The Utilization of Solar Cell for Power Lighting Equipment on the Ferry

**[1] A. Danny Faturachman, B. Shariman Mustafa, and [2] C. Muswar Muslim

Abstract

An electric motor become much more practical and economical having a multiplicity findings on the technology of solar panels, battery and charger better. An electric motor cost-effective care and in working. The installation of an electric motor more simple and does not need the cooler. All the needs of electrical power in supply from batteries being replenished by solar panels. Solar power become one of alternative energy to overcome the presence of the energy crisis especially a reduction in the availability of petroleum and the more expensive world oil prices. Major problems focused on design of electric system as power plant resources in the ship. The main issues discussed on is as follows: 1. Did design system supply resources and also calculation to determine battery and solar panels to be used. 2. Determine the laying on systems equipment. In this research, taking and analyzing data obtained from the results of the field by using the existing theory and make use of data from the internet and literature data. In duty end of this analysis conducted by the use of solar power as the supply of equipment lighting on a ship ferry Ro-Ro 500 GRT. Based on calculations data ship obtained a number of 35 solar panels that is attached to supply 10 batteries power by producing 42000 VA. Power is used to meet the needs of illumination burden 33600 VA to the discharging time 12 hours (from 18.00 – 6.00). So that the installation of solar systems can save energy by 52.5 % of the generator burden.

***Keywords*: Solar power, Lightning equipment, Ferry**

I. INTRODUCTION

The need for energy increases with increasing human needs. This led indication occurs an energy crisis in the world and one of the causes of the energy crisis is still the magnitude of dependence on fossil energy sources, notably oil. As we know that petroleum reserves that are available on this earth is limited. Therefore it needs to be done in order for the energy diversification efforts created a good energy balance. Diversification of the energy can be done by starting to give opportunities to other types of alternative energy that had been developed and a new type of energy. There are a variety of alternative energy could be developed include coal, natural gas, geothermal, biomass, hydro, wind, wave, solar and nuclear. From some of the alternative energy, are classified into two groups, the energy is not renewable and renewable energy. Renewable energy not including consists of petroleum, coal, nuclear and gas. While including the kind of renewable energy include geothermal, biomass, water, wind, solar, wave and others that are still open. Renewable energy has the potential to be superior in comparison to fossil energy. There are several underlying reasons among others due to the build-up of the infinite, renewable and environmentally friendly. Solar energy, water, wind, biomass, Ocean and other alternative energy sources are available in abundance in nature, whereas it is used still little. Remember the sunshine all year round for availability, then it is right if the solar energy is harnessed as a provider of electrical energy. With the layout of the equatorial regions are on Indonesia, which is at a latitude of 6^0 North Latitude and 11^0 South Latitude and 95^0 East Longitude and 141^0 East Longitude and having regard to the circulation of the Sun in a year in the area of 23.5^0 North Latitude and 23.50 South Latitude and the territory of Indonesia will always in sunlight for 10 until 12 hours in a day. Because of the layout of Indonesia are on the Equator then Indonesia has solar radiation level that falls on the surface of the Earth Indonesia (especially the West part of Indonesia) averaged approximately 4.5 kWh/m^2 monthly variation of about 10%.

To build a solar energy system (photovoltaic) that can operate properly then needed some major constituent components are: a. the Solar Panel, b. Charge controller, c. Inverter, d. Battery.

Photovoltaic (PV) is the technology that serves to change or convert solar radiation into electrical energy directly. The word

**Corresponding author

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[1] F. A. Danny Faturachman is with University Malaysia Pahang, Lebuhraya Tun Razak, Gambang, Kuantan, Pahang, Malaysia (corresponding author to provide phone: 60169311350; fax: 303-555-5555; e-mail: fdanny30@yahoo.com).

S. B. Shariman Mustafa was with University Malaysia Pahang, Lebuhraya Tun Razak, Gambang, Kuantan, Pahang, Malaysia (e-mail: shariman@ump.edu.my).

[2] T. C. Muswar Muslim is with the Ocean Engineering Department, Darma Persada University, Jl. Radin Inten 2, Terusan Casablanca, Pondok Kelapa, Jakarta Timur 13450, Indonesia (e-mail: muswar2000@yahoo.com).

is derived from the language of Greece, photos which means light and volt mean voltage. PV is usually packaged in a unit called the module. In a solar module consists of many solar cells that can be arranged series or parallel. Whereas the definition of solar is a semiconductor element that can convert solar energy into an electric photovoltaic effect on the ground. The core of PV job is edit or convert energy from solar radiation into electrical energy. Some of the components used is a semiconductor element called solar cells, and then organized into a solar module.

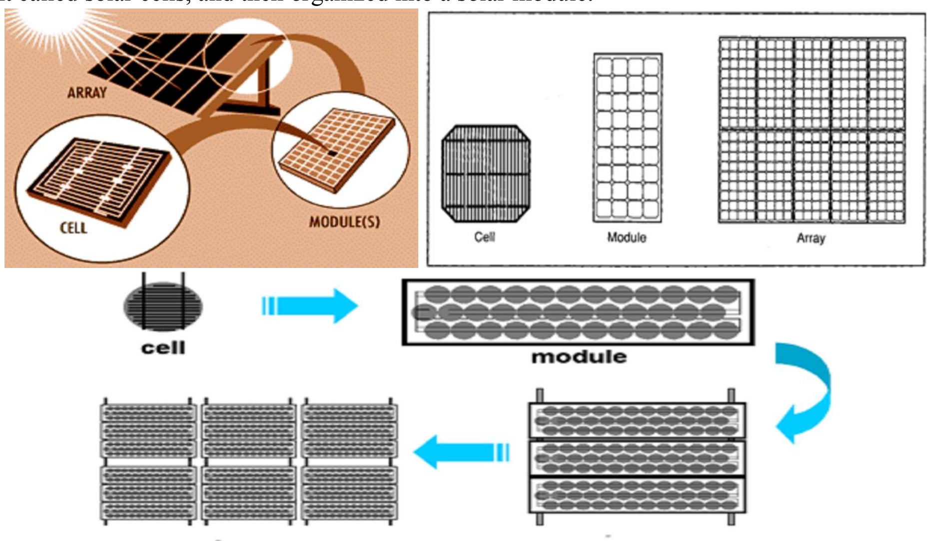

Figure 1 Solar cell module

Solar systems photovoltaic common worn for lighting is a system individuals or that more often known as the solar home system (SHS). This system has voltage 12 V dc, consisting of one module photovoltaic, batteries, instrument controller and 3 lamp and a stop contact. (Abu Bakar, 2006).

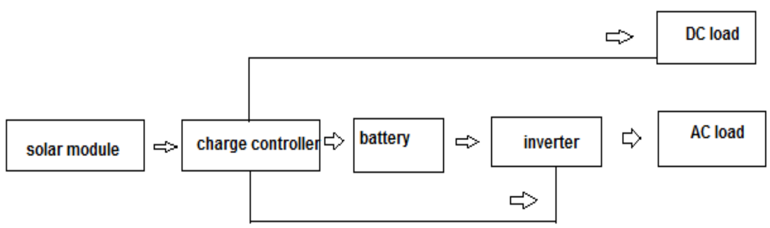

Figure 2 Module Solar Cell System Block Diagram

From the diagram above can explain that the energy in sunlight into electrical energy by the convert module will be channeled to a charge controller to adjust the charging electrical energy in the battery. From this controller charger can also directly use to load DC or go directly to the inverter to change the current air conditioning Next electrical energy in the battery will generate in convert by direct current (DC) to alternating current (AC) so it can be used in the load.

Charge of controller on the system (solar power stations) can as a brain because of their functions as officers electric current good against the current enters or current out / used.

Inverters in principle, photovoltaic generates a current of DC (unidirectional). When the required AC currents (alternating), then it can be met by installing a tool modifiers, electronic equipment that works very efficiently is called an inverter. Inverter specification is not the same i.e., depending on the extent of the power consumption of the entire electrical equipment. The greater the need for power, then the power inverter capacity also grew.

Battery is a device that converts the chemical energy directly into electrical energy. A battery consisting of voltaic one or more cells and every voltaic cell consisting of two half cells connected in series by electrolyte conductive containing the anion (negative ions) and cation (positive ions). In oxidation reaction reduction, battery power reaction reduction (the addition of electrons) to cation happens, at the cathode while oxidation reaction (electrons deleted) to anion happening anode. Electrodes not interconnected, but connected electrically by an electrolyte which may be either solid or liquid. Battery is a source of electricity obtained through a chemical process to get electrical energy by long time it takes plates positive and negative plate enough. Positive and negative plate prepared gregarious then sealed each other and made no relation one against another.

2. PROBLEM STATEMENT

In the utilization of solar energy photovoltaic are used to directly convert solar energy into electrical energy. The use of photovoltaic energy plants as a source of electricity can be said to produce no pollution, air pollution and noise pollution to the surrounding environment. Based on these considerations, it appears that photovoltaic conversion of sunlight into electrical energy will be the main energy source in the future. In addition, the price of conventional energy sources will continue to be higher and its preparation is also very limited, while photovoltaic prices gradually going down as a raw material abundant on the Earth. Electrical energy is generated from photovoltaic can be used for a variety of uses. And to ensure the continuous provision of energy is then used as energy storage batteries. Electric motors become increasingly practical and economically after the number of discoveries on the technology of solar panels, battery and charger are better. Electric motor maintenance and cost effective in the work.

For solar panel treatment more easily enough cleaned once a week. Installation of electric motors is simpler and also does not require refrigeration. All electrical power needs in the supply from the battery is recharged by solar panels. With this system is expected to reduce fossil fuels. But now the problem is confined to the ship, and to apply this system needed a place. In this final project will examine the effectiveness of solar cells. Where the obtained results expected are references to the ability of solar cells in generating electrical energy where the final result is expected to be aware concerning the efficiency of solar cells.

3. RESULTS

The following are the main data from the main Ferry Ro-Ro 500 GRT:

Length Over All L_{OA} = 45,05 m
Length between Perpendicular L_{PP} = 40,15 m
Length of Water Line L_{WL} = 42,00 m
Breadth B = 12,00 m
Height H = 3,20 m
Draft T = 2,15 m
Velocity Vs = 11 knot
Main Engine = 2 × 800 HP
Auxiliary Engine = 2 × 80 kVA
Gen set emergency = 25 kVA

Power lighting needs: a. For the main lighting lights used fluorescent and neon lights. b. For emergency lighting lamps mounted at the steering wheel, desk maps, alleys, stairs, engine room, and locations that are considered important or in accordance with the requirements of the BKI. c. Lighting lights for engine room, bathroom/toilet, kitchen and rooms open from types that are waterproof (water tight).

Table 1 Power lighting needs

Bottom Deck	**Total (unit)**	**Load (watt)**	**Used (hour/day)**	**Power (Kwh/day)**	**Description (hour used)**
Steering engine room	2	20	12	0,48	conditional
Void room (4 rooms)	1	20	12	0,96	conditional
Emergency light (signal)	5	5	12	0,3	conditional
Vehicle Deck					
Emergency generator room	1	20	12	0,24	18.00-06.00
Stairs to engine room	2	10	12	0,24	18.00-06.00
Crew room (6 rooms)	1	20	12	1,44	18.00-06.00
Stairs to void room	2	20	12	0,48	conditional
Engine room stairs	2	20	12	0,48	conditional
Toilet (4 rooms)	1	10	12	0,48	conditional
Vehicle load room	16	20	12	3,84	18.00-06.00
Lifeboat	2	40	12	0,96	18.00-06.00
Store	1	20	12	0,24	conditional
Emergency Light (signal)	16	5	12	0,96	conditional
Passenger Deck					
VIP passenger outside light	2	40	12	0,96	18.00-06.00
VIP passenger room	8	20	12	1,92	18.00-06.00
Ornament room (2 rooms)	1	10	12	0,12	conditional
Toilet/bath room (10 rooms)	1	10	12	1,2	conditional
Economy passenger room	22	20	12	5,28	18.00-06.00
Economy passenger outside light	2	40	12	0,96	18.00-06.00
Cafeteria	1	20	12	0,24	18.00-06.00
Tatami room	2	20	12	0,48	18.00-06.00
Masjid	2	20	12	0,48	18.00-06.00
Urinary	1	20	12	0,24	18.00-06.00
Wudhu (ablution) space	1	20	12	0,24	18.00-06.00
Emergency lamp (signal)	10	5	12	0,6	conditional
Navigation Deck					
Steering room	5	20	12	1,2	18.00-06.00
Chief Engine room	1	20	12	0,24	18.00-06.00
Master room	1	20	12	0,24	18.00-06.00

Mess	2	20	12	0,48	18.00-06.00
Kitchen	2	20	12	0,48	18.00-06.00
Toilet/bathroom	1	20	12	0,24	conditional
Gang way	3	20	12	0,72	18.00-06.00
Ladder to passenger deck	1	20	12	0,24	conditional
Left outside light	2	20	12	0,48	18.00-06.00
Right outside right light	2	20	12	0,48	18.00-06.00
Funnel light	2	40	12	0,96	18.00-06.00
Masthead light	1	60	12	0,72	18.00-06.00
Left side light (red)	1	60	12	0,72	18.00-06.00
Right side light	1	60	12	0,72	18.00-06.00
Stern light	1	60	12	0,72	18.00-06.00
Anchor light	1	60	12	0,72	18.00-06.00
Emergency light (signal)	7	5	12	0,42	conditional
Total	**139**	**1020**		**33,60**	

Solar cell specification:
FV Energy, FVG 240P − MC:
Power peak : 240 W
Efficiency : 14,6 %
Tension module : 30,50 V
Current module : 7,88 A
Open circuit tension : 37,60 V
Short circuit current : 8,28 A

From the selection of the solar panels, it can be calculated how many pieces of solar panels needed to meet the needs of power for lighting load. For conditions in Indonesia, even though the duration of the sun shines for 8 hours/day (08.00-16.00), but the effectiveness of the photon beam obtained solar panels during the day is 5 hours. Thus the number of panels to meet the needs of power of 33600 Wh as much: $\frac{33600 \text{ Wh}}{240 \text{ W x } 5 \text{ hr}}$ = 28 solar cell

In this case will be installed as many as 35 solar panels, where the addition of a number of solar panels as much as 7 units as backup power when the solar intensity less than 1000 W/m^2. With extensive consideration of the deck platform is still able to accommodate the number of solar panels, in addition to the power generated will be greater or in other words the addition of solar panels directly also adds to the amount of power generated. The amount of power generated by the solar panels in one hour: 35 hours x 240 Watts = 8400 Watt hour. The amount of power generated by the solar panels is in 5 hours is: 8400 W x 5 hours = 42000 Watt hour = 40 kWh of solar panel quantity, then solar panels chosen is FV energy, FVG 240P-MC model with consideration to address the needs of the power load of information. It has solar panels power largest so enough to area on the bridge deck 20 m x 8 m = 160 m^2 and is installed with a slope of 15^0.

From the regulator or charge controller specification that is, the maximum current that can be issued charge controller is 60.0 Ampere. Whereas current generated by a solar panel voltage with a 30.50 volt is 7,88 Ampere, so one charge controller is used only for: 60/7.88 = 7 units of solar panels. Total charge (n) = total amount solar panel/7 = 5 units.

Output current for 1 charge controller :

I = 7,88 A × 7 solar panel
= 55,16 A (maximum current released by charge controller 60,0 A)

Output for 6 charge controller :

I_{output} = I × (n)charge
= 60 A × 5
= 300 A

Charger capacity = output charge current × total charger × used time
= 60 A × 5 × 12 hours
= 3600 Ah

Power produced for 5 chargers :

I_{output} = 300 A
V_{output} = 12 V
Power = $I_{output} \times V_{output}$
= 300 A × 12 V
= 3600 Watt = 3,6 kW

To ensure that the system can operate properly and in accordance with good and suits the needs of load need planned design of the battery system. Note the overall burden of the solar panels of 42 kWh battery planned to use Marine Batteries, Rolls Series 5000 type with a capacity of 370 Ah (according to spec). The resulting power battery:

Battery power = battery capacity × battery voltage
= 357 Ah × 12 V
= 4284 Wh
= 4,284 kWh

Total battery for needed the total power 42 kWh :

Total battery (n) = total power / power battery
Total battery (n) = 42 kWh / 4,284 kWh = 9,80 ≈ 10 unit

Battery capacity for 8 units :

Q_{total} battery = 357 Ah × 10 unit
= 3570 Ah

Battery power :

Battery power = 3570 Ah × 12 V
= 42840 Wh
= 42,84 kWh

After determining the number of batteries required, the next step is to calculate the length of use of the battery. Where known: Battery capacity = 357 Ah
Battery voltage = 12 Volt
Long Used = 12 hours

So:

Power per hour = battery power / long used

$$= \frac{357 \text{ Ah x } 12 \text{ v}}{12 \text{ hours}}$$

= 357 Wh

Battery used = power battery / power per hour

$$= \frac{357 \text{ Ah x } 12 \text{ v}}{357 \text{ Wh}}$$

= 12 hours

Battery charge = $\frac{\text{battery power x total battery}}{\text{solar cell over all power}}$

$$= \frac{357 \text{ Ah x } 13 \text{ V x } 10 \text{ batteries}}{42000 \text{ watt}}$$

= 1.02 hour

In the design of this solar panel system, the current is generated from solar panels is direct current or DC (Direct Current). While the current required for the lighting system is current on his boat back and forth turning or AC (Alternating Current). To change the DC to AC inverter needed inverter. Planned use of Xantrex inverter sine wave type, then the number of inverters needed is:

Number inverter = solar cell overall power/ power output inverter
= (42000 W)/(4000 W) = 10, 5 ≈ 11 units

In the plan the placement of solar panels on the deck of the bridge and the solar panel system components in the void or empty space under the deck of the vehicle with a total area of 12.4 m x 12 m = 148,8 m^2. As for the number of each component and its size:

a. Charger controller, amount: 5 unit, dimensions: 37 cm x 15 cm x 15 cm, weight: 0.45 Kg/unit
b. Battery (12 Volt 74 Ah), amount: 10 unit, dimensions: 55.9 cm x 17.8 cm x 6 cm, weight: 123.4 Kg/unit
c. Inverter amount: 11 unit, dimension: 53.4 cm x 38,1 cm x 22,86 cm, weight : 16 Kg/unit

Then the total weight of the whole solar system of solar panels and other components in the completeness of 2054.75 Kg.

4. CONCLUSION

From an analysis of existing loads needs, the design of utilization of power lighting equipment on the 500 GRT Ferry needs:

1. Early loads generator = 80 kVA
2. Necessity after loads = in because of loads 42000 VA supplied by solar system, that generator load is:
   80000 - 42000 = 38000 VA = 38 kVA
3. Energy savings can be done is:
   = early load – after loads × 100 %
   $$= \frac{80000 - 38000}{80000} \times 100\ \%$$
   = 52,5 %
4. The amount of a solar panel that can be mounted on the deck of the bridge with a total area of 160 m2 as much as 35 solar panel considering the rules applicable to the Ro-Ro Ferry ships.
5. The other amounts is: 5 unit charger controller, 10 unit batteries, and 11 unit inverter.

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