IJE available online at www.ije-pyc.org
INDONESIAN JOURNAL OF ENERGY

Multiple Challenges and Opportunities for Biogas Dissemination in Indonesia

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Received May 31, 2018; Accepted August 25, 2018
Available online 31 August 2018

Abstract. More than the half of Indonesian households primarily rely upon firewood for cooking. To overcome this problem, multiple initiatives established the decentralized biogas programs. This paper aims to analyze the environmental problem of firewood cooking and to find out various challenges and opportunities for biogas dissemination in rural areas in Indonesia. The method used in this paper is literature review with frameworks of DPSIR and stakeholder matrix. The result found that the firewood cooking is adversely impacting local wooded ecosystems, deforestation rate and negative effect on human respiratory health. The biogas programme is still not able to replace the firewood use. The research found that it is caused by two major challenges. The first one is the issue with the project's approach in which biogas programmes are still dominated by the government grants. This situation leads to community dependency on the grant, lack of investment and low demand and market in this sector. The second challenge is the technology part where many biogas digesters were not operated due to the low quality of installation, and lack of knowledge and skill of the biogas user about the maintenance and installation of the digester. This study suggests that there is the opportunity to improve the approach of governmental biogas programme. It has to involve more roles from non-state actors. In the user side, the farmers as majority user also should be trained properly how to maintain the biogas installations. As the solution, instead of the full grant, the programme can reduce the percentage of subsidy and turn the cost to provide more digesters and training. Key stakeholders need to have cooperation to increase the quality and quantity of the biogas dissemination.

Keywords: Biogas, firewood, programme, technology, Indonesia

1. Introduction

The global energy system is growing. However, 8.9% of world energy consumption still depends on traditional biomass (REN21, 2016). It involves over 2.5 billion people or 52% of the population in developing countries. Over half of this number come from India, China, and Indonesia (IEA, 2006). The population growth of Indonesia is expected to grow, this means that this growth will have an impact on the energy demands of its country. Indonesia has different manners of using different resources to make use of energy resources. The consumption of energy use in Indonesia is mostly depending on non-renewable energy such as coal (Hasana et al., 2011).

From the perspective of natural condition and geography, Indonesia has great potential for renewable energy such as solar energy, wind energy, hydro energy and biomass energy. Efforts are made to promote renewable energy in Indonesia. As a result, energy policy and regulation are created, this is not enough to give a satisfactory result. Different parties such as the government, non-government agencies, and the public can promote and use the renewable energy more to achieve secure and environmentally sustainable energy resources that people can use on a long term. Although the country encourages utilizing renewable energy, the contribution is only around 3% (Hasana et al., 2011).

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Almost half of Indonesia's household, i.e. 24.8 million households primarily rely upon traditional biomass, such as firewood for cooking (BPS, 2011). Use of firewood has disadvantages for environment and health of poor people in rural areas. Yet they have no alternatives but to collect timber from the forest, and often cut down trees, to collect firewood for cooking. Some people who have access to Liquid Petroleum Gas (LPG), still have the cultural barrier to switch from firewood to LPG. But, overall, centralized Liquid Petroleum Gas (LPG) programme still can't reach all energy-poor people (Andadari, Mulder, & Rietveld, 2014). In order to solve this problem, a decentralized or distributed energy system is required. Some countries define this system as small-scale energy which has some basic characteristics such as using renewable sources (Pepermans, et.al. 2005). This definition is aligned with the expectation of counterproductivity theory's advocates who want to alter the industrial system to be eco-friendly and with 'natural' technologies (Van Koppen, & Spaargaren, 2017). In case of firewood cooking in Indonesia, biogas appears as a distributed energy source to help the energy-poor people. Biogas is produced from agriculture, include animal farming, and household waste through anaerobic digestion process at low temperature and without air (Truong, & Abatzoglou, 2005; Kapdi, et.al. 2005). From 2007-2017, multiple stakeholders have installed more than 30K biodigester in all over Indonesia (MEMR, 2017). Yet, this number is still relatively low compared to the huge potential from agricultural and domestic waste in Indonesia, as raw material to biogas (Transrisk, 2017).

This study aims to identify challenges and opportunities for biogas development to be cooking fuel in rural areas of Indonesia. It includes the technology, environment, socio-economic and policy aspects. In addition, the research also does an analysis of environmental problems on firewood cooking in Indonesia.

2. Methodology and Framework

The primary method is the literature review and at the end, there is a stakeholder matrix to analyze the influence and the interest of the stakeholders toward the biogas programmes. To develop the clear explanation about environmental problems from traditional cooking fuel, this study utilized DPSIR as an integrated framework (Figure 1). DPSIR is a practical framework to understand the cycle of environmental problems, its causes, and its solution. This framework uses these following components: driving forces, pressures, states, impacts and responses (Maxim, Spangenberg, & O'Connor, 2009).

3. Result

3.1. The Problem of Cooking Fuel in Indonesia

Before the people were cooking on LPG, they were using kerosene to cook their meals but in 2007 the government of Indonesia forced kerosene users to switch to Liquefied Petroleum Gas (LPG) as cooking fuel, in a massive centralized energy program. Analysis of the LPG programme found that the programme has benefitted most for higher and medium-income households in suburban areas. In fact, it doesn't succeed to significantly alleviate the average number of energy-poor people in rural areas (Andadari, Mulder, & Rietveld, 2014) which has the high birth rate (Nitisastro, 2006). This situation becomes driving forces for those people remain to use woody biomass as a fuel for daily cooking. Another fact, the number of LPG user increases to replace kerosene, yet the number of firewood user remains the same, even increase. Some people who already have access to LPG, they still like to use firewood due to their preference about a better taste of food cooked by firewood. There is the cultural driver toward the problem. It implies a cultural explanation on this issue. In addition, the firewood cooking is also a social practice for rural people as it has been routinized behavior. Consequently, it happens to be the pressure which is adversely impacting local wooded ecosystems, contribute to deforestation rate and environmental degradation (Usack, Wiratni, & Angenent, 2014). The rate of deforestation in Indonesia is estimated at between 1.6 million and 2.5 million hectares per year. (Nawir et al., 2007). One of the direct causes is linked to human activity (Kaleigh, 2012) such as

taking firewood for cooking by community surrounding forest. Rural people perception does not assess the seriousness of deforestation risk.
Aside from the state of forest degradation, the firewood cooking also causes the state of indoor air pollution and the negative impact on human health. There have been some evidence in Indonesia that showing the impact of cooking with firewood on respiratory health (Silwal, & McKay. 2014). The practice generates high airborne particle matter (PM) and black carbon concentrations when the firewood is burned in the room with poorly ventilated furnaces and cook stoves (Usack et al., 2014; Huboyo, et.al. 2009). These environmental risks are not understandable by the rural people.

In order to respond to the firewood cooking problem, Hivos-International NGO and SNV (Netherlands Development Organization) established a programme in Indonesia called BIRU (biogas for the household) to change the rural people behavior. The programme has installed 16,015 digesters in nine provinces in Indonesia from 2010-2015 (BIRU, 2015). The Indonesian government provides the subsidy to the programme so the rural people are able to use the biogas for free (weADAPT, 2017). Apart of BIRU, currently there is also another response from the European Commission research project to trigger investment for private initiative to develop the biogas business in Indonesia (Budiman & Bobashev, 2016). This project is using the concept of with low carbon energy system as part of energy transitions for sustainable energy in Indonesia which make the case for 'energy trajectories' and connections between scales (Smits, 2015).

The Indonesian government has several biogas programmes from different ministries which mostly connected with BIRU. The biogas programmes come from the Ministry of Energy and Mineral Resources (MEMR), Ministry of Forestry and Ministry of Agriculture in form of an integrated farming programme. The Ministry of Agriculture Indonesia has started the bioenergy development programme including biogas in the rural area across Indonesia since 2006 (Direktorat Pengolahan Hasil Pertanian, 2009)**.** The programme mainly focused on the data mapping of potential energy generation and creating a pilot project in rural areas. In other biogas programmes, the government used to hire YRE as an Indonesian NGO and Hivos as implementing partner. Hivos and YRE also work with certified construction partner organization (CPO) in installing the biogas digester (Su-re.co, 2017). Aside from work with the government, Hivos and YRE are also working on a specific project based on grants and loans. It makes the biogas contribute more to energy security. If there is more energy security the rural areas can begin to grow economically. Biogas as a decentralized energy system seems to be the solution for the remotely rural areas. This technology is expected to be practiced by rural people to be their behavior and affecting their skills and mindsets toward the environment.

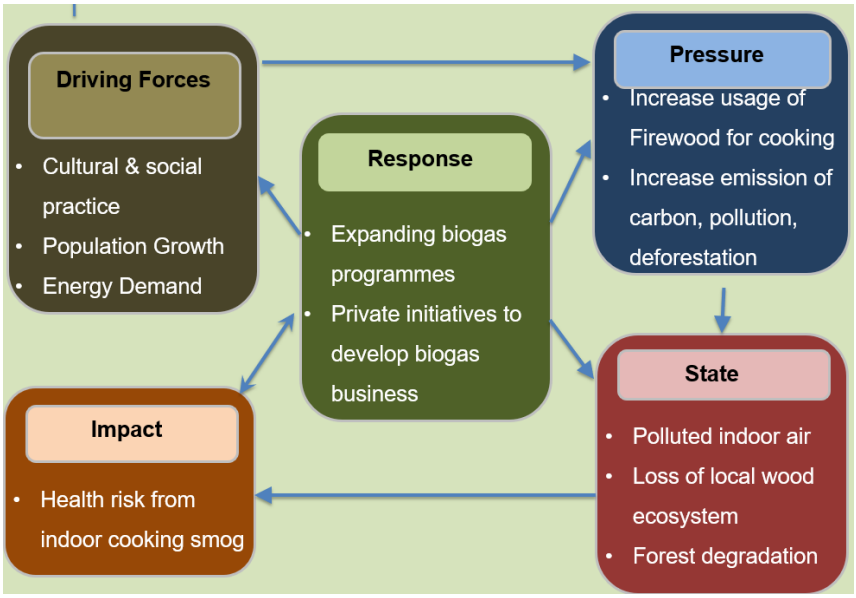

Figure 1. DPSIR analysis of firewood cooking problem

The biogas system in Indonesia is still not widely developed for the household all over Indonesia (Budya & Arofat, 2011). This is one of the reasons why the number of firewood user is still high. However, compared to other renewable technology for cooking i.e. wood pellet biomass, biogas digester is still much more developed in some regions. There are various site-specific challenges and opportunities for biogas dissemination in Indonesia. Biogas is categorized as second-generation biofuels due to its feedstocks (Heijne, 2017). The basic process of biogas is the conversion of organic matter into an energy product. Biogas mostly consists of methane and can easily be obtained. Feedstock to produce biogas is plenty in Indonesia, most existing biogas is using farm manure and slurries in rural areas. Biogas has many different ends uses, such as cogeneration to produce electricity and heat, cooking fuel, to power lights and to drive vehicles (Budiman, 2016). However, in Indonesia, current use is still dominated for purpose of cooking fuel and light (Transrisk, 2017).

The development of biogas in Indonesia has been aligned with the government effort to make a 23% target for renewable energy development across Indonesia by 2025 and 31% by 2050 (ESDM, 2016). Bioenergy including biogas is one of the energy resources to meet the target (JIQ, 2016). Bioenergy is counted as 13% of the total energy using renewable sources target, but currently, the bioenergy only achieves 5.1% from the target. Biogas is the smaller part of that percentage (Budiman, 2016). In term of environmental policy, Indonesia's Intended Nationally Determined Contribution (INDC) 2015 released an unconditional 2030 GHG emissions reduction target (including land-use, land-use change and forestry (LULUCF) emissions) of 29% below business-as-usual (BAU) and a conditional 41% reduction below BAU by 2030 (Climate Action Tracker, 2016). Thus Indonesia is facing a great pressure of CO2 emission reduction and reforestation. Biogas becomes one of the responses in climate change mitigation to tackle those pressures (Figure 1). One biogas unit can reduce 3.2 ton CO2/year (Transrisk, 2017). Biogas also helps on other environmental subjects, when all the animal wastes are used for biogas, then it won't be dumped in nature.

3.2. Stakeholders Analysis

In order to study the feasibility of the solution, this research is using stakeholder matrix to identify the position, influence, and interest of related stakeholders regarding the biogas development (Koppen & Spaargaren, 2017). This research focuses on one of the biggest biogas programs in Indonesia, which is BIRU (domestic biogas). There are five main stakeholders in BIRU. The first one is YRE-Indonesian NGO- which is running the biogas programme with Hivos-Dutch NGO. Hivos has been providing funding for the programme. Hivos and YRE recruit Construction Partner Organisations (CPO) as the local partner to build a biogas digester for farmers who attended this programme as well as educate farmers to maintain the functions of the facility.

Figure 2 depicts that as key players, YRE and Hivos keep good relations with all stakeholders due to their high interest in biogas programme and their influence toward the government programmes. YRE and Hivos have expertise in the biogas programme with support by construction partner organization (CPO). As local partner paid by Hivos and YRE, the CPO has interest in the business yet they cannot really influence the programme as they depend on the size of programmes offered by Hivos and YRE. MEMR has the high influence on the programme monitoring because they have authority on the policy level. Low interest of MEMR is caused by the national priority is more about electricity issue and other sources of energy (Transrisk, 2017). Farmers as the user of biogas have high interest in the programme because they found it useful in their daily life, so they want to protect the existence of the programme. However, as the consumer, they are only able to make little influence on the programme. Position in the matrix is not absolute, it can move depends on the context and situation of the stakeholder interest in time and scale.

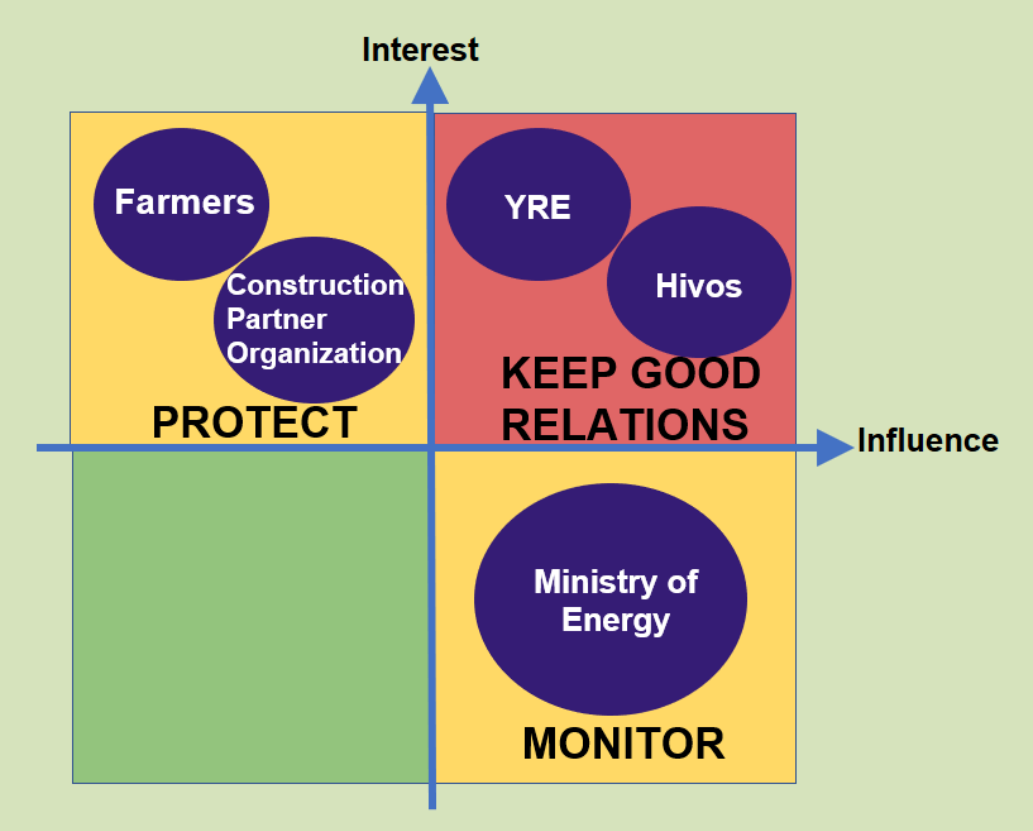

Figure 2. Stakeholder matrix of biogas programmes in Indonesia

3.2.1. Ministry of Energy and Mineral Resources (MEMR)

MEMR takes major responsibility in executing Regulation No. 79 about Indonesia's National Energy Policy to achieve 23% of Indonesia's total energy mix by 2025. MEMR created the roadmap for renewable energy with policy action to provide incentives for renewable energy development and transferring knowledge to rural people. One of focus in the renewable energy (RE) resources is biogas to accelerate the implementation programme (Mujiyanto & Tiess, 2013). The programme aims to support national target on GHG emission reduction 26 % in 2020 as well (Carlson, et.al. 2013)

MEMR drives the policy and main funding for RE programmes through The Public Works Department and The EMR Department in provincial level to implement the programme. Some provinces are interested in biogas because they recognized the potential and availability of feedstock and also because there is demand from the community. In practice, the government has done closely collaboration with BIRU programme (Transrisk, 2017). The biogas digesters are installed by certified experts and certified standard of SNI 7826-2012 which was created by Hivos in partnership with the MEMR. The biogas user, mostly farmers, are given the training to build the biogas and guidebook to use the biogas. From the training, the farmers are expected to be next constructors of the biogas digester. The users are also protected by three years of the warrant for digester (Biru, 2012). In 2013, the government expanded the biogas programme into the concept called “independent energy village”. The MEMR created technical guidance for this programme to be a reference for the local government to apply the concept to the community (Biru, 2012a). In 2016, Yogyakarta, one of the provinces in Indonesia provided funding for 600 biogas digesters development. The total cost was 7.2 billion IDR which was occupied by one of the government partners for installing the digesters to the community as a grant (ESDM, 2016).

The government believes that the biogas programme can bring new knowledge and perspective to the community about the utilization of animal manures as affordable energy resources. It is not only alternatively sustainable energy, but the programme also aims to improve the quality of life and

environment for rural people (Biru, 2012). The anaerobic process of biogas produces bioslurry which can be used by the farmers to be organic fertilizer for their farms. This result of field visit done by the BIRU programme found that from a small-scale digester of 2x3 m can produce 35 liters of bio-slurry which can be used for 1000 papaya trees (ESDM, 2016a)

In the local level, the programme also does cooperation with local NGO to help the transition of the programme to enter the commercial stage by support from microfinance institutions. This whole process is supported by the MEMR (ESDM, 2011). Currently, the government is opening more opportunities for private sectors to get involved in the biogas programme. This opportunity can match with the solution to replace the grant with the subsidy, as well as to provide private training for biogas user. The MEMR is even further to reach the electricity issue. Regulation of the MEMR number 27 in 2014 manages about purchasing of electricity from biogas generation plants (Hukumonline, 2014).

3.2.2. HIVOS

Hivos is one of the NGO's which are active in Indonesia, the main goal is to defend the rights of the normal citizen. They fight against the abuse of power by bigger companies, this is why they also help to set up projects for biogas. The government has financially more interest in the use of fossil fuel because they can sell that. If the citizens change to decentralized biogas they will lose their market and will cut into their finances. The projects of Hivos is biogas for household (BIRU). It was started in 2009 and they have already installed 16.000 digesters to produce biogas, by the end of 2018 they would like to have installed 25.000 digesters which could help over 100.000 households. (Hivos, 2015).

Hivos tried to communicate with the government and the big companies to make the use of biogas more profitable. Hivos work together with the Dutch ministry of foreign affairs and economic affairs. The technology is provided by SNV Netherlands Development Organisation, with this combination of different stakeholders are the possibilities for Hivos a lot bigger than if they would do it without any help. Hivos does not only focus on producing biogas but are also investing in other ways of renewable energy such as solar and wind energy.

If it depended on HIVOS alone, the whole of Indonesia would switch to biogas, because it is much better for the environment and for the farmers that don't have access to continually energy supply. If they do the changes of economic growth would increase, and the farmers would be better off. The only problem is, is that the NGO's should also give proper education on how to maintain the biogas systems. This costs a lot of money and time, this can be too valuable for the NGO’s, but if they want it to work they have to invest in it (Hivos, 2015). So the HIVOS organization has the goal to introduce biogas to all the rural areas in Indonesia, Hivos is positive for it to happen.

In response to suggested recommendations, substitution grant to the subsidy by the government may be the competitor for credit scheme established by Hivos with YRE, if the government will offer a bigger subsidy. However, since the government biogas programmes also work with BIRU, so it may be safe for Hivos. Alternatively, the government subsidy can potentially to be transition pathway for promoting Hivos credit scheme for biogas. For the training, Hivos may not have enough money to conduct training per village in the Regency. Yet, either hands-on practice or more effective method in the training can be tested by Hivos.

3.2.3. YRE

Established in 2012, Yayasan Rumah Energi (YRE) is an Indonesian NGO aims to give a response to the public need for affordable food and energy. And facing the difficulties of unsustainable use of fossil fuels and the impact of climate change, helping people enjoy better on their natural resources. (Yayasan Rumah Energi, n.d). By far, YRE has attended several programs science 2012 that related to biogas generation. Such as Upscaling the Indonesia Domestic Biogas Programme (BIRU), East Java 2013 - 2014 (GIZ), BIRU Programme - Provision of Biogas in Sumba 2014-2015, Development

sustainable Biogas programme in East Java,(ENDEV-Hivos carbon). (Yayasan Rumah Energi, n.d.) All of them are belong to BIRU programme which is mainly driven by environmental concerns from Hivos. YRE does feedback collection over 27 months with two visits while monitoring if the unit works properly to guarantee 3-year using with YRE's funding.

The core of the programme was to reduce carbon emissions, hence the production of biogas was closely connected to the carbon credit market managed by HIVOS and YRE. Currently, YRE through BIRU is selling carbon credits, especially in the European market, which covers 20-30% of the programme cost. YRE needs more units to be installed to cover 100% of the programme costs. At the moment, the revenue generated by the carbon market is used to give 20% subsidy of installation or operating cost of the biogas units. YRE combines this scheme with a loan scheme for farmers in partnership with the private sector and bank. YRE talks with several banks and cooperatives to have agreement on a credit scheme for the financing of the digesters. (Tasciotti, et.al. 2013)

As one of YRE mission is to support Indonesia family have access to renewable energy. And they are aiming at improving social welfare and human development. Using biogas as decentralized energy generation can meet rural Indonesia families needs to cooking as well as reducing CO2 emission and improving air quality. So biogas using have the same goal as YRE. As a national NGO, YRE has a very positive attitude towards install more digester in Indonesia rural area and providing more technical training to farmers who use biogas facilities. Because YRE could provide more work opportunities to technical workers and educators during the process. And they will receive more funding and experience for more projects they handled. Thus YRE could develop and will have more influence in Indonesia. YRE has almost same direction with Hivos in response to the issues. The further issue happens in training context for YRE. More training will be more difficult for YRE since the YRE is still facing many problems with existing training. Many CPOs didn't attend the training and even some who attended still couldn't receive the knowledge and skill properly (Yayasan Bakti, 2016). This situation affects the quality of the training for farmers which is done by the CPO. Therefore, the YRE will prefer to put more efforts on improving the quality of the current training.

3.2.4. Construction Partner Organizations (CPO)

CPO act as the contractor in the BIRU programme who appointed to directly build and supervised the biogas installation. They are responsible to build, supervise, and report the progress of their biogas digester projects in the area. Cooperatives, farmers, and NGO are mostly the one who operates the CPO. Beside the installation responsibility, as BIRU partner they also should disseminate the biogas concept throughout the members with special and regular meetings among members (Yayasan Bakti, 2016). To became one of BIRU's CPO one must have a business plan for at least to built 100 digesters in the first year. For the aftersales plan, the CPO also responsible, as part of BIRU standards, to give two-year services. Initially, there are 10 CPO that is listed on the BIRU website as their partner. They still seek for another CPO to be able to work on digester installation in future biogas digester installation plan area (BIRU, 2015).

BIRU was taking a commercial strategy towards biogas projects installations by involving the CPO in their program. However, there is still some obstacle faced by CPO due to lack of capacity and mismanagement. For instance, in some area of Lombok, there was a lack of transparency and standardized procedures (Tasciotti., et al, 2013). Some conflict even happened because the farmers pay a different amount of money towards CPO due to different cost happened because of variations in material and transportation cost. Some CPO also not yet to have a clear system for selecting the target regions, resulted in the logistic problems which in turn make the production cost more expensive.

By taking the business approach to implementing the biogas business, there should be more clear and standardized conducts that can make the CPO can easily enter the market. In order to be effective as a business entity, CPO also has to be screened properly at the beginning so that they do not encounter a mismanagement in their implementation. Government and NGO parties should be concerned more to establish a better management system within the CPO to deliver the biogas installation service efficiently and effectively (Tasciotti., et al, 2013).

If the government want to replace the grant with the subsidy, more potential biogas digesters are expected to build. Thus, those projects will lead more CPO to be involved in the program. This is a good opportunity for CPO development. The economics scale would be increased so that the margin of the contractor will be bigger too. However, the subsidy given to the consumer must also compensate for the increase in digester quality. The audit must be conducted regularly to avoid the moral hazard from the CPO that can potentially lead to consumer loss. Regarding the training, the CPO will rely on the budget provided by the programme. As long it can cover the expense, the CPO will try to put more efforts on it. Although at this moment the CPO has difficulty in giving training for farmers, there is a positive trend in the growing number of CPO in Indonesia.

3.2.5. Farmers

Farming is the main occupation for three out of five Indonesians which live in rural areas. Poverty remains in those areas, with 13.8 percent of rural people classified as poor compared with 8.2 percent of the urban population in 2014 (Ron Hartman, 2015). The farmers that don't have access to a continuous energy source will have a lot of benefit from the installation of biogas installations. This way they won't be dependent on the big gas companies to distribute LPG the farmers in the rural areas. Because the rural areas in Indonesia are quite big it isn't profitable to connect every farmer to get a regular distribution of gas cylinders. The main problem for the farmers are the short-term costs of the installation of the biogas systems.

Most farmers can't afford to invest that much money. That is where the NGO's or the government can be very helpful in terms of subsidies. But money alone won't be enough for the farmers to maintain the biogas installations, they have enough resources from the animal wastes, but they often lack the knowledge to repair or maintain the installations if something breaks down. So the farmers are very dependable on the people who helped them get the installations in the first place. The communication with the organization should be very clear, in favor of the farmers. If the farmers know whom they need to make contact with if there is a problem with the system, it can be fixed fast and the farmers can learn from it. This process will take a longer time because of the people who have the knowledge about how to fix the installations leave too early, the installations will fall into decay and all the money will be lost (Transrisk, 2017).

The farmers will be more protective of the forest if they start to cook with biogas, instead of with wood like they do now. With the proper ventilation, it will also be more healthy, because burning wood creates a lot of harmful gasses if the room is not ventilated enough. So the farmers will be in a healthier environment and have a more secure method of energy supply. With the right education, there are only upsides for the farmers. However, some farmers said that they love more taste of the food which is cooked by the firewood, compared to food cooked by other cooking fuels. Nevertheless, they also still like if the government gives them the grant of biogas digester as it can support their cooking activity. The farmers found that the biogas does not only support them to reduce the cost for LPG, it also helps them to manage their animal manures. Yet, for some other farmers, biogas is not an option due to its smell. It happens when the biogas leak and it smells like rotten eggs. These farmers also complaint about the biogas technology where they still have to put more efforts into transporting manures to the digester. Consequently, these issues become social acceptance challenges for the biogas development (Su-re.co, 2017).

In response to recommendations, according to the previous case with BIRU credit scheme, the farmers may have difficulty to spend money on the biogas installation (Greenwin, 2017). However, some farmers said it will depend on the price or subsidy given by the programme. If it is reasonable, they may accept the programme. For the training, the farmers will be so happy to receive the training and it will help them to maintain their own biogas for the long-term period, as in some provinces, the farmers don't receive sufficient training to date.

4. Discussion

4.1. Challenges and Opportunities on Biogas Development in Indonesia

There are two major challenges faced by the biogas programmes in Indonesia. The first issue is about the scheme of the programme. Many biogas programmes from the government lead the rural people to be totally dependent on the grant of the biogas digester. There is a social risk of the grant which influences the rural people mentality. The government aid is still one major source to promote biogas development. This scheme is not a good option since there is also the practice of nepotism in the biogas grants programme. The practice exists among stakeholders with power or influence such as the (local) government officers. In this case, the local government officers are favoring their relatives or friends in village level, especially by putting them on the list of the grantee of the biogas programme. A case in Jembrana, Bali, found that the user who got the training and the book is the one who can't operate his digester. This user is the head of sub-village who get involved in decision making in choosing the people to receive the biogas grants. According to the regulation of the program, the grantee should be chosen or recommended by the local government and reviewed by the national government, based on certain standards met by the target group. However, the corrupt government officers ignored the existence of regulation about the requirements for biogas grantee (Transrisk, 2017). This is a classical and systemic problem since Indonesia had a score of 37 and ranked in the 90^{th} position out of 176 countries in Transparency International's Corruption Perceptions Index 2016. The score is indicating endemic corruption in a country's public sector (e.V, n.d.). To overcome this problem, there is the opportunity to change the delivery scheme of government biogas programme by using the green economy approach such as (semi) commercial market-based.

One of the practices within the approach is the circular economy concept. Biogas fits the concepts as it is using biomass resources efficiently. The circular economy in biogas is reducing extraction of firewood resource and optimizing the use of biomass resources. It brings significant opportunities for biogas to practice the circular economy approach (Budiman, 2016). Nevertheless, to date, there is no acknowledged private company who invests its capital in the installation options for biogas digesters. It is caused by low demand and market for commercial biogas (Su-re.co, 2017). Besides the lack of competitive revenue due to the competition with highly subsidized LPG, this market failure has nature and magnitude influenced by the governmental grant. The national gas company (PGN) has not yet extended its distribution system to most villages, natural gas is not available. Meanwhile, Pertamina (State oil company) is appointed by the government to be the sole body to sell LPG 12 or 3 kg cylinders for many households (Budya & Yasir Arofat, 2011). In term of biogas, both companies have only grant programmes for the community in partnership with the university (PGN, 2014; Tempo, 2015). To date, there is no known vision to connecting biogas concept with LPG and LNG by Pertamina and PGN, respectively.

There are five million cow and pig farmers in Indonesia that can potentially generate the biogas. Compared to that number, the number of biogas digesters in Indonesia is still in very small number (Weadapt, 2017). This condition may be caused by lack of investment in this sector due to the dependency of farmers toward the biogas grant. Actually, the BIRU programme has tried to co-operate with private sectors through credit scheme. The farmers are allowed to access credit with the various interest rate to pay for biogas digester. This scheme is delivered through the partnership with the cooperative. The installments are financed by deductions from the payments the farmer receives for their labor work to the private sectors (Tasciotti, et.al. 2013). Another credit scheme has been tried by the German government as well as in partnership with the national bank and local cooperatives (Tempo.Co, 2013). Some farmers go for this option, but in several provinces, they reject this scheme due to financial reason (Tasciotti, et.al. 2013; Greenwin, 2017). Yet, this scheme is still continued to be improved by the BIRU with more private entities to look for more opportunities to expand the biogas development (Greenwin, 2017).

The second challenge is in the technical aspect which is still affected by the first challenge. Biogas from grant programme tends to be low-quality installation. At the other side, the user also doesn't feel

to have the sense of belonging to the digester which they got for free. So when it is broken, most of them leave it. Biogas digester in Indonesia with anaerobic digestion generator is still limited mostly for the raw material of animal waste. It doesn't work for crop residual and other feedstocks yet (Transrisk, 2017). When operating the biogas system, the condition of the biogas system is also crucial to biogas generation. Decreasing water addition ratio will lead to the decrease of biogas generation (Putri, Saputro, & Budiyono 2012). Proper C/N (25-30) is also needed to keep the PH of the biogas generation system. Thus proper water adding and the addition of high C/N raw material is needed (Andriani & Prawara 2015). This condition leads to an issue of support service availability. About 50% of biogas plants are not functioning due to lack of repair and maintenance of facilities (Bound & Templeton 2011). In East Java Province, selected region where the programme is most active and accounted for in 2011, from 677 dairy farmers that are observed, 216 farmers had a biogas digester installed, but there are only 97 farmers already operated a biogas digester (Tasciotti, et.al. 2013). This case of broken biogas digesters is also happening in Jembrana Regency, Bali Province. Out of the 55 installed in the Jembrana, only 40% are currently functioning. The digesters were terminated soon after the development agencies left in the project sites (JI, et.al. 2016).

The biogas programme in Indonesia is equipped with the collective training for CPO and the biogas user. But, Tasciotti et.al (2013) found that only 75% of the user takes part in training courses and 8% of household still need to be educated on how to use and fixed the digester. The training is only done once at the beginning for all users of the Regency. This method is not effective and sometimes the training is given to uncertified CPO. In the end, it leads to failure in operation. Thus, fully equipped and intensive training will be crucial in future (Bhattacharyya. 2012). For the size of biogas generation system, the most popular size of the biogas plant in Indonesia is 6m3 and it is used for one household (Tasciotti & Sparrow & Bedi 2013). Some farmers said this size is still small, sometimes it doesn't fulfill their cooking fuel needs (Su-re.co, 2017). Besides gas, the digester also produces the bioslurry which could become fertilizer for pool and crop (Andriani & Prawara 2015). However, some farmers still haven’t really utilized the bioslurry (Transrisk, 2017).

In 2005, the Indonesian Centre of Agricultural Engineering Research has invented the filtering system which is built in three steps, the first one is having a big water reservoir. The second step is to build a place where the animal wasted are purified and made into pure biogas. The third and the last step is to control the quality of the biogas, if the quality is good enough it can be used in many different ways, mostly for stoves and heating. The disadvantage of using biogas is that the technology is not consumer friendly, so to understand how it works the farmers need a decent education (Widodo, & Hendriadi 2005). The occurrence of having power outages will decrease if the farmers can fix it themselves. There is the opportunity to work with the research institute and university to improve the quality of the training from the biogas programme to the farmers.

4.2. Critical Evaluation

Firewood cooking as cultural and social practice by rural people has to be noticed by the stakeholders. Biogas is expected to change their non-environmental-friendly behavior of cooking. The effective scheme is required to achieve optimum performance of the decentralized biogas programme. Many development programmes in Indonesia ignore social risks in spite of its urgency in tackling environmental problem within social dimensions. The concept of social risks has not been successfully amalgamated into development programmes including social protection policy in Indonesia. Most of the social protection policies only pay attention to the provision of social assistance, such as grants, cash transfers, subsidies, and insurance. It also often happened that the assistance is not given to the poor (Arif, et.al. 2010). In the biogas case, Hivos and YRE agree that the grants method leaves bad mentality for the farmers. Most of them depend on the grant programme by the government and they don't want to put any money for biogas despite it brings positive impact for them. This condition has brought attention to the lack of business opportunities in the biogas demand that was not wanted by Hivos and YRE (Greenwin, 2017).

Hivos and YRE are trying to bring business opportunities to the biogas programme scheme. Currently, the BIRU programme provides the commercial scheme in which the community can order the biogas digester to be installed by its CPO. This scheme gives 20% subsidy of installation or operating cost of the biogas units. The subsidy comes from the programme revenue which is generated by the carbon market sale, especially in the European market. However, this scheme is still not popular among the consumers (Transrisk, 2017a). For farmers, this scheme is not really appealing as they still have access to the firewood.

To date, there is no big corporate or company which put serious investment to develop biogas in Indonesia. This condition is indicating that there are no promising business prospects in the biogas sector. There are 108.4 trillion cubic feet of natural gas reserves in Indonesia (Mujiyanto & Tiess, 2013). When it is reaching all rural areas in Indonesia, then biogas may not be needed anymore. It means there is the only temporary opportunity for private business to take the role in small-scale biogas market. Notwithstanding, there is still another strategy to deal with this issue. Beyond the primary needs for cooking fuel, the farmers can also use the biogas for the further purpose such as for business which can lead to an increase in demand for the biogas. Agriculture accounts for 34.8 percent of the energy consumption in the industry cluster. The stakeholders have the opportunity to improve biogas role in connecting energy demand with the agriculture as one of the main industry sectors in Indonesia. (The Jakarta Post, 2016).

Regarding the recommendation to change the grant into the subsidy, this solution seems like happen to be the common strategy for all stakeholders to trigger more biogas development. To start the programme, the initial stage can go with the scale of 80 (government): 20 (farmers). The scale is conversely version of the BIRU credit scheme. The subsidy idea needs to be communicated in good framing which fits the interest of the stakeholders involved, especially for farmers. In addition, the government also should realize that the subsidy has social risk needs to be mitigated as well. The subsidy can be an alternative option for farmers who didn't get the grant from the government and for those who can't achieve the credit scheme offered by the BIRU programme. This farmers group should be the energy-poor people who still need biogas to replace firewood for cooking fuel. The biogas programmes should be addressed to them properly. The responsibility has to be shared with other stakeholders, not only alone by the government. To tackling the nepotism problem, stage of selecting suitable grantee of biogas can be assisted by YRE and Hivos. The selection has to choose a champion of good biogas user to be a role model to inspire people in the area. It can also be connected with farmers organization to spread the influence and knowledge transfer. In implementing and maintenance stage, the YRE also has to provide more assistance to the government to select certified and well-trained CPO to keep the good quality of digester.

The discourse about digester leads to technology maintenance issue which is worst due to almost half of the thousands installed digesters not working. To fix it, the training about biogas digester for farmers cannot be left to be organized by YRE and CPO only as the trainer. There is the option to involve Hivos as the advisor in the training for purpose of maintaining the quality of the training. But then there is the obstacle to implement this idea due to limited budget for the training. The same obstacle also applies to the idea for private training for farmers or training per village, as collective training is not really effective for farmers. It is not effective not only caused by low education rate of farmers but also because the trainer is not fully capable. Training of trainer which is done by YRE also needs to be improved in term of quality and quantity (Yayasan Bakti, 2016).

Responsibility for technology maintenance then is becoming debate among the stakeholders. The government stated that it should belong to the CPO since they were given funding for the regular maintenance for two years. Meanwhile, the constructors denied that some government officers didn't give them a clear contract regarding this matter. This condition leads to confusion on the farmers when they have technical problems with their digester, they have no idea to whom to report the issue. The farmers can't even recognize the origin of the project, either from the different department in local government, national park or from NGO (Transrisk, 2017b). The government claimed that there is training and guidance book for the biogas users as part of the programme. However, in reality, the

farmers mentioned that it doesn't apply to all users. The training and the book were only provided for one of three users. This condition affects skill quality of farmers on biogas maintenance (Su-re.co, 2017).

The condition above indicates that the recommended solution about technology looks difficult to be applied alone. Since it is linked to the delivery scheme issue, so it should be fixed from the root. If proper scheme through subsidy is successful, it should be completed with detail term about training procedures then the scheme can lead to the integrated solution for better programme implementation, training programme and quality of the biogas and its user.

5. Conclusions and Recommendation

Energy-poor people in rural areas in Indonesia still continue to use firewood as their cooking fuel. The firewood cooking contributes to deforestation rate and respiratory health issue. To date, the governments have tried to accommodate the energy-poor people through LPG programme. However, centralized LPG system makes some remote areas still unreachable by the programme. Even in some reachable areas, some people are still preferably using firewood instead of LPG (Transrisk, 2017). This dependency on the use of firewood caused the government and other stakeholders established the biogas programme as the solution. Decentralised biogas system is needed to fit up the centralized LPG programme. Thousands of biogas digesters have been installed, however many energy-poor people still use the firewood. Challenges are found in the scheme of the programme which is related to the technology issue. Spreading of the programme is limited by the government funding and programme mechanism. Credit scheme built by the NGO does not work well due to the financial condition of the farmers.

This study suggested two main recommendations based on social practice approach. First, biogas can be utilized more by rural people with synergized support from the government, NGO and private sectors to provide better delivery scheme. At the national level, Indonesia's policy scheme needs to be improved and to be concerned in order to develop more biogas in the rural area. The government should change the system of biogas provision, from a grant mechanism to be subsidy model so the budget can be utilized to provide more digesters in rural areas. The government can use evaluation from a commercial scheme established by BIRU as the benchmark for the subsidy model. This scheme will lead opportunity for private entities to taking part in the sector. At the same time, this will also change the mentality of the user toward their own digester. The government also should avoid mismanagement in screening who is eligible for those subsidies, so that the funds that allocated for the improvement of biogas could be spent effectively and efficiently. To encourage more use of biogas, the government can also issue the regulation to reduce LPG subsidy for farmers regions and enforce them to use biodigester. At the same time, support from other actors is also required to provide more incentives for biogas users, to maximize people profit.

The second recommendation is dealing with technical challenges, most farmers still find difficulty in operating and maintenance the digester due to lack of knowledge. However, there are still opportunities to fix this issue when the biogas budget are used efficiently. The budget can be utilized for the training of rural people to prepare them to be independent in managing their own biogas. They need to have the hard skill to use the machinery optimally. The proper training is required, it can be arranged individually or in a central place per one village in partnership with the research institute, university or local organization as certified CPO. The programme has to make sure all users attending the training and understand the content of the training by hands-on practice.

Acknowledgment
Thank you to LPDP and Mattijs Smits to support writing processes of this paper.

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