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# Implementation and Cost of Solar Power Plants for Household Electric Loads

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***ABSTRACT--****The solar power plants to serve household electricity is an alternative for electricity consumers and the government in the face of the threat of electricity crisis, the use of solar cells by the community is still very rare this is because people do not have accurate references about solar cell systems, so their use is often not accompanied by careful planning. This research aims to design a solar cell system for household electricity and determine the investment costs and savings made compared to using PLN electricity. The research method uses an experimental method that is designing and analyzing solar cell system costs for household electrical loads to obtain a careful analysis of the results and get a good design as planned. The equipment used is the photovoltaic modules, solar charge controller, inverter, batteries, control panel, household electrical loads, multimeters, luxmeter and digital temperature measuring device. The results showed that for household electricity needs of 3963 watt.hour, normally requires a 1300 Wp solar panel, 3 batteries with a capacity of 24 volt 200 Ah each, assuming 2 autonomous days. In this research, the solar power plants use 600 Wp solar panels, 1 battery with a capacity of 24 volt 200 Ah , and the solar power plants can serve 3097 watt.hour and investment costs needed Rp. 36,756,000.- with electricity saving costs Rp.41,871 per month assuming an electricity price of Rp 1352 / Kwh.*

***Keywords****-- solar cell, design, investation, saving*

## I. INTRODUCTION

Renewable energy is energy that is produced from natural sources namely sun, wind, rain, geothermal and can be produced repeatedly as needed. The energy is available in large quantities and so far is the source of energy that remains available on this planet. For example energy from the sun can be used to produce electricity. Likewise, energy from wind, geothermal, biomass from plants and tides. When the price of oil in the world market rises, this renewable energy becomes the main alternative to be used as a substitute for the use of non-renewable energy. Renewable energy sources such as solar, water and wind are renewable energy sources that are not depleted or have significant harmful effects on the environment. The world's fossil fuel resources cannot sustain energy needs for the next few decades and hence the need for cheap alternative energy is now urgently needed. Over the last few years many research groups around the world have investigated the semiconductor properties of conjugated materials and their use for leds, photovoltaics and transistors. Research on electricity generation through the use of solar cells is an example of one way scientists try to reduce some of the dependence on non-renewable resources.

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## II. LITERATURE REVIEW

The threat of global warming on earth makes it necessary to find alternative energy sources. The search for renewable and cheap energy is the subject of several current studies, and the discovery of solar cells is one of the breakthroughs towards reliable alternative energy (Asma, Zubair, 2016).The development of solar cells shows impressive evolution over the last few years. This technology has been largely tested in laboratories using integrated devices. The performance of photovoltaic solar cells perovskite is evaluated in tropical weather conditions. Specifically, two perovskite modules with active areas of 17 and 50cm2 were created, encapsulated and tested. and commercial silicon panels as a reference, the two technologies are evaluated for 500 hours by connecting I-V measurements with atmospheric variables measured every minute during sunny weather to get the average performance and efficiency of solar cell equipment, graphically visualizing the characteristics of solar cells in various atmospheric conditions . The results show that the power delivery and short circuit current of the two technologies are linearly correlated with atmospheric variables. In addition, the open circuit voltage of perovskite technology shows nonlinear behavior and improved performance with temperatures at high irradiance (Esteban, Daniel, 2019).

Solar cells are an important part of optical devices because of their ability to convert solar energy into electrical energy. While the use of solar cells to provide electricity is still at an early stage, accounting for only about 1.5% of electricity supply using solar cells from electricity demand worldwide, solar cells are used continuously and increasing every year, further research in all aspects of solar cell installations , from material to devices to the system continues (Barry, 2017). Systems with a 308V DC microgrid voltage for household appliances (internal DC) are modified to operate on 48V DC from the DC distribution line. The electrical system using universal and induction motors for the BLDC (Brushless DC) motor is proposed because it is very efficient with minimum electro-mechanical and no loss of energy conversion. The proposed DC system reduces the power conversion stage, thereby reducing power losses and increasing overall system efficiency. For this reason conventional AC systems can be replaced by DC systems that have many advantages both in terms of cost and performance (Kamran, Bilal, 2017).

Electricity consumption profile data that includes details on electricity consumption can be generated with a bottom-up load model. In this model, the load is built from basic load components which can be household or even individual equipment. This research presented a simplified bottom-up model to produce realistic domestic electricity consumption data every hour. This model uses the input data available in reports and statistics. The results of the analysis show that the resulting load profile correlates well with real data. In addition, three case studies with generated load data show several opportunities for demand-side management. With this scheme, the daily peak load can be reduced by an average of 7.2%. and the peak load on annual peak days can be averaged with a peak reduction of 42% and a sudden loss of 3-hour burden can be compensated with an average load reduction of 61% (Jukha, 2006). The design for photovoltaic (PV) systems provides electricity needed for households. Radiation data and typical household electrical load data at the site are taken into account during the design steps. System reliability is quantified by loss of load probability. A computer program is used to simulate the behavior of a PV system and numerically find the optimal combination of PV arrays and battery banks to design stand-alone photovoltaic systems in terms of reliability and cost. this study calculates the annual life cycle costs

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and annual unit electricity costs. Simulation results show that the value of the probability of loss of load can be met by several combinations of PV arrays and battery storage. The uniquely developed method determines the optimal configuration that meets load demands with minimum costs (Khaled, Doraid, 2012).

## III. RESEARCH METHOD

This This research method uses experimental research methods, namely by designing solar power plants. then make observations and measurements on solar power generation systems such as currents, voltage, temperature and intensity of solar radiation. Measurement of temperature and intensity of solar radiation is done by placing a measuring device next to the photovoltaic module. Measurements were made for 36 hours.

This research uses the following equipment:

- 6 units of solar modules with a total capacity of 600 Wp.
- 4 units of 12V 100 Ah VRLA Battery (Valve Regulated Lead Acid) Batteries.
- 1 unit of SCC (Solar Power Chargers).
- 1 unit of Inverter 2000 W.

- 6 digital ampere meter units
- 3 units of digital voltmeter
- 1 unit luxmeter
- 1 unit of digital temperature gauges
- 25 meters of solar cell cable measuring 2 x 4 mm

**Figure 1**: the solar power generation systems for households used in research

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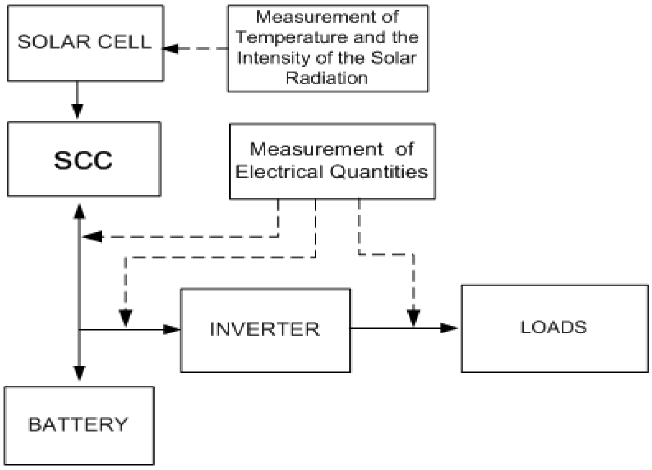


**Figure 2:** Block diagram of the system

## IV. RESEARCH ANALYSIS

In this research calculates and discusses the need for electrical energy for households, the realization of power services by solar power plants, the investment costs of making solar power plants and the savings in electricity bills that can be saved

**Table 1:** investment costs to make solar power plants

| No | Equipment | Spesification | Quantity | Unit Price | Price |
|---|---|---|---|---|---|
| 1 | Solar Panel | Monocrystalline 100 Wp | 6 | Rp1.500.000 | Rp9.000.000 |
| 2 | Battery | 12 volt 100 Ah | 4 | Rp4.400.000 | Rp17.600.000 |
| 3 | Inverter | 2000 W Pure Sine Wave | 1 | Rp3.400.000 | Rp3.400.000 |
| 4 | Solar Charge Controller | MPPT 35 A | 1 | Rp2.250.000 | Rp2.250.000 |
| 5 | Weatherproof Cable | 2 x 4 mm² | 1 | Rp1.200.000 | Rp1.200.000 |
| 6 | Battery Cable | 2m | 1 | Rp120.000 | Rp120.000 |
| 7 | Skun Cable | 25 mm² | 6 | Rp4.000 | Rp24.000 |
| 8 | Cable Connector | connector MC4 | 6 | Rp17.500 | Rp105.000 |
| 9 | MCB DC | MCB 2P 63A DC | 3 | Rp150.000 | Rp450.000 |
| 10 | Box Panel | 40x50x20 cm | 1 | Rp967.000 | Rp967.000 |
| 11 | Digital DC Multimeter | 50A DC | 3 | Rp390.000 | Rp1.170.000 |
| 12 | Digital AC Multimeter | LCD 6 in 1 | 1 | Rp300.000 | Rp300.000 |

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| | | | | | |
|---|---|---|---|---|---|
| 13 | MCB AC | MCB 2P 4A AC | 1 | Rp170.000 | Rp170.000 |
| Total | | | | | Rp36.756.000 |

**Table 2:** calculation of household electricity needs

| No | Load | Watts | Qty | Hours per day | Days / week used | Weekly Watt hours |
|---|---|---|---|---|---|---|
| 1 | Porch Lights | 20 | 1 | 12 | 7 | 1680 |
| 2 | Living Room Lights | 26 | 1 | 5 | 7 | 910 |
| 3 | Front Room Lights | 14 | 1 | 5 | 7 | 490 |
| 4 | Back Room Lights | 24 | 1 | 5 | 7 | 840 |
| 5 | Center Room Lights | 23 | 1 | 5 | 7 | 805 |
| 6 | Kitchen lights | 23 | 1 | 12 | 7 | 1932 |
| 7 | Side Porch Lights | 14 | 1 | 6 | 7 | 588 |
| 8 | Home Rear Lights | 26 | 1 | 6 | 7 | 1092 |
| 9 | Refrigerator | 90 | 1 | 24 | 7 | 15120 |
| 10 | Rice Cooker | 400 | 1 | 0,4 | 7 | 1120 |
| 11 | Blender | 250 | 1 | 0,08 | 7 | 140 |
| 12 | Iron | 350 | 1 | 0,5 | 7 | 1225 |
| 13 | Fan | 90 | 1 | 0,3 | 3 | 81 |
| 14 | Washing machine | 330 | 1 | 0,4 | 7 | 924 |
| 15 | TV | 24 | 1 | 2 | 7 | 336 |
| 16 | Laptop | 46 | 1 | 2 | 5 | 460 |
| | Total hours per day | | | 85,68 | | |
| | Average hours / day | | | 5,355 | | |

Total weekly watt-hours of AC Load (Wh) = 27743 watt-hours

Divided by days per week (7)

Average total watt-hours per day = 27743/7 = 3963 watt-hours

Divided by d.c nominal voltage ( 12, 24 0r 48 Volts )

Average amp-hours per day (Ah / d ) = 3963/24 = 165 Ah

Divided by inverter efficiency see detail spect, let say(0,9) = 165/0,9 = 183,5 Ah/day

Divided by battery efficiency , let say (0.85) = 183,5/0,85 = 215,9 Ah/day

Divided by Depth of Dicharge (let say 80% remaining) = 215,9/0,8 = 269,8 Ah/day

Multiplied by days of autonomy = 2 x 269,8 = 539,7 Ah.

Baterry Bank Size Required ( Ah ) = 539,7 Ah

Battery Ah = 200 Ah , 24 volt

Battery qty based on the capacity = 2,7 or 3 unit

Battery qty based on the voltage from 12v 100 Ah each to supply 24 V, = 3x4 = 12 unit

Total Load watt hours per day = 3963 watt-hour.

Solar Panel KIT 100 watt, with capacity per day ( 5 - 6 hrs) = 13,21

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Total solar panel kit required = 13 unit

While the table not shown in this paper is a charging and loading table by solar power plants because the number of lines is very large, so that only the calculation results for the average electricity needs that can be served for 1 day is 3097 watt hours with 2 days of charging without loading. For that the cost can be saved in 1 month if the price of electricity is Rp. 1352 / Kwh, the cost saved is Rp.41,871 / month.

## V. DISCUSSION

Implementation of the solar power system in this research can serve 3097 watt hours of electricity for one day in fine weather. 100% loading cannot be done in this research because it can cause a decrease in voltage and battery power so that it is faster low. When the weather is cloudy or rainy to serve household electricity can not be done normally. It takes 2 days to fully charge the battery. If a battery is used for charging and discharging, discharging at night is only around 10:00. High investment costs are the reason people do not use solar power plants even though electricity savings can return the investment costs

## VI. CONCLUSION

The household electricity needs in this reseach amounted to 3963 watt hours, in this calculation requires 1300 Wp solar panels, 3 batteries with a capacity of 24 volts each, 200 Ah, assuming 2 autonomous days. In this research, solar power plants use 600 Wp solar panels, 1 battery with a capacity of 24 volts 200 Ah, and solar power plants can serve 3097 watt hours and an investment cost of Rp. 36,756,000, - with electricity cost savings of Rp.41,871 per month assuming an electricity price of Rp.132 / Kwh

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