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DEVELOPMENT OF SOLAR POWER PLANT FOR FISH COOLING IN THE FISHERMAN SHIP

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ABSTRACT

Indonesia as a maritime country with most of its territory is the sea and is located right in the equatorial region with abundant potential of solar energy and marine fish. So far, fishermen using fishing boats are very wasteful because they use two engines, the boat engine and the engine generating electricity on the ship. The operational costs of fishermen going out to catch fish and transport fish are very high, resulting in poor and marginal fishermen. This study aims to provide solutions for fishermen to utilize solar energy as a source of electrical energy for fish cooling and lighting on fishing boats at night.

Keywords: power plant, solar cell, fisherman.

1. INTRODUCTION

Energy is one of the bases for the development of a country and is crucial to enhance technological development and national economic growth [1]. In most developing countries, people are highly dependent on the national electricity grid, but serve a large population. There are still many remote areas which are not connected to the electricity grid and which are connected have a low dependency on the electricity network due to irregular supply [2]. This is due to the poor reliability of the country's utility network without ignoring financial and environmental reasons. Solar power has characteristics as a clean energy resource, and they are always available in nature making it more attractive in the electricity sector[3]. But renewable energy sources all have limitations, such as changes in weather factors. One weakness can be overcome by another strength. Independent solar power system may produce better quality sustainable power [4]. This in turn will reduce the consumption of fossil fuels which produce CO_2 which pollutes the environment [5]. Indonesia as a tropical region and has the potential of high intensity solar radiation that can be explored to produce electricity. United Nation's goal is to make the availability of sustainable energy for the whole world with more than one billion people in developing countries by 2030 under the initiative to develop sustainable energy for all people of the world [6].

Renewable energy is generally regarded as an endless source of energy, solar, wind, hydro, geothermal energy and others. Management of the use of energy is very necessary is to provide energy in the form of electricity with the minimum cost and the slightest natural impact. Energy management is as a plan for the use of energy to improve efficiency and reliability [7]. Energy management can also be defined as the use of strategies and control methods to achieve power supply distribution[8]. Energy management aims to maintain energy optimally and reduce the impact of fossil fuels on the environment. Solar energy is sourced from sunlight which contains photon-shaped energy when,this photon hits the surface of the solar cell, the electrons are excited and causes direct voltage and electric current as a battery charger [9]. Then direct current can be converted into alternating current using an inverter. Solar energy can be utilized through two kinds of technologies, namely photovoltaic (PV) technology and photo thermal technology [11]. PV technology directly converts sunlight into electricity through semiconductor devices called solar cells, while thermal solar technology utilizes heat from solar radiation by using heat collectors or commonly called solar collectors [12]. Solar panel technology is used for solar power generation in the form of a centralized system, a stand alone system and a hybrid system.

Solar Power Generation as one of the environmentally friendly electrical energy solutions must be utilized optimally for fishermen when they are at sea, needing very much electricity on the ship for fishing and cooling lighting [13]. Cooling is a food preservation technology that is based on taking heat from materials or fish. A decrease in temperature will slow down the biochemical reaction and microbial growth in fish, so that the shelf life of the product becomes longer [14]. The use of solar energy as a power plant on a fishing boat is used as lighting and driving a cooling engine. Solar power generation from energy in the form of photons on the surface of solar cells, the electrons will be excited and cause electrical voltage. Electric current generated from solar cells is direct current (DC) as a battery charger, which is then direct current (DC) is converted into alternating current (AC) using an inverter [15]. If it is desirable to store fish longer, a lower temperature is needed. Low temperatures can inhibit changes in the physical quality of fish products or other food products, so this process causes microbial inactivation. Careful handling of material before cooling and freezing is necessary. Cooling is often the process of preserving food and increasing the shelf life of food products that are being or will be processed [16].

2. LITERATURE REVIEW

The application of solar power generation technology is to utilize the potential of solar energy

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available on fishing boats is an appropriate and superior solution [17]. The application of solar technology to ship electricity needs can be done with a variety of solar power generation systems. The solar power system is a Solar Home System, which consists of solar module panels, batteries, controllers and lights, this system is mounted on the roof of the ship with a photovoltaic module mounted on the roof of the ship [18]. This system usually has a photovoltaic module with a power capacity of 50 Wp where on a daily average solar radiation of 4.5 Kwh / m2 will produce energy of approximately 125 to 130 Watt-hours.

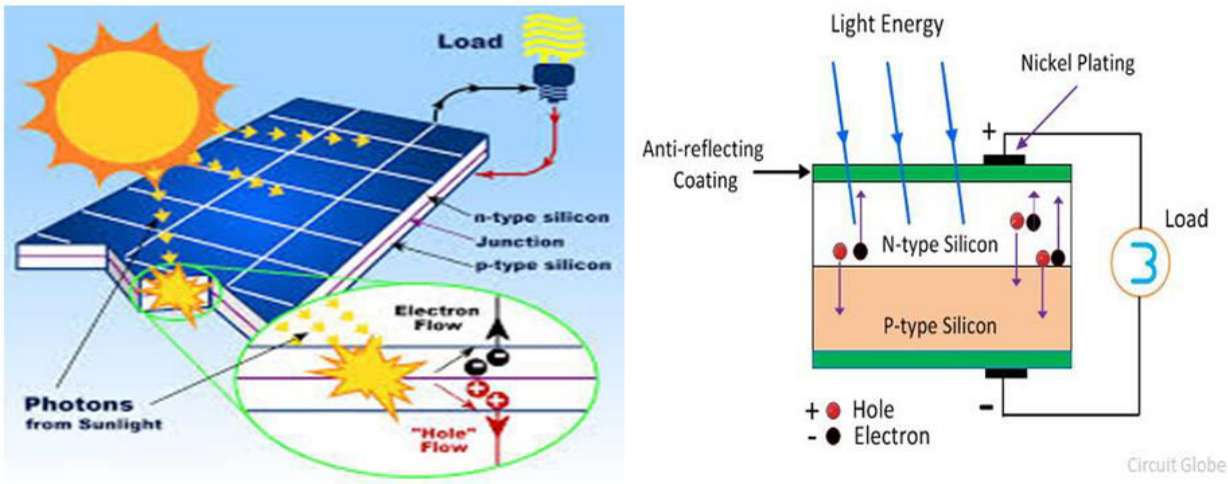

Figure-1. Scheme for the conversion of solar energy into electrical energy
[Source: https://www.google.com/search?q=solarcell]

Conversion efficiency is the ratio between the power that can be obtained by a solar cell with the power received from the sun. The density of sunlight reaching the surface of the earth on a clear day is around 100 m.W / cm² [19]. Effect of solar cell surface area on power Solar cell area affects the power produced by solar cells in this case the relationship is linear. If the solar cell has an area of 100 cm2, the power is twice as large as a solar cell with 50 cm2. Cooling equipment based on heat removal method is categorized as a mechanical refrigerator cooler. Factors that determine the shelf life of refrigerated processed food products, namely the type of food product, the level of microbial destruction and enzyme inactivation during processing, controlling the level of hygienicity during processing and packaging, the nature and type of packaging material, and the temperature of distribution and storage. Cooling equipment based on the method of removing heat by mechanical refrigeration (mechanical refrigerator) [20] has the following main components:

a) Compressor

The compressor functions to pump the coolant working fluid throughout the system and sucks the coolant refrigerant gas at low pressure and the lowest temperature in the evaporator. So the work of the compressor in Figure-2 is to reduce the pressure in the evaporator, so that the liquid cooling material in the evaporator can evaporate at lower temperatures and absorb more heat from the surroundings, so that the gas can condense and provide heat to the medium that cools the condense

Figure-2. Compressor.

b) Condensor

A condenser in Figure-3 (a) is a device for changing a refrigerant from a gas to a liquid. Cooling material from the compressor with high temperature and pressure, the heat goes out through the surface of the condenser ribs into the air. As a result of heat loss, the cooling material of the gas is first cooled to saturated gas, then condensed to liquid.

Figure-3. (a) Condensor (b) Evaporator.

c) Evaporator

Evaporator is a device where the cooling material evaporates from liquid into gas. Through heat transfer

from the walls, taking heat from the surrounding room into the system, the heat is then carried to the compressor and released again by the condenser. Evaporator in Figure-3 (b) is the main component of refrigeration, while other components play a role in changing and circulating refrigerant. Refrigerant in the form of steam or gas flows through the compressor and experiences an increase in pressure, refrigerant flows through the expansion valve and the pressure decreases and the temperature causes the cooling process.

Figure-4.(a) Capillary Pipe(b). Exspansion Valve.

d) Filter

The filter for the cooler is made from copper pipe which is useful for filtering impurities in the system, such as pieces of lead, mud, rust, and other impurities so as not to enter the capillary pipe or expansion tap. The filter must filter all impurities in the system and must not cause a pressure drop or make the system clogged.

e) Capillary pipe

Capillary pipes in Figure-4 (a) are used to reduce the pressure of liquid coolant flowing in the pipe and control or regulate the amount of liquid coolant flowing from the high pressure side to the low pressure side.

f) Expansion valve

Thermostatic exspansion valve lebih banyak dipakai sebagai automatic expansion valve untuk menurunkan cairan dan tekanan evaporator dalam batas yang telah ditentukan dengan mengalirkan cairan bahan pendingin dalam jumlah yang tertentu ke dalam evaporator.

In the refrigerators important properties that must be possessed by refrigerant working fluids are low boiling point and high latent heat of evaporation, high density steam to reduce compressor size, low toxicity, non-flammable, cannot mix with oil in the compressor, economical price and cheap. The technique of cooling food products based on the principle of cooling can be grouped as follows:

a) Cooling blast cold air (air blast chilling), a fast process so it is needed for food products that are very perishable and can be used for various cooling capacities.
b) Coold room is used to keep the temperature of ingredients or food products low, but is not suitable if used for rapid cooling
c) Cryogenic chilling is a technique to produce a fast cooling process. However, controlling the cooling rate is very necessary to prevent freezing.
d) Hydro cooling is used to remove heat after harvesting for fruits and vegetables. The advantage of this technique is that it can prevent freezing, no severe shrinkage, and can recover withered products.
e) Vacuum cooling is usually used for leafy vegetable products that have a large surface area and a high amount of free water. Not suitable for products or food items that have large volumes, are thick, or have waxy surfaces.
f) Ice-slush and ice blank chilling are techniques for inserting products into containers and cold air is blown through the shelves containing the product. Suitable for short-term cooling or preliminary cooling. The advantage of this system is that the cooling rate is faster than the cooling chamber and the relative humidity of the product can be maintained without the risk of freezing.

3. MATERIAL AND METHODS

The method used in the series of analyzes can be carried out several stages, including: a) Literature study, preparation of research materials and instruments, b). Calculation of power requirements c). Determination of the type and capacity of solar panels used, so that in their use there is no shortage of capacity or damage to the solar panel itself; (d). Determination of the regulator components that will be used, so that in the application there is no use error that results in unfavorable or can damage solar panels or electrical equipment installed later; (e). In terms of component use, economic aspects and conditions are also considered in the market, so that in the search for components there are no difficulties. (f). In terms of aesthetics, the design of the tool can be made in such a way that it is neat, attractive and safe in its use; (f). Choose components that pass the qualifications and fit the system requirements.

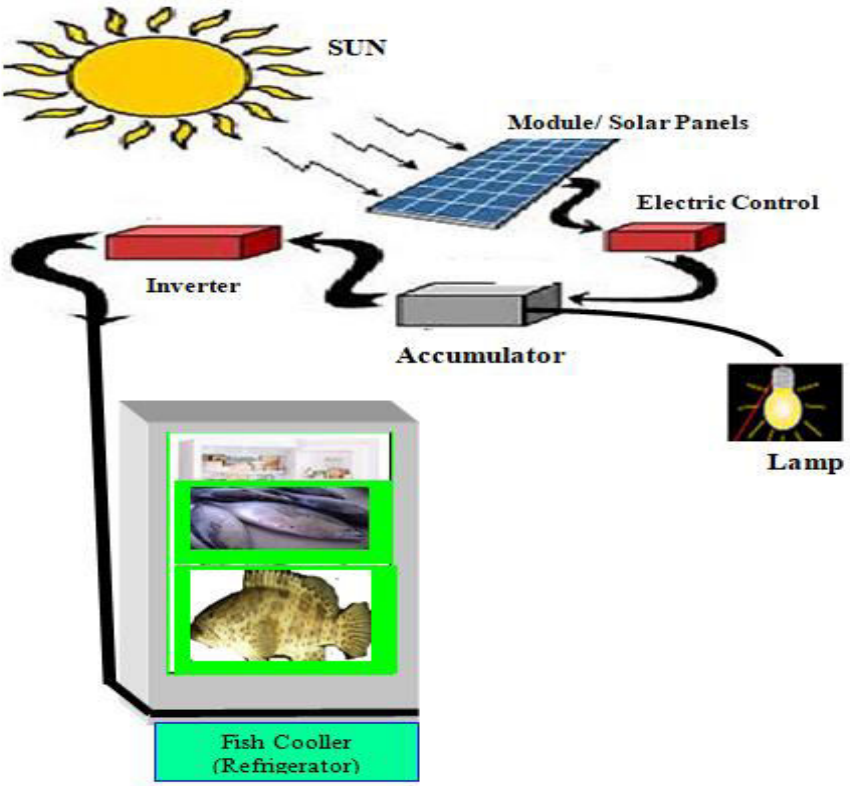

Figure-5. Schema of fish cooling installation with solar energy.

This study uses solar panels as a solar power plant with a capacity of 370 Wp to optimize the utilization of solar electric energy among fishermen, beginning with the identification of the characterization of solar energy, and analyzed to optimize solar power on fishing boats. Data analysis results of measurements of voltage and output power of solar cells for the specified tilt angle. The results of the analysis will be implemented as an effort to optimize the utilization of solar electricity on ships or household scale in the context of alternative energy.

The place of research is in the Laboratory of Electrical, Mechanical, Chemical, UKI-Paulus and Makassar sea study programs. Materials used at the time of the study were iron plates, aluminum, glass, welding wires, paints, cables, rubber and insulators. The tools used when conducting research are Solar Panels, Solar Power Regulators, Inverters, Battery Temperature Controls, Ammeters, Voltmeters, Multi Meters, Balloons, Electrical Regulators, Thermocouple Temperature Gauges, Electrical Contact Cable Sockets, Roll Cables, Switches and Additional Equipment the other.

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4. RESULTS AND DISCUSSIONS

Based on Figure-5 and the implementation stages of the research method used is to optimize solar electric energy in power generation systems [21]. Solar cells will convert energy from the sun into electrical energy can be stored in the accumulator through a charger controller that regulates the voltage and current that enters the accumulator. Load is an electronic device that requires an alternating current (AC) power supply, so an inverter is needed to convert the direct current (DC) current from the accumulator into an AC voltage. A charge controller solar cell is an electronic device that is used to regulate the direct current that is added to the battery [22]. The charge controller solar cells also overcharging and excess voltage from the solar panels, which will reduce the battery. The charge controller solar cell applies Pulse Width Modulation technology to regulate the battery charging function and release the current from the battery to the load [23]. Some functions of the charge controller solar

cell are battery monitoring, regulating the current released / taken from the battery so that the battery does not 'full discharge' overloading, regulating the current for charging to the battery, overcharging, over-voltage. To make a charge controller it is necessary to consider the characteristics of solar cells and accumulators.

Figure-6. Installation of fish cooler and experiment activities.

Table-1. Specifications of solar energy power plants.

Solar Panel:	**Capacity**
Voltage	40 Volt
Out put Power	370 Wp
Accumulator**:**	V : 12 Volt
	I : 100Ampere
Fish Refrigerator:	Dimension
High	49 cm
Wide	44 cm
Long	46 cm
Capacity	44 liter
Power	70 Watt
Voltage	220 - 240 Volt
Frequency	50 Hz

Solar panels on Table-1 are very effective when there is direct contact with sunlight so that they absorb or capture most of the sun's energy [24].A well-positioned solar panel to get the sun's rays going well so that solar energy can be captured to the maximum. Exposure to sunlight can vary depending on the season and the position of the sun against the earth, solar panels must be installed in such a way that they can face the position of the sun to the maximum in each season.

Table-2. Research results data.

Time (hour)	Voltage Put Out Solar Panel (Volt)	Temperatur Refrigerator Fish Coolant Temperature (˚C)	Weather Condition
09.00	39.7	36˚C	bright
10.00	39.8	32˚C	bright
11.00	39.8	25˚C	bright
12.00	39.9	17˚C	bright
13.00	39.9	11˚C	bright
14.00	39,8	1 ^{o}C	bright
15.00	39,8	-1˚C	bright
16.00	39,7	-4˚C	bright

Based on Table-2, the results of research on the installation of solar power plants on fishing vessels using Poly-crystalline type panels, the resulting voltage an average of 39.9 Volt DC, with a power of 370 Wp. In the current and voltage distribution from the solar cell source by charging the battery is very stable because it is regulated by a solar charger controller. Voltage and current will start to increase in the morning at 07.00WIB, then it will reach its maximum level in the afternoon at 09.00-16.00 eastern Indonesia time, and begin to fall in the afternoon. Cooling is a fish preservation technology by reducing the temperature so that the biochemical reaction and microbial growth in fish meat can be slow to increase the shelf life of fish and other products. Longer storage has to be done by lowering the temperature which is getting lower to inhibit changes in the structure of the product because it can cause bacteria and microbes to be inactive. Careful handling of fresh fish and ingredients must be carried out before cooling and freezing. Cooling and freezing is the process of taking heat from food products so that product temperatures and freezing product temperatures are reduced to freezing temperatures to increase the shelf life of food products that are being processed.

A drop in temperature below the minimum temperature for microbial growth can extend the time needed for microbes to multiply. Cooling decreases the speed of enzymatic reactions or changes due to microbes and slows the repiration of fresh food. Factors that control the shelf life or age of fresh food products during refrigeration are the type of food products, the level of microbial destruction and enzyme inactivation during processing, controlling the level of hygienicity during processing and packaging, the nature and type of packaging material, distribution temperature and storage. The development of technology is very fast and the increase in heat flux, there is demand to be the right solution. Suitable heat transfer device from the heat source as an evaporator to the heat sink dissipates heat in a relatively long period of time through the evaporation of latent heat from the working fluid [25]. The development of heat pipe technology has been widely felt, one of which is used as a cooling system in electronic components as heat dissipation which produces greater heat flux due to increased performance and smaller dimensions. The heat pipe has three parts, namely the evaporator, the adiabatic part and the condenser as heat dissipation.

5. CONCLUSIONS

Solar power generation systems that use solar panels with a power capacity of 370 Wp and an average voltage of 39.8 Volts as a source of electrical energy to cool fish on fishing boats are very effective and efficient.

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