IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

International Journal of Advanced Research

in Electrical, Electronics and Instrumentation Engineering

Volume 11, Issue 7, July 2022

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.18

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.18|

||Volume 11, Issue 7, July 2022||

|DOI:10.15662/IJAREEIE.2022.1107002 |

Solar Power System for Salt Production

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ABSTRACT:Salt is a staple that is needed by all industries and consumption. Every year the need for salt always increases, so Indonesia must import. Salt production depends on natural weather, so generally, it can only be produced during the dry season. To increase salt production, modernization is carried out in the distribution of water to production areas, with the use of electric water pumps that utilize renewable energy sources from solar power. The panels convert solar energy into electrical energy and are used to supply power to electric water pumps to circulate seawater. The results showed that the use of solar panel equipment can increase the salt production of small farmers in Lembung Village, Galis District, Pamekasan Regency, East Java Province, Indonesia, by 33%. The use of 1 Kwp panels is able to produce 1.27 tons of salt.

KEYWORDS: Renewable Energy, Salt, Solar Panels, Electric Water Pump

I.INTRODUCTION

Salt is a white solid object in the form of crystals which is a collection of compounds with the largest part of sodium chloride, has hygroscopic properties that easily absorb water, and for cooking purposes is enriched with iodine and is used as a raw material for making metal (Burhanuddin, 2001), (Mulyono, 2001). , 2001). 2009), (Mohi RA, 2014), (Jamil, 2015), (Agus, 2021).

All sectors from the industrial sector, the consumption sector and the preservative sector require salt as a raw material. According to data from the Ministry of Maritime Affairs and Fisheries, the national salt production in 2014 was 2.19 million tons, while salt consumption was 3.61 million tons, so it had to import 2.25 million tons. The area of ponds in Indonesia is 25.8 thousand hectares (Adi, 2021). The need for Indonesian salt in all sectors continues to increase from 2016 to 2020 (Aqwa, 2019). In 2020 total demand reached 4.5 million tons, an increase of 7.26 percent from the previous year. The Ministry of Maritime Affairs and Fisheries (KKP) estimates that in 2020 salt production will reach 1.26 million tons, and in 2020 there will be imports of 2.61 million tons (Workshop data, 2022).

The solution to this problem is that farmers in Indonesia must increase salt production to be able to cover domestic salt needs and reduce salt imports from other countries, although weather factors greatly affect the increase in imports and reduce salt production (Ahmad, et al, 2017). For small salt farmers, the problems faced by many are the erratic weather and water distribution, which still relies on windmills as a means of irrigating salt production land.

Indonesia is rich in solar radiation, because Indonesia is located at the equator, so that Indonesia has two seasons, namely the rainy season and the dry season. This dry season is used to produce salt.Therefore, the use of solar power plants with electric water pumps to distribute water to production areas is expected to increase and accelerate the salt production process for small farmers (Djaufani et al., 2015), (Hafid et al., 2017), (Setiaji et al., 2017), (Miranda, 2020), (Adi, 2021).

II.LITEREATURE RIVIEW

1. Solar Panel

The source of solar energy is a renewable energy source, therefore the use of sunlight can be converted into electrical energy through a tool, namely solar panels. A solar cell or photovoltaic is a device that can convert sunlight directly into electrical energy. Solar cells can be called as the main device to maximize the enormous potential of solar energy that reaches the earth. This solar panel requires a material that can capture sunlight, in addition to being used to generate electricity, energy from the sun can also be maximized through a solar thermal system(Adityawan, 2010). Solar panels are a series of solar cells that convert light into electrical energy, the solar panels themselves are commonly called photovoltaic, or what can be interpreted as electric light. (Photovoltaic cell – abbreviated

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PV)(Purwoto, 2018).Solar panels are a collection of solar cell materials that can convert solar energy into electrical energy that utilizes the role of p-n junctions and semi-conductor-based solar panels (Handini, 2008), (Smet, 2016).

$$E_T = E_B \text{ x } Loss\ and\ safety\ factor \qquad (1)$$
$$= E_B \text{ x } 1{,}20$$

where :
$E_B = Load\ energy\ (Watt\ hours\ per\ day)$
$E_T = Total\ energy\ (Watt\ hours\ per\ day)$

The adjustment factor for solar power plant installations is 1.1 (Hankins, 1991). And the determination of the capacity of the solar panel module uses the following calculations (Abdul, et al, 2017).

$$C_{PV} = \frac{E_T}{IM}\ x\ FP \qquad (2)$$

where :
$E_T = Total\ energy\ (Watt\ hours\ per\ day)$
IM = Solar insolation (Kwh/m^2)
FP = Adjustment factor

2. Solar Charge Control
The solar charge controller is the main tool in the solar power generator system which functions to regulate the electric current output from the solar panel before it is channelled to the battery or to the load to be used. The output voltage from the solar panel is unstable or fluctuates so that it can damage the battery if not set the voltage to be supplied to the battery.SCC has several functions, namely controlling the output voltage of the solar panel, when the charging voltage in the battery has reached a full state, the controller will stop the electric current entering the battery to prevent overcharging. Battery Voltage Monitoring, when the voltage in the battery is almost empty, the controller functions to stop taking electric current from the battery by the load / electrical equipment. Reverse current control, when the solar panel does not charge the battery the current from the battery will flow back to the solar panel, this will damage the solar panel.

Therefore the Solar Charger Controller will regulate these conditions.The load on the ELECTRIC SOLAR PANEL system takes energy from the charger control. The capacity of the current flowing in the charger control can be determined by knowing the overall load used (Djaufani, 2015). Then the current flowing in the solar charger control can be known through the equation:

$$Imax = \frac{Pmax}{Vs} \qquad (3)$$

where:
Imax = Maximum current (Ampere)
Pmax = Maximum power (Watt)
Vs = System voltage (Volt)

3. Battery
Batteries are components for storing electrical energy that are chemically processed, in processing electrical energy storage it is converted into chemical energy and when electrical energy is needed, it changes from chemical to electrical energy. Batteries have very high efficiency and can be called accumulators, because the battery is an electric cell in which an electrochemical process takes place for processing to change from electrical energy to chemical and vice versa (Hamid. etc., 2016).The battery is very useful as a temporary power storage before being distributed to the load. Batteries are the most important component when using a renewable generation system. The renewable system also takes into account the battery requirements needed, so that the needs of the load used can be met. To adjust the needs of the load, the following calculations are carried out.

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Calculation Battery Requirements :

$$\text{Battery capacity} = \frac{Amount\ of\ power\ used}{Voltage\ used} \quad (4)$$

a). Battery capacity involving inverter working efficiency

$$Battery\ capacity = Battery\ capacity_A + [(100\% - 0{,}6)\ x\ Battery\ capacity_A] \quad (5)$$

b). Minimum battery capacity required

$$Ah_{min} = \frac{Total\ Battery\ Capacity}{Maximum\ battery\ usage} \quad (6)$$

c). Amount of battery

$$Amount\ of\ battery = \frac{Ah_{min}}{Ah_{battery\ used}} \quad (7)$$

The storage system is a major component in running aelectric solar panel work system process in an off-grid system, because the energy produced by the panel cannot be channelled directly to the load. Therefore, the main function of the battery is a temporary storage place and to optimize renewable energy sources before being channelled directly to the load (Mallick, et al, 2016). Determination of storage needs must be calculated to match the needs of the load used, the calculation uses the following equation (Setiaji, 2017).

Table 1. Relationship between DOD and Battery Life

Depth of Discharge (DOD)	Life Time (*Cycle*)
10%	6200
20%	5200
30%	4400
40%	3700
50%	3000
60%	2400
70%	2000

Table 3 shows the relationship between DOD and battery life (Mario, 2015). With this table, it is determined that the amount of DOD used in this study is 50%, then the battery capacity changes and to find out the battery capacity after adding DOD using the following equation.After knowing the required battery capacity, the number of batteries to be used is calculated by determining the battery capacity used using the equation below.

4. Inverter

Inverter is a device that is used to convert DC current into AC current, in this case the battery can store DC current electrical energy. However, the load of the electric water pump requires AC current. The inverter has a working system rating in supplying the load power to be used, which is about 20% - 25% of the required power capacity. If the load approaches the workload of the inverter, the efficiency will be higher (Hartono &Purwanto, 2020).The workings of the inverter system is that the input power in the form of alternating electric current or called AC (Alternating Current) is converted into direct current or called DC (Direct Current). After that it is converted back into alternating electric current or AC with adjustable frequency changes, to be able to control the desired output frequency. The load used must be calculated to adjust to the inverter used, because the inverter has certain specifications so that the efficiency of the work carried out will be maximized (Syukriadi, 2010).

5. Load (Electric Water Pump)

An electric motor is a tool for converting one energy into another, namely in the form of electrical energy into mechanical energy (Guntoro in Denny, 2019).Electric motors themselves are widely used for family needs, because they are considered very helpful in facilitating and speeding up household work such as washing machines, water pumps, blenders, fans and many others.The water pump is an electronic working system that is assembled into a single instrument and has the function of supplying water on a small or large scale. The working principle of the water pump is to suck water from a container or reservoir and channel it to another container area. When the suction power and

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channel or discharge power are greater, the electrical power required will be higher (Aisuwarya&Fauzi, 2020). Water pumps are divided into two, namely reciprocating pumps and rotary pumps (Triyanto, 2020).

III. METHOD

In this research, in obtaining the data and results from research in accordance with the objectives, several stages will be carried out in the research process. The activities to be carried out can be explained as follows.

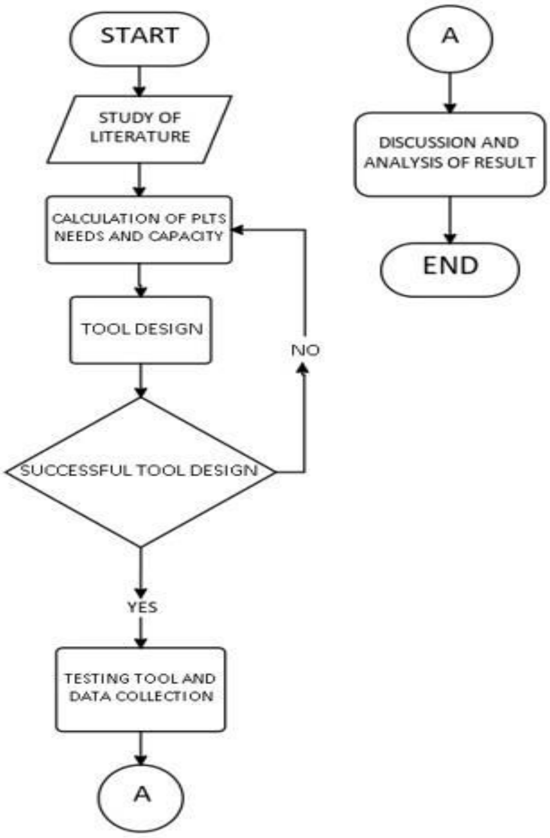

Fig 2. Research Flowchart

The stages carried out in this study were carried out on the salt land of smallholder farmers in Lembung village, Galis sub-district, Pamekasan district, the first to find sources of literature, design hardware and combine all devices. From the tests to be carried out, including measuring the radiant heat received by the solar panel, then measuring the output generated by the solar panel, storing the electrical energy generated by the solar panel in the battery and distributing it to the load in the form of a water pump machine.

1. Calculation of Electrical System Requirements

In this research, calculations are carried out to determine the number of panels and electrical systems used, so that the length of time for filling salt fields is calculated using the following equation.

$$LAND\ FILLING\ TIME = \frac{Amount\ of\ water\ needed}{water\ flow\ per\ hour} \quad \ldots (8)$$

By using equation (1) (Markhaban, et al, 2017) the time of using the load to fill the land can be known.

2. Calculation of Solar Panel Needs

The solar panels used are monocrystalline with a capacity of 300 WP each. Below are the specifications of the solar panels used.

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Table1. Solar Panel Specification

Spesifikasi	*Moncrystalline*
Dimention	1950 × 990 × 40
Maximum Power Peak	300 WP
Open Circuit Voltage	44 V
Short Circuit Current	9.05 A
Maximum Power Voltage	35.8 V

In the electrical system of solar power plants, a factor of 20% is added to the load as a substitute for system losses and a safety factor. Then the watts per hour load will be multiplied by 1.20 (Salman, 2013), so that the following equation is obtained:

$$E_T = E_B \text{ x } Loss\ and\ safety\ factor \quad (9)$$
$$= E_B \text{ x } 1{,}20$$

The adjustment factor for solar power plant installations is 1.1. And the determination of the capacity of the solar panel module uses the following calculations (Abdul, et al, 2017).

$$C_{panel\ surya} = \frac{E_T}{IM}\ x\ FP \quad (10)$$

3. Storage Capacity Calculation

Determination of storage needs must be calculated to match the needs of the load used, the calculation uses the following equation (Setiaji, 2017).

$$Ah = \frac{W_T}{V_S} \quad (11)$$

4. Inverter Capacity

The use of an inverter to change it, but the work of the inverter can reduce the battery capacity. Then the inverter work efficiency must be calculated, and added to the storage capacity using the following equation.

$$Battery\ Capacity = battery\ capacity_A + [(100\% - 0{,}5)\ x\ battery\ capacity_A] \quad (12)$$

5. Calculation of Electrical System Requirements

To find out the battery capacity after the addition of DOD using the following equation.

$$Ah_{min} = \frac{Total\ Kapasitas\ baterai}{Maksimal\ penggunaan\ baterai} \quad (13)$$

After knowing the required battery capacity, the number of batteries to be used is calculated by determining the battery capacity used using the equation below.

$$Amount\ of\ Battery = \frac{Ah_{min}}{Ah_{battery\ used}} \quad (14)$$

IV.RESULT AND DISCUSSION

In this study, the resulting solar panel power data, data on electric water pump power requirements, data on salt production and comparison of salt production for smallholder farmers in Lembung village, Galis sub-district, Pamekasan regency.

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1. Electric Solar Panel Electrical System

In this study using the electric solar panelelectrical system as follows.

Fig 3. Solar Panel Contruction

The installation of solar panels was carried out on the salt land of smallholder farmers in Lembung village, Galis sub-district, Pamekasan Regency. The specifications of the solar panels used in this study are as follows.

Table 2. The specification of Solar Panel

Jenis	*Moncrystalline*
Dimensi (cm)	1950 x 990 x
Maximum Power Peak	300 WP
Open Circuit Voltage	44 V
Short Circuit Current	9,05 A
Maximum Power	35,8 V
Maximum Power	8,38 A

In this study, 2 solar panels were used in series.

Fig 4.Electric Solar PanelElectricity System

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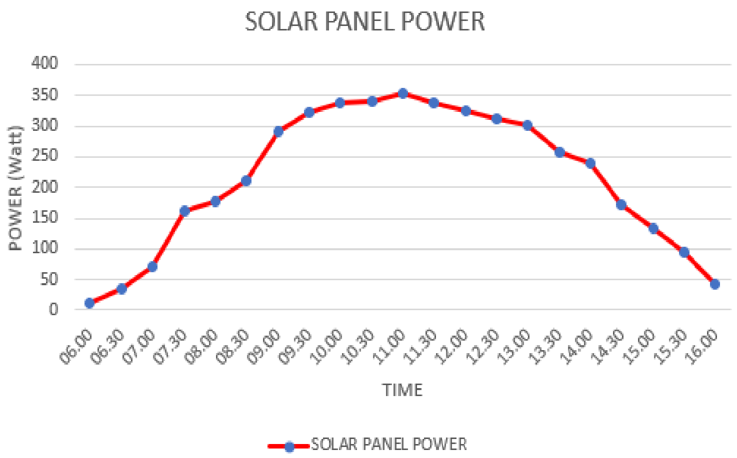
In Figure 4 above is the electrical system in this study, the system begins with the absorption of solar energy which is absorbed by the solar panels, after that it enters the DC MCB as a power limiter to secure the MPPT with a capacity of 40 A. From the DC MCB directly to the MPPT to set the power that will go to the battery. From the MPPT passes through the MCB DC 60 A for the input power breaker to the battery, and for additional protection before entering the battery. After the power enters the battery, then the power is channelled to the MCB DC 40 A, after the MCB DC is paired with a watt meter to measure the output power from the battery and directly connected to the inverter. The inverter used requires a voltage of 24 V and a capacity of 1000 W, this inverter is of the low frequency type and the maximum load used is 1000W. And the output of the inverter is given a safety MCB AC 4 A 2 pole for security from the inverter for limiting the current that can be charged to the inverter used. After the AC MCB directly to the load of the water pump with a capacity of 700 watts.

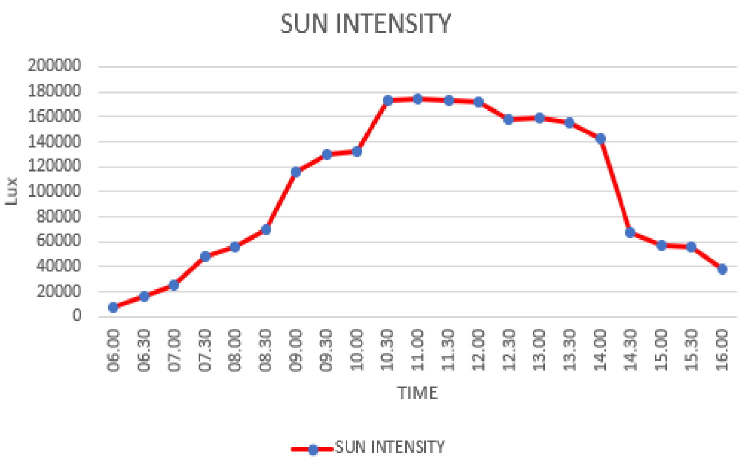
2. Electric Solar Panel Electrical System Testing

The Electric Solar Panelelectrical system was tested to determine the performance of the system, the results of the system test can explain the results of the output power and solar intensity at the location of Lembung Village, Galis District, Pamekasan Regency.



Graph 1. Solar panel output power

From graph 1 above, it shows that the smallest output power of solar panels at 06.00 is 10.64 watts and the largest output power at 11.00 is 353.32 watts.



Graph 2. Solar panel output power

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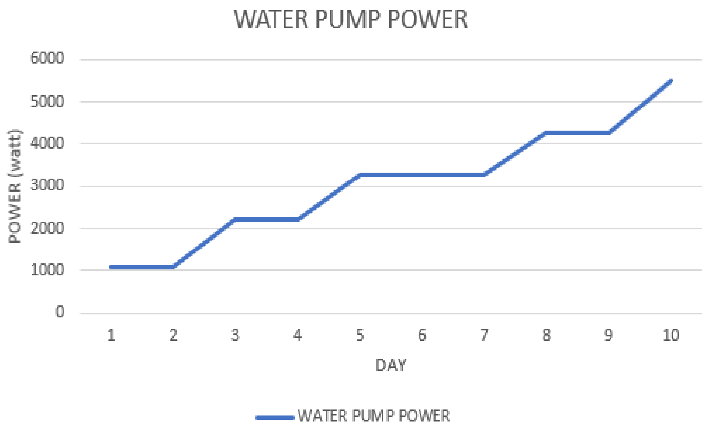
From graph 2 above, it shows that the lowest solar intensity at 06.00 is 6851 lux and the highest solar intensity is at 11.00 at 173900 lux.

3. Test Result Data

The test results data are shown by the power table of the electric water pump which proceeds in one salt harvesting process for 10 days.



Graph 3. Electric water pump power

From the data of graph 3 above, it shows that the use of electric water pumps is not used every day, the water pump is used for 5 days, on the first, third, fifth, eighth and tenth days. The total power of using an electric water pump in the salt production process is 5,494 watts or 5,494 Kw.

4. Comparison of Salt Production Result using Conventional Windmill and Renewable Energy

In this study, we will compare the salt production of smallholder farmers in Lembung village, Galis sub-district, Pamekasan district using conventional windmills with renewable energy Electric Solar Panel electricity systems.

Table 3. The Salt production electric solar panelsystem

Day	Salt Production (Ton)
10	7
20	7,4
30	7,2
Number	**21,6**

From table 3 it can be seen that using the electrical system of a solar power plant with water distribution using an electric water pump with a capacity of 700 watts every ten days farmers can produce salt with an average yield of 7.2 tons. So that smallholder farmers in Lembung village in 1 month can produce a total of 21.6 tons.

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V.CONCLUSION

The results of this research, it was concluded that the electrical system of the power plant used to run the 700 watt electric water pump was running well.The use of the electricity system, the power plant used can increase the salt production of smallholder farmers in lembung village, which has increased by 33%.From the electrical energy produced by the power generation system and converted to smallholder farmers' salt, which is 1 kilowatt, it produces 1.27 tons.

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