

3rd Bioenergy and Electrification Workshop Report: On sustainability and resilience of bioenergy for Climate change

Green Business and synergy action for climate
change mitigation and adaptation to realize
100% electrification rate and climate smart
agriculture (8-11 April 2018)



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1. Introduction

The 3rd Bioenergy and Electrification Workshop on Sustainability and Resilience of Bioenergy for Climate Change is the last part of a series of annual bio-energy workshops, taking place from 2016 to 2018, which is organized as a joint initiative of the Ministry of National Development Planning of Indonesia (Bappenas), Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG), and the European Commission (EC) Horizon2020 projects: GREEN-WIN and TRANSrisk. The workshop was attended by 71 participants from different backgrounds such as governmental officers, representatives of the private sector, NGO officers, farmers, and researchers.

During the second workshop in 2017, experts, stakeholders, and biogas users concluded that while there is a considerable opportunity for the continuation of biogas development in Bali, many critical barriers also needed to be addressed further. Moreover, the synergy of biogas utilisation and value-addition activities were concluded as the key activities to increase biogas diffusion rate. Future activities will focus on connecting stakeholders, with each of them having a role to play in the biogas development.

The main objectives of the 2018 workshop are to:

- i. Explore the biogas sector further based on scientific assessments, including the diffusion and econometric models
- ii. Explore sustainable, resilient, and scalable business revolving around synergising biogas and agricultural value-addition activities.
- iii. Connect the policymakers, researchers, and biogas users to further align the knowledge supply from the researchers and the knowledge need of the policymakers.

Concisely, the third workshop sought to shed further light on the opportunities of biogas and related climate-smart agriculture (CSA) in Indonesia with critical reflections on the associated risks and barriers, developed from the preliminary sessions with Bappenas and models from previous workshops. It facilitated a mechanism to ease the collaboration between researchers, policymakers, and biogas users to further align the knowledge supply from the researchers and the knowledge need of the policymakers.

To achieve these objectives, the workshop was structured into three different sections and different methods were applied. Firstly, concrete pilot projects of agricultural product value-addition activities using biogas and BMKG's Climate Field School (CFS) were showcased during a two-day field visit. The third day consisted of experts' presentations and thematic panel discussions concerning various areas such as climate change mitigation, adaptation, and the green finance. These consisted of exercises to facilitate participants to better interact and exchange about their perception of bioenergy development in Indonesia. A focus group discussion (FGD) was conducted on the basis of (i) a business model canvas (GREENWIN) to come up with higher-value products using biogas and (ii) co-effect of biofuel pathways sector in Indonesia followed by a macroeconomic modelling approach (TRANSrisk) in order to quantify the impact of policy/development and to reduce risks and uncertainties. For this FGD, participants were asked to forecast biogas and small-scale biodigesters and electricity production using biogas for the future to implement the macroeconomic model. Another exercise used a Q-methodology approach (TRANSrisk), integrated with Technology Needs Assessment (TNA), allowing a stakeholder to consult regarding the next actions to support biogas development in Indonesia.



2. Field Visit

The participants (32 people) who were to attend the workshop as speakers, representatives for the government and partner, joined a field visit to Jembrana, West Bali (8th-9th April). The field visit permitted to showcase to the participants the result of the implementation of the research studies regarding biogas deployment as a climate change adaptation and mitigation action conducted with GREEN-WIN and TRANSrisk. In this case, the coffee and cocoa farms (see 2.2) shown during the field visit have been supported over the past three years to adopt CFS practices through training (see 0) and the installation of two types of biogas digesters, namely a fixed-dome and a removable one. There were two farmers perceived as farmer champions, who have been chosen as pilot contributors in the Indonesian case study. Both projects (GREENWIN and TRANSrisk) have assisted in the farmers' livelihood improvement and given them an economic incentive to better adopt sustainable practices. Furthermore, different biogas digesters have been used for value-addition activities and were shown during the visit. Two finished products, namely su-re.coffee and su-re.coco, have been commercialised so far. For instance, the su-re.coco has been produced at Cau Chocolates Factory (see 2.1.), where the factory incorporated some lower valued coffee beans into the chocolate products in order to minimise coffee farmers' loss.

2.1. Visit to Cau Chocolates Factory

On the first day, the participants visited Cau Chocolates Factory, which was established in 2014. The factory is engaged in the production of the organic chocolate by processing the beans to ready-to-eat chocolate pieces. Cau Chocolates Factory's value and business model is similar to su-re.co and they have been producing su-re.coco chocolate since early 2018. During the visit, the participants learnt about the company's business structure, witnessed the chocolate production and produced some su-re.coco samples, which ended up as chocolate tastings.

su-re.coco consists of two chocolate products made by combining the ground and whole coffee beans into the chocolate products. Recently, these products have been developed to optimise the coffee bean sales that lose value caused by in-farm production faults. The beans are, in fact, no longer suited for coffee production, but their quality is not altered for chocolate production. su-re.coco ensures that the farmers do not suffer from revenue loss and variability of the selling price from these coffee beans. su-re.coco follows the idea of su-re.coffee, which is made through the combination of value-addition activities and the use of biogas digesters to obtain organic and marketable end-products.

2.2. Coffee and cocoa farms and biogas

On the second day, the participants visited I Gusti Chakra's coffee farm and Ketut Windya's cocoa farm in Jembrana, where biogas digesters are installed. These farmers were selected using the "Championship Approach," where well-known and influential farmers were approached due to their experience and performance. These farmers have the ability to motivate other farmers regarding the benefits of CSA and the opportunity to link it with coffee and cocoa processing. With a biogas digester, they can use the bio-slurry for their crop fertilizer and the biogas to process the beans and for personal use such as cooking and lighting.

I Gusti Chakra (a coffee farmer) owns a 4m³ fixed-dome biogas reactor, which was built in collaboration with the Biogas Rumah (House Biogas, hereafter BIRU) programme of Yayasan Rumah Energi (YRE), an NGO aiming at providing accessible renewable energy across Indonesia. Ketut Windya (a cocoa farmer) has a portable biogas bag, designed by the GREEN-WIN Indonesia case and su-re.co team with a similar size to the other digesters. These two different types of biogas systems were installed as pilot projects to experiment with a mix of



feedstock of animal manure and organic wastes such as cacao pod. The cacao pod was used as alternative feedstock for the sake of waste management and to reduce environmental impacts.

During the visit, the participants had the opportunity to witness three different types of use of biogas digesters, which could become additional sources of income in the future for the farmers: (i) the bio-slurry, the by-product in the gas production (ii) coffee-roasting using the biogas: to process a more environmentally friendly product, and (iii) puffer snack produced from rice, dried bananas, beans, etc. The puffer machine is home-built and fueled with biogas. Overall, the aim was to picture how biogas supports the livelihood of smallholder farmers and to see the opportunity for incentivising biogas usage by linking it to money-making activities through community-based projects with coffee and cacao farmers.

2.3. Climate Field School

This year's field visit included the opportunity to attend the final session of the CFS pilot, a result of a partnership between SEI, BMKG, Jembrana agricultural agency, and su-re.co. The principle of the Climate Field School is to educate farmers about climate-based decision making and sustainable day-to-day farming activities.

By giving the farmers knowledge about climate change and its impacts on their crops, the farmers are more prepared for the changing weather, season, and climate, and how they can better adapt to them. For instance, the harvesting time can change depending on the weather condition, and the farmers need a robust information to cater their decision-making processes. The objective is also to have an interactive relationship between the farmers and the information providers, being BMKG and extension workers (agricultural experts at the district and sub-district level). The relationship will continue while formulating a longer-term collaboration with the farmers. The CFS can be adopted as a value-addition activity to sell the farmers' crops. The project started in early 2018 and as such, the thorough result of the CFS is still under measurement. Nevertheless, an evaluation showed that the farmers' knowledge about weather and climate increased by 30% compared to how it was before the training sessions.



3. Workshop presentations

The opening of the 3rd Bioenergy and Electrification Workshop was led by Prof. Dr. dr. A. A. Raka Sudewi, Rector of Udayana University, followed by Cynthia Ismail, a team member of su-re.co, who introduced and delivered the progress of the Indonesian case under GREEN-WIN and TRANSrisk project as a background for this workshop. Currently, the Indonesian case has progressed, for instance, an engagement with policymakers at the national level (e.g. Bappenas and other ministries) to formulate a background study of bioenergy to contribute to Mid-term Development Plan (RPJMN). At the community level, a pilot CFS for coffee and cocoa has been conducted to increase farmers' knowledge about climate change affecting their agricultural activities. Subsequently, the first-panel discussion regarding policy, mitigation, and energy session was conducted.

3.1. Policy, Mitigation and Energy session

3.1.1. Policy related to Bioenergy and Electricity

Ms. Syamisdar Thamrin – Senior Planner for Energy and Climate Change – Ministry of Planning and Development (Bappenas)

Sustainable development goals (SDGs) are the driving policies in the Indonesian government and have milestones in 2025 and 2030. The Indonesian government has developed five national priorities, created a budget, and assigned responsibilities to the relevant ministries. The five priorities include: (i) human resources development through decreasing poverty and increasing basic services; (ii) decrease disparities between regions through strengthened connectivity and maritime programs; (iii) increase added value through agriculture, industry, and productive services; (iv) security of energy, food and water resources; (v) stability of national security and successful election.

The presentation was focusing on the fourth national priority, namely the security of energy, food and water resources. Policy direction for the development of the fourth national priority has four stages, with the first programme priority being to increase the production and supply of energy. This will be carried out through an increased production and reserve of oil, natural gas, and other energy sources; the construction of power plants, transmission and distribution lines; development of renewable energy; an increased utilisation of coal and natural gas for the domestic market; and increased energy efficiency. However, the production of oil and gas is continuously declining while the national demand is steadily increasing. This growing deficit creates an avenue for the development and implementation of renewable energy technologies, specifically bioenergy. Wide-scale installation of biodigesters is occurring across Indonesia with the aim of reaching emission reduction targets.

Moreover, the integrated funding sources for programme priority for the fourth national priority mostly comes from line ministries (IDR 2 trillion), Special Allocation Fund (DAK) for local governments (IDR 1.6 trillion), and from private investors/communities. It implies a set of funding opportunities for renewable development, including bioenergy, if the funding above can be accessed.



3.1.2. Importance of policy dialogue: connecting policymakers & researchers.

Oliver Johnson, SEI

Science-policy link has been ongoing during the whole TRANSrisk and GREENWIN projects to achieve “evidence-based policy”. Two assumptions have to be made: (i) we need policy for development towards a green and sustainable future, globally and in Indonesia, and (ii) the policy we want is based on evidence. Risks, uncertainties, and possible solutions should be taken into account when making policy effectively. Therefore, a policy dialogue is necessary to transform scientific evidence and political needs into efficient policymaking. It is significantly important to link socio-technical research with policy plans for Indonesia. If the link between science and policy is lacking, the research will have a minor impact while less-evidence based policy will not be able to robustly address climate change issues.

This 3rd workshop is an example of how this process of linking research and policy is undertaken. Evidence-based policy is an iterative process (we try, fail, fix, repeat, try...) and it is important to maintain this direction because policymaking for renewable energy is difficult to navigate. For instance, winners and losers may exist during the policy implementations. Thus, there is a need to engage and analyse opportunities and threats for the renewable energy market and country development.

The bioenergy workshop contributes to reducing the gap between policymakers and researchers' knowledge and it is beneficial to keep this direction to achieve evidence-based policymaking. We need diverse types of top-down and bottom-up research with various approaches such as technical, economic, and social risks. It is essential to bring together projects with different approaches and engage evidence for the policymaking.

3.1.3. Bioenergy, climate and innovation with a focus on electrification and bioenergy

Dr. Francis X. Johnson SEI

Dr. Francis Johnson presented about sustainability and resilience of bioenergy for climate change. The transition from the economic form of natural low-tech and renewable feedstock, to a fossil-based economy with high-tech non-renewable feedstock is not sustainable. Bioeconomy as a solution that runs renewable feedstock using a high-tech approach is a technological innovation and disruption that we should strive for. With a sound planning and policy, backed by robust research, a transition to bio-economy can become a sustainable solution. However, transitioning to sustainable bioenergy occurs differently in each country.

A comparison of Kenya, Indonesia, and Sweden bioenergy transitions showed the differences of bioenergy transition in each country. Each case is as follows: Kenya – solid biomass is used for cooking in urban settings with sustainable charcoal technology; Indonesia – biogas collected in small-scale biodigesters is used for cooking and lighting in rural areas; Sweden – gasoline is substituted with biofuel nationwide within the public transportation sector. Indonesia requires a complex plan to introduce biogas into policy. Briefly, market, policy, and science need to merge.

This session presented issues at three different levels in bioenergy transitions. For example, at the niche level, bio-slurry is more valuable than biogas, and it has a market. Additionally, Kenya was used as an example of how an increasing population created a charcoal supply shortage, creating a larger demand for renewable energy. The presented solution in this



session is sustainable charcoal production and consumption, which is a circular system and chain that is completely sustainable. All the three cases show the importance of the agricultural sector in bioenergy. Biomass, biogas, and bioethanol all rely heavily on farmers and sustainable production. How to sustain this system and the need is a good policy question.

3.1.4. Value Creation Bio-slurry

Lina Moeis, Yayasan Rumah Energi (YRE)

Lina Moeis, the leader of YRE, gave a presentation about the issues of the biogas market in Indonesia. Nowadays, there are approximately 33,000 domestic biogas digesters installed across Indonesia. YRE has the ambition to develop this technology further, yet a market for the biogas is close to non-existent. Moreover, LPG is strongly subsidised, creating no value for small-scale biogas plants to be targeted. YRE is currently developing an initiative to produce and distribute bio-slurry in cooperation with small-scale farmers. The organic fertilizer was perceived as the potential way to monetize the biogas projects.

Lina Moeis also described the issues and project cases at Citarum River, a river polluted by cow dung, in which a biogas plant might be the solution. Moreover, the project contributed to adaptation purposes as water pollution was suppressed while improving water quality. Since water is an important element for crop irrigation purposes, it is fundamental to preserve it for agriculture opportunities and the local economy. Because this project has improved water quality, it has led to efficient crop planting management. On the other hand, issues to commercialise bio-slurry also exist, in which the actual price does not cover the costs. At the moment, economic support for biogas is lacking, such as less interest rates from the banks and limited funding. Although Credit Union has provided some supports, Lina stated that there was a need to focus on the incentives and technical support.

3.1.5. Small-scale Biogas Electric Generation

Prof. Tjokorda Tirta Nindya, Universitas Udayana

Biogas and electricity generation are considered as a problem solver for organic waste and greenhouse gas emissions (GHGs). According to Prof. Tjokorda, assessments are not enough, which is why actions exist. There are many biogas opportunities in Indonesia and the availability of the feedstock is huge, especially in Bali. According to him, so far, biogas is only used for cooking and as direct fertiliser in small biodigester facilities, which subsequently release GHG into the atmosphere. Udayana University has created a four-stroke engine that converts biogas into electricity. It has proposed the creation of a low-cost two-stroke biogas engine that can be marketed to electrify Bali. The engine can be powered by gasoline, LPG, and biogas. A small engine costs approximately \$500. Another problem-solving technique is to convert seaweed into biogas using seawater.

Furthermore, since there is no market for small-scale biogas digesters, Professor Tjokorda stated that there would be a big potential for large-scale biogas plants.



3.1.6. Closing Remarks

There is a need for scientific and economic benefit evidence for the Indonesian Government to ensure that the plan for biogas and electrification are significant. By having it incorporated into the policy, the government can allocate a higher budget in order to achieve the 2020-plan for biogas and electrification goals. Relationships between researchers and policymakers should be emphasised as well. The Indonesian case as a whole project and the workshops are considered as a promising starting point to improve this relationship and engagement from both sides. It permits a better understanding of each perspective and work. Also, it is important to increase the awareness of bioenergy in the country.

Regarding the support of bioenergy markets, there are concerns about the quality of the products and market availability. Biogas requires an involvement of many sectors and stakeholders to promote this technology. Thus, there is a need to take into account not only technical aspects but also socio-economic and environmental. Ensuring training and adequate operation after deployment is also considered as a key to success besides adding value to ensure market accessibility. Furthermore, community engagement is indeed crucial to building a strong foundation for a programme. Local private sectors and organisations need to explore local energy units while the Udayana University may allow them to implement bioenergy individually.

3.2. Adaptation and Synergy session

3.2.1. Climate Field School

I Wayan Andi Yuda – Representative of BMKG Climatology Station Jembrana, Bali

Climate-related knowledge of Indonesian farmers is limited, including of those in Bali. The CFS aims to make farmers better prepared for climate change in their agricultural practices by using climate information provided by BMKG. BMKG has had a previous experience in this activity since 2013, where they have trained rice-paddy farmers, maize farmers, and fishermen. CFS was put in place last year in Warnasari village as a pilot collaborative project focusing on coffee and cocoa.

The default CFS method developed by BMKG is as follows. First, there is a training for the trainers to increase the extension workers' awareness and to build comprehensive adapted training for farmers. Second, knowledge transfer to farmers during CFS sessions. A practical approach has been promoted, which includes field observations, climate and variability lessons, and an analytical phase for the decision-making process in crop handling. The delivered materials include monthly rainfall forecasts, monitoring days without rain, groundwater availability, and crop morphology.

As mentioned previously, during the site visit, an increase of 30% on climate change knowledge among coffee and cocoa farmers was achieved. This positive result is expected to contribute to better decision-making for handling coffee and cocoa in dealing with climate change.

The next step for BMKG is to target subak¹ meetings to implement the CFS as the plans for the local agriculture are made here. It is mainly aimed at sharing responsibility in the management of gardens and cropping patterns to improve the welfare of farmers. As farmers can experience

¹ a water management (irrigation) system in Bali, which was developed in the 9th century



uncertainty caused by their newly-acquired knowledge about climate change, they would be more confused when facing changes without it.

3.2.2. Using an integrated assessment model to assess the opportunities and challenges for developing bioenergy

Dr. Brad Stelfox, Alces Group

With the right data, Alces Online provides a spatiotemporal simulation model that can track the benefits, demand and supply of bio-energy options on regional landscapes. The model can also evaluate how dynamics can be affected by land use and climate change. Their software can track sustainable land use around the world and consider economic, social, environmental, and demographical aspects. While putting the energy sector into consideration, an integrated approach is adopted.

A set of scenarios was established to picture Bali's land and energy use (i.e. the simulations are preliminary and for demonstration purposes only). The key signals for the food sector are susceptibility of existing crops and livestock to climate change and the loss of croplands to tourism infrastructure. With regard to transportation, GHG emissions and health implications (particulates) have been highlighted due to a rapid increase in motorcycle, commercial truck, and car fleets. The infrastructures might be inefficient relative to current and future demand. Human population trajectories, settlement patterns, mean temperatures indicators, sea level rise, coastal inundation, tourism person-days (i.e. a tourism activity day and all what is involved in terms of consumption, transport) or potential for cattle dung for biogas could also be assessed thanks to this solution.

3.2.3. Synergizing: Poverty eradication and resilient Livelihoods – India, South Africa, Indonesia

Prof. Louis Lemkow, UAB and Dr. Takeshi Takama

Louis Lemkow presented two case-studies: one conducted in Uttar Pradesh, India, and another one in two different parts of South Africa. Afterwards, Takeshi Takama spoke about the Indonesian case, applied in the area of Bali. In India, the objectives were to implement small-scale solar panels for water access and irrigation purposes in poor communities. They operated with the help of the social enterprise Technology and Action for Rural Advancement (TARA). What they learnt is that success cannot be replicated without considering the case specificities (biophysical, social, cultural and economic aspects). For instance, the Government of India made it mandatory for profit-making corporations to provide funds for this kind of a project through their corporate social responsibility (CSR) programmes. Another lesson is that local communities are involved to make projects work, emphasising the necessity to train them for the maintenance.

In South Africa, the project involved local partners to foster the enabling conditions to promote local sustainable well-being (community alternative currencies, organic and green tourism farm, learning to target youth employability, and fighting water pollution). South Africa is specific through its high rate of unemployability. Also, its legacy of segregation and apartheid is still very visible when looking at the infrastructures. About the results, integrated and 'learning by doing' solutions are preferred while some issues of standardization and certifications of the products have been encountered. Also, some conditions were highlighted,



such as financial incentives, administrative conditions, access to technologies, market, cultural and biophysical conditions.

In Indonesia, the objective is to synergise the mitigation and adaptation. According to Takeshi's experience, when either adaptation or mitigation only is addressed, one may expect failure. Therefore, a comprehensive solution is required to tackle mitigation and adaptation of climate change. It is reported that 30% of Indonesians are farmers and are impacted by climate change because of rising temperature, decreasing precipitations, while 30% of Indonesians live off primary biomass energy such as firewood and suffer from indoor house pollution. The solution found was then to monetise products or activities that have values yet do not have a market through a synergy. By using biogas and bio-slurry in processing the coffee, chocolate, or even indigo, we add value to the product and synergise both climate responses. The product can then be sold at a higher price thanks to the green image associated. The profit from the sales will then be used as subsidies for the biogas.

Louis was then asked about the source of leadership when working with local communities in India and South Africa, and what the top-down and bottom-up of the approaches was. For South Africa, it was local. Municipal groups are organised into one local authority and were involved in some of the fundings. In India, the role of the NGOs is important, sometimes related to money management and choice of the projects. India has chosen that route to push their successful profit-making cooperation's to guide their social cooperate responsibility activities into these rural projects and many of them are controlled by NGOs. In Indonesia, the approach is commonly through the *subak* group system. However, the Indonesia case study used the championship approach and through the local cooperative system.

3.2.4. Introduction of Activities and Funding Opportunities

Masaki Sato, director of Singapore office, Japan Science and Technology Agency

Japan Science and Technology Agency (JST) supports scientists, technology and science infrastructure through co-funding activities. It also promotes science and technology diplomacy. The agency makes a strategy based on data and science, then proposes the strategy to the ministry. JST operates both at a national and international level. One programme by JST is SATREPS (Science and Technology Research Partnership for Sustainable Development Program), founded by JST and JICA. The purpose is to enhance cooperation in science, technology, knowledge and innovation. The main aims are to solve global issues such as infectious diseases, maintaining bio-resources, and developing new energy based on global and environmental issues, mainly in developing countries. JST also promotes research with development assistance, such as international corporations, and seeks to meet the local needs. Since their early programme in 2008, JST supported 225 projects in 47 countries. Almost half of the projects are running in Asian countries, mainly in south-east Asia with one programme running in Indonesia. Furthermore, JST has 20 projects under Sicorp Chirp, a joint research project platform. This platform aims to mitigate the termination and disappearance of the research once the project is completed. The platform serves as a way to solve this problem and other global issues by supporting the renewable energy, bio-sources, and mitigation of disaster events.

3.2.5. Closing Remarks

In order to add value and effectiveness, such adaptation projects need to be synergised with mitigation measures. However, different issues to make adaptation activities economically



sustainable were raised, and monetisation is one of them. For instance, the government funds the CFS for now but BMKG hopes that in the future, they will find partners and a way to sustain this activity. The cost of adaptation and mitigation is one of the barriers but the overall cost of inaction needs to be assessed and put into comparison because international corporations expect an overtime sustainability when financing this kind of activities while companies support profitable projects. Thus, researchers (e.g. ALCES, su-re.co), government representatives (e.g. BMKG, local agricultural agencies), donors (e.g. JST), and private companies must work together to increase the transparency and efficacy as some of the major requirements. This kind of collaboration will require every party to be part of the solution. Transparency could be an answer where there are no conflicting interests. Perception is important in terms of use while transparency can generate trust and it helps to work well. As elaborated during the synergy session, it is also important to find the key actors in order to reach the targets of the beneficiaries, to minimise unnecessary efforts, to align with the local goals, and to attain transparency. Such engagement would facilitate the creation of synergised actions of adaptation and mitigation.



4. Focus Group Discussions and Exercises

4.1. Biogas and electricity generation modelling using E3ME to analyse the impacts of policy in Indonesia

A roadmap of Sustainable Development Goals (SDGs) from 2018 to 2030 was divided into three phases: 2018 - 2019, 2020 – 2024, and from 2025 – 2029, where mid-term development plans are necessary to meet the SDGs. There are 5 sectors that are interacting to form the impacts of policies related to biogas and electricity generation: technology, energy, materials, emissions, and the economy, which are elaborated as model parameters in E3ME.

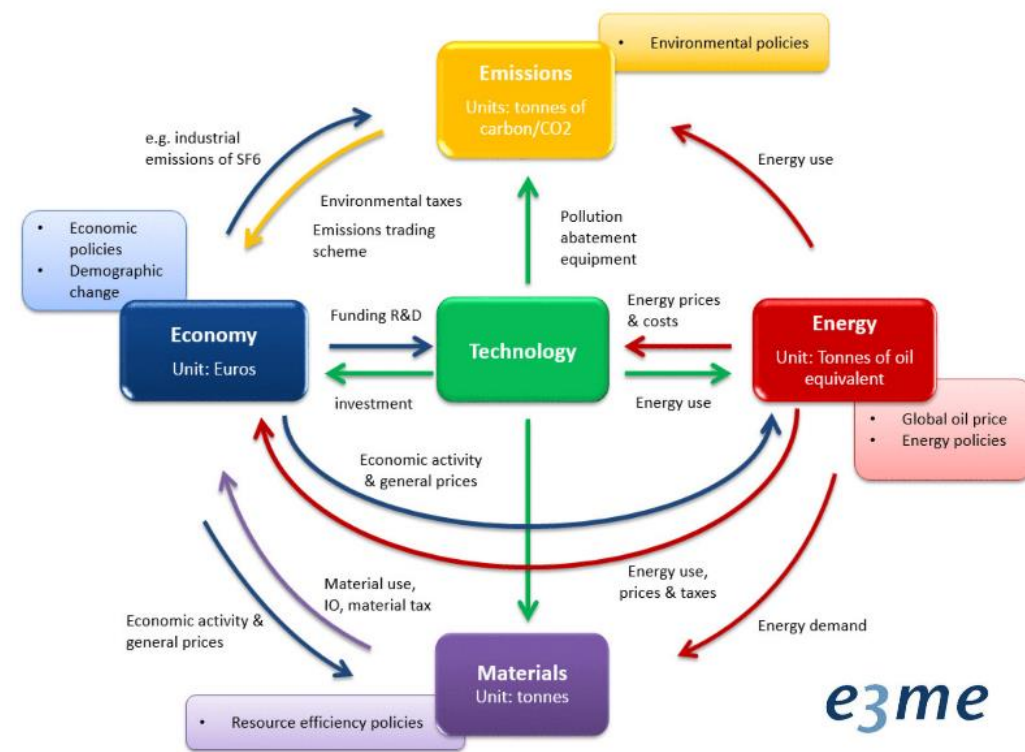


Figure 1: Model parameters in E3ME

The model is used to quantify policy/development impact (money for farmers and the government, jobs) and thus gain insight into risks and uncertainties (what happens if there is more cow farming, what happens if the government pays for half of the biodigester?; see Table 1). However, the preliminary results are not based on any stakeholder-consulted scenarios. Applying this model into the appropriate scenarios would help the policymakers acknowledge the potential impacts or plan any policy leverage for renewable energy targets.

Table 1. Preliminary results from the E3ME model for Indonesia in 2025

E3ME Model results for Indonesia (Example)	
GDP, m euro 2005m induced by additional electrification in 2025	+3%
Energy CO ₂ emissions in 2025 (increase from electrification w/o new renewable energy sources (+90TWh))	+10%
Employment induced by building a 1MW biogas plant	1,875
Small scale biodigesters installation (2009-2025), employment	1,500
Increase in CO ₂ emissions from LPG. (2009-2025)	~69mtCO ₂
Lives saved due to decrease in indoors pollution (2009-2025)	10% = 48,000

110 thousand digesters per year installed from 2017

The speakers then asked the participants to forecast small-scale biodigesters and electricity production using biogas for the year 2021, 2025, and 2030. The four questions asked were: *How many, overall? Which technology? Which use? Who are the actors?* Four groups of participants were settled on a mixed basis. Two groups were in charge of the small-scale biodigesters forecasts and the two others were in charge of the electricity production using biogas. The different scenarios would then be added by the two speakers to build up one scenario for the deployment of both.

Results and discussions:

Group 1: Small-scale biodigester A

Facilitator: Juan Sanchez (su-re.co)

Note taker: Coralie Kowalski (su-re.co)

Participants: I Wayan Andi Yuda (BMKG); Ni Wayan Tatik Inggriati (FAPET UNUD); I Made Susatra (Udayana University, researcher); Lina Moeis (YRE)

How many overall?

Based on the livestock data records in 2008, projections mentioned that there could potentially be 1 million domestic users of local small-scale bio-digesters in Indonesia. However, in 2018, the livestock database indicated that there were only about 23,000 domestic users in the country but an additional 30% of users should be taken into account due to the lack of data records. This amounts to approximately 30, 000 domestic users throughout Indonesia.

From the recorded data and charts, it is estimated that by 2025, approximately 1% of the Indonesian energy mix should come from domestic biogas, which translates into roughly 165, 000 domestic users. Nevertheless, there will still be a major gap between the predictions and real numbers. Therefore, the number of estimated domestic users in 2025 would be worth 65, 000 and only 62% of the target shall be met. This approximation is based on the existing data and statistics using a realistic implementation of 4000 biogas installations a year.



This gap between the projections and data is due to the fact that farmers cannot afford to pay for the credit required to acquire a bio-digester. In order to hit the target of 4000 installations a year, specific credit funds need to be created, obtained, and/or increased.

Which technology?

Improvements on the design of bio-digesters are also necessary to spread and democratize small-scale biogas use. Presently, the most popular bio-digesters have a 6m³ volume. In order to feed these bio-digesters, the farmers need to own at least 4 or 5 cows, yet most Indonesian farmers do not have that many. Consequently, a huge portion of Indonesians is excluded from the prospects of such projects simply because they do not own enough cows and cannot afford the technology. Thus, **it should be aimed to reduce the size of bio-digesters to 2m³** in order to include a bigger portion of Indonesian farmers to the potential users.

Which use?

The bio-digesters discussed were **small-scale, domestic and targeted the farmers**. In terms of resource, cow manure and human, food, and agricultural waste have been considered as they are *halal*², which is one of the main considerations in Indonesia.

Who are the actors?

In order to increase the number of domestic users, the value of bio-slurry has to be increased. It is thus necessary to create a market for biogas (due to increasing prices of fossil fuels) and bio-slurry. Finally, the **government** would have to promote biogas use. Some policies can be adopted in order to facilitate biogas production. For example, stricter rules on cow manure management could be implemented to forbid the dumping of cow manure in rivers; creating a demand for bio-digesters as they can be used to eliminate the cow manure. Similar policies should be implemented regarding human, food, and agricultural waste.

Economic measures should be put into place to enable the affordability of domestic use of biogas. For example, compensation for the reduction of carbon emissions or allowing the farmers to pay their biodigester back with the milk produced by their cows.

Promoting biogas production through small-scale **CFS**. These events could be used to endorse the use of 2m³ biodigester as well as to connect the farmers with those facilitating the use of biogas by helping both sides to find mutual benefits.

In conclusion, if all these changes are made, the diffusion of biogas would grow exponentially, possibly allowing the target of **165,000 users to be met by the year 2030**.

Group 2: Small-scale biodigester B

Facilitator: Sabrina Hopf (su-re.co)
 Notetaker: Lisa Thorning (su-re.co)
 Translator: Yudiandra (su-re.co)
 Participants: Francis Johnson (SEI), I Made Buda (Distpn bun, province government), Renato (Akuo Energy), Theresia Aruan (KPSRB Bappenas, national

² an Islamic Arabic term meaning "permissible"



government), I Gusti Ayu Made Kim Iswari P. (KPSRB Bappenas, national government), Brad Stelfox (Alces Group)

How many overall?

31 million farmers – 775.000 biogas digesters, based on the number of farmers, being roughly 30 % of the population and divide with 20, while most farmers share the biogas digester by 20 persons, by 2030.

Which technology?

In general, the participants considered that improvements still need to be done and tried to consider what could suit Indonesia the best. The participants then considered whether it should be **a removable or a fixed-dome biodigester**. Regarding the fix-dome option, it could indeed last longer, but it would also need more maintenance and it could be fragile in case of an earthquake, for instance. Regarding the removable options, the material needs to be taken into consideration as PVC is rare in Indonesia. Also, the government is worried that the farmers would sell it, but this issue can be solved if they are financially involved. In terms of economic flexibility, as long as it is easier to install and its mobility function works, these components could be convincing.

Considering the **resources used**, participants insisted that it should be **mixed ones** as Indonesia and especially farm activities produce a lot of different kinds of waste. **Cow waste** would be the first one as it is the more predominant living stock in Indonesia. Secondly, it would be **vegetal organic waste** with pig waste being a small part of it as pig rearing is limited in the country. **Two or three cows** were the number estimated per digester. The problem highlighted by the participants was that the **waste has to be sorted**. Some kinds of waste are not suitable for biogas usage and this could be considered as a challenge in its adoption. The waste also needs to be ground and mixed with water.

Which use?

The participants then agreed that for now, the **bio-slurry used as an organic fertilizer** is the more common use of the digester, yet it could provide a broader use if it could also produce electricity. On a small scale, the biogas could be used for **lighting and cooking** and especially for **drying meat** processes. The bigger scale system for the biodigester was considered as more promising in terms of the number of usages allowed by such technology.

Who are the actors?

There is a possibility for **subsidies**, but they would stop when the usage of the digester makes the system economically self-sufficient.

Group 3: Large-scale biodigester (1)

Facilitator: Maja Harren (su-re.co)

Notetaker: Thijs van der Meeren (su-re.co)



Participants: Alfi Kurnianingsih (Ministry of Energy, national government), Rizka Devriyani (KESDM, national government), Masaki Sato (Japan Science and Technology Agency), Antoine Mandel (University Paris 1 Panthéon Sorbonne), Pak Cakra (farmer),

Overall, the participants considered settled their definition of what is a small- and a large-scale biodigester. A biodigester is considered to be small if its volume is up to 4m³ and large-scale if its volume ranges between 8 and 20m³ (details in the discussion below). In that sense, they were out of the subject considering the objective of the electrification allowed by biogas plants that are commonly considered as large-scale. The following report from the discussion still considers the information given regarding the small-scale bio-digester that was, in the end, the main subject discussed.

How many overall?

The participants assumed that there are currently no large-scale bio-digesters that create electricity in Indonesia. They did not find it realistic that there will be many built by 2025. Also, it has been pointed out that often, the number of realised bio-digesters is dependent on a countries' dependency on oil.

Which technology?

The participants started to make the assumption that **not every technology can work everywhere**. Two different technologies of bio-digesters were evoked: **one version is stationary and underground while the other one is the portable balloon version**. The optimal version depends on the surroundings and the people living there. The suggestion was made to consider an island and label it "average Indonesia". The 'Sumba Iconic Island', which is representative of renewable technologies in Indonesia and part of a programme for new and renewable energy, was considered for its role.

The participants then admitted that large-scale may mean different things in different parts of the world and that it is important to discuss volumes. They agreed that in terms of resources, the small-scale bio-digesters are for people that have a minimum of 2 or 3 cows and can contain 4m³ of resources and that the large-scale biodigesters are 8-20 m³ in volume. The information was given that in Europe, there are large biogas plants that produce electricity and that a whole **transportation network** is in a place where they pick up the input from farms and bring it to the factory with trucks. The capability of the storage was also brought into the debate, there is a need for a **storage technology**.

Right now, there are a lot of requirements to make biogas. The cattle must eat a certain food, for example. It is complicated to make a good biogas—at least from cow dung. This scares off farmers who would potentially have used a biodigester because it is a hassle for them to get all the variables just right. Even if a farmer owns a biodigester, he/she may not use it for this reason. On a broader scale, municipal waste and green waste are also possible future resources for biogas production through gasification, but the price of organic waste might rise once the farmers realise the potential.

Another resource for the biodigester was considered as there seems to be a need to explore other materials to feed biodigesters. There have been experiments in Thailand for using palm oil waste in biodigesters but it would be difficult to force all palm oil plantations to use their waste products. Also, the technology can be a barrier. This type of technology requires the use of a catalyst. Also, a biodigester on a palm oil plantation needs approximately 30 tons of palm oil mill effluent (POME) each day. Some palm oil companies



are creating large-scale biodigesters and most of the biogas created is the company's property, and they use it to power their operations. Some question remained regarding this technology: what are the catalysts? Is it sustainable? How expensive is it?

Which use? On the iconic island, there are 8-20m³ biodigesters. The biogas is used **exclusively for cooking**; they are rarely used for the production of electricity.

A farmer from another area, Jembrana, Bali, gave his experience as an example. For him, there are a lot of requirements for cows to produce good quality manure for biogas production. The location of the biodigester is dependent on whether or not they can use the slurry. The best-case scenario would then be to use the slurry and gas locally. **He would also like to use biogas to power machines on his farm, either directly or by converting it to electricity**, and for example, help him crush the cocoa or coffee beans. Right now, he mainly uses it to cook rice but the amount of biogas he can produce is small and does not supply him with many opportunities. The **quantity produced** could then be one of the requirements for large-scale biodigesters.

Who are the actors? The **central government** is not really involved in the Iconic island. **Local governments** are responsible for renewable technologies. The programme started in 2013. The government is collaborating with an **NGO** called Hivos, resulting in many installed biodigesters. The programme was then transferred to the Ministry of Finance. The **Ministry of Energy** would like to see the people in East Nusa Tenggara being more independent.

In Thailand, as evocated regarding the palm oil, there is a lot of pressure on the government to promote bioenergy. The Ministry of Energy in Indonesia prefers not to subsidize biogas. As organic wastes are abundant, it should be affordable to utilize. Already, there are many regulations and the ministry is not willing to give more subsidies to oil companies.

Regarding the large-scale biodigesters in Europe, the way these plants make money is by selling electricity to the **energy companies**. Delivering electricity to the grid is hard when produced on a small scale. Farmers need an incentive (financial gain) in order to use biogas. Subsidies to oil companies would lower the price of LPG, which would not help promote biogas.

Group 4: Large-scale biodigester (2)

Facilitator: Nacho Candela (su-re.co)

Notetaker: Paul van Dijk (su-re.co)

Participants: Kobayashi Yoshihide (Japan Science and Technology Agency), Ainu IWafa (DGE-Industry), Ena Mahrita Sembiring (PLN-Industry), Jayanti Maharani (ETI-Bappenas, national government), Oliver Jonhson (SEI)



How many overall?

On one hand, some participants mentioned that the country should be ambitious regarding the future of biogas in Indonesia. Indeed, it seems that there are many biogas locations and opportunities in the country. On the other hand, some participants are still sceptical regarding the potential of electricity production and value-making out of the biogas in order to attain the Indonesian renewable energy goals.

The new goal to be attained by 2025 is that 23% of the energy comes from renewable sources. The bioenergy target is set (10% of the 23%), but this target is not split up in biomass/biogas/waste. The large-scale biogas production is only 0.3% of all renewable energy sources. To produce 400MW out of the biogas, the biomass and waste sector was considered as an ambitious target for 2025. Actually, there are no specific goals when it comes directly to large-scale biodigesting. In general, the increase of renewable energy is considered as a whole and does not specify which kind of energy should be promoted. People do not mind what kind of renewable energy it is as long as it is green energy. If there was a focus on specific renewable energy sources, it would be easier to set up goals and to create a plan on how to achieve them.

Which technology?

Large-scale bio-digesting has to be a continuous plan, which is what the government wants to see and hear. The government is not concerned about the continuous of supplies. Indonesia can use **plantations and their waste for self-consumption** to create biogas.

Which use?

The **energy generation** was mostly considered as the group was talking about large-scale biodigesters. However, when selling the biogas produced, people sell it at a higher price than the government recommends. A remark from the participants also pointed out that some people want to make and use biogas, but they have no idea about it.

Who are the actors?

The **government** could support the sector by making a **regulation on subsidies** so that **farmers** and **companies** can get biodigesters. However, the budget for renewable projects is low in Indonesia, resulting in low subsidies on biogas, which is not enough to cover the investment that people have to make. At the moment, the government does not seem to realise the standard of the cost.

Private partnership could be the solution for the problems around the financial part of the renewable energy, but the banks are not interested in financing the projects around climate change, as they are not financially attractive. Besides, there is a gap between capital cost and developers' cost. One way to close the gap between capital cost and developers' cost is to have auctions to let them compete so that the prices of renewable energy can go down.

4.2. Green Business by synergizing adaptation & mitigation of climate change

Some actions and products are proven to have a positive social and environmental benefits but have limited-to-no impact because the market is lacking. For example, clean renewable



energy in rural areas of Bali has a limited impact because LPG is a much more affordable alternative for farmers since it is subsidised by the government. To solve this issue, su-re.co aims to monetize these renewable actions and products by synergising it with products that already have a market. By doing so, su-re.co synergises adaptation and mitigation measures, creating value-aggregated products; in this particular case, biogas and bioslurry. In essence, by creating incentives for biogas use, farmers will be interested in installing biogas digesters in their farms and benefit from the use of bioslurry, biogas, and an increase in their income through the sale of value-aggregated products. Incentives come in the form of a green business.

Seven incentive opportunity activities or in other words, value-aggregated products related to su-re.co Company were introduced. During the presentation, a distinction was made between household and large-scale biogas system. Figure 2 below shows the connectivity and interaction between the different activities. It all started with the biogas as a clean energy. The su-re.coffee, su-re.coco, natural dyeing and puffer snacks are all benefits of their biogas usage, which increase their value. The CFS interact with those four last products on the larger scale as a lesson about climate change is dispensed to the farmers and workers related to these activities. In a whole, the eco-tourism project intends to raise awareness and bring the knowledge acquired about climate change, clean energy, sustainable agricultural practices, and green business activities to a broader audience. Then, the participants were asked to build business canvas models around five of them: su-re.coco, natural dyeing, puffed snack, household and large-scale biogas, and ecotourism.

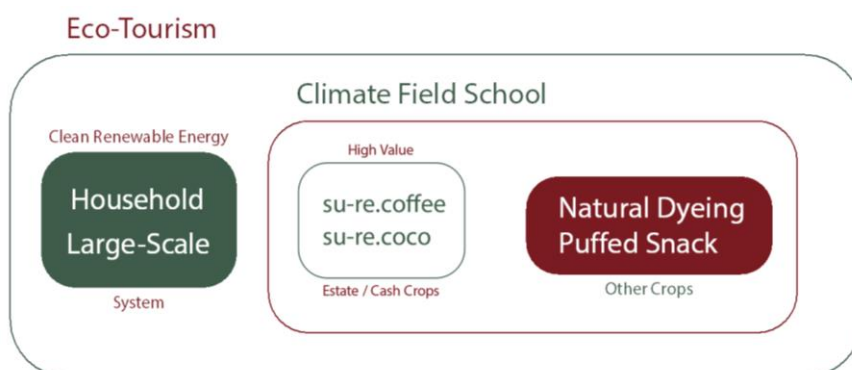


Figure 2. Summary of the synergy of su-re.co activities

Group 1: su-re.coco

Facilitator: Charlotte Reboul (su-re.co)

Participants: I Wayan Diana (KSS Kakao, farmer); Francis X. Johnson (SEI); Susanne Hanger-Kopp (ETHZ); Prof. Takahiro Osawa (Udayana University); Dewa Weda (Rumah Energi), Dharma; Louis Lemkow (UAB); Aaron Mashano (Udayana University)

As the su-re.coco project is already on-going, some decisions have already been implemented beforehand. The su-re.coco business focuses on using broken coffee beans, which would otherwise be thrown away, to create some coffee-tasted chocolate products. It provides farmers with extra income as they are able to sell their broken beans. During the workshop, the discussion focused on finding ways on which the coffee business could further improve, yet due to much participation of participants, the business model canvas shifted to a



conversation of how to build a business. In particular, most of the participants were extremely engaged in the discussion of value proposition and customer segment. Their value propositions identified a rush of emotions while eating chocolate, women as a target market, and the customer segment to be business to business. Consequently, some categories such as key resources and cost structure were not discussed whatsoever.

Key Partners	Alive Whole Food Store
Suppliers	Cau Chocolate Factory, Farmer Pak Chakra
Existing Partners (from su-re.coffee)	Alive Store, DTE Joglo, Green Habits,
Potential Partners	Environmental friendly hotel (e.g. Serenity Eco Guesthouse), yoga clubs, green and healthy restaurant, organic wholefood stores
Key Activities	Supplying chocolate
Short term	Find a reliable supply source in order to be able to sustain an expansion campaign
Long-term	
Key Resources	Not completed
Values Propositions	Feelings: SADNESS, HUNGER, ENVY => After eating our chocolate : HAPPINESS, FULLNESS, SATISFACTION Other ideas to add value to our activity: use certification of the CAU Chocolate Factory
Customer Segment	Expat and tourist women from 20 to 50 years old Business to Business (B2B) / OFFLINE / STORYTELLING / TRIBE
Cost Structure	Not completed
Revenue Stream	A different way to retail A different way to communicate about the product

Group 2: Household and large-scale biogas

Notetaker: Sabrina Hopf (su-re.co)

Overall, most of the participants tried to look up information on their laptops instead of participating in the discussion, which is why the business model canvas was not properly completed. Out of all the products discussed biogas was the one that received the less input.

Key Partners	MEMR, Agriculture, Bappenas
Suppliers	Not completed
Existing Partners (from su-re.coffee)	Not completed
Potential Partners	Not completed
Key Activities	Biogas for cooking/ heating, Reduce greenhouse gas emissions, Electricity generation
Short term	Not completed



Long-term	Not completed
Key Resources	Agricultural waste, Municipal waste, Palm oil, Animal manure/human manure, Pipeline connector to distribute the gas.
Values Propositions	Reduce greenhouse gas emissions To increase electrification value
Customer Segment	Target market, Household: i.e. Farmers (business to customer), Industries (business to business)
Cost Structure	Commissioning test SLO Standard of operating feasibility, Labour wage, Production cost
Revenue Stream	Selling to costumer -> sell electricity Biogas selling (how to transport) Subsidy for clean energy installation from government (Viability gap fund) from the ministry of finance
Channels	On-grid system, PLN, Potential private-power utility, PGN (National gas company)

Group 3: Natural Dyeing

Note-taker: Maja Harren (su-re.co)

The participants discussed the importance of the sale of indigo t-shirts. In particular, they agreed that the sales should focus on the aggregated value of the t-shirts; in other words, make it clear that organic dye is used and that the t-shirts are eco-friendly. In terms of the target market, they agreed that Indonesian people are willing to pay more for the better-quality shirts. New collars have to be added to the t-shirts. The brown and blue are just the standard right now, but new colours should be included and currently, they are working on pink. The name of the brand was also discussed as the participants agreed that in the apparel business, it would be very important as well. The name should somehow let the customer know what he is buying. The participants talked about the production of original t-shirts, agreeing that this must be known. Packaging has to be eco-friendly as well. The shirts could be sold on the website and there could also be a possibility for people to choose a certain design or collar they like.

Key Partners	Farmers, Textile Producer, Dyers, Designer, Distributors, suppliers
Suppliers	Not defined yet
Key Activities	Growing Indigo, making textiles, design the product, dying process, marketing, selling, distributing, customer service
Short term	Supply
Long-term	Not completed
Key resources	The indigo (dying mixture), Textile, Distribution channel, Packaging
Value propositions	The storytelling, Bioenergy, Sustainable supply choice, Packaging,
Key channels	Shops, Online (Website, Facebook, Twitter, Instagram, etc.), Local markets
Customer Segment	Pricing a higher end (?) Wealthier locals, Expats, Environmentally conscious people



Cost structure	That a part of the profits go to charity (minimum of 2.5%) Use Coffee structure for the packages, Use local textile weavers (Lombok) licenses for dying, MBT, labour, Wages + equipment, rent
Revenue Stream	Sales
Sustainable Supply chain	The fabric used, a tag with Indonesian technique/info about the shirt / the history and background behind it. The Indonesian market may be difficult to enter, but they are willing to pay more money for better quality. Indonesians will see the difference between chemical made and handmade t-shirts.

Group 4: Puffed Snack

Facilitator:	Nacho Candela (su-re.co)
Note taker:	Thijs van der Meeren (su-re.co)
Participants:	Pak Chakra (farmer), Laksmi (su-re.co), Antoine Mandel (Paris 1 Panthéon Sorbonne), Rizka (Ministry of Energy), Bunga (Ministry of Energy)

The discussion focused on analysing different ways of commercialising the puffer snacks. One of the key topics of discussion was the price the snacks would have since local rice snacks are extremely cheap. Although the puffer snacks are healthier and more sustainable, the price of the local alternatives will make it difficult to compete. Furthermore, there is no concrete way to use biogas in the process of making the puffer snacks, which limits its overall aggregated value and differentiation from local alternatives. Also, granola was discussed as a potential second-option product that could be made from the puffer machine.

Key Partners	Farmers, the ministry of finance, distributors, women in the fields
Suppliers	Not completed
Key Activities	Snack, Granola, Puffer machine
Value Propositions	Biogas, Organic Product, Bio slurry, Healthy Snack
Key resources	Crops (rice, soya beans, bananas) or a combination of all of them for added value. Ingredients (banana, insect) i.e. Dry bananas might not require a lot of labour, they can dry at the open then it would be an improvement and help to be cost-effective. Labour (women in the farms)
Key channels	Not completed
Customer Segment	Local --> farmer's community "Canggu area" + Jakarta --> "rich costumers" --> We need to consider the product according to it and provide a good package/storage for the farmers to store them and the package needs to be attractive (for instance a box of 10 snacks with 10 different flavours) as we need to settle on a segment where people are willing to pay for a nice product, built a brand that people would be able to recognize.
Cost Structure	Not completed
Revenue Stream	Not completed



Supply Chain	Crop and puffing activity in farmers' place (we need the biogas). Provide transportation in the right package as it might be a barrier to the farmers, they would need training on how to package it.
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Group 5: Eco-Tourism

Facilitator:	Lisa (su-re.co)
Note taker:	Alexis (su-re.co)
Participants:	I Wayan Andi Yuda (BMKG), Marjory (external), Lina Moeis (YRE), Ni Wayan Tatik Inggriati (FAPET UNUD)

The tourism discussion group focused on finding a solution for the management of a tourism business when su-re.co is not a tourism company. The idea of a partnership with a tourism company came up, yet this also brought up the current lack of information present in the products that su-re.co presents such as su-re.coffee and su-re.coco. The discussion group agreed that if an external tourism agency will manage the tourism business, clear information on su-re.coffee and su-re.coco is needed. In other words, the supply chain needs to be extremely transparent so the tourism agencies can market them accordingly.

Key Partners	Farmers, Tourism, companies, Cau Chocolates Factory
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Suppliers	Not completed
Key Activities	Coffee/cacao factory visits eco-agriculture visits Bioenergy production site Management of homestays, transportation etc.
Value Propositions	Discovering of eco-solutions, organic farming Coffee/cacao/indigo making, Biogas discovering the Balinese culture
Key resources	Farmer (coffee, cacao) organizations, management Planning Staff (guides, translators, transport, etc.)
Key channels	Social media, Flyers, Presentations, Schools
Customer Segment	Student (short-term internships), school children, Business people
Cost Structure	Not completed
Revenue Stream	Payment from the tours; students, schools etc. Hotels, agencies Selling su-re.co products
Supply Chain	Not completed



4.3. Q-Methodology and TNA exercises: perception and next actions toward biogas development (for farmers and practitioners)

This exercise is a follow-up activity of the Q-methodology and Technology Needs Assessment (TNA), which was conducted during the second Bioenergy Workshop in 2017. During the second bioenergy workshop, three perspectives (i.e. factors) towards biogas development were successfully identified by a stakeholder consultation (18 local participants). On the other hand, TNA successfully identified as the next actions that are considered urgent to be done by three different groups of stakeholders: policymakers, researchers, as well as engineers and farmers. On the third workshop, another session of Q-methodology was done to validate the three perspectives to the participants. To bring the perspectives to a life and allow the participants to make a connection to the information, a storytelling method was used in this exercise (**Error! Reference source not found.3**). Meanwhile, the TNA session aimed to identify the prioritization of the actions and which stakeholders are responsible. Three perspectives of Q-methodology resulted from the second bioenergy workshop is illustrated below.

Table 2. Three perspectives towards biogas development in Bali using Q-methodology

<i>Description</i>	
<i>Factor 1</i>	This factor is described as an NGO officer who has been interested in the biogas development for a long time. This factor perceives that the farmers' enthusiasm towards the technology is high. One of the main difficulties is the lack of the maintenance guarantee, which demotivates the farmers to repair the installation if a disruption occurs. However, this factor believed that technical drawbacks can be overcome. To enhance biogas development, government involvement and capacity-building for farmers are critical. Overall, Factor 1 sees a positive and optimistic attitude towards small-scale biogas.
<i>Factor 2</i>	This factor is described as a provincial government official who emphasises the importance of the livestock sector in supporting biogas development as well as promoting environmental protection to contribute to economic development. To achieve this, the government should work closely together with the support of international agencies and raise awareness of biogas. In the future, the role of government should not only be in quality assurance but should also be in supplying biogas technology. However, the development still bears one big challenge: the readiness of the business sector. Moreover, the government is a far more important actor than banks or the other parts of the business community. In regards to the scale, this factor supports the installation of communal and large-scale biogas where larger facilities will give more benefits. On the other hand, this factor disagrees that the guarantee and monitoring period for government-supplied biodigesters is too short, and the contracted installers do a poor job.
<i>Factor 3</i>	Factor 3 is illustrated as a perspective from the farmers. In the beginning, communal biogas was seen as a burden instead of a benefit and they decided to decline the communal biogas installation. After that, there was another opportunity to install individual digesters at their farms and they started to experience the benefits of biogas. Biogas provides organic fertilizer and clean gas which support their daily activities (i.e. farming and cooking). Hence, they concluded that an individual digester is easier to manage than communal installation that they experienced previously. In the process, they learnt that biogas business is adequately developed, for instance, the spare parts of the technology are accessible. This group of farmers disagreed that the cost reduction will motivate the farmers to utilise the technology because the motivation is highly dependent on the farmers themselves. Ultimately, biogas gives more independence as this factor is not highly reliant on LPG and chemical fertilizers.





Figure 3. Storytelling to deliver three factors of Q-methodology

The activity was attended by 9 participants with various backgrounds who have been involving in biogas development in Bali, such as NGOs, farmers, and the private sector. The list of participants and the selection of factor that they relate to are tabulated in 3. It can be seen that Factor 3 is dominant among the participants. However, there are two participants who could not relate to the stories probably because their main scope of works is not relevant to biogas development. Serenity emphasised the consideration of market barrier as one of the barriers to biogas development and necessity for standardisation of technology, which are not covered in all factors.

Table 3. List of participants in the follow-up discussion of Q-methodology

Participant No.	Role/Institution	Type of Institution	Selection of Factor
1.	Yayasan Rumah Energi (YRE)	Foundation	3
2.	Koperasi Kerta Semaya Samania	Cooperative	1
3.	Coffee Farmer	Farmer	1
4.	Serenity	Private sector	None
5.	Coffee Farmer	Farmer	3
6.	Koperasi Kerta Semaya Samania	Cooperative	2
7.	Cacao Farmer	Farmer	3
8.	Koperasi Kerta Semaya Samania	Cooperative	3
9.	Serenity	Private sector	None

Furthermore, following up the next actions identified in the TNA exercise during the second bioenergy workshop, the participants were asked to rank the next actions to support biogas development in Indonesia, particularly in Bali Province. Table 4 **Error! Reference source not found.** shows some responses from the participants mentioned in Table 3 concerning the sequence of the next actions to support biogas development, which showed quite different views on what the most urgent actions were, and on who should take the main roles. For instance, some participants emphasised more the communities and local leaders (Participant 1) whereas others thought that technical experts and university academics should be central to the urgent actions (Participant 2).

Table 4. The ranking of actions to support biogas development in Indonesia

Measure or action to address barrier/issue	Who should do it?	How should they do it?	Ranking of Next Actions by Participants		
			Participants No. 1	Participants No. 2	Participants No. 7
Set-up a facilitating O&M training/support program	Development of such a programme could be led by knowledge institutes, in close cooperation with farmer cooperation's, technology suppliers, and government.	Start by making an inventory of existing (more ad-hoc) training and support programmes and structures and see if there are good practices that can be replicated or revised to improve quality and reach.	5	4	2
Set-up an R&D and innovation programme for biogas / bio-slurry (could be part of a broader strategy to improve agri-sector)	Universities, research institutes in close collaboration with local/national government and other (foreign) research institutes, technology suppliers,	Develop an R&D agenda, ask a broad group of stakeholders to prioritise specific components of that agenda and make a priority selection. Revise the agenda periodically (e.g. once every three years).	6	1	5
Set up technology practice dissemination, information and data exchange programme(platform/networking)	Local networks and communities, perhaps supported with resources via NGO's / regional government?	It is preferred to embed this initiative within the already existing (informal) social network structures like the Pajar, Subak, and village level. Existing social networks/communities should be involved to ask if they also want such a program.	1	5	7
Develop a Bali promotional programme– linking tourism with sustainable/organic agriculture and renewable energy	Agricultural cooperatives, together with tourism organisations, local government.	Develop marketing/communication plan for the coming period (e.g. 5 years). Develop it based upon the assessment of 'promotional needs' of various stakeholders. Preferably embed it within existing communication and dissemination channels.	7	10	10
Develop and implement robust (performance) standards and	National Standardization Organizations (e.g. BSN) could lead such programs, supported	Closely look into what other countries are doing on this aspect and develop standards or certification schemes	10	2	4



Measure or action to address barrier/ issue	Who should do it?	How should they do it?	Ranking of Next Actions by Participants		
			Participants No. 1	Participants No. 2	Participants No. 7
certification procedures	by technical experts from universities, companies, tech. suppliers.	that (could) link to existing (inter)national ones.			
Re-focus development plans on biogas + include assessment provisions in plans + include many levels (from national to provincial)	Academia BAPPENDA Regulators Operational Units	Participants opined that it was already working well and they could not envision any improvements	9	3	1
Foster "Champion Programmes"	Private – Public Partnerships; bring many stakeholders together	Eco-Tourism a promising champion; also, implicating a lot of stakeholders exercises more pressure: it's better if academia, AND NGOs, AND farmers AND hotels demand biogas	8	9	6
Multi-Stakeholder Partnership	Involved stakeholders (government, NGOs, businesses)	Regular meetings, implementation of a task force	4	8	3
Farmer to farmer knowledge sharing	Farmers, as individuals that are willing and interested to learn from each other	The main venue to share is in farmers meetings like the Subak Sangkep. The information about biogas installations and how they work could be shared at the meetings first. Then, if non-adopters are interested, visits to the adopters' households could be arranged.	3	6	8
Collaboration between the head of the village, the subak and the Banjar	Head of village/ subak/ Banjar	Before the leaders planned individually. At present, they would like to collaborate more closely, where the village head can inform the heads of the subak and the Banjar, and in	2	7	9

Measure or action to address barrier/issue	Who should do it?	How should they do it?	Ranking of Next Actions by Participants		
			Participants No. 1	Participants No. 2	Participants No. 7
		turn, these leaders can inform the farmers.			

4.4. Exercise on biogas diffusion model: Potential of local currency to foster biogas diffusion

This presentation explained the model of biogas technology diffusion implemented in Bali and developed by GREENWIN. The model analyses socio-cultural data to understand the influence that the different districts of Bali have over the adoption/diffusion of technology as well as to comprehend the influence that each district has on each other. This model will later be used to facilitate an efficient diffusion of the production and use of biogas.

The GREENWIN project also includes research about climate finances, which are aimed at finding solutions to finance low-carbon projects all over the world. While addressing the case of biogas in Bali, the main concerns that emerged in relation to the sustainable implementation of biogas in Indonesia have to do with the financing and maintenance of biodigesters. In order to alleviate these issues, the GREENWIN team came up with the idea of creating a local currency connected with biogas utilisation, namely the “biocoin”. This “biocoin” would be created and utilised in Bali and Indonesia to provide an easy access to finance for farmers fostering biogas diffusion. The farmers would use “biocoins” as a means of payment for the biogas digesters. It would be used as debt for the farmers that they would be able to pay back with agricultural products or certified emission reductions.

Different issues relating to the feasibility of this project could arise and were discussed with the participants of the workshop during the presentation. Indeed, Prof. Mandel wondered if this solution was too optimistic and if it could be implemented and used in a region such as Bali or Indonesia. Also, how should taxation issues be addressed? Could subsidies from the government be included in this model?



5. Concluding Remarks

The 3rd bioenergy workshop demonstrated that there are vast opportunities to increase the number of biodigesters in Indonesia. Firstly, biogas requires an involvement of many sectors and stakeholders. To create a coordinated, sustainable and transparent biogas system, policymakers, researchers and biogas users have to be connected. This relationship proves how biogas supports the farmers' livelihood, promotes bio-energy renewable development and contributes to the Mid-term Development Plan. Also, biodigester represents an adaptation activity that is economically sustainable and relevant to CSA. Moreover, biogas digester proposes a large scale of use, offering different perspectives for the users (e.g. cooking, lightning, farm activities, slurry fertiliser, etc.)

During the workshop, different discussions highlighted the two main barriers that curb the biogas evolution, namely the cost and the source of funding. From the farmers' perspective, it is relatively expensive and difficult to install biogas digesters. In view of the low government investment and the lack of financial attraction for private partners, funding in the biogas sector is still minor. With the argument reached during the workshop, the objectives are then to convince of the legitimacy of the biodigester from su-re.co and to find new financing sources.

Furthermore, a part of the workshop was focused on potential solutions presentation, namely to create incentives for farmers to use biodigesters consistently. For example, to return to the funding problem, one of the approaches discussed was to monetise the biodigester bag by commercialising value-aggregated products. Overall, the main topic of conversation in the workshop was to present the barriers that limit the growth of biodigester use in Indonesia. Building business around farmer aggregated value products was the common solution to overcome the existing barriers and encourage the widespread use of biodigester bags.



ANNEX

PROGRAMME DETAILS

TWO DAYS TRIP – FIELD VISIT

Day 1 - Sunday, 8 APR 2018

TIME	ACTIVITY
14.00	Trip to Cau Chocolates Factory
15.00	Cau Chocolates Factory visit Kabupaten Tabanan
16.30	Trip to Pengeragoan beach
18.00	Dinner in Pengeragoan beach
19.30	Continued trip to Jembrana
20.30	Check-in to Jimbarwana Hotel
21.00	Free time

Day 2 - Monday, 9 APR 2018

TIME	ACTIVITY
08.00	Breakfast and check-out
09.00	Trip to Modengsari Village
09.30	Visit Pak Cakra's coffee farm and biogas installation <i>Warnasari village, Melaya district, Jembrana regency</i>
11.30	Climate Field School visit
12.30	Traditional Balinese lunch
13.30	Visit to Pak Ketut's cocoa farm and removable biogas installation <i>Modengsari village, Melaya district, Jembrana regency</i>
15.30	Trip back to Canggu
18.00	Check-in Grand Balisani Suite
18.30	Free time

Day 3 - Tuesday, 10 APR 2018 @University of Udayana Denpasar

TIME	ACTIVITY
08.30-09.30	Registration
09.30-09:35	Welcome Speech and Opening Prof. Dr. A. A. Raka Sudewi - Rector of Udayana University
09.35-09.45	Recalling 1st and 2nd bioenergy workshop Cynthia Juwita Ismail, su-re.co
	Policy Session
09.45-10.00	Policy related to bioenergy and electricity

	Ms. Syamsidar Thamrin – Senior Planner for Energy and Climate Change - Ministry of Planning and Development (Bappenas)
10.00-10.15	Importance of Policy Dialogue: Connecting Policymakers & Researchers Dr. Oliver Johnson, SEI
10.15-10.45	Photo Session & Coffee Break (Networking)
	Mitigation and Energy Session
10.45-11.00	Bioeconomy, climate and innovation with a focus on electrification and bioenergy Dr. Francis X. Johnson, SEI
11.00-11.15	Value Creation Bio-slurry Lina Moeis, Yayasan Rumah Energi (YRE)
11.15-11.30	Biogas and electrification Prof. Tjokorda Tirta Nindya, Universitas Udayana
11.30-12.15	Panel Discussions: • <i>Connecting Policy and Science: How we can improve science and policy engagement from both sides?</i> • <i>Renewable Energy on Climate Change Mitigation: How can we make/support bioenergy markets?</i>
12.15-13.30	Lunch
	Adaptation and Synergy
13.30-13.45	Climate Field School I Wayan Andi Yuda – Representative of BMKG-Station of Climatology Negara-Bali
13.45-14.00	Using an integrated assessment model to assess the opportunities and challenges for developing bioenergy Dr. Brad Stelfox, Alces Group
14.00-14.15	Synergizing: Poverty Eradication and Resilient Livelihoods: Indonesia, South Africa, India cases Prof. Louis Lemkow, UAB and Dr. Takeshi Takama, su-re.co
14.15-14.30	Introduction of Activities and Funding Opportunities Masaki Sato, director of Singapore office, Japan Science and Technology Agency
14.30-15.30	Panel Discussions: • <i>Enabling Adaptation Measures with Synergy with Mitigation: How to make your adaptation activities economically sustainable?</i>



- *Governance Mitigation and Adaptation Integrated with Policy: Which is more important, top-down or bottom-up, and why?*

15.30-16.00 Coffee Break

Day 4 - Wednesday, 11 APR 2018 @ GRAND BALISANI SUITE, Oberoi – BALI

TIME	ACTIVITY
09.30-09.35	Introduction to Day 4
09.35-10.30	1) Focus Group Discussion (part I): Biogas & Electricity Generation E3ME Model to Analyse the Impact of Policies and considering the risks and uncertainties in biogas development Dr. Annela Anger-Kraavi, Cambridge, Susanne Hanger, ETHZ and Ms. Syamsidar Thamrin Expected outcomes: Area of science support on policy making & Risk and uncertainties insights 2) Exercise Q-methodology: Perception of biogas development (for Farmers/Practitioners) Novelita W. Mondamina, su-re.co Expected outcome: Data collection
10.30-11.00	Coffee break
11.00- 11.45	Focus Group Discussion (part II): Biogas & Electricity Generation E3ME Model to Analyse the Impact of Policies and considering the risks and uncertainties in biogas development Dr. Annela Anger-Kraavi, Cambridge, Susanne Hanger, ETHZ and Ms. Syamsidar Thamrin Expected outcomes: Area of science support on policy making & Risk and uncertainties insights
11.45-12.30	Exercise biogas diffusion model: potential of local currency to foster biogas diffusion Prof. Antoine Mandel, Paris School of Economics Expected outcome: Validation and more information for diffusion model
12.30-13.30	Lunch
13.30-15.20	Focus Group Discussion: Green Business by Synergising Adaptation & Mitigation of Climate Change - Sustainable Bioenergy Utilization and Renewable Electricity Generation Through Policy and Community Development



Yudiandra Yuwono, su-re.co	
Expected outcome: Business models/plan needs for science and policy	
15.20-15.30	Closing
15.30-16.00	Coffee break

PARTICIPANTS

No	Name	Affiliation (1)	Affiliation (2)	8th - 9th April	10th April	11th April
1	I Made Susatra	Udayana University	Researcher		v	v
2	Prof. Dr. Tjokorda Gde Tirta Nindhia, ST, MT	Udayana University	Researcher		v	
3	I Wayan Andi Yuda	BMKG	Government	v	v	v
4	Masari Nagatha	Udayana University	Student		v	v
5	I Ketut Bayu Sutresna	Udayana University	Student		v	
6	I Gede Artha Negara	Udayana University	Student		v	
7	Alfi Kurnianingsih	Ministry of EMR	Government (National)	v	v	
8	Brad Stelfox	ALCES Group	Researcher	v	v	v
9	Louis Lemkow	ICTA-UAB	Researcher	v	v	v
10	Syamsidar Thamrin	Bappenas	Government		v	v
11	Anella Anger Kravi	Cambridge University	Researcher	v	v	v
12	Masaki Sato	JST	Private sector		v	v
13	Ainul Wafa	Directorat General of Electricity	Government (National)		v	v
14	Wachid Marindra	Directorat General of Electricity	Government (National)		v	v
15	Susanne Hanger-Kopp	ETHZ	Researcher	v	v	v
16	Antoine Mandel	PSE	Researcher		v	v
17	Ni Wayan Tatik Inggriati	FAPET UNUD	Researcher		v	v
18	Francis X. Johnson	SEI	Researcher	v	v	v
19	Jayanti Maharani	ETI-Bappenas	Government (National)	v	v	v
20	Ena Mahrita Sembiring	PLN	Government (Province)	v	v	v
21	I Gusti Ayu Made Kim Iswari P.	KPSRB Bappenas	Government (National)		v	v
22	Theresia Aruan	KPSRB Bappenas	Government (National)		v	v
23	I Made Buda	Distpn bun	Government (Province)		v	v
24	I Gusti Made Chakra	Jembrana	Farmers	v	v	v
25	Komang Sulatra	Jembrana	Farmers	v	v	v
26	Kadek Sebayuana	Denpasar	Student		v	v
27	Renato	Akuoenergy	Private sector		v	v
28	I Made Sedana	BPP Jembrana	Government	v	v	v



29	Guntur, SST., M.Sc.	TAHURA	Government		v	v
30	Yansyah	Serenity	Private sector		v	v
31	Fika	Serenity	Private sector		v	v
32	Lina Moeis	YRE	Private sector		v	v
33	Rizka Devriyani	KESDM	Government		v	v
34	Bunga Krismaya	KESDM	Government		v	v
35	I. B. Setiawan	Dinas ESDM Prov Bali	Government		v	
36	Dewa Weda	Rumah Energi	Private sector	v	v	v
37	David Lie	Udayana University	Student		v	
38	Prof. Takahiro Osawa	Udayana University	Researcher		v	
39	Ketut Wiadnyana	KSS Kakao	Farmers	v	v	v
40	Komang Sindu Yoga	KSS Kakao	Farmers	v	v	v
41	I Wayan Diana	KSS Kakao	Farmers	v	v	v
42	Aaron Mashano	Udayana University	Researcher		v	v
43	Takeshi Takama	su-re.co	Researcher	v	v	v
44	Laksmi Pratiwi	su-re.co			v	v
45	Cynthia Juwita Ismail	su-re.co	Researcher	v	v	v
46	Yudiandra Yuwono	su-re.co	Researcher		v	v
47	Novelita W. Mondamina	su-re.co	Researcher	v	v	v
48	I Gst Gd Mayun Bary	su-re.co		v	v	v
49	I Gusti Ayu Widya Sari	su-re.co		v	v	v
50	Elena Delanne	su-re.co		v	v	v
51	Charlotte Reboul	su-re.co			v	v
52	Timothée Regis	su-re.co		v	v	v
53	Juan Sanchez	su-re.co			v	v
54	Lisa Thorning	su-re.co		v	v	v
55	Sabrina Hopf	su-re.co			v	v
56	Coralie Kowalski	su-re.co			v	v
57	Sergei Kazarian	su-re.co			v	v
58	Alexis Regis	su-re.co			v	v
59	Paul Van Dijk	su-re.co			v	v
60	Thijs Van Der Meeren	su-re.co			v	v
61	Nacho Candela	su-re.co			v	v
62	Maja Harren	su-re.co			v	v
63	Abdel Ghachtouly	su-re.co			v	v
64	Fumi Harahap	KTHZ	Researcher	v		
65	Erik Bromander	Guest		v		
66	Jan Gaffney	Montessori school	Private sector	v		
67	Clara Anger Kravi	Guest		v		
68	Kobayashi Yoshihide	JST	Private sector	v	v	v
69	Samuel Evander	Kesato	Private sector	v		v
70	Pierre Desrentes	Kesato	Private sector	v		v
71	Dr. Ir. I Wayan Alit Artha Wiguna, M.S	CAU Chocolates Factory		v		

