

Climate Technology Centre and Network (CTCN) Technical Assistance

Technical Assistance (TA) project for the Organic fertilizer and Anaerobic digestion to produce biofuels technology for Vietnamese agricultural sector

Local Community Stakeholder Analysis & Network Building

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The Climate Technology Centre & Network (CTCN) has provided Technical Assistance through pro-bono support from Ecosian and National Institute of Green Technology (NIGT) to implement the pre-feasibility study for the Organic fertilizer and Anaerobic digestion to produce biofuels technology for Vietnamese agricultural sector.

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1. Introduction

1.1 Concept and Objectives of the Capacity Building Program

Capacity building programs in international cooperation projects seek to analyze challenges faced by developing countries in various fields, such as education, health, energy, agriculture, forestry and fisheries, and provide appropriate practical knowledge through education and training. They assist developing countries to overcome the difficulties they face re. shortages of technological, human, and social resources and help them work towards becoming self-reliant.

In particular, capacity development projects pursuing the transfer of advanced technology are encouraged so that advanced technology can be established and operated without risk in the target country in the future through an increase in professional manpower, vitalization of R&D, and cooperation with local residents.

1.2 Capacity Building Activities in the Vietnam TA(Technical Assistance) Project

In this Vietnam TA project, the 'Vietnam composting of livestock manure and biogas power plant generation' capacity building program was carried out to prepare local stakeholders for the future transfer of Korean biogas technology to Vietnam.

The key target recipients for the TA capacity building program were officials of pig farms including Trong Khoi Company, and local residents in Thái Nguyên, which was selected as the final test area, as well as research institutes related to biogas plants such as the Vietnam National University of Agriculture.

This program is intend to transfer technology trends and an overview of the installation and operation of advanced large-scale biogas plants, as well as explain the objective and significance of the TA project to lay the foundation for future cooperation when the project goes ahead. Furthermore, in the long term, it will promote the expansion of biogas plants and technology in Vietnam.

1.3 Main Outputs

There are two main outputs resulting from the implementation of this activity:

- i) Building a network of local stakeholders
- ii) Hosting a capacity building program

Ecosian secured a network with local stakeholders through the cooperation of MARD (Ministry of Agriculture and Rural Development) and local Vietnamese companies. MARD facilitated networking with central/local government officials and research institutes affiliated with local governments, while various local companies facilitated networking with engineering companies and local residents' groups in the target area.

After building up a network of stakeholders like this, Ecosian then proceeded to hold a capacity building program for them. At this time, considering that most of the participants were Vietnamese locals who had little to no understanding of the project and needed an introduction to advanced biogas technology, the program was designed with three main topics namely Introduction to the TA project – Overview of Biogas Technology in Vietnam & Korea - Understanding Methods to Manage Odors.

Program facilitators were recruited from working-level staff directly implementing the TA project and experts in Korea and Vietnam with experience in biogas technology. In addition, a questionnaire form¹ was developed based on the CTCN Training Evaluation Form to gauge the degree of satisfaction with the program contents and increase in capacity.

¹ Refer to Annex B and C for a sample questionnaire.

2. Capacity Building Training Program

2.1 Determined stakeholders

The objective in establishing a network of stakeholders is to identify the need for the introduction of biogas technology in Vietnam and to establish a system of cooperation with various stakeholders such as the government, companies, and non-governmental organizations.

To implement this TA project, Ecosian Ltd. gathered 71 stakeholders from 14 organizations such as government agencies, university research institutes, private companies, and local residents and farmers from Thái Nguyên Province.

The different types of stakeholder and objective in securing each one are shown in the table below.

- Central government officials and local government officials from Thái Nguyên Province : Promote government-level research and technology support
- Officials from university research institutes affiliated to government departments involved in TA projects : Promote research into biogas and eco-friendly composting technology
- Employees of private sector engineering companies : Increase number of companies in the private sector using biogas technology
- Local residents and farmers : Create a favorable atmosphere for the introduction of biogas plants in Thái Nguyên and encourage cooperative participation, while preventing conflicts between residents arising from the introduction of plants

2.2 Capacity Building Training Program

2.2.1 Summary of the program

The 'Vietnam composting of livestock manure and biogas power plant generation' capacity building program was held in Hanoi, the capital of Vietnam, in April 2023 to introduce the TA project to local stakeholders and share the current status of biogas technology in Korea and Vietnam. It was an event that promoted continuous technology exchange between the two countries to facilitate a successful technology transfer.

The main objectives of the program were as follows.

- i) Increasing Vietnamese stakeholders' understanding of advanced biogas technology
- ii) Building a network of cooperation for the TA project

The capacity building program covered Introduction to the TA project, biogas plant technology in Vietnam and Korea, and industrial odor removal technology. The objective of each presentation is shown in the table below.

Table 2.1 The capacity building program of lectures and objective of each presentation

Category	Presenter	Objective
Introduction of TA Project	Mr. Heynsu Yoon [Head of Division, Director, Ecosian]	Introduction of this TA Project, its objectives and significance
Biogas plant Technologies in Vietnam	Mr. Nguyen Quang Kahi [Vietnam Biogas center]	Overview of livestock manure-based biogas plants in Vietnam
Biogas plant Technologies in Korea	Dr. Seeyoung LEE [CEO, BKT Vietnam]	Overview of the installation and operation of advanced large-scale biogas plants, and recent trends
Industrial and Home odor removal technology	Mr. Seokwoo Kim [CEO, ODIN]	The importance of managing odors and introduction of related technology

2.2.2 Opening Remarks

[Speaker : Mr. Dung Tat Thang, General Director of Department of Livestock Production, Ministry of Agriculture and Rural Development]

Mr. Dung Tat Thang acknowledged and appreciated the technical assistance (TA) provided by the CTCN and the Korean government and thanked the Korean Mission for its contribution to the TA and the Capacity building training program.

He noted that the number of pig livestock farms in Vietnam is increasing and commented that it will be necessary to introduce livestock manure biogas technology to Vietnam to solve the livestock manure treatment issue and increase energy independence. He also noted that Vietnam is the second largest breeder of pigs in the world, raising 31 million pigs, accounting for about 4.6% of the global population of domesticated pigs as of 2020. As such, pork production plays a very important role in Vietnam, so the government continues to pay significant attention to it and make major investment in pig breeding. However, he said that the problem of environmental pollution caused by livestock manure is becoming serious due to the increasing number of pig farms, and efforts to use livestock manure as a resource through the introduction of advanced technology are needed in Vietnam.

Regarding these issues, he said that livestock manure biogasification and organic composting technologies could solve the livestock manure management issues facing Vietnam. He emphasized that this technology will eventually increase Vietnam's energy self-sufficiency

rate and make a great contribution to national carbon neutrality and said more efforts should be made to research and develop sustainable livestock manure treatment technology. Lastly, he expressed his gratitude to Ecosian and BKT for preparing the program and to the participants for attending, saying that he hoped that this program would serve as an opportunity to cooperate for the exchange of biogas technology between Vietnam and Korea.

Figure 2.1 Opening remarks by MARD



2.2.3 Vietnam Biogas Plant TA Project

[Speaker : Mr. Heynsu Yoon, Head of Division, Director, Ecosian]

Mr. Heynsu Yoon, who is in charge of this TA project, introduced the background to and progress of the project, its expected effects, and future plans to enhance understanding of the biogas plant project among stakeholders who participated in the program.

He mentioned the growing problem of environmental pollution caused by livestock manure and the increase in demand for manure treatment technology as being the background to the promotion of this technology transfer project. He said livestock farms in densely populated areas in Vietnam cause serious environmental pollution due to livestock manure because they are operated at high density on small sites. In particular, the main source of pollution in livestock farms is organic waste such as livestock manure and livestock carcasses. Nevertheless, inspections by the Vietnam Ministry of Natural Resources and Environment (MONRE) found that most livestock farmers are not considering investing in environmental protection, wastewater and solid waste treatment plants.

In addition, he explained that according to a survey² he conducted with local stakeholders, 'eco-friendly composting technology for livestock manure' and 'biogas production technology through anaerobic digestion of agricultural waste' ranked first and second respectively in

² The survey was conducted as part of the scope of the 'Demand Creation Reverse Proposal Model Project', a research project commissioned by the National Institute of Green Technology and conducted by Ecosian (2021)

terms of demand for technology in Vietnam's agricultural sector. As such, he emphasized that there is a growing demand for climate change response technologies such as those converting waste into resources and energy in the agricultural sector.

Considering the current situation in Vietnam, in 2022 Ecosian proposed to promote the 'Technical Assistance (TA) Project for the Organic fertilizer and Anaerobic digestion to produce biofuels technology for the Vietnamese agricultural sector' targeting the pig farming regions in Vietnam. According to Mr. Yoon, this project is being facilitated by international cooperation and networking between MARD, Ecosian, and BKT.

Ecosian is the Korean eco-friendly consulting company in charge of this technology transfer project, and is carrying out the project in tandem with technical advice from BKT and active project support from MARD, the Vietnamese government department overseeing the project.

Mr. Yoon said that the processes applied to the business consist of livestock manure pretreatment, anaerobic digestion, biogas power generation and wastewater treatment. He explained that these technologies not only reduce environmental pollution by reducing greenhouse gas emissions such as methane, but can also generate by-products such as geothermal heat, electricity and eco-friendly compost.

In addition, through this project, biogas and compost can be produced by transferring climate technology to the livestock sector in Vietnam, which is an agricultural-oriented economy. Therefore, it will be possible to generate additional power supply within the region and increase agricultural production, which may have a positive impact not just on the environment and technology but on all aspects of the economy, industry, and society.

He announced that in the future after completing the CTCN TA project, it is planned to conduct a feasibility study of the project for the target site followed by preliminary and detailed design of a biogas plant, commissioning, and after construction is complete to establish the foundation to operate the plant.

He said that the technology transfer facilitated by this project will allow waste to be converted into energy, making it possible to achieve distribute power to the local community as well as supply organic fertilizer to nearby areas, ultimately achieving a circular economy. In addition, he mentioned that since many Vietnamese stakeholders were gathered together, he hoped that this program would serve as an opportunity to introduce the technologies of both countries and build cooperation for the plant installation in the future.

Figure 2.2 Presentation of 「Vietnam Biogas Plant TA Project」 Session



2.2.4 Technologies for Biogas Plant in Vietnam

[Speaker : Mr. Nguyen Quang Kahi, Vietnam Biogas center]

Mr. Nguyen Quang Kahi divided Vietnam's biogas plants by scale and explained the biogas technology for each category. Since there are almost no mid- to large-scale biogas plants in Vietnam, he mainly introduced the small-scale biogas plants that are popular in Vietnam.

He explained the biogas plants in Vietnam by classifying them by size. At this time, in general, small plants refer to plants where the Volume of distribution (VD) is less than 50 m³, medium plants are those that are more than 50 m³ but less than 1000 m³, and large plants are those that generate more than 1000 m³.

According to him, small plants are more widely and diversely used in Vietnam than medium and large plants, and can be subcategorized into plastic bag type, plastic cover type, KT type, and complex type.

First of all, in the plastic bag type plant, a storage tank is filled with livestock manure and then a pipe is connected to the tank to move biogas. The biogas is captured in plastic or polyethylene bags suspended below the pipeline. In addition, the plastic cover type is a method of storing livestock manure in the soil and covering it with a large sheet of plastic to prevent biogas from escaping from the ground.

In the case of KT type plants, it is a more advanced method than that using vinyl, and it is further subdivided into KT1, KT2, and KT3 etc. types. The majority in Vietnam are either KT1 or KT2 plants. KT1 plants are used when the conditions for soil excavation are favorable, while KT2 is used when soil excavation is relatively difficult or when there is a lot of groundwater. Both plants are commonly constructed in the form of a spherical dome, and both the storage tank and digester plant are installed underground, and biogas is collected at the top of the digester. Such plants became widely adopted and installed after a Dutch organization supported the installation of biogas plants in the Vietnamese livestock farm area through

cooperation with the Vietnamese government as part of the “Support to the biogas program for the livestock industry in some provinces of Vietnam” project in 2003.³

In addition, complex type small plants are spherical in shape, and there are two cylindrical passages at the top. One of them is narrow and is used to inject organic matter into the sphere, and the other is wide and is used to collect the biogas that is discharged.

The majority of medium-sized plants utilize tubular devices, with the lower part of the plant being buried underground, and the biogas discharge pipeline above ground so that biogas can be supplied to homes.

For large-scale plants, there are box-type plants and HDPE film cover types. There are remarkably few large-scale plants, and the majority of medium and large-scale plants currently in use were installed with funding from the international community, such as the world bank and FAO.

Finally, he said that Vietnam has so far focused on small-scale biogas plants, and there was a subsidy policy for biogas technology until 2020, but it has now ended. Therefore, he said that he hopes to introduce high-quality biogas technology to Vietnam assuming the establishment of effective support policies in the future.

Figure 2.3 Presentation of 「Technologies for Biogas Plant in Vietnam」 Session



2.2.5 Biogas Plant Technologies in Korea

[Speaker : Dr. Seeyoung LEE, CEO, BKT Vietnam]

Dr. Lee explained there are three main methods applied to major anaerobic digestion technologies. Then he described an overview of the operation of the biogas plant in Miryang, which was installed and operated by BKT, a Korean water treatment company.

³ Journal of Vietnamese environment (2011), Small-scale anaerobic digesters in Vietnam development and challenges

He first explained that Semi-CSTR (Semi-Continuous-flow Stirred Tank Reactor), PFR (Plug-flow Reactor), and ASBR (Advanced Sequencing Batch Reactor) are the main options for operating anaerobic digestion tanks in biogas plants. The Semi-CSTR method is the one favored by many Korean companies, which intermittently inputs and discharges microorganisms and continuously stirs them. The advantages and disadvantages of the Semi-CSTR method are as follows.

Table 2.2 Pros and Cons of the Semi-CSTR Construction Method

Tech	Advantages	Disadvantages
Semi-CSTR	<ol style="list-style-type: none"> 1. Easy to maintain and operate 2. Possible to control the inflow amount according to the condition of the reaction tank 3. Sludge deposition rate is low 	<ol style="list-style-type: none"> 1. High microorganism discharge rate 2. High emission rate of undigested solids 3. Weak against shock loads

Next, he introduced the PFR method whereby microorganisms are continuously input and discharged and continuously mixed. ($HRT=SRT$) The advantages and disadvantages of the PFR method are as follows.

Table 2.3 Pros and Cons of the PFR Construction Method

Tech	Advantages	Disadvantages
PFR	<ol style="list-style-type: none"> 1. Simple method 2. Excellent mixing efficiency 3. Can place the microbial community in different locations depending on the stage of anaerobic digestion 	<ol style="list-style-type: none"> 1. Emission rates for microorganism and undigested solids are similarly high 2. Weak against shock loads 3. Mixing efficiency is weak in the case of vertical type

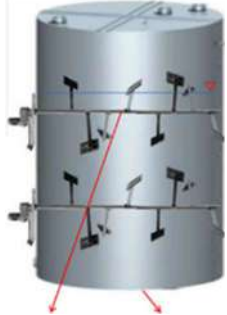


Lastly, he introduced the ASBR method whereby microorganisms are intermittently injected and discharged, and mixing is also performed intermittently. ($HRT < SRT$) This method was the one applied when BKT installed a biogas plant, and it was introduced as the technology to be introduced to the anaerobic digestion process in Vietnam in the future.

Table 2.4 Pros and Cons of the ASBR Construction Method

Tech	Advantages	Disadvantages
ASBR	<ol style="list-style-type: none"> 1. Possible to cultivate highly-concentrated microorganisms 2. Preservation of undigested solids in the digester 3. Resistant to shock loads 4. Possible to shorten initial commissioning time 	<ol style="list-style-type: none"> 1. High rate of sedimentation of inflow impurities 2. High concentration of solids in digester 3. Need to maintain condition during settling time

The characteristics of these three anaerobic digestion methods differ as follows.

Table 2.5 Key Anaerobic Digestion Construction Methods in Korea

Method	Semi-CSTR	PFR	ASBR
Schematic			
Mixing Method	Upright shaft mixing device + scum dispersal mixing device	Upstream flow	Mechanical mixing
HRT	More than 30 days	More than 15 days (SRT: more than 30 days)	30 days (SRT: More than 45 days)
Characteristics	<ul style="list-style-type: none"> - Improved mixing efficiency by installation of internal discharge - Scum and foam controlled through use of mixing device - Temperature increased through internal hot water pipe 	<ul style="list-style-type: none"> - This method preserves solids leading to an excellent organic solids removal rate - Difficult to maintain when a blockage occurs - Solids must be introduced within 7% 	<ul style="list-style-type: none"> - Uses intermittent input and outflow operation method - Has separate equipment at the bottom for discharging sediment - Uses omnidirectional mechanical mixing device

Next, Dr. Lee introduced a case study of a Korean livestock manure biogas plant. The 'Miryang Clear Water Management Center' located in Sangnam-myeon, Miryang-si, Gyeongsangnam-do is a biogas plant that processes 100 tons of organic waste (80 tons of livestock manure and 20 tons of food waste) per day. This plant was constructed by BKT and has been in operation since January 2023 following eight months of commissioning.

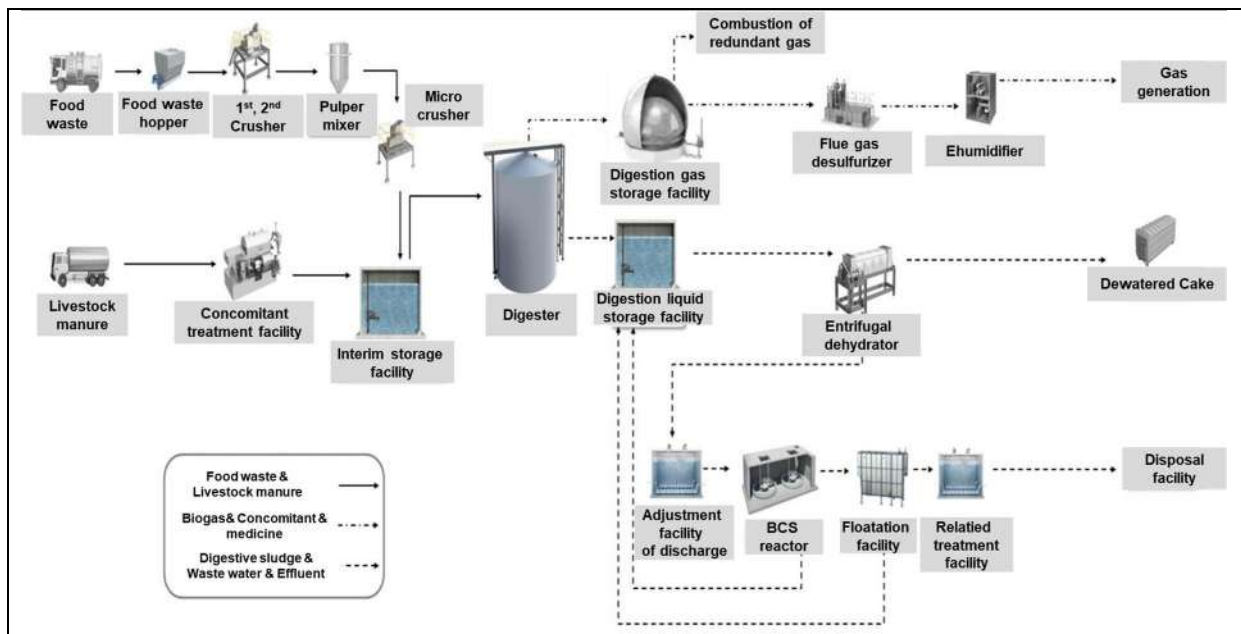
He also explained the main equipment used in the biogas plant in Miryang. He explained the major internal equipment used at each step, from the input and supply of organic waste to the last step, wastewater treatment.

Table 2.6 Key Equipment Used at the biogas Plant in Miryang, Korea

Category	Key Equipment
Input and Supply	Intake hopper, Crushing, Gravity Separation, Fine Crushing
Anaerobic Digestion	Anaerobic Digester, Mixing device, Sediment Discharger
Digested Sludge Treatment	Centrifugal Dehydration
Use of Biogas	Desulfurization and Dehumidification Equipment, Gas storage Tank, Generator
Wastewater Treatment	BCS (BKT's SRB)

The process flow chart of the biogas plant in Miryang is as follows.

Figure 2.4 Process Drawing of Biogas Plant in Miryang, Korea



He explained the operational status and results of the Miryang biogas plant from January 2023 until the present date. The biogas plant in Miryang is a plant that applies a single-stage mesophilic anaerobic digestion tank, and operates with an HRT of 35 days and an SRT of 55 to 60 days. As a result, the organic load ratio (OLR) was 0.94~1.23kgVS/m³d, and the methane collected was 0.477Nm³CH₄/kgVS, an increase of 33% compared to the design forecast. In addition, the organic waste removal rate through anaerobic digestion reached 71.4%.

As a result of operating the plant, the daily average biogas produced is 1643 m³CH₄/d, and the average daily power produced is 2,660kWh/d. This is an amount that can save 160 million WON (about 120 thousand USD) in annual electricity fees. In addition, when operating this plant, the annual greenhouse gas reduction effect compared to fodder or composting is 6,452 tonCO₂eq, and the fossil fuel substitution effect reaches 140 tonCO₂eq per year.

He said that Korea has anaerobic digester technology that is highly efficient, and that the technology is being applied by installing plants in several regions. Most of the existing livestock manure biogasification projects in Vietnam are small-scale plants using very simple technology. However, he said, Vietnam is a country with great potential for biogas market growth, so introducing biogas plants to livestock farms will effectively reduce greenhouse gases and solve livestock wastewater problems.

Figure 2.5 Presentation of 「Biogas Plant Technologies in Korea」 Session



2.2.6 Industrial and Home odor removal technology

[Speaker : Mr. Seokwoo Kim, CEO, ODIN]

After mentioning the odor management activities implemented in Korea to reduce odors emanating from livestock, Mr. Kim explained the sterilization performance of odor removers produced by Korean companies and their actual effect on odor reduction.

Odor generation is a major issue in the operation of livestock farms. Mr. Kim said odor is a sensitive issue in villages near livestock farms and in industrial areas where organic waste treatment plants operate. In order to solve this problem, the Korean government is promoting regional odor management and the expansion of odor collection equipment.

As part of regional odor control, local governments, farms, livestock environment management officers, and local residents were required to form local committees in areas where livestock odors persist, and established odor reduction plans tailored to local conditions. In addition, after installing ICT-based odor collection equipment, a real-time monitoring and regular management system was established. In addition, a significant budget was allocated to odor reduction activities, such as a pilot scheme to spray deodorizers using drones.

Korean chemical companies are also making efforts to reduce odors in waste treatment plants or livestock plants by using deodorizers. Representatively, ODIN, which has industrial deodorizing technology, is a company that manufactures iodine-based oxidation deodorants. Mr. Kim explained that in the case of ODIN's deodorizer, the neutralization of the four major

odor substances, namely ammonia, trimethylamine, hydrogen sulfide, and methanethiol, was confirmed, and its performance in sterilizing major pathogens such as E. coli, Staphylococcus aureus, and pneumonia was also confirmed.

According to him, ODIN's deodorizer has been certified for its performance through the results of spraying it on Korean livestock farms. He mentioned a pig farm in Cheonan as an excellent case study. First, when ODIN's deodorizer was sprayed three times at the Cheonan pig farm, it was confirmed that the odor concentration was reduced by 42% and this increased to 63% after spraying eight times. In addition, a noticeable decrease in NH₃ concentration was observed at pig farms in Icheon and Boryeong.

He said that odor management will ultimately deliver benefits that outweigh the costs, regardless of the size of the farm. In addition, he said that if Vietnam establishes an institutional system for odor management and develops related technologies, the livestock odor problem can be reduced in the future, reducing conflicts between civil complaints and residents.

Figure 2.6 Presentation of 「Industrial and Home odor removal technology」 Session



3. Feedback Survey

3.1 Purpose of Survey

A feedback survey on the capacity building program was conducted to evaluate and analyze the level of understanding, increase in capacity, overall satisfaction, and increase in knowledge of the participants.

3.2 Methodology

On April 2023, a survey was conducted on 71 local stakeholders in Vietnam who participated in the Capacity Building program.

CTCN's 'Training Evaluation Form' was used for the questionnaire, and the questionnaire comprised four evaluation indices and a total of ten questions. The evaluation indices were classified into (I) Level of understanding, (II) Level of capacity building, (III) Overall level of satisfaction, and (IV) Level of technological knowledge improvement.

(I) Level of understanding, (II) Level of capacity building, (III) Overall level of satisfaction comprised a total of eight questions and were scored on a 5-point scale (Likert Scale), (IV) Level of technological knowledge improvement has two questions and was scored on a 4-point scale.

(I) The level of understanding evaluation judges the extent to which the capacity building program contributed to the improvement of participants' understanding of biogas plants and the need for related technologies.

(II) The level of capacity building evaluation judges the extent to which the participants felt the capacity building program contributed to their ability to perform at work and share the knowledge gained with colleagues.

(III) The overall satisfaction evaluation judges the suitability of the program contents, the time allocated to each part of the program, the question and answer and discussion sessions, and overall satisfaction.

Finally, (IV) The evaluation of increase of technical knowledge judges the existing knowledge level of the participants and the improvement in their technical knowledge about biogas plants gained through this capacity building program.

3.3 Survey Results

3.3.1 Analysis of Participants

A total of 71 participants participated in the survey, of which 59% were male and 41% female. As a result of surveying the participants' institutions, there were two government institutions, ten private institutions, two universities and research institutions, and one local government institution represented. The statistical results are shown in the table below.

Table 3.1 Statistics of Survey Participants

Category		Value	Unit
Participants		71	Persons
Gender	Male	42(59%)	Persons(%)
	Female	29(41%)	Persons(%)
Affiliation	Government agencies	2	No. of Organizations
	Private sector	10	No. of Organizations
	Non-governmental	0	No. of Organizations
	Research institute, University, Laboratory	2	No. of Organizations
	Local government	1	No. of Organizations
	Etc.	0	No. of Organizations

3.3.2 Analysis of Survey Results

After the capacity building program was over, questionnaires were collected from 71 local stakeholders, and positive results⁴ were analyzed on a 5-point scale index for (I) Level of understanding, (II) Level of capacity building, and (III) Overall level of satisfaction, and a 4-point scale index for (IV) Level of technological knowledge improvement.

First, as a result of analyzing the statistics of the 5-point scale indicators, 91.5% of participants gave a positive response to the level of understanding evaluation, 90.8% to the level of capacity building evaluation, and 88.7% to the overall level of satisfaction. As a result of aggregation, 90.3% of the attendees gave positive evaluation scores to the capacity building program for the above three questions, and as a result, the evaluation of this capacity building program is at a positive level.

⁴ In the case of the 5-point scale, answers of 'Agree' (4 points) and 'Strongly agree' (5 points) were considered to be positive answers. For the 4-point scale, answers of 'Somewhat increased' (3 points) and 'Significantly increased' (4 points) were considered to be positive answers.

Questions	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)	Percentage of 4&5 points
I. Understanding						
I-1. The training contributed to my understanding of the biogas plant.	0	0	6	41	24	91.5%
I-2. The training contributed to my understanding of the necessity of similar technology.	0	0	6	39	26	91.5%
II. Capacity Building						
II-1. The training received is useful in relation to my work and capacity building.	0	0	7	35	29	90.1%
II-2. The training enabled me to share professional experiences with colleagues.	0	0	6	40	25	91.5%
III. Overall Satisfaction						
III-1. The format of the training was well suited to the learning objectives.	0	0	8	38	25	88.7%
III-2. The length of the training was adequate for the objectives and content.	0	0	8	36	27	88.7%
III-3. The training allowed adequate time for questions and discussions.	0	0	6	38	27	91.5%
III-4. Overall, I am satisfied with the training provided.	0	0	8	38	25	88.7%
Total			71			
Proportion giving 4 points or more			90.3%			

Next, as a result of analyzing the statistics of the 4-point scale indicators, the level of existing knowledge of the participants before this workshop was an average of 2.5 points out of 4 points, and most of them had some or a good prior level of understanding. After participating in this workshop, the ratio of positive responses to the improvement in technical knowledge evaluation was 90.1%.

As a result of holding this capacity building program targeting participants with knowledge of biogas plant technology above the basic level, it can be seen that 90.1% of the participants improved their technical knowledge.

IV. Knowledge			
IV -1. Please indicate your previous level of knowledge on the biogas plant technology addressed in the training.			
No prior understanding (1)	Some prior understanding (2)	Good prior understanding (3)	Very good prior understanding (4)
2	31	35	3
IV -2. Please indicate your level of knowledge increase on the biogas plant technology addressed in the training.			
Not increased (1)	Moderately increased (2)	Somewhat increased (3)	Significantly increased (4)
0	7	56	8
Total		71	
Proportion giving 3 points or more		90.1%	

3.3.3 Listening to Other Opinions from Residents

After the capacity building program, local residents who attended were interviewed to hear their opinions on support for this technology transfer. As a result, most local residents mentioned that 'active introduction of anaerobic digestion technology is necessary to minimize environmental pollution such as water pollution caused by livestock manure'.

In addition, according to other residents, 'the fact that residents can coexist using the compost & liquid fertilizer and gas produced as a by-product of operating the plant means local residents think positively in regards to the introduction of this project.' Also, there were comments that 'there is demand to operate such plants, but technical training support such as practical knowledge, operating know-how, and instructions in how to use the equipment will be necessary to start the project in earnest'.

4. Conclusion

This capacity building program was conducted to build a cooperative system among stakeholders by introducing the TA project to stakeholders from the project site in Vietnam, and to strengthen their understanding of advanced technologies by sharing trends in Korea's biogas technology.

The capacity building program was conducted for local stakeholders in Vietnam. After listening to presentations on each topic conducted by the TA project facilitators and biogas plant technology experts from Korea and Vietnam, they came to understand the purpose and significance of the TA project and acquired knowledge about Korean technology in the relevant fields.

In addition, after the competency building program was completed, the effectiveness of the program was confirmed using a questionnaire.

It said that 90.3% of the participants were generally satisfied with the program, including improving their understanding and capacity building, and 90.1% responded that their technical knowledge of bigas technology had improved through this. Therefore, it can be seen that stakeholders in the target region's awareness of biogas technology has increased.









As a result of the program, 'Trong Khoi Company', a livestock farming company in Thai Ngyuen Province, signed a Letter of Intent(LOI)⁵ to support the pilot project resulting from this project 'The pre-feasibility study for the Organic fertilizer and Anaerobic digestion to produce biofuels technology for Vietnamese agricultural sector'

Through these activities, it is expected that if biogasification and eco-friendly composting related technologies are introduced and operated in the future in this region, local residents will be able to accept the new technology and operate the plants more easily.









⁵ Refer to Annex D and E

Annex A: List of Workshop Participants

~~Vietnam~~ composting of livestock manure and biogas power plant generation Capacity Building program
Session 2. Composting of livestock manure and biogas power generation

No	Name	Gender	Affiliation		Position	E-mail	Signature
			Organization	Category			
	<i>Example</i>	<i>Male/ Female</i>		a) Government agencies b) Private sector c) Non-governmental d) Research Institute, University, Laboratory e) Local government		<i>abc@gmail.com</i>	
	Loang Thi Hai	Fe		C			
	Nguyen Tien Huy	M		C			
	Nguyen Minh Tuan	M		C			
	Vinh Thi Hoa	Fe		C			
	Le Thi Thuy	Fe		C			
	Hoang Minh Thuy	F		C			
	Nguyen Minh Ngoc	M		C			
	Loi Thuy Anh	Fe		C			

Vietnam composting of livestock manure and biogas power plant generation Capacity Building program
Session 2. Composting of livestock manure and biogas power generation

No	Name	Gender	Affiliation		Position	E-mail	Signature
			Organization	Category			
	<i>Example</i>	<i>Male/ Female</i>		a) Government agencies b) Private sector c) Non-governmental d) Research Institute, University, Laboratory e) Local government		<i>abc@gmail.com</i>	
	Le Thi Nhat Hoa	F		C			
	Doan Thi Dieu	F		C			
	Trinh Lan Huong	F		C			
	Le Ai Long	M		C			
	Hoang Thi Thuy	F		C			
	Le Hoang Minh	M		C			
	Le Minh Thuan	M		C			
	Nguyen Viet Tuan	M		C			

Vietnam composting of livestock manure and biogas power plant generation Capacity Building program

Session 2. Composting of livestock manure and biogas power generation

No	Name	Gender	Affiliation		Position	E-mail	Signature
			Organization	Category			
	Example	Male Female		1 Government agencies 2 Private sector 3 Non-governmental 4 Research institute University, Laboratory 5 Local government		example@gmail.com	
30	Euynh So	F	KOTRA	1	Director		
31	Nguyễn Quang Dũng	M	CTU THANH HÓA Trung Ương Kỹ Thuật Nông Nghiệp		Chủ trì kỹ thuật		
32	Nguyễn Văn	M	TRUNG ƯƠNG Trung Ương		Chủ trì kỹ thuật		
33	Nguyễn Cường	M	TRUNG ƯƠNG Trung Ương		Chủ trì kỹ thuật		
34	Nguyễn Văn Hải	M	CHUYÊN NGHIỆP		Phó GP		
35	LÊ TIẾN DƯƠNG	M	Việt Nam		Chủ trì kỹ thuật		
36	Đông Sơn	M	CAN		PTP		
37	Hoàng Thị Thủy	F	CAN		Chủ trì		

Vietnam composting of livestock manure and biogas power plant generation Capacity Building program

Session 2. Composting of livestock manure and biogas power generation

No	Name	Gender	Affiliation		Position	E-mail	Signature
			Organization	Category			
	Example	Male Female		1 Government agencies 2 Private sector 3 Non-governmental 4 Research institute University, Laboratory 5 Local government		example@gmail.com	
38	Yun Jinsul	F	KOTRA		Deputy Director	jinsul_y@kotra.or.kr	
39	Đỗ Đình Trung	M	Chi cục chăn nuôi, thủy và thú y		Phó Chi Cục Tưới Tưới	trungdts@gmail.com	
40	Nguyễn Mạnh Tuấn	M	Chi cục chăn nuôi, thủy và thú y		Chuyên viên	manhtrung@gmail.com	
41	Lý Quốc Dân	M	Chi cục chăn nuôi, thủy và thú y		Phó Phó	lyquocdan@trungtam.com	
42	Võ Ngọc Thuận	M	Chi cục chăn nuôi, thủy và thú y		Viện	thuanngoc@gmail.com	
43	Nguyễn Thế Lâm	M	CAN		GPDA	vietnamapp@gmail.com	
44	Trần Mạnh Cường	M	CAN		CN	manhtrung@gmail.com	
45	Hoàng Thị Ngọc	F	Sinh viên HNVA		Học sinh	hoangthuyngoc@gmail.com	

Vietnam composting of livestock manure and biogas power plant generation Capacity Building program

Session 2. Composting of livestock manure and biogas power generation

No	Name	Gender	Affiliation		Position	E-mail	Signature
			Organization	Category			
	Example	Male/ Female		1) Government agencies 2) Private sector 3) Non-governmental 4) Research institute, University, Laboratory 5) Local government		abc@gmail.com	
1	Mr Tuan Manh	Male	Số 10 Nguyễn Huệ			tuanhmanh25112004@gmail.com	

Vietnam composting of livestock manure and biogas power plant generation Capacity Building program

Session 2. Composting of livestock manure and biogas power generation

No	Name	Gender	Affiliation		Position	E-mail	Signature
			Organization	Category			
	Example	Male/ Female		1) Government agencies 2) Private sector 3) Non-governmental 4) Research institute, University, Laboratory 5) Local government		abc@gmail.com	
5	Trần Thị Thanh Huỳnh Anh Tuấn		Cục Chăn nuôi Hà Nội NVN		Chuyên viên Trợ lý viên	tranthithanh@gmail.com huynhanh@vnav.vn	

Vietnam composting of livestock manure and biogas power plant generation Capacity Building program

Session 2. Composting of livestock manure and biogas power generation

No	Name	Gender	Affiliation		Position	e-mail	Gift/Fee/N/A	Signature
			Organization	Category				
-	Example	Male/Female		01 Government agencies 02 Private sector 03 Non-governmental 04 Research institute 05 Academic Laboratory 06 Local authorities		example@gmail.com		
1	Hoàng Thị Lệ	Nữ (F)	Evoburg	b	manager	yanleung9935@gmail.com		
2	Nguyễn Thị Huệ	Nữ (F)	BKT	b	manager	nguyenthu10.dinh@gmail.com		
3	Nguyễn Thị Bích Ngọc	Nữ (F)	BKT	b	manager	nbk@bkt21.com		
4	Nguyễn Thành Tâm	Nam (M)	BKT	b	engineer	tantat@gmail.com		
5	Nguyễn Văn Tuấn	Nam (M)	ODIN	b	CEO	stao_bk@bkt21.com		
6	Nguyễn Văn Tuấn	Nam (M)	BKT	b	CEO	ky10@bkt21.com		
7	Nguyễn Thị Ngọc	Nữ (F)	Evoburg	b	Executive			
8	Nguyễn Thị Ngọc	Nữ (F)	Evoburg	b	Accountant			
9	Nguyễn Văn Tuấn	Nam (M)	Evoburg	b	Senior Accountant			
10	Nguyễn Văn Tuấn	Nam (M)	Evoburg	b	Accountant			

Annex B: Feedback Form (English)

Vietnam composting of livestock manure and biogas power plant generation Capacity Building program

Thank you for participating in Vietnam composting of livestock manure and biogas power plant generation Capacity Building program. This survey is designated by Ecosian for CTCN TA Capacity Building Program Evaluation. For your guidance, please refer to *the description in italic font* and leave all the other words and format as they were given.

General Information

Title of training	「Vietnam composting of livestock manure and biogas power plant generation」 Capacity Building program
Start date	
End date	
Location (Address)	
Location (City)	Hanoi
Location (Country)	Vietnam
Affiliation	
Type of Affiliation	<p>Function:</p> <p><input type="checkbox"/> <u>Government agencies</u></p> <p><input type="checkbox"/> <u>Private sector</u></p> <p><input type="checkbox"/> <u>Non-governmental</u></p> <p><input type="checkbox"/> <u>Research institute, University, Laboratory</u></p> <p><input type="checkbox"/> <u>Local government</u></p> <p><input type="checkbox"/> <u>Others</u> <i>(if checked 'Others', please provide us with brief introduction of your organization.)</i></p> <p>▶</p> <hr/> <p>Area of focus / expertise:</p> <p><input type="checkbox"/> <u>Policy</u></p> <p><input type="checkbox"/> <u>Technology</u></p> <p><input type="checkbox"/> <u>Finance</u></p> <p><input type="checkbox"/> <u>Network/Engagement</u></p> <p><input type="checkbox"/> <u>Others</u> <i>(If checked 'Others', please provide us with a brief description of the technology or policy area that your organization focuses on.)</i></p> <p>▶</p>

Survey

Please assess the (I) Understanding, (II) Capacity Building and (III) Overall Satisfaction on a scale from 1 to 5, using mark the "V".

Composting of livestock manure and biogas power generation

- Anaerobic Digestion and Biogas Technology in Korea (BKT Vietnam)
- Biogas Technology in Vietnam (Bio-Gas Center)
- Introduction to industrial/home odor removal technology (ODIN)

Questions	Strongly disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly agree (5)
I. Understanding					
I-1. The training contributed to my understanding of the biogas plant.					
I-2. The training contributed to my understanding of the necessity of similar policy /technology.					
II. Capacity Building					
II-1. The training received is useful in relation to my work and capacity building.					
II-2. The training enabled me to share professional experiences with colleagues.					
III. Overall Satisfaction					
III-1. The format of the training was well suited to the learning objectives.					
III-2. The length of the training was adequate for the objectives and content.					
III-3. The training allowed adequate time for questions and discussions.					
III-4. Overall, I am satisfied with the training provided.					

Please assess the (IV) Knowledge on a scale from 1 to 4, using mark the "V".

IV. Knowledge			
IV -1. Please indicate your previous level of knowledge on the biogas plant policy addressed in the training.			
No prior understanding (1)	Some prior understanding (2)	Good prior understanding (3)	Very good prior understanding (4)
IV -2. Please indicate your level of knowledge increase on the biogas plant policy addressed in the training.			
Not increased (1)	Moderately increased (2)	Somewhat increased (3)	Significantly increased (4)

Do you have comments on the presentation of the Program?

If you need any further information, please write down additional comments:

Annex C: Feedback Form (Vietnamese)

Ủ phân gia súc và phát điện khí sinh học tại Việt Nam Chương trình nâng cao năng lực

Cảm ơn Anh (chị) đã tham dự Hội thảo “Xây dựng Năng lực tại Việt Nam - Ủ phân gia súc và phát điện từ nhà máy điện khí sinh học.” Qua khảo sát này, Ecosian thu thập thông tin để Đánh giá Chương trình Nâng cao Năng lực CTCN HTKT. Chi tiết hướng dẫn vui lòng tham khảo [phần mô tả bằng phong chữ in nghiêng](#).

Thông tin chung

Tiêu đề	「Ủ phân gia súc và phát điện khí sinh học tại Việt Nam」Chương trình nâng cao năng lực
Ngày bắt đầu	
Ngày kết thúc	
Địa điểm	
Thành phố	Hanoi
Quốc gia	Vietnam
Liên kết	
Loại hình liên kết	Chức vụ: <input type="checkbox"/> Cơ quan nhà nước <input type="checkbox"/> Công ty tư nhân <input type="checkbox"/> Phi chính phủ <input type="checkbox"/> Viện nghiên cứu, trường đại học, phòng thí nghiệm <input type="checkbox"/> Chính quyền địa phương <input type="checkbox"/> Khác <i>(Nếu chọn “Khác”, vui lòng cung cấp thêm thông tin ngắn gọn về Tổ chức.)</i> ▶
	Lĩnh vực tập trung / chuyên môn: <input type="checkbox"/> Chính sách <input type="checkbox"/> Công nghệ <input type="checkbox"/> Tài chính <input type="checkbox"/> Mạng lưới/kết nối <input type="checkbox"/> Khác <i>(Nếu chọn 'Khác', vui lòng cung cấp thông tin ngắn gọn về công nghệ hoặc chính sách đang hướng tới.)</i> ▶

Khảo sát

Vui lòng đánh giá (I) Mức độ hiểu biết, (II) Xây dựng năng lực và (III) Mức độ hài lòng với thang đánh giá từ 1 đến 5, sử dụng dấu “V”.

Ủi phân gia súc và phát điện khí sinh học

- Công nghệ kỵ khí và khí sinh học tại Hàn Quốc (BKT Việt Nam)
- Công nghệ khí sinh học tại Việt Nam (Trung tâm khí sinh học)
- Giới thiệu công nghệ khử mùi công nghiệp/gia đình (ODIN)

Câu hỏi	Hoàn toàn không đồng ý (1)	Không đồng ý (2)	Trung lập (3)	Đồng ý (4)	Hoàn toàn đồng ý (5)
I. Mức độ hiểu biết					
I-1. Hội thảo giúp tôi hiểu hơn về công nghệ sinh học					
I-2. Hội thảo giúp tôi hiểu được sự cần thiết của chính sách/công nghệ tương tự.					
II. Xây dựng năng lực					
II-1. Hội thảo rất hữu ích và liên quan đến công việc và khả năng nâng cao năng lực của tôi.					
II-2. Hội thảo giúp tôi chia sẻ kinh nghiệm nghề nghiệp với các đồng nghiệp.					
III. Mức độ hài lòng					
III-1. Hình thức hội thảo phù hợp với tôi.					
III-2. Thời lượng hội thảo phù hợp với mục tiêu và nội dung.					
III-3. Hội thảo với khung thời gian hợp lý cho phần câu hỏi và thảo luận.					
III-4. Nhìn chung, tôi hài lòng với khóa đào tạo.					

Vui lòng đánh giá (IV) Kiến thức theo thang từ 1 đến 4, sử dụng dấu “V”.

IV. Kiến thức

IV -1. Vui lòng cho biết mức độ hiểu biết trước đây của Anh (chị) về chính sách khí sinh học được đề cập trong hội thảo.

Không có hiểu biết trước đây (1)	Hiểu biết một chút (2)	Hiểu biết tốt (3)	Hiểu biết rất rõ (4)
IV -2. Vui lòng cho biết mức độ nâng cao kiến thức của Anh (chị) về công nghệ sinh học được đề cập trong hội thảo.			
Không cải thiện (1)	Cải thiện chút ít (2)	Cải thiện tương đối (3)	Cải thiện hoàn toàn (4)

Anh (chị) có nhận xét gì về phần trình bày của Chương trình?

Nếu anh (chị) cần thêm bất kỳ thông tin, vui lòng thêm nhận xét bổ sung:

Annex D: LOI from Trong Khoi Company Limited (English)

Dear Ecosian & BKT & Department of Livestock Production,

On behalf of [Trong Khoi Company Limited], we are pleased to announce our intention to support the pilot project resulting from "The pre-feasibility study for the Organic fertilizer and Anaerobic digestion to produce biofuels technology for Vietnamese agricultural sector," which is supported by the Ministry of Science and ICT Korea (MSIT) and the Korea Research Foundation (NRF) and supervised by the National Institute of Green Technology Korea (NIGT).

We recognize the potential benefits of biogas plants in our farm, particularly in addressing our waste management challenges and providing a reliable source of energy. We believe that this project could help us achieve these goals and benefit our local communities.

Therefore, we would like to express our sincere interest in collaborating with Ecosian & BKT Korea in Vietnam and [Trong Khoi Company Limited] to install a biogas plant project on our farm. We are fully committed to providing all necessary support and assistance to ensure the success of this project.

Thank you for considering our participation in this project. We greatly value the opportunity to work with Ecosian and BKT and Department of Livestock Production and hope that this collaboration will yield positive results for our region.



Director

Nguyễn Đăng Khôi

[Trong Khoi Company Limited]

Annex E: LOI from Trong Khoi Company Limited (Vietnamese)

Kính gửi Ecosian, BKT và Cục Chăn nuôi

Công ty chúng tôi trân trọng thông báo bày tỏ quan tâm quyết định hỗ trợ dự án thí điểm "Nghiên cứu tiên khả thi Công nghệ phân bón hữu cơ và phân hủy kỵ khí để sản xuất nhiên liệu sinh học cho ngành nông nghiệp Việt Nam," được hỗ trợ bởi Bộ Khoa học và Công nghệ Thông Tin Hàn Quốc (MSIT) và Quỹ Nghiên cứu Hàn Quốc (NRF) và được giám sát bởi Viện Công nghệ Xanh Quốc gia Hàn Quốc (NIGT) thông qua Cục Chăn nuôi.

Chúng tôi nhận thấy tiềm năng của các công trình khí sinh học ở Việt Nam, đặc biệt là trong việc giải quyết các thách thức về quản lý chất thải và cung cấp nguồn năng lượng sạch. Chúng tôi tin rằng dự án này có thể giúp địa phương nơi dự án triển khai đạt được những mục tiêu cũng như lợi ích cộng đồng.

Vi vậy, chúng tôi thống nhất hợp tác với Ecosian, BKT Hàn Quốc tại Việt Nam, Cục Chăn nuôi để khảo sát tiên khả thi trước khi lắp đặt một dự án công trình khí sinh học tại huyện Đồng Hỷ tỉnh Thái Nguyên. Chúng tôi cam kết sẽ hợp tác tối đa để mang lại sự thành công của dự án.

Chúng tôi xin trân trọng cảm ơn quý Ecosian, BKT Hàn Quốc tại Việt Nam, Cục Chăn nuôi và chúng tôi đánh giá cao cơ hội hợp tác này và tin rằng quan hệ hợp tác này sẽ mang đến kết quả là dự án được ký kết chính thức, triển khai và sẽ là một công trình khí sinh học tốt cho địa phương.

Kính thư,

CÔNG TY TNHH MTV TRỌNG KHÔI

Giám đốc



Nguyễn Đăng Khôi