

Report on 2nd Bioenergy Workshop:

SUSTAINABILITY AND RESILIENCE OF BIOENERGY FOR CLIMATE CHANGE:
SCALING UP THE POTENTIAL OF BIOGAS WHILST LIFTING THE BARRIERS

22-24 MAY 2017



Abbreviation List

BAEF	Barrier Analysis and Enabling Framework
BAPPEDA	Badan Perencana Pembangunan Daerah (Indonesian: Regional body for planning and development)
BAPPENAS	Badan Perencanaan Pembangunan Nasional (National Development Planning Agency Republic of Indonesia)
BIRU	Biogas Rumah
BPPT	Badan Pengkajian Penerapan Teknologi (Agency for the Assessment and Application of Technology)
BSN	Badan Sertifikasi Nasional (National Standardization Organization)
CH ₄	Thermogenic methane
CPO	Construction Partner Organization
CRESOS	Center for Remote Sensing and Ocean Sciences
EC	The European Commission
EEP-PSE	École d'Économie de Paris-Paris School of Economics
EU	The European Union
E ₃ ME	Energy - Environment - Economy Model for Europe
GHG	Greenhouse Gas
GRDP	Gross Regional Domestic Product
GREEN-WIN	American Anthropology Association
ICCTF	The Indonesia Climate Change Trust Fund
KSS	Kerta Semaya Samaniya cooperation
LPG	Liquid petroleum gas
NGO	Non-government Organization
NTT	Nusa Tenggara Timur (East Nusa Tenggara)
PVC	Polyvinyl chloride
SIMANTRI	Sistem Manajemen Pertanian Terintegrasi
SEI	Stockholm Environment Institute
SURECO	Sustainability and Resilience Co
SWOT	Strengths, Weaknesses, Opportunities, and Threats
TAP	Technology Action Plan
TARA	Training and Research for Action
TNA	Technology Needs Assessment
TRANSRISK	Transitions Pathways and Risk Analysis for Climate Change Mitigation and Adaption Strategies
UNFCCC	United Nations Framework Convention on Climate Change
UNUD	Universitas Udayana
USAID	United States Agency for International Development
WP	Work package
YRE	Yayasan Rumah Energi

Table of Contents

Executive Summary	iii
Field Visit: Biogas to Support Livelihood in Bali.....	1
Biogas and Coffee Farm	1
Biogas and Cacao Farm.....	2
Workshop Presentations	0
Day 1 (Tuesday, 23 rd May 2017)	0
Day 2 (Wednesday, 24 th May 2017)	2
Risks and Barriers Related to Biogas Deployment.....	4
Discussion 1: Assessing attitudes toward biogas development.....	4
Exercise introduction	4
Result	5
Discussion.....	Error! Bookmark not defined.
Discussion 2: Biogas Diffusion Model.....	7
Sustainable and Resilient Business Models for Biogas Deployment in Indonesia	10
Discussion 3: Assessment of sector opportunities for biogas innovation.....	10
Exercise Introduction	10
Result	10
Discussion 4: Opportunities of Biogas Servitisation	14
Exercise introduction	14
Result	14
Discussion 5: Strategic and Action Plan for Biogas Deployment.....	18
Exercise introduction	18
Result	20
Next Steps	26
Annex.....	28
Annex 1 Workshop Agenda	28
Day 0 - Sunday, 21 May 2017	28
Day 1 - Monday, 22 May 2017.....	28
Day 2 - Tuesday, 23 May 2017.....	28
Day 3 - Wednesday, 24 May 2017.....	29
Annex 2 Participant List.....	30
Annex 3 Question and the answer from A Network Analysis of the Diffusion of Biogas Technology session.....	33

Executive Summary

The International Workshop on Sustainability and Resilience of Bioenergy for Climate Change is part of a series of annual bio-energy workshops, taking place from 2016 to 2018. The workshops are organized as a joint initiative of the Ministry of National Development Planning of Indonesia, the Indonesian Climate Change Trust Fund, the European Commission, Udayana University and su-re.co (Sustainability & Resilience). The workshops are part of two multi-annual H2020 research projects, financed by the European Commission, TRANSrisk and GREEN-WIN and have as the objective to accelerate bioenergy development and promote climate change mitigation as well as adaptation pathways in Indonesia. During the first workshop in 2016, international experts and stakeholder groups envisioned, scoped and prioritized the opportunities of bio-energy development in Indonesia, resulting in a commitment to further explore the potential of biogas, on both the regional and the national level. The workshop was attended by 52 participants from different backgrounds: government, the private sector, NGOs, farmers, and researchers. The workshop encompassed a site visit, a seminar, extensive stakeholder consultations, brainstorming sessions, a survey, and a focus group discussion.

The main goal of the 2nd bioenergy workshop in 2017 was to shed further light on the opportunities of biogas in Indonesia, with critical reflections on the associated risks and barriers. This objective is based on the findings of the 1st Bioenergy Workshop, where small scale biogas was selected as a priority technology based on a multi-criteria assessment. Small-scale biogas in Bali has the potential for rapid technology diffusion, while there is still an existing financial support. Moreover, it is in line with the development programme of the local Balinese government. This finding thus led to the main topic for the 2nd Bioenergy International Workshop: “Scaling the Potential of Biogas whilst Lifting Barriers”.

Four methods were applied during the workshop: A Q-method exercise, the presentation of a technology diffusion model, a business model canvas, and a Technology Needs Assessment (TNA). The Q-method was applied in order to assess participants’ attitudes toward biogas development. The Technology diffusion model described what limited the acceleration of biogas development, while the business model canvas exercise was used to come up with new business ideas and applications for biogas systems. Lastly, the TNA encouraged active stakeholder involvement in the process of making and implementing a strategic action plan for biogas development.

This 2nd workshop successfully identified biogas opportunities and strategic action plans for accelerating biogas adoption. Several stakeholder groups came up with specific solutions. Policy makers agreed that financial support and specific biogas targets should be included in the local development plan. The group comprised of researchers and engineers emphasized that the optimum yield of biogas and knowledge-sharing are important to promote the technology, while the biogas users opined that knowledge sharing was important to operate the technology and to access to the funding. In terms of the biogas network, workshop participants concluded that farmers were at the heart of biogas deployment and that they would need the support from other stakeholders, such as policy makers, private sector players, banks, NGOs, etc. Each stakeholder has their role in contributing to biogas development, as shown during the TNA exercise. Furthermore, most of participants suggested that considering co-benefits of the biogas system, such as accessing further revenue streams by selling by-products could be a way to promote biogas while resolving environmental issues and improving the well-being of the farmers.

Field Visit: Biogas to Support Livelihood in Bali

The workshop started with a field visit to Jembrana regency, in West Bali, attended by researchers from different backgrounds. The field trip was an opportunity to showcase a successful green business model aiming at eradicating energy poverty through bioenergy usage on a household level. The participants were able to see how biogas could support and improve the livelihood of farmers.

Installing biogas digesters at coffee and cacao farms is meant to link biogas to agricultural activities, to incentivize biogas usage. It further serves as a link between business activities and biogas uptake thus creating demand for biogas by enabling the farmers to increase their portion in the value chain, while utilizing renewable energy.

Farmers were selected using a “championship approach” which means that local farmers could serve as an example and influence the others. This approach was opted as fellow farmers are found to be good ‘promoters’ in terms of technology options. Selecting motivated farmers who are eager to learn and accept new technologies can support the success of championship approach. As a result, the information about the benefits of biogas and the opportunities to link it with income-generating activities is likely to diffuse among the farmers. The field trip included visits to two types of farms, a coffee farm and a cocoa farm.

Biogas and Coffee Farm

The coffee farmer’s name is I Gusti Cakra, previously the head of *Subak* Abian¹. Hence, he is quite well-known among the other farmers in their area. A bio-digester was installed on his premises in February 2016, in collaboration with the BIRU Programme of Yayasan Rumah Energi. It is a fixed dome bio-digester with a concrete structure and a compensation tank which is used in achieving the required pressure. This digester’s capacity is 4 m³, enough to accommodate manure generated by two to three cows. The installation cost for this type of bio-digester was around IDR 9 Million, with the expected lifetime of 15 – 20 years. Some opportunities and drawbacks of this technology are presented below.

Table 1. Advantages and disadvantages of a fixed dome digester

Advantages	Disadvantages
Long life span if built well	Certain specific technical skills are required to ensure a gas-tight construction
Local construction provides opportunities for skilled local employment	Some spare-parts are not available locally
Underground construction saves space and protects the digester from temperature fluctuations	Risk of gas leaking may occur when constructed by inexperienced masons

¹ The *Subak* system is a cultural practice that links water management, cultivation process, traditional belief, and social organization. Furthermore, *Subak* Abian is a farmer organization and system of cultivating horticulture plantation such as coffee, coconut, cacao, etc. One *subak* could consist of a diverse number of farmers from 25 to 100 people.

Absence of moving parts or corroding metal parts	Difficult to repair once constructed as the digester is located under the soil
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Biogas is used by Cakra's family for daily cooking and coffee roasting for about 2 hours per day. Coffee roasting, using a traditional roaster, usually takes 15 minutes per 500 g. Therefore, it is still sufficient to roast coffee for self-consumption and for supplying the local market. Nevertheless, the possibility to connect biogas with a post-harvesting facility (e.g. a roasting engine and drying facility) still needs to be explored in the future.

Another benefit is bio-slurry production and utilisation. The system produces good-quality bio-slurry fertilisers, which have been used on Cakra's coffee and spinach plantations.



Figure 1. Field Visit to Chakra's coffee plantation

Biogas and Cacao Farm

The second farmer the workshop team visited was Ketut Windya, a cacao farmer. He was also the head of *Subak* Abian. His cacao has already been certified by the UTZ, which is an organic certificate, with the help of the Kerta Semaya Samaniya, a cooperative that he is registered at. He is also quite well-known within the farmer community, with a number of people coming to him to learn about the cacao plantation and his farming practices. His experience and reputation could serve as a good opportunity to share the advantages of biogas with other farmers.

Ketut received a bio digester in April 2017 to support sustainable farming of his organic cacao. It was a tubular and removable bag digester using PVC fabric. PVC is an elastic material that can accommodate the need of gas pressure. This technology was developed and installed under the GREEN-WIN project. The digester costs around Rp 6 Million with the expected lifetime of 5 years. The advantages and disadvantages of this type of biogas are presented below.

Table 2. Advantages and disadvantages of PVC removable biogas digester

Advantages	Disadvantages
Reduced space for installation and ease of transportation	Relatively short lifespan
Low construction costs	Requires protection from possible external damages
Easy to construct and remove	Lower gas pressure
Uncomplicated emptying and maintenance	Local craftsmen are rarely in a position to repair a damaged balloon
Higher digester temperatures in warmer climates	Material usually not locally available
Shallow depth of installation suitable for use in areas with high groundwater levels or hard bedrock material	Scum cannot be removed from the digester

Ketut's family previously used firewood for cooking. After this installation, they now use biogas to substitute the firewood for cooking and lighting in his garage. Additionally, the bio-slurry is used to support his cacao organic farming practice as it has a better quality than fertiliser from dried cow manure.



Figure 2. PVC biogas digester installation

Workshop Presentations

Day 1 (Tuesday, 23rd May 2017)

Moving forward, looking back at the 1st Bio-energy Workshop

By Cynthia Juwita Ismail

The first presentation recapped the 1st Bioenergy International Workshop held in 2016. It presented the objectives of the first workshop and the methods that have been used to narrow down the scope of the bioenergy workshop. There were 4 options considered for further investigation:

1. Rice residues for biomass pellet
2. Small-scale biogas plant from rice residues and manure
3. Large scale biomass gasification
4. 2nd generation of bioethanol

These options were assessed over 4 dimensions: social, technology, economic and project interest, and synergies. Small-scale biogas installation was ultimately selected as the main topic for further investigation. It also served as a main topic for the 2nd Bioenergy International Workshop because it offered better opportunities over the 4 dimensions, such as the availability of technology and its strong encouragement by the government.

Introduction to GREEN-WIN & preliminary results

By L. Lemkow Zetterling, UAB

The opening speech of the GREEN-WIN project WP7 leader included case studies that have been conducted in countries other than Indonesia, such as India and South Africa. These countries were assessed based on 3 GREEN-WIN research action pillars:

1. Identify the win-win solutions
2. Examine the business models
3. Identify the enabling conditions

The aim of those case studies was to reduce energy poverty and increase the resilience of livelihoods through research and action. The business model, which was developed in Indonesia, is connecting the coffee roasting process with biogas in order to increase farmers' incomes and reduce their fossil fuel and unsustainable biomass energy use, such as LPG and firewood. In South Africa, the main research efforts were directed at exploring green infrastructure solutions based on bioremediation and biomimicry principles, which aimed to tackle water pollution in and from informal settlements. Whilst in India, the GREEN-WIN team supported and worked closely with

the Social Enterprise TARA - Development Alternatives, to analyse the successful implementation of renewable energies in poor communities.

Framing of risk and uncertainties in biogas development

By J. Lieu, Sussex University.

This presentation introduced the concept of risk and uncertainties of biogas developments in Bali based on the IPCC concept. Uncertainty, appearing as the consequence of incomplete knowledge, inadequate information, and the absence of agreements on what is known, is a concept at the heart of what is commonly understood as “risk”. Risk exposes the high potential of negative consequences and therefore impacts the society, environment, and other aspects negatively. The scope of risk and uncertainty is based on the spatial and temporal context, depending on political views, policy propagation, environmental condition, technological development, societal situation, and economic circumstances. To determine possible risks of our activities, we should first determine three domains:

1. Objective or main goal
2. Required actions to reach the goal, including the barriers and the risks during implementation
3. Projection, including the possible negative outcomes of risk as a result.

It is essential to map risks and uncertainties from a wider perspective by classifying which components are ambiguous or less ambiguous. Therefore, the analysed components can be used to determine how the biogas development activities can be conducted while minimising possible risks and uncertainties.

Result of the socio-institutional analysis of biogas technology implementation in Bali

By. T. Devisscher, Stockholm Environment Institute

The aim of this session was to present findings of the social network analysis of biogas technology, carried out during last year's field work in Bali.² The analysis consisted of three steps of collecting data. Firstly, information on drivers, barriers, opportunities, and user behaviour, was collected by interviewing related stakeholders from the local and national government, NGOs, private sectors, and end users. Secondly, a focus group discussion (FGD) was conducted among some of the interviewees. Discussions included gauging who the most important actors of a biogas system were, what their roles were, and what was needed to make the biogas system work better. The FGDs included a session where the stakeholders talked about the network and resources in biogas development in Bali.

The result of the analysis was that there are four kinds of biogas technologies implemented in Bali. They each have different drivers and motivations, which stem from social, environmental and economic reasons. The reason for the implementation of biogas technology from BIRU (Biogas Rumah programme) and a biogas programme from West Bali National Park was to raise

² Field work was carried out in addition to the first workshop in October 2016

environmental awareness. BIRU tends to focus more on reducing GHG emissions while the motivation of the West Bali National Park is to avoid deforestation and forest degradation by decreasing firewood usage. SIMANTRI and the Public Works Agency, two other biogas programmes, stated that economic reasons, such as additional income for the farmers and increased livestock sector growth, were the highest motivation for the people to use biogas technology in Bali.

Co-effects of transition pathways in the livestock sector in the Netherlands

By E. Spijker, JIN. A. Anger-Kraavi, Cambridge Econometrics

The speakers presented the climate mitigation issues in the Netherlands from an agricultural perspective with 2 pathways: (a) livestock reduction and (b) integrated manure management to reach the national 33% CH₄ reduction by 2030. To achieve this target, the first pathway requires a 37.5% livestock reduction. The latter requires 17,000 farm-scale plants and 60 industrial-scale plants for both cattle and pig manure. The presentation compared both pathways, including how they affect emissions, land usage, employment, economic output, human health and animal welfare, biodiversity, etc. To improve the comparison, some preliminary macro-econometric results from the Macro-Econometric Energy-Environment-Economy Model (E3ME) were presented, by inserting variables such as technology, energy, economy, emissions, and materials. The model could also be used in the Indonesian context, where, according to first modelling efforts, biogas showed a positive impact in some sectors, such as the national economy and employment.

Day 2 (Wednesday, 24th May 2017)

Piloting a Green Business Model based on biogas solutions

By I. Bobashev, M. Ghiandelli, Su-re.co

This presentation explained the business model of the GREEN-WIN case study in Indonesian context: integrating biogas into the coffee roasting process for households and small-scale farmers. To increase the number of biogas end-users within farmer communities, WP7 designed a removable bio-digester system which has several advantages compared to the fixed dome design, such as:

1. Simple maintenance
2. Easy to install, repair, and remove
3. Low cost

Further improvements are still ongoing such as reducing the cost of the bag and the biogas stove, and implementing alternatives for biogas-related activities to increase farmers' incomes.

Farmers' experience on using biogas and bio-slurry for coffee plantation

By I Gusti Made Cakra, coffee farmer and biogas user

The presentation told the story of Pak Chakra, a farmer, who was selected as the beneficiary of the biogas digester installation, based in Jembrana. He was the irrigation group leader of *subak*, a farming practice. Chakra mentioned that he had an interest in the biogas system as he could use his livestock's manure to obtain energy. He claimed that the bio-slurry produced by the digester helped to increase his coffee farm's productivity. However, he has faced some issues regarding the biogas utilisation, such as difficulties in gathering the cow manure since the cows are farmed in an open space, and only two of them are in the stable. He has limited capacity to build a new stable due to space restrictions.

A Network Analysis of The Diffusion of Biogas Technology

By A. Mandel, Paris School of Economics (EEP-PSE), France

The topic of this presentation was a model of biogas technology diffusion implemented in nine provinces in Indonesia, including Bali. It explained that the biogas implementation among Indonesian provinces had significantly increased during the period of 2009 to 2016. The best way to develop biogas implementation in Indonesia was through analysing the socio-cultural data provided. A questionnaire was handed to all the participants to gather primary data from related and specific stakeholders who would help to reconstruct the biogas network system in Indonesia.

Risks and Barriers Related to Biogas Deployment

Discussion 1: Assessing attitudes toward biogas development

Lead and prepared by R. Taylor, Stockholm Environment Institute

Exercise introduction

This session was an individual exercise where each participant was given 49 statements regarding risks and barriers of biogas deployment in Indonesia. The statements were constructed based on the interview with bioenergy stakeholders in Indonesia and Bali in October 2016. Then, each statement was prioritized based on scale -3 (most disagreed) to 0 (neutral) and to +3 (most agreed) relative to all other statements which then resulted in a 7x7 table. Therefore, participants needed to prioritise the statement carefully. During this exercise, the participants were divided into three separate facilitated groups, so they could reach a consensus on what the most agreed, the most disagreed, and the controversial statement was.

Result & Discussion

The exercise was attended by 18 local participants, divided into three groups. After the exercise was done for each person, done by themselves, there was a discussion about the most agreed and most disagreed statement. Participants explained their reason for the most agreed and disagreed statement. Then, in a group, participants determined each statement that they most agreed and disagreed with and gave their reasoning therefore. The results are presented in the table below.

Table 3. The most agreed statement about biogas deployment in Indonesia

Group Number	Most Agreed Statements	Reasons
1	No 36 If local banks would provide farmers with sufficient credit, then farmers would pay for a bio digester.	A bio-digester installation is relatively expensive for people in rural area. A credit with 0% interest would be important to exist. However, it is relatively hard for people in rural areas to obtain credits. In fact, farmers usually have many assets, but not a lot of them are financial. Farmers don't have collaterals for banks to obtain loans A loan solely for installing biogas is not interesting for farmers and it would be more appealing if it would be bundled with another programme, such as an integrate farming system.
2	No. 39 Biogas gives people more independence, which is important.	Farmers claimed to have more independence by having a biogas system, such as energy access, protecting the environment from pollution, and increasing the agricultural production.
3	No. 46 Producing electricity from animal waste will increase electricity access No. 43 Subsidized fossil fuel products and policies continue to undermine bioenergy projects	20% of the population still lacks access to electricity, especially in rural areas. Utilizing local resources, such as animal waste, could improve the electricity access. Renewable energy will not develop if the government still provides subsidies for fossil fuels

Table 4. The most disagreed statement about biogas deployment in Indonesia

Group Number	Most Disagreed Statement	Reasons
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1	No. 16 If the initial cost of biogas installations could be reduced by about one-half, it would be affordable and most farmers would be able to buy it themselves.	Price reduction will influence the quality, which then might impact bio-digester development. If farmers could get access to credit or programmes from the government that could subsidise credit schemes, it would prevent the reduction of quality.
2	No. 23 Women might be overlooked as potential users when deciding on who is eligible for biogas subsidy.	Gender equality is claimed to exist within Indonesia. There are significant roles held by women, for example, of president and minister. Therefore, we do not agree with this statement. Furthermore, 70% of the operators of biogas are women while men keep the cattle in the village
3	No. 26 Family relations or knowing the right people is very important in order to be chosen as a recipient of a biogas unit.	Everyone has right to get the access to biogas support. It is not supposed to depend on the relations, but more on the resources, such as availability of the land and feedstock. The truth is that most of the selection is based on the network of beneficiaries.

Table 5. The most controversial statement about biogas deployment in Indonesia

Group Number	Most Controversial Statement	Reasons
1	No.10 Chemical fertiliser is very expensive compared to organic fertiliser-villagers find it difficult to afford and would prefer to use organic fertiliser.	The majority of farmers in Indonesia use urea fertiliser as the government provides a subsidy, creating a confusion about this statement. However, in other parts of the Indonesia there is a lack of access to subsidized fertiliser, which is difficult to access. It depends on the location, indicating unequal access of governmental aid.
2	No. 3 People usually don't know much about the purpose, advantages, and opportunities of biogas.	It was proven that the information dissemination quality and/or quantity by the government is still lacking. People still do not know anything about biogas regarding the purpose, advantage, and opportunities of this technology. In fact, even the awareness of biogas is low.
3	No. 15 Without government subsidies, farmers would not be able to afford biogas.	Sometimes the installation initiated by the users and their own investment works better because they have the sense of ownership of the bio-digester. High subsidy on other energy sources and the lack of incentive for using biogas made people not willing to invest into having one.



Figure 3. Stakeholder consultation: Identification of risks and barriers using Q-method

It can be concluded that most of the participants agreed that bio-digesters could give independence to farmers in terms of energy access. In addition, participants disagreed with the selection method of who gets to own biogas installations because it is mainly based on the farmers' social network hence it is far from fair. For instance, the selection should not be based on family relations and gender, it should, on the contrary, be based on the resource availability to run the bio-digester.

Furthermore, there was a discussion about financial access for farmers to fund biogas installations. Thus, establishing a credit scheme would be essential. It could be included in the package of integrated farming credit scheme. On the other hand, subsidized fossil fuel and LPG from the government might also hinder the development of biogas itself, as an alternative energy access. Gender issues were also discussed during the workshop; however, the participants agree that biogas would not raise gender inequality. In fact, women and children are considered as the main beneficiaries of biogas since time for wood collecting can be eliminated.

Discussion 2 : Biogas Diffusion Model

Exercise Introduction

The workshop offered an opportunity for a first presentation of the results coming out of WP3 and WP7 of the H2020 GREEN-WIN project. First a map was provided, demonstrating the spread of biogas throughout the Indonesian provinces over 2009-2016. Despite the growth, as emphasised at the workshop, there is still much room for improvement. On the other hand, there has been a decline in biogas usage in some provinces. Diffusion networks could help identify existing or potential paths of diffusion, answering the question of what kind of stakeholders influence other stakeholders and biogas users? One of the questions discussed was whether biogas should be kick-started resembling a political campaign or through viral marketing; it can also be viewed as the inverse problem of preventing disease propagation. Finally, stakeholders were asked a series of questions that can provide insights into the diffusion network. The questions are the following:

- From how many people/institutions did you receive information about biogas/agriculture? Who are they?
- How many people are you going to talk/advertise about biogas? In the village? Other villages? Regionally, nationally?
- Are there people that are more influential? Who are they?

- Do you think that eventually all the farmers will adopt biogas?
- How long will it take for all farmers to adopt biogas?
- On average, how many examples of installations do you think a farmer needs to decide to use the biogas?
- What are your expectations/is something that you want to see?
- How many biogas users are needed?

These questions were followed up by a survey administered by Auditya Sari (UNUD/su-re.co), with the answers provided in Annex 3.

From discussions before, during and following the workshop, conducted in order to better understand the diffusion process and underlying factors that can accelerate the speed and spread of biogas energy, two alternative modelling approaches have been proposed.

The first is a macro-econometric model incorporating interactions between provinces implementing recent dynamic spatial panel data model techniques. A comparative econometric analysis at the province-level allows to empirically investigate and provide useful insights to policymakers on the impact of enabling factors, such as socioeconomic conditions, supply and demand enhancing activities of BIRU, and whether geography plays a significant role in the diffusion of biogas technology.

Using combined data sources to model the spatiotemporal diffusion process empirically, the main questions addressed are: (i) What are the patterns and the driving forces of technological diffusion? (ii) What are the respective roles of demand and supply support policies? (iii) How important is the role of networks in the dissemination of information?

This study is a collaboration between GREEN-WIN WP3 and WP7 teams. The data compilation consists specifically of:

- A detailed BIRU biogas digester installation database, where the latest release and check has been completed
- A questionnaire on insight on different stakeholders' views (see Annex 3)
- BIRU data from their reports for as many years available on their demand and supply support policies (e.g., number of community meetings, CPOs per province)
- Other data, including the *Badan Pusat Statistik* (Central Statistical Agency) and potential agricultural census) for available years
 - Geographic distance and road network data between provinces
 - Population (total and by gender)
 - Percentage of population over 15 by educational attainment (measure of human capital)
 - Land use (measures in hectares unless indicated otherwise)
 - Agricultural land: paddy wet field; non-paddy wet field; non-agricultural land; harvested area; production rate (kw/ha), production (ton); -area of forest
 - Livestock population (total and by different livestock?)
 - Gross Regional Domestic Product (GRDP); GDRP per capita

The second alternative is a model with a more behavioural microeconomic focus. This approach would require more information on the social and/or economic ties in the model between agents.

Having data, as indicated above, on the number of CPOs provides some indication of the role of competition. To gain more insight into the behaviour of the CPOs, especially into their role as intermediaries in the dissemination of information, it would be interesting to conduct a questionnaire to get a better idea of the “seeds” of the diffusion process and what is conducive for the creation of the market for biogas energy.

Result & Discussion

The survey successfully engaged with 10 respondents from various backgrounds including government (local and provincial level), academics/researchers, people from the private sectors, and farmers.

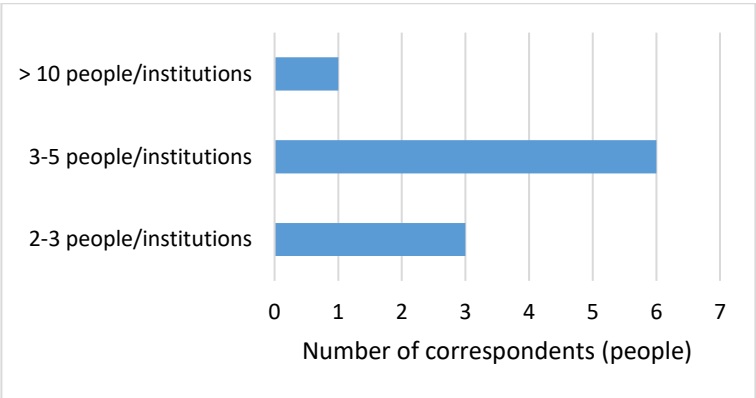


Figure 4. Number of people/institutions sharing biogas information

Most of the participants are connected with 3-5 other people/institutions. The institutions include NGOs, the government, universities, fellow farmers, and the private sectors. At a village level, knowledge transfer usually occurs from local government to farmers or from one farmer to another.

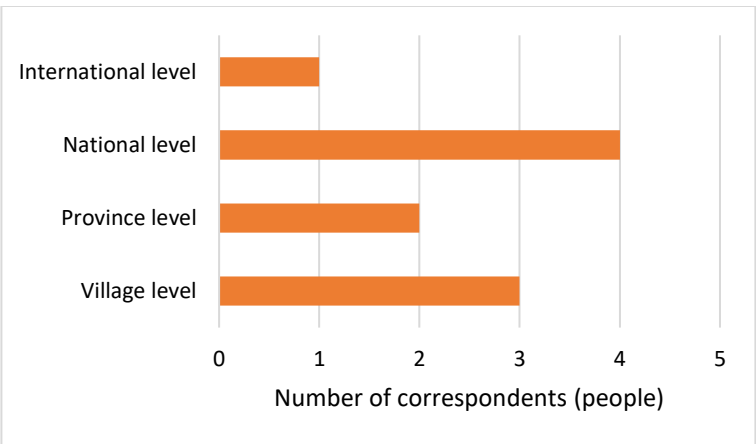


Figure 5. Stakeholders’ willingness in promoting biogas at different geographical level

Based on Figure 5, the stakeholders agreed that a communication about biogas and promotion from national to village level is necessary to promote the technology.

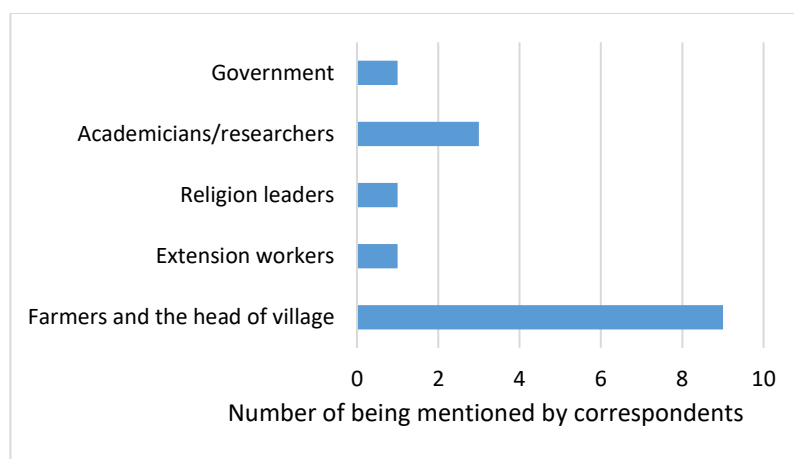


Figure 6. Influential actors in biogas diffusion in Indonesia

Based on Figure 6, there are 5 influential actors highlighted by the participants to promote biogas utilisation: government, academics, religious leaders, extension workers and farmers. To accelerate the biogas deployment in Indonesia, most of the participants pointed out that farmers are playing key roles.

All participants agreed that all farmers in Indonesia should have access to biogas technologies but that it might take more than 25 years to realize this ambition. To accelerate biogas utilisation at the village level, the champion approach should be applied, as suggested by many farmers.

Sustainable and Resilient Business Models for Biogas Deployment in Indonesia

Discussion 3: Assessment of sector opportunities for biogas innovation

Exercise Introduction

As a part of the analysis of biogas potential in Bali, this exercise was developed to help analyse other opportunities and activities to be paired with the anaerobic digester technology to create a sustainable production system. The assessment included, but was not limited to; usage of biogas, biogas by-products development, and utilizing biogas for production. Moreover, the exercise explored the fact that conventional forms of energy remain highly subsidized by the government, which hinders biogas developments.

Participants were divided into four random selected groups with su-re.co members acting as facilitators. Each group discussed the key activities, key resources, and key partners for each opportunity. The group then proceeded to create a SWOT table based on their respective ideas. Below is the result of each discussion:

Result & Discussion

First Group

Facilitator: Novelita Mondamina & Mariana Silaen

1. Guntur (Ministry of Forestry, City level)
2. Dewa Weda (Yayasan Rumah Energi, BIRU Programme)
3. Dita, (Gadjah Mada University)
4. Agus Fakhi (BAPPEDA NTT)
5. Cyprien (su-re.co)

6. Tahia (TransRisk)
7. Eise (TransRisk)

During the brainstorming session, there were five business ideas for promoting biogas coming from the participants, including: charcoal made from biogas, health services using biogas, organic pesticide, eco-tourism and advanced bio-slurry. Considering the viability (environmental issues, interest and limited data), economical value of bio-slurry was then selected to be further analysed. However, a SWOT analysis for the activity was not discussed at that moment due to time limitations. SWOT analysis was only performed on charcoal and pesticide production.

Table 6. SWOT analysis for charcoal production using biogas proposed by the first group

Strength	an alternative of biogas usage for burning the material: coconut husk/ firewood
Weakness	burning activity in the process could lead to carbon emission
Opportunity	the availability of a market, e.g. food market
Threat	environmental issue due to the burning process

Table 7. SWOT analysis for organic pesticide production proposed by the first group

Strength	another alternative to liquid bio-slurry usage, instead of fertiliser
Weakness	limited knowledge about making this product
Opportunity	new markets
Threat	very limited researches about the contents of organic pesticide and their applicability

Second Group

Facilitator: Arti Indallah & Kai The

Group Members:

1. Debora (BPPT NTT)
2. Onike (BPPT NTT)
3. Satya (Yayasan Rumah Energi)
4. Buda (Agricultural Agency - Bali Province)
5. Jenny (Transrisk)
6. Annela (Cambridge econometrics)
7. Joshi (Su-re.co)

At the beginning, two business ideas of connecting biogas to other sector activities were discussed: (1) using biogas in the tourism sector, thus facilitating eco-tourism and (2) use of biogas in small and medium-sized enterprises for women communities. The discussion then focused on eco-tourism, given the tourism sector's importance on Bali. In the past, conflicts have been reported between the tourism sector (hotels and guest

housse) and farmers who keep pigs and cows on their farms, especially in Ubud. Hotels protested the bad smell of the manure, which then led to social conflicts between the parties. The idea that came up was to use the bio-digesters to tackle the sanitation and odour problems by using feedstock from the manure and organic waste from the hotel Key resources and key partners were discussed in Table 8.

Table 8. Proposed business activities for biogas by the second group

Key resources	Key Partners
Centralized platform that includes farmers and hotel associations to discuss the collaboration and the opportunity	Farmers, hotel association, Government Agency, Agricultural Agency, tourism agency, NGOs, Yayasan Rumah Energi/YRE and Universities

A strong collaboration between stakeholders is required to realize this eco-tourism concept. Farmers, hotels and tourism agencies were identified as key stakeholders. This activity should be encouraged by the government, NGOs and private sector players including Yayasan Rumah Energi/YRE as the big player of biogas in Indonesia. According to the participants, the government could play a significant role in policy making and data management. Meanwhile, NGOs and the private sector can support eco-tourism by knowledge-transfer and providing assistance during the implementation. Furthermore, the group came up with a SWOT analysis to identify the likelihood of the activity implementation:

Table 9. SWOT analysis of eco-tourism proposed by the second group

Strength	- Generates additional income for farmers - Increases the hotel's reputation
Weakness	Possibility to generate non-stable quality of bio-slurry for the fertiliser
Opportunity	Bali Clean and Green Vision
Threat	Resistance from the parties that they will lose their job after the introduction of this activity (e.g., the group of people who collect organic waste for open dumping)

Third Group

Facilitator: Cynthia Ismail & Laksmi Pratiwi

Group members:

1. I Made Budi Utama (Head of Tukadaya Village)
2. I Komang Warken (Farmer)
3. I Gusti Made Cakra (Farmer)
4. I Gede Madiasa (Farmer)
5. I Ketut Sukadana (Farmer)
6. I Made Oka Guna Antara (Student of Udayana University)

During this session, the farmers proposed the following business model which could increase the biogas deployment.

1. Biogas packaging to reach a wider market
2. Fertiliser packaging to reach a wider market

Currently, biogas and fertiliser are only for self-consumption meaning that this activity has low economic benefits. Farmers suggested that to earn income and reach more customers, packaging for biogas and fertiliser is necessary.

Table 10. Proposed business activities for biogas by the third group

Key Activity	Key resources	Key Partners
Biogas packaging	Biogas installation, water, biogas package	Package manufacturers, government, farmer group, bank, small restaurant (<i>warung</i>)
Bio-slurry packaging for fertiliser and feeding animals	Biogas installation, water, biogas package, drying facilitation	Package manufacturers, government, farmer group, bank

Furthermore, a SWOT analysis was carried out to estimate the viability of the proposed business activities. However, based on the analysis, those activities still face some obstacles. Although the social acceptance of introducing biogas is quite high, the participants identified high investment needs, LPG subsidy and firewood abundance as hindering factors to biogas diffusion in the rural areas.

Table 11. SWOT Analysis of bio-slurry and biogas packaging

Strength	- Willingness from the farmers - Locally available feedstock
Weakness	High investment cost
Opportunity	Local market
Threat	LPG subsidy and firewood abundance

Fourth Group

Facilitator: Ivan Bobashev & Marco Ghiandelli

Group members:

1. Takeshi Takama (su-re.co)
2. Annet Duncan (GREEN-WIN)
3. Louis Lemkov (GREEN-WIN)
4. Solmaria Halleck (Université Paris 1 Panthéon-Sorbonne)
5. Richard Taylor (SEI)
6. Antoine Mandel (Université Paris 1 Panthéon-Sorbonne)

Table 12. Key resources and key partners of jam production proposed by the fourth group

Key Activity	Key resources	Key Partners
Jam/preserve production	Heat Fruit Fruit by-products	BIRU Farmers

	Fertiliser Sugar Packaging/distribution	Jam making expert (private sector, Antoine's mother)
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To conduct the jam making activity, participants suggested a collaboration between BIRU³, farmers, jam experts and other private sectors is necessary. Furthermore, SWOT analysis encompassing only strength and weakness was discussed during the workshop, as shown below:

Table 13. SWOT Analysis on jam production using biogas proposed by the fourth group

Strength	- Abundance of fruit and sugar cane - Circular economy mindset
Weakness	Expiration/shelf-life

According to the participants, jam production can be a potential business activity, given the fruit's abundance in Indonesia. Nevertheless, the quality of jam obtained from biogas is suggested to be explored further.

Discussion 4: Opportunities of Biogas Deployment

Exercise introduction

This session was a continuation of Discussion 3. The groups designed business workflow diagrams for their value proposition based on the ideas created during the previous discussion. The facilitators encouraged the participants to consider different types of business models, ranging from traditional ventures to models based on the pay-per-use principle, as-a-service and leasing concept. An important aspect of this exercise was to inform the participants of the possibility of opening a new area of commercial opportunity. This opportunity also comes with different collaborative structures, which triggered a discussion about the role of cooperatives, service providers or social enterprises, in what could be the future business-as-usual scenario.

Result & Discussion

First Group: Bio-slurry

³ A programme led by Yayasan Rumah Energi in cooperation with Hivos, in order to promote biogas utilisation in the rural areas in Indonesia

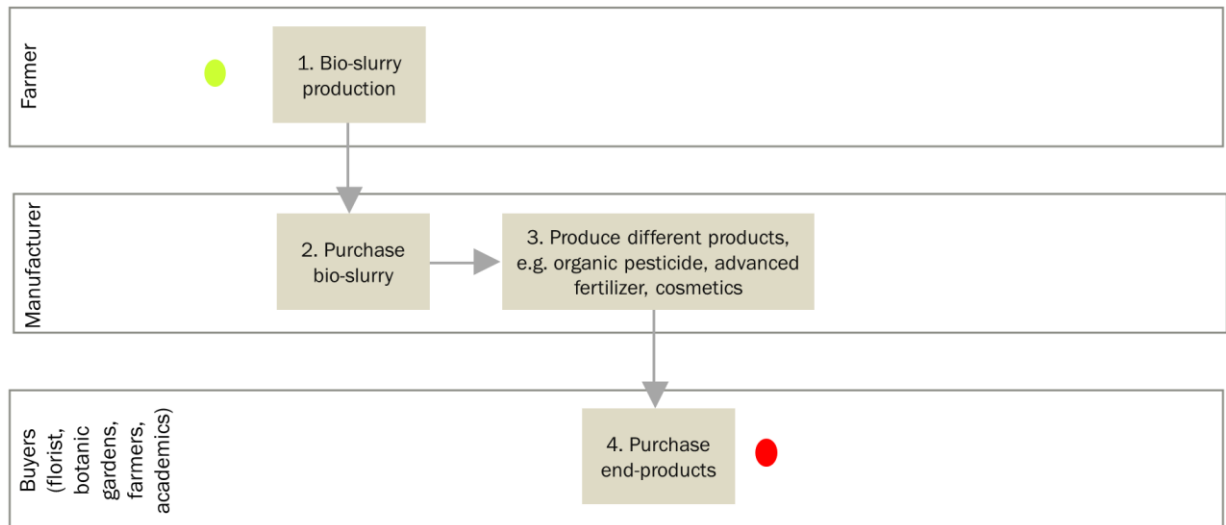


Figure 7. Value proposition of the advanced bio-slurry product

By assuming the biogas installation is ready at the site, this group focused more on after bio-slurry production. The first group expressed that it was necessary to process the bio-slurry further, beyond its status as an organic fertiliser. The bio-slurry could be processed further into pesticides, and even cosmetics⁴. This activity involves farmers acting as biogas owners, processors of bio-slurry and as buyers. Further buyers may be florists, botanic gardens and cosmetic producers.

The strength of this approach is that the proposed products already have targeted markets. Organic pesticides can be sold to organic farming communities, advanced fertilisers can be sold to farmers who want to optimise their yields, while bioslurry-based cosmetics could target environmentally conscious clients. However, the existence of targeted users is a double-edged sword, indicating that this scenario will require further research on the market competition.

Second Group: Biogas and Ecotourism

⁴ It was proven in West Java that bio-slurry increases breeding activities of worms. The worms are used in pharmacy and cosmetic industry. Source: <http://www.biru.or.id/en/index.php/news/2015/07/16/192/liputan-biogas-wartawan-bbc-indonesia-di-lembang-jawa-barat.html>

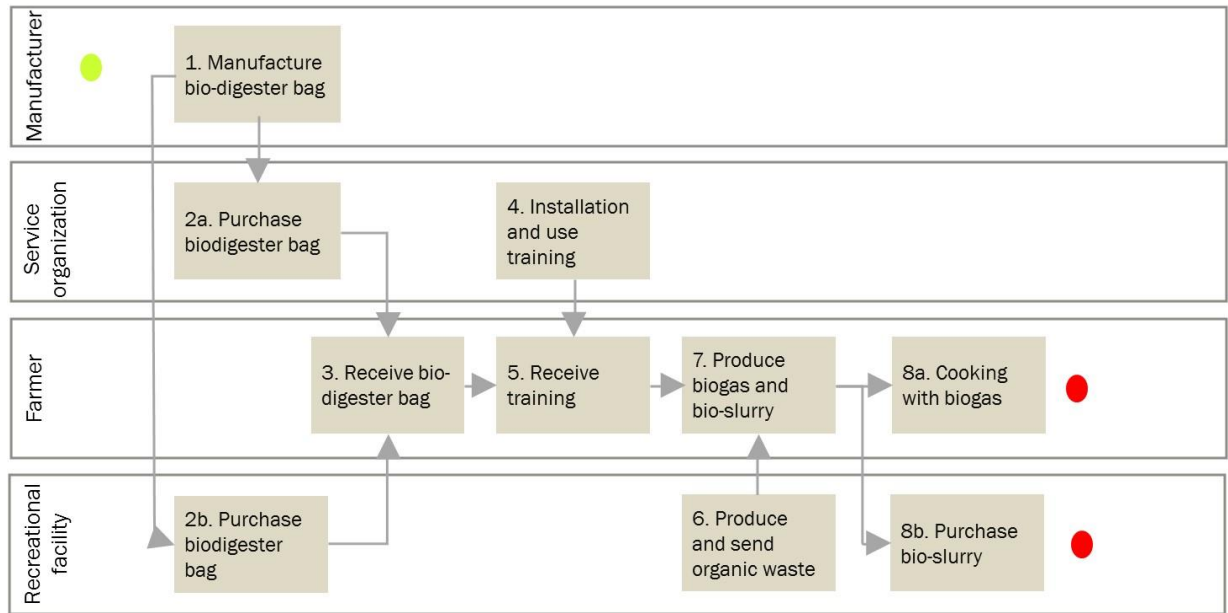


Figure 8. Value preposition of biogas and eco-tourism

This group emphasized the collaboration between farmers and recreational facilities such as hotels or city parks, in order to turn biogas utilisation into a tourist attraction. The recreational facilities would provide organic waste, while the farmers could operate the biogas for cooking. Also, farmers might provide bio-slurry useable for gardening at the recreational facilities. Other forms of cooperation could be established between the biogas digester builders (e.g. YRE and its CPOs, refer to Table 9) and service organizations to create knowledge transfer between technicians and users. One way forward might be for recreational facilities to provide financing for the farmers in the form of loans, since banks are reluctant to lend to farmers so the access to finance remains a problem.

Third Group: Packaging bio-slurry

This group consisted of farmers from the Tukadaya Village in West Bali, some of whom already had positive experiences with biogas. They agreed that packaging of biogas and bio-slurry should be promoted to embrace not only local market but also national market access, if possible. Currently, they only use biogas and bio-slurry for self-consumption. Packaged bio-slurry was discussed further to identify key processes and the role of each party involved (refer to Table 10). In general, this value chain requires 6 important parties including farmers, banks, government, packaging manufacturers, farmer groups and customers.

Initially, banks would provide funding support i.e. a credit to purchase biogas. Installations should also receive assistance from the government. Furthermore, the farmers suggested that the bio-slurry can be used not only as a soil conditioner but also could be further processed as animal food (currently tested on poultry) by drying it under sunlight for a couple of days. Currently, there does not exist an advanced technology that farmers can use, in order to eliminate bacteria that may cause diseases. Thus, the quality of bio-slurry for animal feed should be studied further. After the drying process, farmers would buy the package for bio-slurry from the manufacturer (they should be available locally). Packaging would be done by the farmers. The group suggested that marketing should be handled by the farmers themselves, so that they would be able to sell their products directly to the customers.

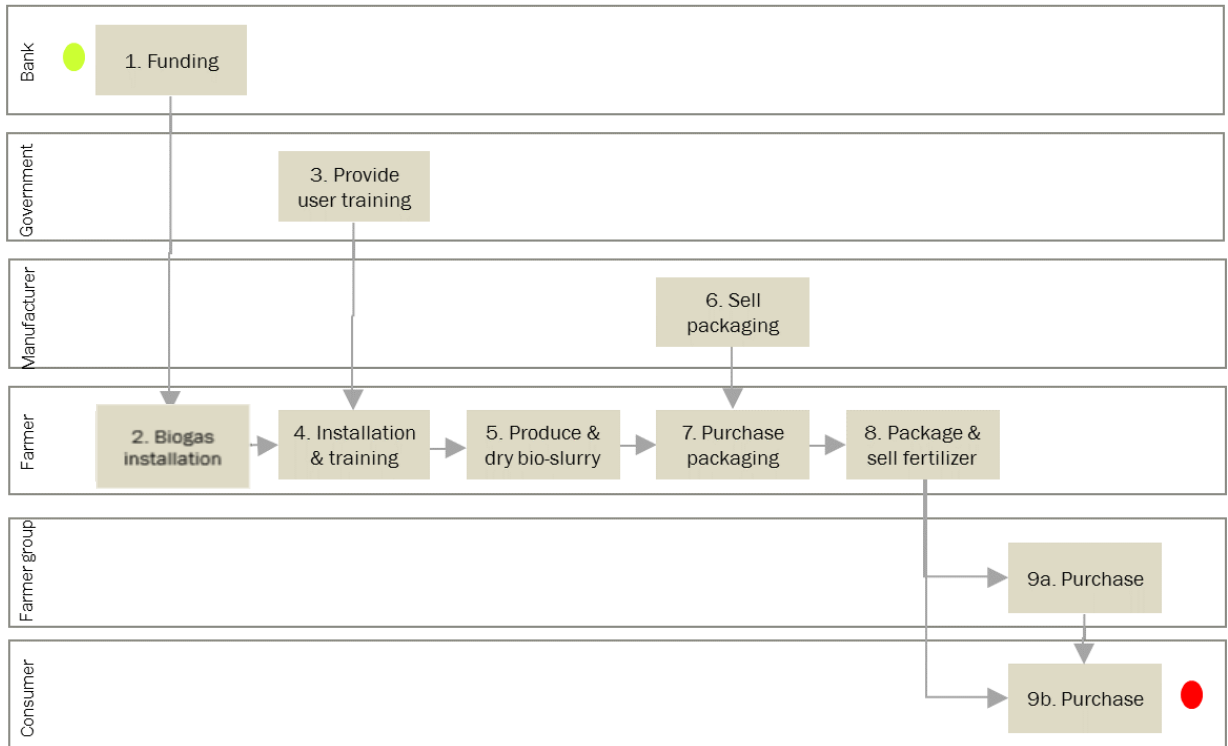


Figure 9. Value preposition of packaged bio-slurry

Fourth Group: Jam production

To facilitate biogas utilisation for jam production, this group opined there were 4 important parties: biogas equipment manufacturers, service organisations, farmers, and consumers. At the beginning, the biogas equipment would be manufactured then purchased by the service organisation, to be distributed to the farmers. Farmers would have significant roles including operating the biogas, cultivating and harvesting fruits, producing and packaging jam, and marketing the product. All the activities should be assisted by service organisations like YRE and food industry experts, for example. Similarly as with the second group, it can be seen from Figure 10 that the biogas facility is provided by service organisations for farmers in the form of grant.

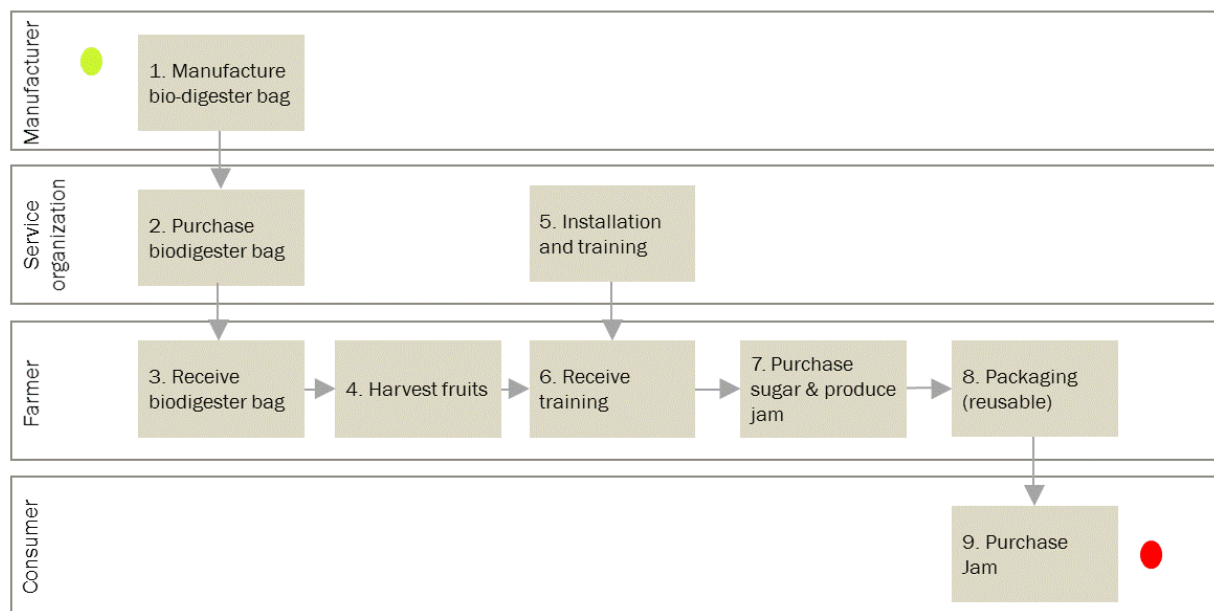


Figure 10. Value proposition of jam production from biogas

Discussion 5: Strategic and Action Plan for Biogas Deployment using TNA

Exercise introduction

An important step to develop a Technology Action Plan is to perform a Technology Needs Assessment (TNA) which was carried out in this exercise.

Technology Needs Assessment

“A set of country-driven activities that identify and determine the mitigation and adaptation technology priorities of Parties other than developed country Parties, and other developed Parties not included in Annex II, particularly developing country Parties. They involve different stakeholders in a consultative process, and identify the barriers to technology transfer and measures to address these barriers through sectoral analyses. These activities may address soft and hard technologies, such as mitigation and adaptation technologies, identify regulatory options and develop fiscal and financial incentives and capacity building (UNFCCC, 2002, p.24).”

http://unfccc.int/ttclear/misc_/StaticFiles/gnwoerk_static/TNR_HAB/b87e917d96e94034bd7ec936e9c6a97a/1529e639caec4b53a4945ce009921053.pdf

TNA promotes active stakeholder involvement in the process of making and implementing a strategic action plan for a specific priority technology in a specific priority sector. TNA's are mainly performed at the national level, and as such might not necessarily reflect (or match) the development priorities of regions within the country. This is especially true for large countries that have a varied economic structure and/or operate in different climate zones.

The 2012 TNA for Indonesia did not include biogas in agriculture, as a priority technology. Priority sectors in the report were Energy, Waste and Industry. Having in mind that the Balinese economy focuses more on agriculture and tourism, the national TNA does not seem a perfect fit.

The idea is to develop a more regional TNA assessment, with the help of knowledge and information from different sources, such as the EU co-funded project TRANSrisk. A considerable amount of information gathered in those projects would fit perfectly in the three-step TNA process and could aid the development of a draft Technology Action Plan for Biogas in Bali.

There are 3 steps of a TNA. The first step focusses on the identification of (regional) priority sector(s) and technologies while the second step aims to select appropriate technologies. The third step, which is the final one, focuses on creating the Technology Action Plan. For the Bali TNA, we focused on agriculture as a priority sector and biogas as a priority technology. Barrier analysis requires an assessment of the stakeholder networks (role, function, perception, etc.) as well as market systems, which we had conducted in previous work. Actor and market system analysis have been important elements of the case study research performed within TRANSrisk. However, the third step, or the Technology Action Plan has not been taken yet. Given the number of barriers for biogas in place, a subset of actions (or measures) to overcome these challenges is needed to improve the implementation of biogas in agriculture.

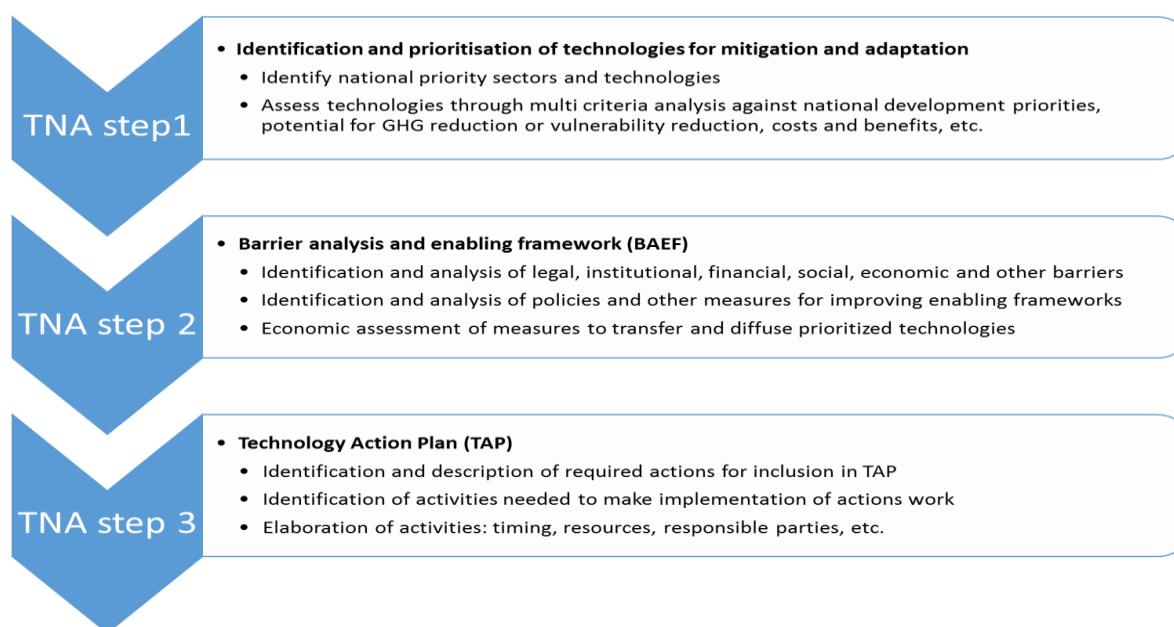


Figure 11. The 3-step process of a TNA

During the 2nd International Workshop on biogas in Bali, the workshop participants were asked to formulate a series of (desired) actions to overcome barriers identified in the biogas system and build on opportunities (presented at the beginning of the workshop). Those actions had to be linked to the day-to-day activities of the various stakeholders, but all needed to contribute to the overall national ambition (target) for renewable energy by installing a large number of farm-scale digesters in the region by 2025. Three groups were formed. One group consisted of policy makers, the second group of local farmers and the third group was comprised

of researchers/NGOs. All three different groups were asked to identify actions that they think would help further up- and out-scale biogas in Bali, and generally in Indonesia.

Aided by a facilitator, all three stakeholder groups were given time to provide propositions for a possible future action plan for biogas in Bali or other regions in Indonesia. The results of that assessment of actions and planning of those actions are presented in the tables below.

During this exercise, the participants were divided into three groups based on their backgrounds: (i) policy makers, (ii) researchers and engineers and (iii) biogas adopters/farmers. This exercise aimed to get input about the strategy and action plan required to enhance biogas deployment in Indonesia. During the discussion, there were seven questions to be discussed, as listed in the Table 14, and those where:

- **Measure/Action** Denotes the action to be taken to promote biogas technology
- **Why is it important?** Denotes the reason why the action should be taken
- **Who is the actor?** Denotes the relevant actor that should implement the action. For example, government, NGOs, private sector and so forth.
- **How?** Implies the set of strategies to be implemented in order to support the action
- **Timing** Denotes the duration during which the action should be implemented
- **Progress (monitor)** Denotes the monitoring period of the respective action
- **Who should pay?** Denotes the source of funding for action implementation

Table 14. Example of TNA table for biogas deployment

Measure/ Action	Why is it important?	Who is the actor?	How?	Timing	Progress (Monitor)	Who should pay?

Result

Group 1: Policy makers

Stakeholders in this group emphasised 3 important actions to be taken: (i) including biogas programmes in the regional development plan supported by scientific evidence (ii) fostering the “champion programmes” and (iii) encouraging partnership in biogas sector. Every province in Indonesia has different regional development priorities, described in the Regional Medium-Term Development Plan (in Bahasa: *Rencana Pembangunan Jangka Menengah Daerah*/RPJMD). Including biogas programmes in the RPJMD would be an important step to secure funding from regional income and would increase the biogas utilisation in a region. This action should be carried out not only by the government (e.g. Bappenas and Bappeda), but also by academics who should provide relevant studies. Furthermore, implementing a champion approach amongst biogas users is important to further biogas deployment. This would require cooperation between relevant public and private institutions. Ecotourism is also considered as a good initiative and could be included in the “champion programme”. Overall, promoting biogas requires collaboration from all stakeholders, not only government but also private sector. However, the government should encourage every party to contribute.

Table 15. Action plan proposed by the policy makers for biogas development

Measure/ Action	Why is it important?	Who is the actor?	How?	Timing	Progress (Monitor)	Who should fund?
Include biogas programme in the region development plan (RPJMD) supported by scientific evidence	To secure funding through the development plan document + integration of streams + multi-sector	- Academia - Bappenas and Bappeda - Operational unit		Long term target could ensure the continuity		
Implementing the "champion programmes"		Private and public	E.g. ecotourism. It could increase pressure for many stakeholders			
Partnership	Brings together the stakeholders	Involved stakeholders	Regular meeting through working group	As soon as possible	Report to governor	Cost will be distributed



Figure 12. Focus group discussion: formulating strategic plan for biogas diffusion in Indonesia by the policy maker group

Group 2: Researchers and engineers

The group of researchers and engineers opined that there were 5 important actions to be taken by this group, as shown in Table 16. First, a stable production of biogas is necessary. The crew from YRE argued that biogas can be used for up to 3-hours of cooking. Yet, this biogas amount fluctuates thus the users still need other energy sources, e.g. firewood, to meet their energy demand and this was also identified as one of the barriers. Moreover, solely using biogas for cooking was not profitable, compared with the subsidized fossil fuel. In cooperation with the government and NGOs, a pilot project is required to demonstrate a stable biogas production to promote this technology. To do that, it requires intensive research and training for at least 5 years. Furthermore, a comprehensive research & development programme should be implemented and lead

by universities and research institutes with the objective of exploring feedstock potential, filter systems, affordable technology, bio-slurry treatment and biogas for electricity. This activity should be done continuously to encourage the development and innovation of this technology. In terms of financial support, this group agreed that funding may come from the government, private sector and developed countries (distributed from their agencies like USAid, European Commission, etc.).

Table 16. Action plan proposed by researchers and engineers for biogas development

Measure/ Action	Why is it important?	Who is the actor?	How?	Timing	Progress (Monitor)	Who should fund?
Stable yield of biogas	To enable uptake	- Government institutions - NGOs - Researchers	Pilot projects, training programme s	Start: As soon as possible Duration : 1-5 years.		
R&D Programme: 1. Feedstock (uptake scenario) 2. Filter 3. Low-cost technology 4. Slurry treatment 5. Market uptake 6. Gas buffering 7. Compression 8. Electrification	To uptake and out-scale biogas deployment	Universities, Research institutes		Endless process		Government , EU, UN Agencies, USAid Private sectors
R&D Platform	As a communication media among researchers and other stakeholders					
Standardization & certification		BSN/NSO Universities				
Bali Promotion: - Technology - Productivity In tourism and agriculture sector	To accelerate biogas adoption		Events, Tourism channels			

During the research programme, researchers would need a platform to communicate and publish the progress for other researchers and stakeholders. At the commercial level, standardization and certification is considered important for quality and safety assurance. Thus, it requires a capable institution that regulates the requirements and the process of standardization and certification. To promote biogas technology, this group suggested using biogas installations in the tourism sector, since this sector is growing rapidly in Bali. Thus, a collaboration with hotels and/or tourism agencies was identified as a good way forward.

Group 3: Biogas users

Differing from the two previous groups, the group of biogas users, consisting of farmers, emphasized the need for a knowledge transfer, in order to foster the biogas deployment. Group members suggested 5 actions to increase the knowledge among biogas users: knowledge sharing among farmers, getting information from local organization (e.g. *subak*), training in proposal development to access biogas funding, attending workshops, and getting more sources independently. In the case of Bali, the knowledge sharing can be facilitated during regular farmers' meetings, namely *Sangkep*. In general, *Sangkep* is held at any time, but the main meeting will be held every two months and attended by many heads of villages who are considered as the 'door for information' for the community. Hence, the role of the heads of villages is imperative for knowledge transfer. Furthermore, this meeting would be attended by non-biogas users, thus this can be an aspect to foster the biogas diffusion.

Table 17. Action plan by biogas user using TNA for biogas development

Action	Why is it Important	Who is Responsible	How	Timing	Monitoring progress	Estimated cost of the action
Farmer-to-Farmer knowledge sharing	Learning by evidence from someone doing the similar things	Farmer as an individual who are willing to learn and share knowledge about biogas	1. Usually farmers have regular meetings named <i>Subak Sangkep</i> ⁵ . They often share anything on this occasion 2. The non-adopter farmer goes to visit the adopter farmer	Balinese farmers have many kinds of <i>Sangkep</i> at any time. However, the main <i>Sangkep</i> is usually once every 2 months. After meeting and talking in that <i>Sangkep</i> , this group said that they need around a week to initiate and visit the biogas adopter farmer.	1. The biogas adopter farmer usually has a registration form in their house. So, it would be easy to recap who is coming to visit their biogas installation. 2. Sometimes, the farmer can evaluate everything	Farmers said that this action could cost the most time. Either one hour for the <i>Sangkep</i> or one and half hours for the field visit.

⁵ Balinese language, means farmer organization meeting.

Action	Why is it Important	Who is Responsible	How	Timing	Monitoring progress	Estimated cost of the action
					on the next <i>Sangkep</i> .	
Collaboration between farmer and local organization such as Banjar, Subak, head of village etc.	Farmers agreed that the head of village/local organization is the “door for information”. Therefore, if farmers have a good relationship with them, it will make them stay connected with the global world. For instance, the information about this workshop.	Farmer and the head of the village and the head of the local organization (<i>Subak</i> , Banjar)	The information usually goes to the head of village. Then, the head of the village will circulate the information to the head of the Banjar and/or the <i>Subak</i> personally. Afterward, the head of the Banjar and/or <i>Subak</i> will deliver it to all of their member (farmers) on a <i>Sangkep</i> occasion.	It takes around a week from getting the information until <i>Sangkep</i> (meeting). And will take approximately 2 hours for the <i>Sangkep</i> .	Usually, only the head of village will decide anything by way of people deliberation to reach the decision. So, everything will be evaluated through its decision.	It doesn't take any cost except time and energy to circulate the information from the head of the village to the head of the local organization. However, this group mentioned that it sometimes costs IDR200.000-300.000 per <i>Sangkep</i> to buy some snacks and drinks for around 100 people.
A training for farmers on how to write a proposal to get biogas funding from government and other NGO programmes						
Participation of farmers in any bioenergy workshop to get more involved in						

Action	Why is it Important	Who is Responsible	How	Timing	Monitoring progress	Estimated cost of the action
sharing knowledge about biogas						
Be more involved to have more accessible information within farmer community						

Concluding Remarks

Bali has a huge potential to adopt biogas technologies such as bio digesters at the household level, as long as the scaling up strategies can be undertaken and the barriers can be minimised. The Q-method exercise shows considerable social acceptance within the farmers, but they come together with barriers that need to be addressed. For instance, in our case study, bio-digesters must compete with subsidized LPG. Moreover, the agricultural land is coming under pressure to be used in more lucrative endeavours, such as tourism development. Therefore, it is expected that economic development, which favours the fossil fuel based regime, will be a strong contextual driver soon. The identified barriers should be minimised as they may hinder the achievement of a more sustainable household level biogas development.

Additionally, this workshop successfully identified biogas opportunities and a strategic action plan to accelerate biogas adoption. The policy makers agreed that financial support and biogas agenda included in local development plan are required to foster the biogas development in Indonesia. Meanwhile, researchers and the engineer group emphasised that the optimum yield of biogas and knowledge sharing are important to promote this technology. As opposed to the group comprised of policy makers and researchers, the biogas users opined that knowledge sharing is important to operate the technology and access to the funding. Compiling these opportunities paired with appropriate actions will be able to encourage wider usage of biogas technology.

In terms of biogas network, it can be deduced that farmers are the heart of biogas deployment, who still needs support from other stakeholders: government, private sector, banks, NGOs, etc. Each stakeholder has their role in contributing to biogas development in Indonesia, as shown from the TNA exercise. Furthermore, most participants suggested that connecting the biogas to the money-making activity can be a way to promote biogas while resolving environmental issues and improving the well-being of the farmers. A further economic analysis on utilizing biogas system for household should be undertaken to enhance the clarity on whether this system is beneficial for the users or not. The result of the exercises, as well as the biogas diffusion and macro-economic models, will be the main base for determining the next focus topic for the 3rd Bioenergy International Workshop, which will be held in the middle of 2018.

Next Steps

The result of exercises will be the main base for determining the next focus topic for the 3rd Bioenergy International Workshop, which will be held in the middle of 2018. Further assessment on biogas diffusion in Indonesia and macro-economic analysis are imperative to picture the biogas development in the future. The detailed information regarding a breakdown plan for the workshop will be circulated after an internal meeting.

Annex

Annex 1 Workshop Agenda

Day 0 - Sunday, 21 May 2017

BLOCK A : FIELD VISIT

Time	Activity		
11.00	Informal Greeting from GREEN-WIN Indonesia Case Study team	11.30	Lunch (invitation only)
13.00	Trip to Jembrana <i>Meeting Point in Lobby Grand Balisani Suites Hotel, Canggu</i>		
13.30	Short visit to Tanah Lot – sightseeing		
14.30	Continued trip to Jembrana		
16.30	Sunset scenery and dinner in Suito's Bamboo Terrace, Jembrana		
18.30	Continued trip to Jembrana		
19.30	Check-in to Jimbarwana Hotel		
20.00	Free time		

Day 1 - Monday, 22 May 2017

Time	Activity
07.00	Breakfast and check-out
08.00	Trip to Warnasari Village
09.00	Visit to Pak Chakra's coffee farm and biogas installation <i>Warnasari village, Melaya district, Jembrana regency</i>
11.00	Visit Pak Ketut's cacao farm and biogas installation <i>Modeng village, Melaya district, Jembrana regency</i>
12.00	Traditional Balinese lunch
13.00	Trip back to Canggu
16.00	Check in to Grand Balisani Suites
16.30	Free time

Day 2 - Tuesday, 23 May 2017

BLOCK B: RISK AND BARRIERS RELATED TO BIOGAS DEPLOYMENT

Time	Activity
08.00	Registration
09.00	Welcome and recap of field visit experience <i>By: Dr. T. Takama, D.Phil –Su-re.co, Udayana University, Stockholm Environment Institute</i>
09.20	Opening speech <i>By: Prof. Drs. I Made Suastra, Ph.D - vice rector of Udayana University</i>
09.30	Moving forward, looking back at the 1 st Bio-energy Workshop <i>By: C. Ismail, Su-re.co</i>
09.45	Introduction to GREEN-WIN & preliminary results

Time	Activity
	<i>By: L. Lemkow Zetterling, Institute of Environmental Science and Technology of the Autonomous University of Barcelona</i>
10.00	Participants introduction
10.15	Coffee break
10.45	Framing of risk and uncertainties in biogas development <i>By: J. Lieu, Sussex University.</i>
10.55	Result of the socio-institutional analysis of biogas technology implementation in Bali <i>By: Dr. T. Devisscher, Stockholm Environment Institute</i>
12.00	Photo group session & lunch
13.00	Co-effects of transition pathways in the livestock sector in the Netherlands <i>By: E. Spijker, JIN. A. Anger-Kraavi, Cambridge Econometrics</i>
15.00	Coffee break
15.30	Assessing attitudes toward biogas development using the Q-method <i>Facilitated by: Dr. R. Taylor, Stockholm Environment Institute</i>
18.00	Dinner and entertainment @ TURTLE OPEN STAGE

Day 3 - Wednesday, 24 May 2017

BLOCK C: SUSTAINABLE AND RESILIENT BUSINESS MODELS FOR BIOGAS SOLUTIONS IN INDONESIA

Time	Activity
09.00	Introduction to Day 3
09.15	Piloting a Green Business Model based on biogas solutions <i>By: I. Bobashev, M. Ghiandelli, Su-re.co</i>
09.30	Farmers' experience on using biogas and bio-slurry for Coffee Plantation <i>By: I Gusti Made Cakra, coffee farmer and biogas user</i>
09.45	A network analysis of the diffusion of biogas technology <i>By: Dr. A. Mandel, Paris School of Economics (EEP-PSE), France</i>
10.00	Assessment of sector opportunities for biogas innovation <i>By: Yudiandra Yuwono, GREEN-WIN</i>
12.00	Lunch
13.00	Opportunity of biogas servitisation for the empowerment of BOP <i>By: Dragana Vujkovic, GREEN-WIN</i>
15.00	Coffee break
15.30	Strategic action plan for biogas in Bali <i>By: Dr. T. Devisscher, Stockholm Environment Institute. E. Spijker, JIN</i>
16.30	Closing speech <i>By: Prof. Drs. I Made Suastra, Ph.D - vice rector of Udayana University</i>

Annex 2 Participant List

No.	Name	Affiliation	Day 1 [22 May]	Day 2 [23 May]	Day 3 [24 May]
1	Debora Kanahau	Assessment Institutes for Agricultural Technology of East Nusa Tenggara Province	X	√	√
2	Onika Tali Lailogo	Assessment Institutes for Agricultural Technology of East Nusa Tenggara Province	X	√	√
3	I Made Buda	Agriculture and Plantation Agency of Bali Province	X	√	√
4	Suradi	Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG) of Bali Province	X	√	√
5	Agustinus Farik	Bappeda (Regional body for planning and development) of East Nusa Tenggara Province	X	√	√
6	Guntur	Forestry Department of Bali Provincial Forestry Agency	X	X	√
7	I Made Budi Utama	Farmer	X	√	√
8	I Komang Warken	Farmer and biogas user	X	√	√
9	Gede Madiasa	Farmer and biogas user	X	√	√
10	I Ketut Sukadana	Farmer	X	√	√
11	I Gusti Chakra	Farmer and biogas user	√	√	√
12	I Nyoman Sudita	Farmer	X	√	√
13	I Ketut Wiadnyana	Kerta Semaya Samania (KSS) Cooperation	X	√	√
14	Satya Budi Utama (Tommy)	Yayasan Rumah Energi	X	√	√
15	Gede Dewa Weda	Yayasan Rumah Energi	X	√	√
16	Prof. Made Suastra	Udayana University	X	√	√
17	Prof. Ida Ayu Giriantari	CORE Unud	X	√	√
18	I Nyoman Satya Kumara, PhD	CORE Unud	X	√	√
19	Nyoman Setiawan	CORE Unud	X	√	√
20	Prof. Tjokorda	CORE Unud	X	√	√

No.	Name	Affiliation	Day 1 [22 May]	Day 2 [23 May]	Day 3 [24 May]
21	I Made Oka Guna Antara	Udayana University	X	√	√
22	Annela Anger-Kraav	Cambridge Econometrics (CE)	X	√	√
23	Eise Spijker	JIN	√	√	√
24	Jenny Lieu	SPRU	√	√	√
25	Louis Lemkow	UAB	√	√	√
26	Anet Duncan	UAB	√	√	√
27	Richard Taylor	SEI	√	√	√
28	Stefan Bossner	SEI	X	√	√
29	Tahia Devisscher	SEI	√	√	√
30	Solmaria Halleck	Paris School of Economics	√	√	√
31	Antoine Mandel	Paris School of Economics	√	√	√
32	Imroatul Ippah	CreSOS	X	√	X
33	Swardika	CreSOS	X	√	√
34	A Besse Rimba	CreSOS	X	√	√
35	Camilo	Green School	X	√	X
36	Gusta	Green School	X	√	√
37	Helena	NGO Kalimajari	X	√	√
38	Dita Anggraini	Green School	X	√	√
39	Takeshi Takama	SEI, UNUD, su-re.co	√	√	√
40	Laksmi Pratiwi	UNUD, su-re.co	X	√	√
41	Auditya Sari	UNUD, Su-re.co	X	√	√

No.	Name	Affiliation	Day 1 [22 May]	Day 2 [23 May]	Day 3 [24 May]
42	Ivan Bobashev	Su-re.co	X	√	√
43	Joshi Boomputte	Su-re.co	√	√	√
44	Marco Ghiandelli	Su-re.co	√	√	√
45	Mariana Silaen	Su-re.co	X	√	√
46	Cyprien Donnet	Su-re.co	X	√	√
47	Kai The	Su-re.co	X	√	√
48	Yudiandra	Su-re.co	X	√	√
49	Stan Tommy	Su-re.co	X	√	√
50	Yasmine Adelantado	Su-re.co	X	√	√
51	Novelita Mondamina	Su-re.co	X	√	√
52	Cynthia J Ismail	Su-re.co	X	√	√

Annex 3 Question and the answer from A Network Analysis of the Diffusion of Biogas Technology session

Q.1 From how many people/ institutions did you receive information about biogas/agriculture? Who are they?

Answer:

A1. Dewa Weda, Quality control of Biogas Rumah (BIRU) programme, Yayasan Rumah Energi

There are around 3-5 people who gave me information about biogas. Mainly from academicians, universities, scientists, environmental activists and the government.

A2. I Gusti Made Cakra, coffee farmer in Jembrana (biogas user)

Around 3-5 people, mainly from *Subak* members in my village

A3. I Made Budi Utama, head of Tukadaya village in Jembrana

Around 2-3 people, they are from government parties

A4. Guntur, Bali Provincial Forestry department officer

More than 10 people. from farmers, agricultural agency, extension workers, NGOs and researchers

A5. Satya Budi Utama, National Coordinator of the BIRU programme, Yayasan Rumah Energi

Around 5 people. They come from HIVOS, Ministry of Energy, government and other international projects related to bioenergy

A6. Onike Lailogo, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

Around 3-5, all coming from government parties

A7. I Made Buda, Bali Provincial Agricultural Agency

2-3 institutions. They were from PT. Swen Bogor, Udayana University, and Yayasan Rumah Energi through BIRU programme

A8. Debora Kana Hau, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

2-3 institutions including government, researchers from university and international NGOs

A9. Dita Anggreni, bioenergy reasearcher, Gajah Mada University & intern in Green School

3-5 institutions consisting of Gajah Mada University, KOMASE (renewable energy NGO), Green School, BIRU and Community Rmpowerment Organization

A10. Agustinus Fahik, East Nusa Tenggara Regional Planning Agency

3-5 institutions. They come from government agencies including Regional Environmental Agency, Regional Planning Agency, Ministry of Environment, Energy and Mineral Resource Agency

Q2. How many people are you going to talk/advertise to about biogas? In village? Other villages? Regency, national?

A1. Dewa Weda, Quality control of Biogas Rumah (BIRU) programme, Yayasan Rumah Energi
To all the potential users

A2. I Gusti Made Cakra, coffee farmer in Jembrana (biogas user)
At this time, we only did within our village and to another village

A3. I Made Budi Utama, head of Tukadaya village in Jembrana
From village to another village

A4. Guntur, Bali Provincial Forestry department officer
From our village to other villages. So far, it's only village scale

A5. Satya Budi Utama, National Coordinator BIRU programme, Yayasan Rumah Energi
On a national scale, as much as possible

A6. Onike Lailogo, Assessment Institution of Agriculture Technology, East Nusa Tenggara province
As much as possible on the province scale.

A7. I Made Buda, Bali Provincial Agricultural Agency
On the provincial scale within 9 regencies in Bali, to as many as people possible

A8. Debora Kana Hau, Assessment Institution of Agriculture Technology, East Nusa Tenggara province
On the national scale through bioenergy seminars and workshop activities.

A9. Dita Anggreni, bioenergy researcher, Gajah Mada University & intern in Green School
A lot of people, as much as I can. It is possible to expand the information on the international scale because I work with a team of people from all over the world.

A10. Agustinus Fahik, East Nusa Tenggara Regional Planning Agency
On a national scale

Q3. Are there people that are more influential? Who are they?

A1. Dewa Weda, Quality control of Biogas Rumah (BIRU) programme, Yayasan Rumah Energi

Farmers are the only ones who are influential in the biogas programme. Especially for the bio-slurry. If one farmer is also using the bioslurry and has implemented the sustainable farming with it, then he/she can influence other farmers. Especially in terms of the decrease of the farming cost through producing organic fertiliser by themselves

A2. I Gusti Made Cakra, coffee farmer in Jembrana (biogas user)

Yes, the head of the village or the head of *Subak* (agriculture organization system in Bali)

A3. I Made Budi Utama, head of Tukadaya village in Jembrana

Yes, there are. It must be the head of village

A4. Guntur, Bali Provincial Forestry department officer

Yes, there are. It must be the head of village and the farmer

A5. Satya Budi Utama, National Coordinator BIRU programme, Yayasan Rumah Energi

Yes, there are. The academicians, researchers, the private sector, and some experts in Biogas

A6. Onike Lailogo, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

Yes. They are farmer groups, local government, head of the Regional Planning Agency, and the extension workers on a local scale.

A7. I Made Buda, Bali Provincial Agricultural Agency

Yes. They are academicians and researchers related to the biogas technology development, and also the farmer groups.

A8. Debora Kana Hau, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

Yes, they are the heads of villages, heads of farmer groups, the religious leaders.

A9. Dita Anggreni, bioenergy researcher, Gajah Mada University & intern in Green School

Yes, academicians, researchers, and farmers

A10. Agustinus Fahik, East Nusa Tenggara Regional Planning Agency

Yes, chicken farmers and cattle farmers

Q4. Do you think eventually all the farmers will adopt biogas?

A1. Dewa Weda, Quality control of Biogas Rumah (BIRU) programme, Yayasan Rumah Energi

Yes, if only the farmers could get information access about biogas. So far, the farmers are not using biogas because they know nothing about it. Therefore, if there is good communication and information for the farmers, there is a possibility for them to install biogas and increase the biogas adoption.

A2. I Gusti Made Cakra, coffee farmer in Jembrana (biogas user)

Yes, I have that foresee.

A3. I Made Budi Utama, head of Tukadaya village in Jembrana

Yes

A4. Guntur, Bali Provincial Forestry department officer

Not all of them, but maybe most of the farmers

A5. Satya Budi Utama, National Coordinator BIRU programme, Yayasan Rumah Energi

Yes, as long as there exists collaboration amongst the stakeholders. For example, government, private sector, financial institutions, and also farmer involvement.

A6. Onike Lailogo, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

No. Because biogas is an expensive technology for the farmer. It will only happen if there is 100% subsidy from other stakeholder such as government. And so far, it seems government has another priority, in education, rather than a new and renewable energy. Logically, biogas will have a hard way to be implemented widely.

A7. I Made Buda, Bali Provincial Agricultural Agency

We can see that biogas is cheaper and easier as a long investment, even friendlier to the environment compared to the conventional gas (LPG). Therefore, I think this can be an energy alternative to be widely implemented in the near future. However, it still needs innovation to make it more applicable for the farmer.

A8. Debora Kana Hau, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

It depends on the sustainability of the biogas technology. As long as the technology gives the benefit of free gas and also organic fertiliser, and doesn't need complicated bureaucracy. I think farmers will adopt biogas eventually.

A9. Dita Anggreni, bioenergy researcher, Gajah Mada University & intern in Green School

As long as the user got the exact and complete explanation and education about biogas.

A10. Agustinus Fahik, East Nusa Tenggara Regional Planning Agency

Maybe some. It depends on the feedstock availability.

Q5. How long will it take?

A1. Dewa Weda, Quality control of Biogas Rumah (BIRU) programme, Yayasan Rumah Energi

More than 25 years, depending on the biogas digester material quality

A2. I Gusti Made Cakra, coffee farmer in Jembrana (biogas user)

As long as the biogas gives benefits to the farmers

A3. I Made Budi Utama, head of Tukadaya village in Jembrana

As long as possible

A4. Guntur, Bali Provincial Forestry department officer

I consider 5 years as the longest period. It depends on how the biogas digester quality and also on the government's concern of the biogas programme.

A5. Satya Budi Utama, National Coordinator BIRU programme, Yayasan Rumah Energi

Hopefully for at least 20 years.

A6. Onike Lailogo, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

It could happen as long as the farmer can get a grant or 100% subsidy and also as long as they have their own land to install biogas.

A7. I Made Buda, Bali Provincial Agricultural Agency

As long as the biogas installation can produce the gas and the farmers know how to use it. As I know, it will be around 20 years with good maintenance.

A8. Debora Kana Hau, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

Around 5 years

A9. Dita Anggreni, bioenergy researcher, Gajah Mada University & intern in Green School

It depends on their commitment. But I think it will be 2 years in average.

A10. Agustinus Fahik, East Nusa Tenggara Regional Planning Agency

It is uncertain, depends on the feedstock availability and the farmers' willingness to commit.

Q6. On average, how many examples do you think a farmer needs to decide about installation?

A1. Dewa Weda, Quality control of Biogas Rumah (BIRU) programme, Yayasan Rumah Energi

All farmers who have cows and pigs should be considered as biogas users.

A2. I Gusti Made Cakra, coffee farmer in Jembrana (biogas user)

It states that Bali has around 65% farmers who owns cows. So that number could be considered to increase and use the biogas installation

A3. I Made Budi Utama, head of Tukadaya village in Jembrana

I really wish at least 60% of our farmers in my village will install the biogas

A4. Guntur, Bali Provincial Forestry department officer

60% from total farmers in Bali.

A5. Satya Budi Utama, National Coordinator BIRU programme, Yayasan Rumah Energi

1 or 2 farmers is enough

A6. Onike Lailogo, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

20%

A7. I Made Buda, Bali Provincial Agricultural Agency

Considering the current condition, related to the quality, mental awareness, and also financial supporter. I guess it will need more than 95% of implemented cases to make farmers trust this technology.

A8. Debora Kana Hau, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

I do not have any idea how to answer this.

A9. Dita Anggreni, bioenergy researcher, Gajah Mada University & intern in Green School

50% of farmers in each village.

A10. Agustinus Fahik, East Nusa Tenggara Regional Planning Agency

I guess 30% of farmers in each village, as the pilot project.

Q7. What is your expectation? Is there something that you want to see? How many biogas are needed?

A1. Dewa Weda, Quality control of Biogas Rumah (BIRU) programme, Yayasan Rumah Energi

My expectation is to see the farmers applying good agriculture practices and starting to use biogas to integrate their farming. Of course, it also means that the number of biogas installation increase in the future.

A2. I Gusti Made Cakra, coffee farmer in Jembrana (biogas user)

To have at least one village using biogas.

A3. I Made Budi Utama, head of Tukadaya village in Jembrana

To create the sustainable farming and independent farmer through biogas usage. Also, enabling the environment by using the bio-slurry

A4. Guntur, Bali Provincial Forestry department officer

I expect that biogas could be an alternative for sustainable farming in Bali, even in Indonesia.

A5. Satya Budi Utama, National Coordinator BIRU programme, Yayasan Rumah Energi

Biogas installation completion of at least 7000 units/year in Indonesia

A6. Onike Lailogo, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

If necessary, all of the farmers in at least one village would adopt this technology. But once again, please be realistic that this is too expensive for the farmer. We need to help them and work hand-in-hand to make this happen.

A7. I Made Buda, Bali Provincial Agricultural Agency

I hope biogas will be widely adopted and that energy poverty decreases in Indonesia. And also help the farmers minimize their living costs through free gas and bio-slurry for fertiliser.

A8. Debora Kana Hau, Assessment Institution of Agriculture Technology, East Nusa Tenggara province

I hope all the communities in rural areas will adopt the biogas technology and can access the clean energy independently.

A9. Dita Anggreni, bioenergy researcher, Gajah Mada University & intern in Green School

I have a dream, that all the related stakeholder from policy makers, business, private sector, NGOs, and even farmers as the users working in collaboration to make this happen. It will be also good if the biogas user is not only farmer, but also all the stakeholders mentioned above.

A10. Agustinus Fahik, East Nusa Tenggara Regional Planning Agency

I hope at least 70% farmer in each village will adopt the biogas.