Republic of the Philippines
Bureau of Fisheries and Aquatic Resources
(BFAR)

Pilot Survey for Disseminating SME's Technologies for Photovoltaic system (Solar Panel) as Power Source for Milkfish Production in the Philippines

Summary Report

March 2016

Japan International Cooperation Agency (JICA)

Power Bank System, Ltd.

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Contents

1. Background

As an important source of protein for Filipinos or as a potential products for export, the efficient mass production of milkfish is one of the key interests in the fisheries industry of the Philippines. However, its production is reaching the limit due to various problems, such as high fatality of fry, water pollution caused by overfeeding and delay of the dissemination of information on aquaculture technology.

Given such circumstances, and also Power Bank System, Ltd. (PBS) is interested in expanding business abroad by promoting its proprietary, originally-developed halotolerance solar panel as a power source of aeration in milkfish cultivation, it carried out a project entitled "Dissemination of the Utilization of Photovoltaic Power Generation in the Milkfish Farming Business" as a dissemination project for the government of emerging countries, under the commission of Japan Government ODA Overseas Economic Cooperation Project of the Year 2012. While the tendency of improvement in the fatality rate of fry due to the introduction of aeration was generally observed in the said project, data gathered in the experiment on both growth rate of the fish and improvement in water quality were not sufficient due to the restriction of timing and duration of the project. Therefore, further collection of data is desired.

In this survey, based on the results of the previous experiment, PBS shall perform demonstration (assessment and validation of concept) in order to gather additional data, conduct training for local personnel about the operation of solar-powered aeration system, and other activities for the dissemination of such system.

2. Outline of the Pilot Survey

2.1 Objective of the Survey

The purposes of the survey are as follows:

- Through experiments in two places, perform a comparative analysis for the subjects both in brackish water to test the effectiveness of the products in the Philippines. The measured parameters for the evaluation are as follows:
    - Growth rate of milkfish
    - Fatality rate of milkfish
- Provide trainings for aquaculture technology in the Philippines including developing capacity for the monitoring skills required in aquaculture of milkfish
- Business development of PBS in the Philippines including promotions to the government agencies.

2.2 Information of product/Technology provided

In this project, "UKISHIMA", a floating aeration device that consists of the following two products, Halotolerant Solar Panel and Microbubble Generator was installed.

Name	UKISHIMA
Specification	Microbubble Generator powered by halotolerant solar panels （For land） ・Function: Microbubble Generator powered by halotolerant solar panels ・Performance: Use submersible pump which has 400W（maximum 5units）

	・Valid range: About 20～30m from bubble nozzle ・Total power output: About 10kW（80W x 120 Panels） ・Battery：12V、100A、12 units（1200Ah） （For sea）3 units ※ the spec is for one unit ・Function: Microbubble Generator powered by halotolerant solar panels ・Performance: Use submersible pump 400W（maximum 2 unit） ・Valid range: About 20～30 m from bubble nozzle ・Total power output: About 3.4kW（80W x 42 Panels） ・Battery: 12V、100A、8 units（800Ah）
Feature	**・Ukishima System** The biggest feature of this system is that it is off-grid type solar system generating electricity in the sea easier than usual. That's because this system equips solar panels and batteries, it can work as an independent system in the sea. This system also does not need to use submarine cables, which cost a lot to install, and generators for power with charging. This advantage makes it possible to keep Micro bubble Aerator work with low running cost for a long term. **・Salt-tolerant solar panel** It is a solar panel made of polycarbonate instead of metals originally developed by PBS. Because of the materials used in the solar panel, it is light-weight and salt-tolerant compared to conventional mono crystal solar panels. It can be used on the sea for a long period of time. **・Micro bubble Generator** It is an ultrafine air bubble generating device developed by Kumamoto University and Prefectural University of Kumamoto that supplies the air into the water and stirs the water. It can be effective for avoiding lack of oxygen which might cause fish sickness. It's also effective on improving water quality in overcrowded farming case.
Comparative advantage with other competitors	It is light-weight and rust-free because it's made of polycarbonate instead of metals.
Sales performance domestic and foreign	1.The project is a collaboration between the industry and academe (Kumamoto University – School of Engineering, Kamiamakusa City, Kumamoto Prefecture 2010) 2.Demonstration the next generation energy project (Minamata City, Kumamoto Prefecture: METI From 2011 to 2014)
Installation location	<u>For Sea:</u> Size: 10,000mm x 8,000mm x 650mm Weight: About 2 tons (A little over 4kgs/ panel, Around 170kgs with 42 panels)
	<u>For Land:</u> NIFTDC garden pond, Dagupan City <u>For Sea:</u> First Experiment – Offshore in Sual Second Experiment – Offshore in Anda
The number of proposed products	For Land: 1 set For Sea: UKISHIMA – 3 sets
Price	Manufacturing Cost – Demonstrating System: For Land: 120 panels at 12 million yen/ set For Sea: 42 panels at 5 million yen/ set Selling Price per unit (one set) for the future: 3 million yen Total amount of equipment costs (including transportation fee): 33 million yen

Figure 1 Solar Power Generation System for Land (Left) and for Sea (Right)

2.3 Counterpart Country Government Agencies

The local counterpart agency is the Bureau of Fisheries and Aquatic Resources (BFAR) under the Department of Agriculture (DA). It is the concerned government bureau on fisheries and aquaculture of the Philippines. Other than holding various decision-making and licensing rights concerning Philippine fisheries and agriculture, BFAR holds a variety of research facilities in main farming areas for aquaculture.

2.4 Target Area and target group

After coordination with BFAR, Pangasinan Province was selected as a target area. Pangasinan Province where the industrial cluster of milk fish is positioned in the National Spatial Planning. Due to the abundant variety of fish species for aquaculture business where there is a chance to penetrate the luxury fish farming business with shrimp, oyster, crab, or grouper variety, Pangasinan Province was considered suitable site for this pilot survey. Target group is Fish farmers for milkfish production.

Figure 2 Location of the target area

2.5 Implementation System

This pilot survey was implemented the methods shown in Figure 3.

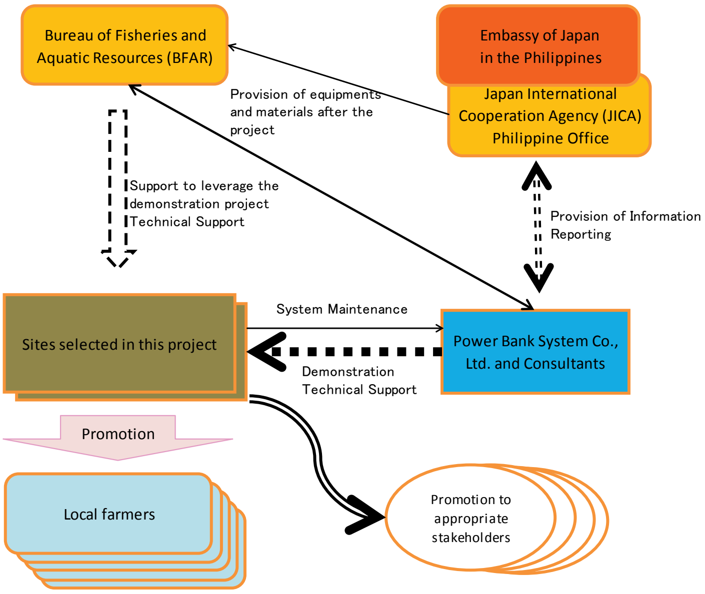

Figure 3 Implementation System

2.6 Project Schedule

This pilot survey was conducted from August 2013 to December 2015. Based on the original schedule, the third phase was supposed to be completed in January 2015, however due to the delay of preparation at the beginning, it had to be extended to December 2015. The original schedule is shown in Figure 4.

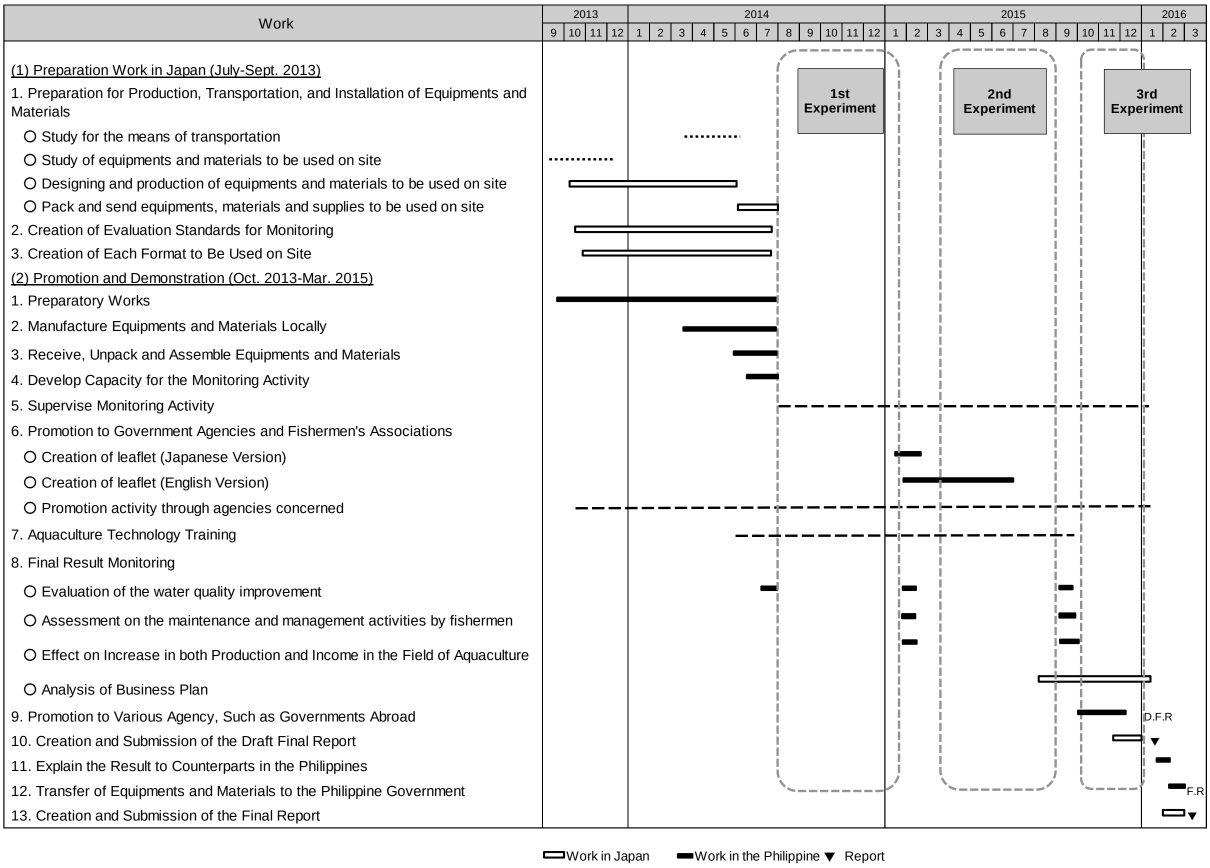

Figure 4 Project schedule

2.6 Manning Schedule

The manning schedule of this pilot survey is shown in Figure 5.

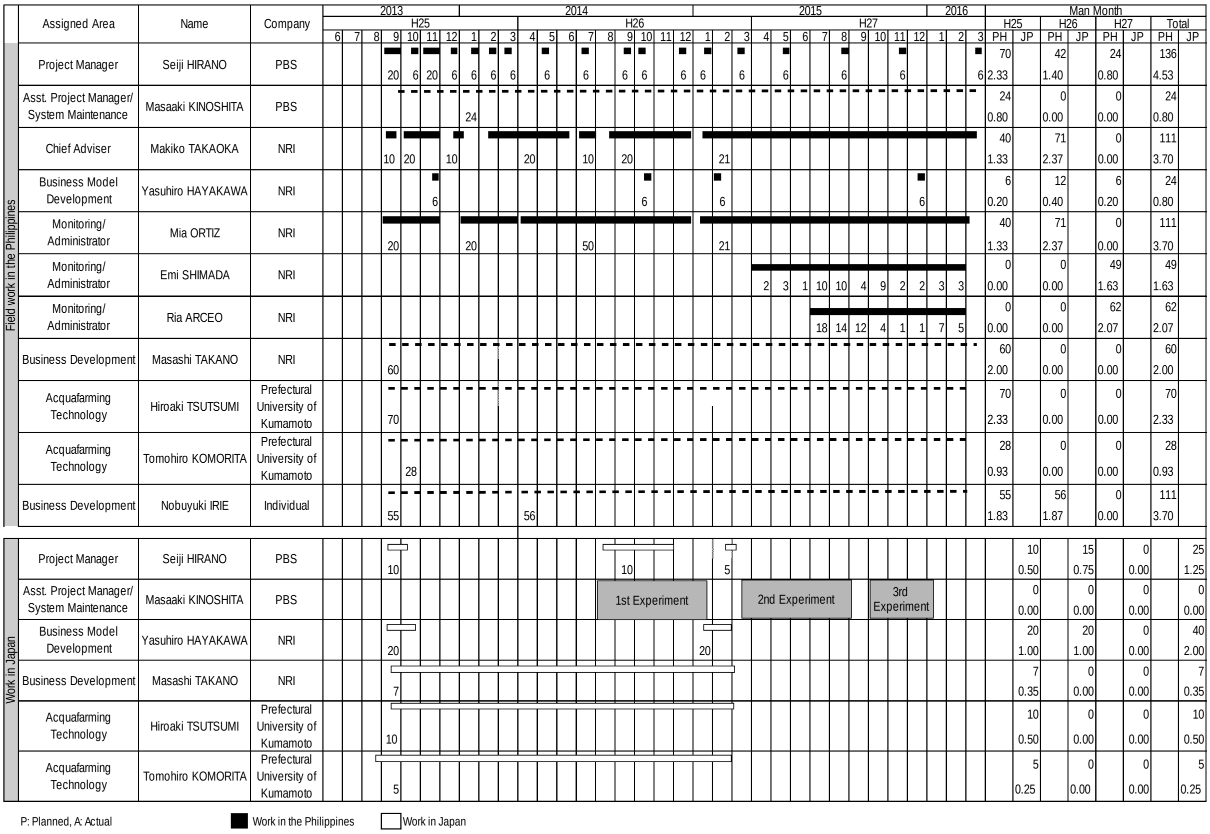

Figure 5 Manning Schedule

3. Achievement of the Survey

3.1 Demonstration and dissemination activities

There are three phases in this pilot survey, the Ukishima which is the technology provided was tested in the sea and in the land at each experiment.

Table 1 Summary of the two experiments in the sea

		The first phase experiment		The second phase experiment	
Location		Sual, Pangasinan		Anda, Pangasinan	
Period		Aug. 2014 – Dec. 2014		Mar. 2015 – Aug. 2015	
Subject fish species		Milk fish		Milk fish	
		Experimental pond (With aerators)	Control pond (Without aerators)	Experimental pond (With aerators)	Control pond (Without aerators)
Survival Rate (%)		95.6%	94.9%	88.4%	81.8%
Weight (g) (Average of cages)		225.3g	183.4g	324.0g	348.1g
Feed Conversion Ratio(FCR)		1.7*1	2.1*1	1.7	1.8
Dissolved Oxygen (mg/L)	AM	2.28～7.02	2.06～7.05	4.64～5.13	3.68～5.34
	PM	2.60～7.56	2.09～7.71	3.90～6.08	3.84～6.10

*1 based on recorded mortality

Table 2 Summary of the two experiments in the land

		The first phase experiment		The second phase experiment	
Location		BFAR-NIFTDC, Pangasinan		BFAR-NIFTDC, Pangasinan	
Period		Aug. 2014 – Dec. 2014		Apr. 2015 – Jul. 2015	
Subject fish species		Milk fish		Vannamei (White Shrimp)	
		Experimental pond (With aerators)	Control pond (Without aerators)	Experimental pond (With nano-bubble aerators)	Control pond (With US made aerators)
Survival Rate (%)		8.2%	0.0%	97%	96%
Weight (g) *Average of ponds		103.6g*1	100.8g*1	15.3g	15.4g
Feed Conversion Ratio(FCR)		N/A*2	N/A*2	1.08	1.10
Dissolved Oxygen (mg/L)	9AM	1.9～5.8	1.3～1.9	6.7	6.9
	3PM	5.8～11.5	2.1～10.4	8.9	8.2
	10PM	-	-	5.5	5.7

*1 the weight of the fish is as of Oct.
*2 due to the fish kill, the total biomass was not able to be measured.

3.1.1 First Phase Experiment

a-1) Sual (Fish cages in the sea)

- Survival Rate
  The survival rate of experimental cages (cages with aerators) is 95.6%, it is 0.7 points higher than control cage (without aerators). It seems that the aerators have little effect on the survival rate of the fish in the cages. This is most likely due to the good water condition in the Sual cove.

- Weight of Fish
  The fish cultivated in experimental cages with aerators are heavier by an average of 23% compared to cages without aerators upon harvest day.

- Dissolved Oxygen (DO) Levels
  The cages with aerators (Experimental cages) have higher DO levels compared to cages without aerators (Control cages). The experimental cages have generally higher DO level by 0.1%-23.5% in the morning and 0.2%-24.3% in the afternoon compared to the control cages. The DO level of experimental cages is able to reach the optimum DO levels (3pm above) up to depths of 9 meters in the morning and afternoon.

- Feed Conversion Ratio (FCR)
  There was a loss in the total biomass amount upon the harvest due to an operational problem, thus the theoretical computation of FCR is shown in Table 1 based on the last monitoring before the harvest. If the first experiment was able to realize the expected output, the cages with aerators (experimental cages) have an average of 1.7 FCR compared to the 2.1 FCR of the cages without aerators (control cages) (a 23% difference). This means that farmers can spend less of feeds and get a higher production volume. The average 1.7 FCR is lower compared to the standard FCR of milkfish in marine cages (from 2.0-2.5).

a-2) BFAR-NIFTDC (Fishponds in the land)

In the experiment with fish ponds, there are 5 ponds prepared as follows;

- Pond A: Pond without fish and without aerator
- Pond B: Pond with fish, without aerator
- Pond C: Pond with fish and with aerator
- Pond D: Pond with fish and with hybrid aerator
- Pond E: Pond with fish and with aerator

- Survival Rate

During the first phase, fish ponds experienced fish kill on the last week of October and so the month of November, it was reported 0.0% survival rate for the control pond (pond with no aerator). In spite of the fish kill, the survival rate of experimental ponds (ponds with aerators) is 8.2%. It means that aerator contributes to improve the survival rate. The pond E had the highest survival rate after the fish kill happened, however due to the high density in the pond and higher growth, most of the fish died from lack of air in a short period.

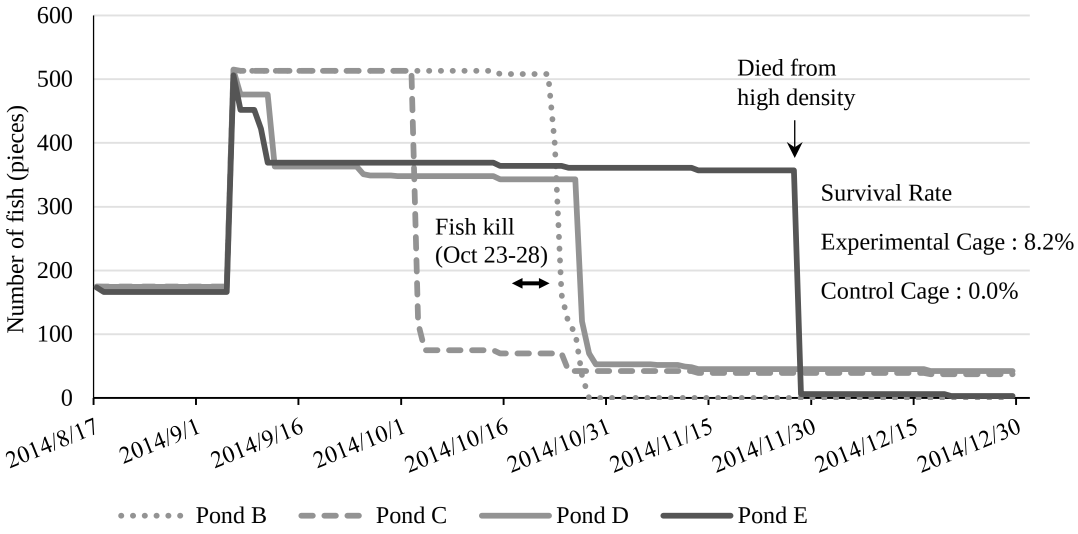

Figure 6 Survival rate of fish in ponds at the first experiment

- Weight of Fish

Since the fish in the control ponds died from fish kill in the last week of October, the weight data of control pond upon the harvest is not available. As of October, the average fish weight of experimental pond with aerator is higher than control pond by 3%. Especially, the weight of the fish in pond E which is with fish and with aerator is the higher than that of control pond by 20%.

- Dissolved Oxygen (DO) Levels

The average DO level of ponds with aerators is higher than control ponds without aerators in all the measured levels (surface, middle and bottom). In related to the fish kill, aerators contributes to improving the DO level so that the survival rate of the fish in the ponds with aerators is higher than that of control.

- Feed Conversion Ratio (FCR)

Due to the fish kill happened in October 2014 and suffocation happened in the pond E, there is no sufficient data available for calculating FCR.

3.1.3 Second Phase Experiment

b-1) Anda (Fish cages)

- Survival Rate

  The survival rate of experimental cages (cages with aerators) is 88.4%, it is 6.6 points higher than control cage (without aerators). This result is likely contributed by the two factors; (i) improved DO level by the aerators, (ii) high mortality with 4,000 fish dead occurred in the control cages due to the typhoon hit in July 2015 while the experimental cages had only 2,000 fish dead. Based on the DO level monitoring, there is no significant difference between experimental cages and control cages, thus this higher survival rate is not entirely contributed by the aerators.

- Weight of Fish

  The fish cultivated in experimental cages with aerators are lower in weight by an average of 7.43% compared to cages without aerators upon harvest day. It seems that due to the higher survival rate, the number of the fish in the experimental cages became larger than that of control cages, thus there were less space to grow for the fish in the experimental cages. This high density might have been affected on the growth of the fish in the experimental cages.

- Dissolved Oxygen (DO) Levels

  The DO levels of the depth from 0m to 10m don't have significant difference between the experimental cages and control cages. This might be caused by that the condition of the water changes every monitoring, and it's hard to equalize the base condition of the sea. In addition to that, the water environment of the experimental cages might have been worse than that of the control cages because of the location. The control cages were located closer to the sea opening, thus water in this location was exchanged better by tidal current. It might have resulted in providing better DO levels.

- Feed Conversion Ratio (FCR)

  FCR of experimental cages at 1.7 is 0.1 point lower than the FCR of the control cages (1.8). This means that feeds in experimental cages are more effectively converted into biomass. The FCR of both experimental and control cages are lower compared to the standard FCR of milkfish in marine cages (from 2.0 – 2.5). This means that farmers can spend less of feeds and get a higher production volume.

b-2) BFAR-NIFTDC (Shrimp School)

The second experiment in the land was designed with vannamei shrimp as target fish species, and the both ponds (experimental pond and control pond) had aerators. The results for this experiment as expected, were two points: (1) an improvement in the survival rate and growth rate due to an increase in the DO level and (2) reduction in the electric power cost by using this system as the power source for the aerator. The nano-bubble aerator was used in the experimental cage while US-made aerator was used in the control cage. The nano-bubble aerator is reported to generate fine bubbles being able to stay in the water longer than the bubbles generated by the conventional aerator, thus it is expected that DO levels of experimental pond is higher than that of control pond. The consumption of electricity was measured to calculate and compare the cost of the electricity between the pond with solar powered aerators and the pond with normal powered aerators.

- Survival Rate

The survival rate of experimental pond is 97%, it is 1.0 point higher than control pond. This result is likely contributed by the nano-bubble aerator, however there is no significant difference between experimental cages and control cages, thus this slightly higher survival rate is not entirely contributed by the aerators, but might have been contributed by the better water environment including algae growth and inorganic factors.

- Weight of Shrimp
  The weight of shrimps cultivated in experimental pond is lower by 0.6 % than that of control pond on harvest day. However this difference is only 0.1 gram in the absolute figure, it is not the significant difference.

- Dissolved Oxygen (DO) Levels
  The experimental pond had higher DO level than control pond in the afternoon (3pm), but had slightly lower DO level than control pond in the morning (9am) and at night (10pm). It is not the expected result under the experimental design, the DO level in the experimental pond was expected to have higher than that in control pond in the morning and at night. It might be attributed to the difference in performance between aerators, the improper location of the nano-bubble aerators, or disparity in the prerequisite conditions (water quality and temperature, etc.). Another possibility is that method of monitoring DO level is compromised as monitoring staff's skill is insufficient. Since survey team was not allowed to participate in actual monitoring in the shrimp school due to the bio security purpose, provided data might be low reliability. Considering the performance of aerators, the output capacity of the US-made aerator is higher than that of the nano-bubble aerator (US-made aerator is 2 Horse Power, 3.8 times larger than nano-bubble aerator), thus more air might have been be supplied. As the fact, the number of the nano-bubble aerators installed was two at the beginning of the experiment, however as shrimps grew larger, the more aerators were needed to prevent severe mortality. Based on these facts, the lower DO levels in the experimental pond in the morning and at night might be contributed by the less capacity of the aerators used and improper location of aerators set in the experimental pond.

- Feed Conversion Ratio (FCR)
  FCR of experimental pond at 1.08 is 0.02 points lower than the FCR of the control pond, there is no significant difference in both ponds.

- Electricity consumption during the experiment
  Due to system control panel malfunction, only a reduction in electricity cost for an aerator was achieved. Assuming that the system performs fully operation, electricity costs can be reduced up to Php 20,700. If there are 3 culture periods in a year, yearly cost reduction is at Php 62,100. Considering total investment and maintenance at Php 1.5 million and annual increase in electricity at 3%, return on investment will take around 20 years. Return on investment can be shortened to 11 years if US-based aerator will be utilized (2 horsepower at around 1,500W) due to calculated yearly cost reduction benefit of around Php 137,040. The only problem would be that the system is not designed to be connected to a 2 horsepower aerator. There is a need to revise the system if this is the case.

3.1.3 Third Phase Experiment

In the third phase experiment, the monitoring of the performance of Ukishima system is focused. For the land based Ukishima system, the scale and output capacity of the system are redesigned to fit for the practices of in land aquaculture industry.

c-1) Floating Ukishima system

Since the actual performance of Ukishima system such as power generation, battery performance, or effectiveness of aerator are not monitored in the previous experiments, and there is no available data in PBS, the following performance indicators were monitored.

- Performance of Power generation of solar panel (monitoring once a month)
  - Measure the voltage of electricity transferred from solar panels to batteries

- Performance of batteries (monitoring once a month)
  - Monitor duration of the charging and discharging of batteries
  - Monitor degradation level of batteries (Measure the voltage of newly installed batteries and monitor the duration of aerator continuously operated)

- DO level while aerators operate (monitoring twice a day, three times a week)

Due to the damage by the typhoon during the send experiment, system B was concluded as not being operational by the Japanese engineer, thus the monitoring was conducted on the remaining two systems (system A and C).

Methodology of monitoring performance of Ukishima system

The brief configuration of Ukishima system is shown in the figure 7. The Ukishima system is consisted from 4 functional units such as, (i) solar panels, (ii) control panels, (iii) batteries, and (iv) aerator.

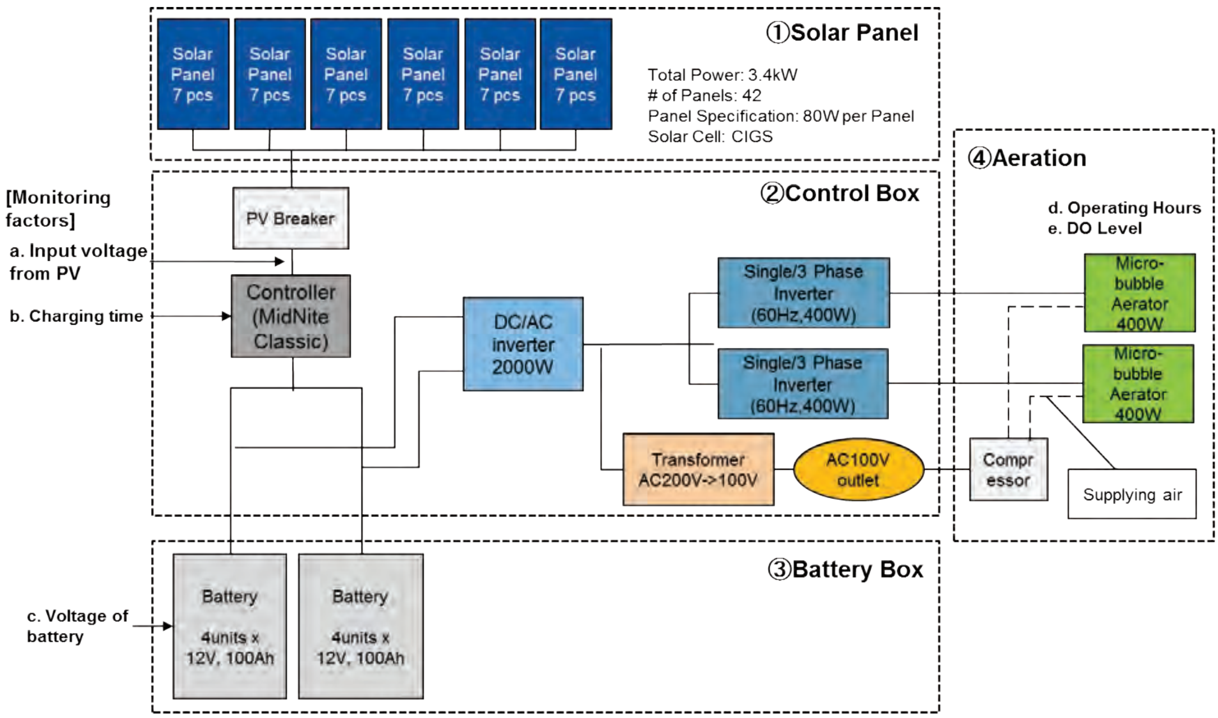

Figure 7 Configuration of Ukishima system (Floating type)

Table 3 Results of monitoring

<table>
<tr><td rowspan="2"></td><td>Month</td><td>September</td><td>October</td><td>November</td><td>December</td></tr>
<tr><td>Weather / Indicator</td><td>Sunny/Cloudy</td><td></td><td>Sunny</td><td>Cloudy</td></tr>
<tr><td rowspan="3">System A</td><td>Input voltage upon power generation*1</td><td>112.2V</td><td rowspan="3">No data*3</td><td rowspan="3">No data *3</td><td>115.9V</td></tr>
<tr><td>Duration of charging batteries*2</td><td>5 hours</td><td>2.4 hours</td></tr>
<tr><td>Duration of discharging (operational time of aerators)</td><td>3.7 hours</td><td>1 hour</td></tr>
<tr><td rowspan="3">System C</td><td>Input voltage upon power generation*1</td><td>82.4V</td><td rowspan="3">No data*3</td><td>101.9V</td><td>91.1V</td></tr>
<tr><td>Duration of charging batteries*2</td><td>Batteries didn’t reached to fully charged after 7 hours of charging</td><td>Batteries didn’t reached to fully charged after 7 hours of charging</td><td>Batteries didn’t reached to fully charged after 6 hours of charging</td></tr>
<tr><td>Duration of discharging (operational time of aerators)</td><td>13 hours</td><td>8 hours</td><td>7.7 hours</td></tr>
</table>

*1：Average input voltage from solar panels(8am to 2pm)
*2：Duration of charging time until control panel display shows “FLOAT”
*3：No monitoring due to recovery work from the damage by typhoon

The following observations are a brief summary of assumptions from system monitoring results.

Solar System performance
System A:

- Charging is very fast but also fast discharge
- Might be due to old batteries or malfunctioning charge controllers
- System does voltage equalization (voltage is equalized among batteries so a malfunctioning battery will cause system to shorten running time)

System C:

- Batteries unable to fully charge may be due to:
  - Malfunctioning solar cells
  - Malfunctioning panel cables (1 malfunctioning cable affects 30% of charging capacity)
  - Malfunctioning charge controllers
- Water may have entered control box during the typhoon and causes malfunctioning of charge controllers
- Volt-in displayed by charge controller is low and not enough to fully charge batteries (below 90v – 100v only)

Effectiveness of micro-bubble aerator

In the third experiment, no significant difference between the area with aerator and without aerator was observed. It is attributed to the capacity of the aerator or the severe condition of water. The population of fish cage in Anda is relatively high, the area of monitoring can be considered as high-oxygen demanding area. In order to monitor the actual effectiveness of the aerator, selecting the monitoring area where the condition of the water is relatively equal, it is recommended to use the aerator in the closed environment such as pond.

c-2) Land based Ukishima system

The performance of the land based Ukishima system was monitored during the second experiment. Since the duration of operational time of the aerator was almost the same as theoretical figures, it is concluded that there was no major problem on the power generation, charging and discharging batteries. However, the output capacity of each line on the system is limited up to 400W, technically the land based Ukishima can't operate paddle wheel or conventional aerator with 1 or 2 horsepower normally used in the aquaculture business. In order to meet those needs, re-designing of the system was considered. New design of land based Ukishima system equips 40 pieces of 80W solar panels, the total output capacity is 3.2kW. It features one output line with 3 phases 200V, 1,500W, and another output line with 3 phases 200V, 400W. This new model is smaller than the original land based Ukishima system, it's not suitable for using 24 hours due to the capacity of total output. It targets the aquaculture farmers who needs intensive aeration usage during daytime or critical time (1am to 5am) only. With this downsizing, the land based Ukishima can achieve the reducing the initial cost of installing.

3.2 Future Business Plan

3.2.1 Product Planning and Target Figures

Table 4 Product list

Item	Sales Unit	Purpose	Production
Ukishima system (land based or floating)	Solar generation system	Aeration, paddling, lighting	Japan, local
Solar panel	Solar panel (single item)	Lighting, etc.	Japan
Mobile phone charger	Charger (Finished product for consumers)	Charging a phone	Japan

Table 5 Target figures

Item	Unit price (thousand JPY)		2016	2017	2018	2019
Floating Ukishima	3,000	Unit	1	3	5	10
		Price	3,000	9,000	15,000	30,000
Land based Ukishima	3,000	Unit	1	3	5	10
		Price	3,000	9,000	15,000	30,000
Solar panel	30	Unit	50	200	500	1,000
		Price	1,500	6,000	15,000	30,000
Mobile charger	10	Unit	50	300	1,000	2,000
		Price	500	3,000	10,000	20,000
Total			8,000	27,000	55,000	110,000

3.2.2 Business Plan

Table 6 Five-year Business Plan

	2015	2016	2017	2018	2019
Key activity	Market research searching the local agents	Individual contracts, negotiation with the local agents	Contracts with the local agents	Sales and technical assistant for the local agents	Overseas business expansion
Sales activity	Initial contact, needs understanding	Following the potential partner companies	Following the local agents	Following the local agents, further customer development	Overseas business expansion
Manufacture and procurement	Procurement mainly from Japan, and from others	Consideration of local production	Commencement of local production (2, 3) choosing the partners	Commencement of local production (1)	

3.2.3 Marketing Strategy

Selling points of PBS's solar panel are using renewable energy and being installable on the land or the sea

- Floating system (on the sea)
  The smaller size floating system would be promoted as well as the same scaled system tested in the pilot survey. The floating system would also be promoted as a power generating system for selling electricity purpose.
- Land based system
  Land based system would be promoted not only as an off-grid type solar powered system, but also as an on-grid system connected to normal power supply. With the combination of solar power and normal power supply, cost effective operation can be realized. For example, solar power can operate paddle wheels or aerators during the daytime, and also can charge the batteries at the same time. Also, the charged batteries can operate aerators at night, and if the power from batteries is short, normal power supply can be the alternative power source.

The feasibility of selling floating system tested in this pilot project to milk fish aquaculture industry seems low at this point due to the following points:

- The cost-benefit performance of Ukishima system is not expected in the milk fish aquaculture industry where the farm gate price is very low (Initial cost is much higher than income).
- It is sometimes challenging to keep the device set effectively because of strong environmental influences such as current and water temperature.
- Since it is an off-grid system, the power supply is intermittently (It depends on the weather and battery capacity).
- Frequent system maintenance is required, especially when typhoons damage the system.

On the other hand, inland aquaculture such as cultivating shrimp where the water environment is relatively closed, it might lead to better business results.

- Farm gate price of shrimp is high and business scale is also large. Therefore, farmers might be able to afford the system.

- Due to the closed environment, the system is not hugely affected by the natural environment.
- The normal power supply can be used as alternative power source if solar power is not available.
- System maintenance is easier compared to the system installed on the sea.

a) Sales concepts of solar panel

The strong selling points of PBS's solar panel are its salinity tolerance, lightness and durability. PBS's solar panel utilizes its strength especially in the coastal area or on the sea. For those area, simple usage of solar panel being assembled with a battery and a controller is proposed for charging mobile phone or lighting. In this usage, battery and controller can be prepared by users since those parts are widely available in the market. With this business model, PBS specializes in selling only solar panels and can minimize the risk of customer service for trouble shooting because warrantable item is only solar panel. Moreover PBS solar panel guarantees 10 year warranty, it means that the product can last for 10 year under the proper usage, thus the estimated cost of this proposed usage (assembling solar panel, battery and controller) is approximate 3 pesos (10 Japanese yen) per day that can be a strong appealing point for supplier and users. In order to validate this example usage, an assembled lighting set consisted of one solar panel, one battery, one controller, and one LED light was placed in Sual, Pangasinan in March 2015, then a survey was conducted targeting the users involved in aquaculture business there. Based on the survey, positive comments were given by respondents, the security of the area was improved with the light turned on through the night. Moreover, the installed solar powered light got reputation among the area, and this reputation reached to the local government unit (LGU) in Sual. This survey result shows that PBS's solar panels can enrich the public's welfare especially in coastal area. In farming area in Sual, there are more than 100 guards in charge of monitoring around 200 cages. Assistance from LGU would be a key to enhance disseminating PBS solar panels not only in this area, but also for all over the Philippines.

b) Sales concepts of mobile charger

This charger is a small solar panel with a USB terminal. This product is already sold in Japan and the sales promotion in the Philippine has just started.
The potential application or usage for the product are following:

- In a construction area
- On a beach or a poor side
- Public transportation
- On a fishing boat
- In a plantation or a farm
- The area with frequent power outage (e.g. Mindanao region)

c) Potential Target Countries for Ukishima System

Ukishima system equips a micro-bubble aerator and solar panels. Each device has a strong selling point that can maximize the possibility to penetrate the market.

(c-1) Aerator

- Shrimp farming

  CP group (Thailand), which is the world biggest farming company shows an interest in the new cultivation method using the panels and aerator. As the company already runs a huge business, there are more chances to sell PBS products. Shrimp farming needs much electricity-running aerators to sustain shrimp's growth and health. However, because of frequent blackout, the business owner is required to set a large generator or an aerators powered by diesel fuel. If the initial cost of Ukishima system can be lower enough to compete with the cost of generating electricity by diesel fuel and its maintenance, there is an opportunity to sell the system not only in Thailand, but in other countries such as Vietnam, Indonesia and Myanmar where the power supply is not stable.

- Fry farming
  In the previous project with fry farming, micro-bubble aerator contributed to significant low mortality. It will be an attractive point for aquaculture owners who have difficulties with high mortality of fry. In addition to this advantage, the solar panel can appeal as an eco product since “eco-farming” is current concerns from customers to aquaculture industry. There would be needs in Norway or Chile where fry farming of salmon is active and the industry has started tackling on eco-farming.

(c-2) Solar panel

- Lighting power source for sea cultivation
  In island countries or coastal areas, such as Indonesia, Vietnam, Africa and Carib, we could stress on its salt durability of our culture system.

4. Future Prospects

4.1 Impact and Effect on the Concerned Development Issues

In this pilot survey, establishing the land based Ukishima system can be considered as the impact on development. By using the combination of the normal power supply and solar powered supply, the local supplier can easily handle the system as the same configuration as conventional solar system is installed. For the actual marketing, marketing of the downsized land based Ukishima system would be more effective to penetrate the aquaculture market, it shall propose not only aeration purpose, but also other functions such as usage for paddle wheels, communication technologies, or other monitoring devices. For sales and marketing, establishing the marketing network or having business partners is estimated to take a little bit longer time. Since the flexible and light solar panel has got good reputation and interests from potential customers during the pilot survey, settling down the marketing environment and marketing strategy for solely selling solar panel shall be focused first, then expand the sales and marketing activities for land based/floating Ukishima system based on the established network with suppliers.

4.2 Lessons Learned through the Survey

The following 4 points are the learnings from this pilot survey.

① Difficulty in comparing environmental parameters under the nature environment

In this survey, comparison of experimental area and control area was the key to measure the effectiveness of the Ukishima system. However, the survey didn’t get the expected data. Preparing the experimental and control area to be the same condition was hardly achieved under the natural environment.

② Difficulty in collaborating with private sector

On the second experiment in the sea, the pilot survey was conducted collaborating with a private business owner of milk fish aquaculture. Since the private sector pursued the profit and avoiding mortality, they changed the feeding practice or added fingerings without notice while the survey needed the stable operation and no change of initial setting. It resulted in obtaining unaccountable data. Although collaborating with private operator was the request from the counterpart, control of the experiment shall be well discussed with counterpart in order to obtain accountable scientific data.

③ Professional skill of monitoring staff

The professor in the survey team suggested having monitoring staff with professional skill or knowledge on aquaculture to obtain data of environmental parameters, and then survey team requested the counterpart to recommend the personnel. Although instruction and training were conducted before the pilot survey started, there were many issues occurred due to the capability of the monitoring staff, such as lack of good maintenance of monitoring equipment, quick resignation from the project, or lack of calculation skill. In order to overcome those issues, obtaining human resource with fundamental knowledge of science of fisheries, especially water quality monitoring and quick learning competency is necessary. Improving the competency human resource in the Philippines would be a suggestion for counterpart as well to obtain better outcomes in another pilot survey in near future.

④ Risks on procurement of parts and technical service

In this pilot survey, local procurement of parts for the solar system was maximized. Due to the locally purchasing, the cost of the system was reduced, but on the other hand, the risk of having defectives or inefficient service increased. For example, the batteries locally purchased got easily deteriorated in a short period, eventually the operational time of aerators got shorter than expected. This problem affected on the experimental data. Also, the lack of knowledge on electrical engineering was affected on this survey largely. Not only the local supplier or cooperator, but also the survey team didn’t have the human resource with sufficient knowledge, the identifying the problem and solving it took long time.

4.3 Recommendation through the Survey

The recommendations are the following 3 points.

①Improvement on procedures to utilize the unique product into ODA scheme

In order to consider the utilization of PBS products, the existing ODA scheme doesn’t fit. PBS solar panel is suitable for the projects where emergency power supply needed on disaster or special function such as applying to the curve area is required. With regards to it, applying the general scheme requesting to generate electricity by solar powered system where the price drives the competition doesn’t work for PBS products. The reality is that there is no suitable project scheme rather than ODA loan project, “pilot project” formulated through data collection survey or technical assistance for utilizing PBS’s solar panel.

On the other hand, this new scheme, the disseminating Small Medium Enterprise’s (SME’s) technologies scheme, is observed to commission to the niche technologies that have not been seen in the market, there is a mismatch between the existing ODA scheme and the new scheme. For example, if the bidding document for the procurement of technologies and products clearly states that “pilot project shall utilize the technology of SME proposed in SME supporting project.” in the data collection survey or “pilot project” formulated through technical assistance, the opportunities to utilize niche SME technology hugely increase.

②Utilization of the training in the third country

Using the training in the third country is one of the most effective methods to disseminate the technology of Japanese SMEs to the world and to generate the seeds of ODA projects. However, consultants don’t have the know-how on the third country training, only JICA has the know-how. In this pilot survey, the de facto formulation of third country training for aquaculture technical skill was originally envisioned, but due to the malfunction of the system and unaccountable experimental data, this envision was given up.

As an expectation to JICA, at the very beginning of pilot survey for disseminating SME’s technologies, considering providing supports to the SME’s products which have the potential to expand the market to the third country is strongly requested.

③Establish the database of SME and its products for pilot survey for disseminating SME’s technologies

PBS’s Ukishima system is consisted from 4 functional units such as controlling box, solar panel, batteries, and aeration, each functional unit can be considered as an individual business line. Furthermore, there might be another SME developing the more advanced functional unit than PBS. If those information is available in public, improving the products to be fit in the country where the survey is conducted. For example, in this pilot survey, the system got damaged due to the little lizard trapped inside the system. If only the information of technologies such as painting to avoid insects and lizard is available, this problem could have been solved and the product would have been improved to fit to the local environment. It also would be useful for SMEs to improve their products if the database has the information of all technologies proposed by SMEs to JICA regardless of it was adopted in the project or not. Furthermore, this database would be able to formulate a platform as an open source utilized on ODA projects.