development is gaining public acceptance, which includes understanding biogas, awareness of current energy availability, knowledge of the benefits of biogas, and other related aspects that need to be known and understood by the community. Community acceptance plays a crucial role in the success of biogas adoption.

Islamic boarding school are significant community group in Indonesia, a country with a majority Muslim population. Therefore, a challenge for the government in biogas development is understanding the acceptance of biogas among Islamic boarding schools. This research aims to explore how the Islamic boarding school community in Central Java perceives and accepts biogas.

The analysis of the FGD results reveals that the five Islamic boarding schools rely on electricity supplied by PLN for their power needs and they use a combination of LPG and firewood for cooking. The total monthly expenditure for electricity ranges from five hundred thousand rupiahs to ten million rupiahs, sourced from student tuition fees.

When exploring the possibility of switching to biogas energy sources, it was surprising to find that the majority of cottage managers had never considered or desired to use biogas as an energy source, and on average, they had not received information on this topic from various parties. Even when it was pointed out that Islamic boarding schools had a significant opportunity to develop biogas using raw materials obtained from the feces (feces) of Islamic boarding School residents, their responses varied. Some were surprised, laughed, smiled, and other expressed disbelief. It turns out that human waste can indeed serve as raw material for biogas production.

The composition of raw materials used in anaerobic digestion plays a crucial role in determining final yield of methane gas in biogas production. The most common raw materials used for biogas include wastewater, sludge, and manure (25%), animal manure (23%), agricultural waste (14%), and other materials, including human waste. Degradation of the fat component can lead to increase in fatty acid content in the fermentation medium, which can limit and slow down the overall degradation of the raw material (Smyth et al., 2009).

Moreover, when asked about their opinion on biogas, they expressed agreement as long as it brings benefits, but under the condition that is nor considered najis (impure), a viewpoint widely supported by the majority of scholars. However, achieving consensus on this matter is challenging due to differing interpretations among scholars regarding the impurity of biogas emissions. For example, according to the book Bughyatul Mustarsyidin, biogas emission is deemed impure if they originate from impure substances, despite being indirect. The impurity can persist even if the surface is washed, and the taste of impurity may linger in food.

In the Maliki and Hanbali madhhabs school of thought, animals whose meat is considered halal (such as camels, goats, and cows) are not considered impure. Therefore, when waste from these animals is converted into biogas, it is also not considered inherently impure. Conversely, substances like blood, urine, feces, and vomit, from all types of animals are deemed impure in the Shafi'i school. However, there is an alternative opinion within the Shafi'i school that the urine and feces of animals whose meat is halal deemed pure. This viewpoint, advocated by Sheikh Abi Sa'id al-Ustukhri, aligns with the perspectives of Imam Ar-Rawyani and the Maliki and Ahmad schools. Nonetheless, the prevailing view in the Shafi'i school considered such substances as impure.

Regarding the response of Islamic boarding schools to offers biogas development, opinions generally vary. Some agree, while others express disinterest. Some mention that it depends on community's agreement, emphasizing the importance of available raw materials, absence of smoke or smell, and ensuring that the installation is safe and does not disrupt cottage or local residents' lives. However, the concept of safety is relative, as biogas, a gas mixture primarily consisting of carbon dioxide (CO_2) and methane (CH_4), is produced through the fermentation of organic matter by bacteria under anaerobic conditions (Raja & Wazir, 2017).The presence of methane and the anaerobic processes involved pose a risk of explosion if there are installation issues.

When asked about the obstacles of implementing biogas in Islamic boarding school, the location was identified as a major obstacle. Islamic boarding schools are often located in separate complexes within communities, adjacent to residential areas. Therefore, constructing communal biogas in Islamic boarding school requires careful consideration and planning.

The application of biogas from human waste in Central Java appears to require further attention and follow-up. The initiative to implement this in Islamic boarding schools, given their large student population and necessity for effective waste management, has not yet been fully endorsed. Challenges persist regarding both the human feces biogas system and the technology itself, which still need better understanding within the community. One of the main difficulties lies in transferring the technology effectively to society. Managing communal latrines as a raw materials source is also crucial. A roadmap or investment strategy for small-scale communal systems, capable for integration with centralized piping, is expected to yield economic benefits while supporting the waste to energy program. In this regard, cooperation between the government (particularly in the legal domain) and the Islamic boarding school community is essential.

5. Policy implication and conclusion

The results indicate that the acceptance of biogas usage within the Central Java Islamic Boarding School Community, as part of effort to accelerate the national renewable energy mix, remains varied. However, there is a condition in their responses: they agree to its benefits, provided it is safe, source from clean materials, and developed in unsuitable locations. Based on the feedback from our exploration of the ten schools, it appears that the government's renewable energy program still requires optimization in terms of socialization and its approach within Islamic boarding schools.

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