

A study of solar energy for an aquaculture in Jakarta

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Abstract. This paper presents the study of integrating solar panel over a grouper fish cage culture. The study is aimed to investigate the required illuminance for the fish to grow. This aspect is necessary since the application of the solar panel will affect the illuminance below it. The results showed not all the PV panels type could facilitate the required illuminance. The steps of study is as follows: (1) to study the optimum light for the growth of the grouper fish, (2) to study the structure of the floating net cage, and (3) to study the optimal solar panel type that later will be integrated with the selected facility building

Keywords: solar energy application, aquaculture, grouper fish

1. Introduction

This study was raised based on one of United Nations Habitat programme that focused on a better urban future. The mission is to promote socially and environmentally sustainable human settlements development and the achievement of adequate shelter for all. This vision basically occur, since currently many cities in the world are facing a huge challenge of its demographic, environmental, social and spatial as a results of rapid urbanization. To overcome the challenge, the UN Habitat has seven focus areas as their strategic plan. They are as follows [1]:

- Urban legislation, land, and governance,
- Urban planning and design,
- Urban economy,
- Urban basic services,
- Housing and slum upgrading,
- Risk reduction and rehabilitation, and
- Research and capacity development.

The third focus essentially is the one that the local government of Indonesia is now actively doing to improve its urban economics. Jakarta, the capital city of Indonesia that is becoming an extensive urban area and it has spread out to the islands in the northern. There are several island in its northern region and the inhabitants are mostly fisherman. Currently, the island is now an urban area whereas some of the inhabitants are still fisherman and are having aquaculture as their main income.

Aquaculture is one the potential to be developed since Indonesia is a maritime country that rich with its marine wealth, however, the facilities to support the utilization of the maritime wealth are generally lack. An aqua culture, one of several prospect business, is still need improvement to run its activity.

Panggang island, the selected area for this study, is one of many islands in the northern Jakarta. The island has a wide coral area. This wide coral is used as grouper aquaculture by the inhabitants since coral area is the proper habitat for the grouper cultivation. So that the government of DKI Jakarta provides capital loans to cultivators with a profit sharing system of 20-80, 20% of profits for the



government which will be returned to the cultivation agent in the form of cultivation facilities, while the 80% profit for the cultivator itself [2].

The grouper fish cultivation system that fits in the oceanic land and has been used by the inhabitants is the floating net cage system, because this floating net cage is used by utilizing land in the form of water for cultivation. Another reason to cultivate this type of fish is because the fish is high in nutrition as well as the sale price [3].

There are some facilities in the aquaculture area, and in order to support the facilities, electricity is required. Today, the main source of the electricity is from the local grid owned by the local government. However, according to the Indonesian Energy Outlook, the use of fossil fuel as the electricity source should be reduced at around 30% by 2030 and it is valid for industry sectors [4].

Based on the data made by the Ministry of Energy, the most potential renewable energy are bioenergy, geothermal and solar energy consecutively (Tabel 1) [4]. The first two options are preferably produced on the ground, whereas, the study investigate the energy alternative that can be integrated with the aquaculture facilities. As such, this study chose solar energy as the object research.

Essentially, this paper presents the initial study and it contain the study of: (1) to study the optimum light for the growth of the grouper fish, (2) to study the structure of the floating net cage, and (3) to study the optimal solar panel type that later will be integrated with the selected facility building.

Table 1. New and Renewable Energy Resources

Energy Source	Resources	Installed Capacity	Utilization (%)
Hydro	94,476 MW	5,024 MW	5.3
Geothermal	29,544 MW	1,403.5MW	4.8
Bioenergy	32,000 MW and 200,000 bpd BBN	1,740.4 MW	5.4
Solar	4.80 KWh/m ² /day ~207.9 GW	78.5 MW	
Wind and Hybrid	3-6 m/s ~60 GW	3.1 MW	
Marine Energy	61 GW Wave:1,995 MW Ocean Thermal (OTEC): 41,001 MW Ocean wave: 17,989 MW	0.01 MW	
Shale Gas	574 TSCF		
Coal Bed	456.7 TSCF		
Methane (CBM)			

Source: <https://www.esdm.go.id/>

2. The methodology

2.1. The method of study

The diagram below shows the methodology applied in this study (Fig.1). The study is basically a literature review of the optimum illuminance for the growth of grouper fish, the floating net cage structure and the PV panel type. The result of the study is a concept of integrating PV panel over the floating net cage system or Keramba. Moreover, the selected panel should be made of material that can resist the high temperature, as Pulau Panggang is in the tropical region.

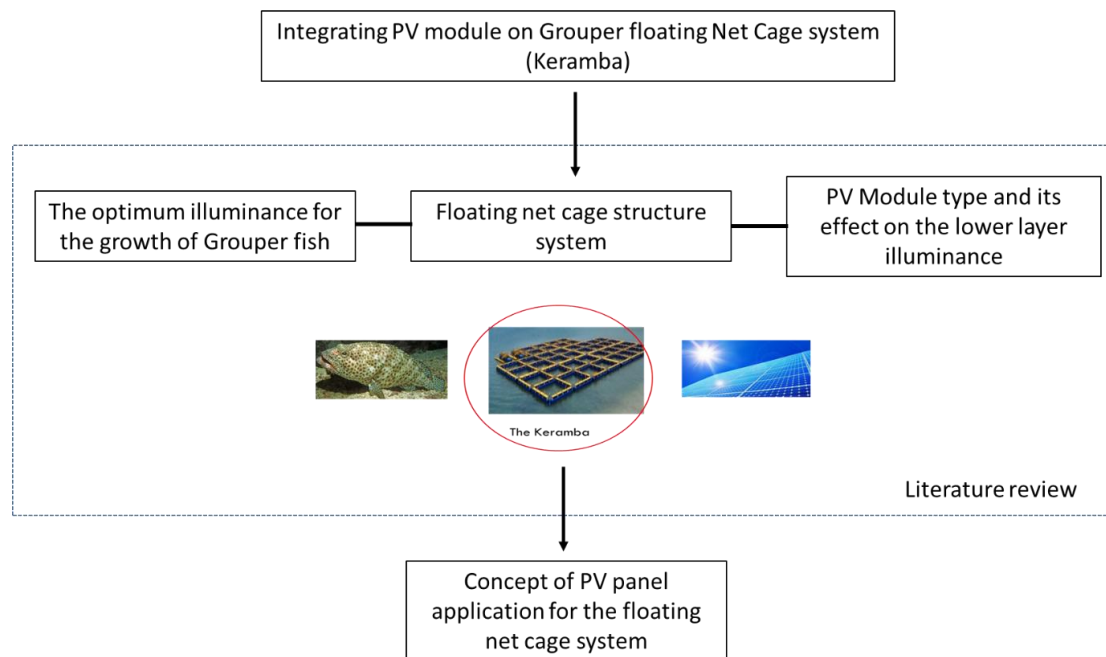


Figure 1. The diagram of methodology

2.2. The case study

The study selected Pulau Panggang, an island in northern of Jakarta (Fig 2 a, b). The regional boundaries of the island is as follows: North Side: $05^{\circ}41'41''$ S - $05^{\circ}41'41''$ S and $106^{\circ}44'50''$ E. The inhabitants has developed an aquaculture since the local government has banned purse seine to harvest fish which resulted in the reduction of their income. The cage they apply is a Keramba or a floating net cage to grow the fish. The area of Keramba is quite wide and this is the main facility of the aquaculture. Therefore, this facility is a potential area for adding some PV modules.



Figure 2 a). The Panggang Island that is located at the north of Jakarta

2 b). The location of the floating net cage or Keramba

Source: google maps



Figure 3. The Keramba or the floating net cage

Source:

3. Result and Discussion

3.1. The optimum illuminance for the growth the grouper fish

Based on the Better Management Practise book [4] the fish calendar of the grouper is presented in Fig.

4. The critical phase of the growth of the fish is at the third step which is happening for about 5 months.

This phase need a proper environmental condition and one of them is illuminance [5].

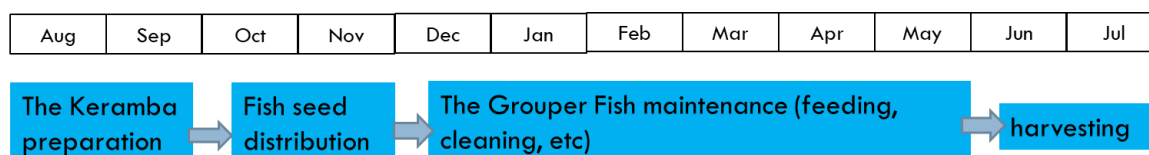
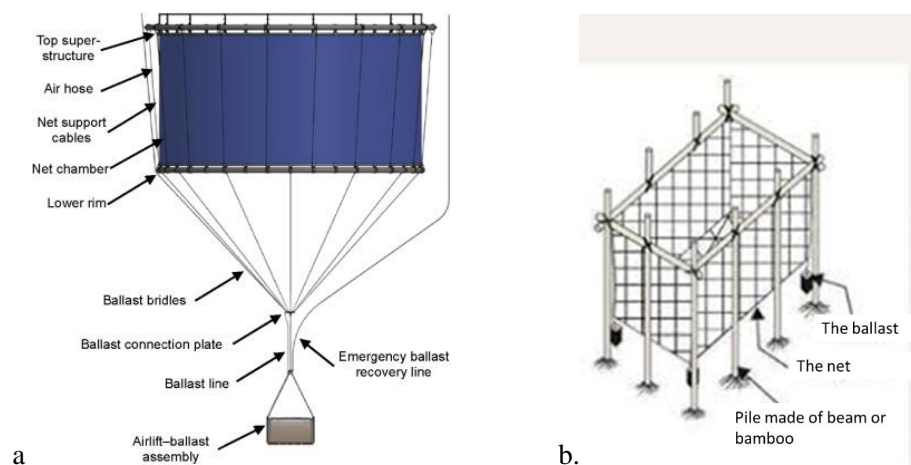


Fig 4. The calendar of grouper fish development [4]

A research that conducted in Indonesia, has revealed that the grouper fish can growth significantly under 200 lux [4]. This research using half cover over a experimental tub. Another research, conducted in China, showed that the specific growth rate (SGR) of the grouper fish as well as their weight and survival rate were significantly higher in the between 320-1150 lux treatment [6]. Also, a research found that the type of fish like the grouper fish could growth well under 600 lux [7]. As such, the proper illuminance for the growth of the grouper is between 200 and 1150 lux.

3.2. The floating net cage system

There are several floating net cage system structure. However, in accordance to the principle of Sustainable Development, whereas the local material should be the priority in selecting the material used, therefore, the analysis focused on the net cage system that apply local material. In general, the variety of the net cage system are mooring system and pile or pole system (Fig. 5a, b). The mooring system uses rope to fasten the net, while the pole system uses column that can be made of concrete or beam to fasten the net. The pile can be made of bamboo or timber. The material can be found in local area



**Figure 5 a. Mooring system [7],
5 b. Traditional pile system [4]**

Based on that systems mentioned above, the most appropriate structure to support the PV module is the one with pile system. This system could be more stable and be able to retain the weight of the PV panel construction.

3.3 The PV module type

Based on the facts above, the selection of the PV modules is mainly focused on the resulted level of illuminance below the panel. As such, the study deployed three type of panel to investigate the illuminance below the panel and they can be described as follows (Fig. 6 a.b and c):

1. Panel with fully covered with solar cell
2. Panel that has transparent area in between the solar cell
3. Panel with transparent solar cell film



**Figure 6 a. The solid PV module
6 b. The semi transparent PV module
6 c. The transparent PV moudule**

From the measurements, the most potential of the panel is the panel with transparent material in between the solar cell. The illuminance below the panel is around 300 to 500 lux. The fully covered PV module of solar cell resulted in a dark condition with the illuminance less than 100 lux. The last PV module type or the transparent resulted in a high illuminance at above 1200 lux.

Indeed, the hypothetical concept in using PV module could be the one with transparent area between the solar cell or the second type. The concept of using this type is also considered from the original habitat of the grouper fish. The characteristic of the habitat is generally at the depths of ± 10 -11 meters indicate groupers prefer watersheds with hard coral habitat dominated by coral massive mounds that form holes and the behavior of grouper move and pair in a dark place (low visibility) with low light intensity [8].

Additionally, since Pulau Panggang is an island that in the tropical region, therefore, the appropriate technology for the solar cell is made of amorphous [9]. This type of technology could response the high temperature because of the high solar irradiance.

4. Concluding Remarks

The study of PV module type in order to be applied in an aquaculture has been conducted and the remarks can be conclude as follows:

- The grouper fish could be growth properly under 200-1150 lux.
- The appropriate structure type to support the PV module over a net cage is the one with pile system and the material can be found in the local area since it can be made of timber or bamboo. This kind of materials should be applied to an area with small waves.
- The most appropriate type of PV module is the panel with transparent area in between the solar cell.

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