Increasing of Solar Cell Output Power in Equator Land By Using Dynamic Control System

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Abstract. *A varied method for Power output of solar cell measurement will be increased. Energy demand continues to increase as increasing in development and population growth. This paper describes an energy searching method of solar cell by using dynamic measurement. The measurement was held in Padang as equator land. Solar cell is a piece of semiconductor to change sunlight Intensity to electrical Energy. Solar cell hat advantage, it can generate energy without fuel and noise. This solar cell is to match for rural area. Actually, Solar cell produces maximal power if the sunlight position is exactly vertical on the cell surface. In this research, a prototype of photovoltaic energy searching on solar cell will be realized to get optimal power. The Position of Solar cell module is operated by DC motor to match the sunlight moving. This step moving module starts from 7.00 o'clock until 17.00. The motor moving from 07.00-08.00 can make 15º angle of module or every hour move module 15º angle. After 18.00 o'clock, the solar cell back moves to the first position to prepare to get a next intensity sun on tomorrow. To measure the power is used static and dynamic method. The research result that a dynamic measurement can be found, that the voltage of solar cell module at 07.00~11.00 will be increase from 12,9Volt until 14 Volt and the average voltage is 14.8 Volt at 11.00 ~ 17.00 pm. So, that a dynamitic solar cell module is 14,7% better than static instrument without power efficiency.*

Keywords: *Solar Cell, Module, Renewable Energy, Dynamic and Static*.

1. INTRODUCTION

The Progress in application of silicon technology for Photovoltaic (PV) system is pushing at increasingly fast pace, especially sensitive layer surface. [1] The development in the field of solar cell components and system for the control and regulation of small and smallest intensity is always interesting. Projects within this solar cell theme are technology intensive, and explore the relationship of fabrication technology, devices physics, and integrated circuit design, all driven by the requirements of specific Microsystems [2]. This System is used for developed Solar Cell application. Nowadays, solar PV has a great opportunity to dominate for renewable energy sources [3].

Besides that, the price of PV-energy Power in Watt hours (wH/m2) is always decrease International conference referred repeatedly to it that the observed rise of the content of New and Renewable Energy in the world will lead with high probability for energy producing changes with possibly very fatal consequences [4]. Off-grid PV system accelerates the rural electrification. The usage of solar cell can decrease the fuel consumption, which is getting more expensive. Almost of household equipment need energy consumption as prime mover. Illumination consumption is now in rural or in the city area as primary requisites. Varied PV application research has developed for rural electricity. For the reliable reason PV systems are located in the rural area or mini station area need the second alternative power supply beside PLN or other generator. Power extracted from PV energy contributes a significant proportion of consumers' electrical power

demands. So, the use of produced energy for household needs is limited to energy for cooking, lighting and communication. In other addition, about 80% of households in low-income rural areas making it difficult to rely on renewable energy sources to meet their basic energy needs. Besides that, about 10% of low-income households are energy poor and unable to use electricity to meet their basic energy needs. However, because energy consumption in rural area is very important for household needs, hence the increase in power output of solar cells plant needs to be subsidized in order to meet the energy consumption [4][24].

The power supply that uses solar cell is really appropriates to be used particularly in the rural areas of not getting power supply from the PLN (the state electricity Enterprise) or even in the isolated place as in the rural or in the mountain ranges area, island and other area where other source of energy available become not economically to develops [21]. Sun influence of environmental factors on its photovoltaic system components. The sun's rays as the main environmental factors influence the output power of a photovoltaic system. Effects of environmental conditions on photovoltaic efficiency are discussed [5]. The energy output of solar photovoltaic plants mainly depends on the availability of solar flux, quality-related power conditioning equipment incorporated in the system, the technical specifications of the panel, geographical location and also on environmental parameters. This paper focuses on analyzing and increasing the energy output of solar cells with dynamic control for village housing in Sijunjung by considering their energy use profile. Concentrating solar power (CSP) seems to be a promising solution for rural electrification [14][23].

For this reason, the Sijunjung area was chosen as one of the equatorial areas in Sumatra as a research location. This PV-research location is Sijunjung city, west Sumatera. Sijunjung area situated as isolated areas on equator has abundant solar cell potency as alternative energy supply with the average of sunlight intensity of 4.8 KwH/m2/day but it's not optimal to use. The main problem of this research is according to get the optimally energy of solar cell. The PV-Energy potential in Indonesia can be shown at figure 1. Solar cell Energy Potential in Indonesia will illustrated by figure 1. Sijunjung city legs in west Sumatera as optimum potential energy or equator area. West Sumatera is one of red area with high potential energy, beside other lands: middle Kalimantan, Middle Celebes and east Papua. The five functions components systems of this PV-technology are: PV-Module, BCR, Battery, temperature Sensors and Inverter. The Inverter is used in this system to get AC Current. In the resent years there has been increasing interest in Photovoltaic in Research area, because the Photo Voltaic (PV) power prices in USA and Europe as case study is always decrease.

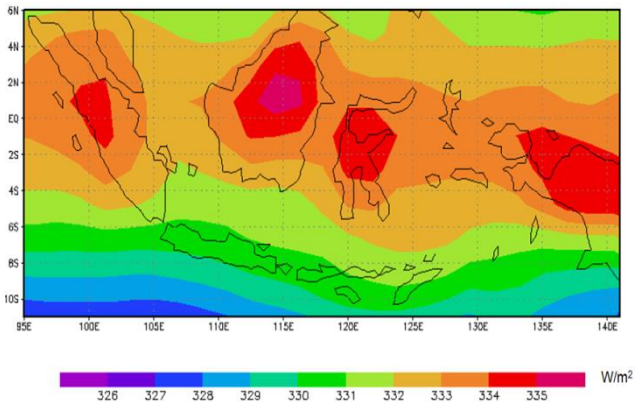


Figure 1: Configuration of solar cell potential in Indonesia with several Levels

2. LITERATURE

Although at the present rural electrification projects still exist that use conventional diesel generators. Indeed, lower upfront costs, but operating costs will continue to rise compared to the cost of the system Photovoltaic [6][25]. In addition, research shows economic competitiveness in the Energy Storage System (ESS) and the application of solar energy has increased opportunities for rural energy access [7]. Off-Hybrid mini grid system is developed [8][13].

In this situation, the solar system is used exactly as engineering contribution in facing the challenges of Industrial revolution 4,0 for land society or rural electricity. Nowadays, 84% of the world population without access to electricity is located in rural areas of developing countries [16]. It is besides that, Indonesian position as developing country is an equator area and sunlight as power quale always exists. For this reason, The Solar System research and application are very interesting theme. This used solar system research in Indonesia has several reasons, they were used to product new and renewable Energy [9][11].

The reasons of used photovoltaic on research and application for rural electrification in Indonesia as equator land and developed country are [10]: 1).This solar Energy is one of the new and renewable energy because sunlight provided many in Indonesia and is very economical. 2) Solar cell includes the environmentally friendly energy. 3) Solar cell panels are extremely everywhere simply reliable. 4) Solar cells module makes no noise while collecting, clean and friendly energy. 5). In the long run, solar cell electricity is cheaper than buying it from the state power company. 6). A huge variety of solar cell panel systems and hybrid developing are available. 7). No need for access to power grid (isolated area, mountain area, rural area). 8). Sell excess electricity if grid-tied. 9) Government should support gives a tax credits for new and renewable energy. 10) Solar technology is constantly improving to research and applications developing [12][17].

Many studies of application, optimization method and efficiency have been conducted on FPV systems which have assessed these systems from different points of view [15][18][20]. In this paper, an analytical analysis and studies increasing Output Power of Solar Cell in Equator Land By Using Dynamic Control System. A dynamic aspect of FPV systems as a output power generation system is presented. Data derived from experience in the field for installing PV / hybrid mini-grids shows a range of expensive costs from the data collected. PV characteristics of the PV array is needed to serve peak load evenly distributed together [16]. Various studies have been carried out on FPV systems that have tested and assessed this system from different points of view. In this paper, an analysis of the most recent increase in FPV output power in the equator region. Also, a comparison between a PV systems installed dynamic and compared with a static PV installation [20].

3. METHODOLOGY

This chapter describes the used research method, PV system and configuration to obtain measurement data or test it and the planned research. The ratio of measured power output between static and dynamic system that will be presented. Some references are supported to make reached research objective. Due to its ability to increase the power output of the PV system, the dynamic control system is used as the maximum power point tracker (MPPT) to motion toward the sun. This technology has been used in measuring the output power along solar motion and then the measurement results are compared with the stand alone (static) PV measurement results [19][22].

3.1 PV SYSTEM AND CONFIGURATION

During this period, the application field of the Photovoltaic (PV) has been expanded from safety to effectively optimal Power and environment control application. Based on the developing of PV-Technology, National Institute of Science and Technology continues to analyze and expand solar cell power quality, sensor application, measurement and lowering the cost and optimal PV-power production [1]. The solar cell control system concept is illustrated at Figure 2. The System consists of PV-Module, BCR, Battery, Inverter, Contactor and Load.

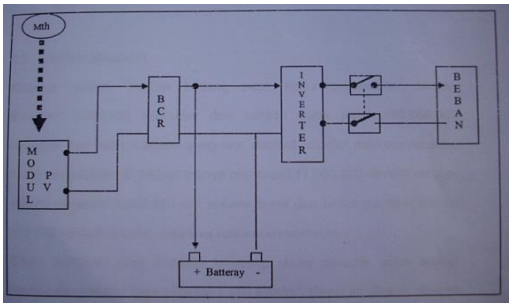


Figure 2: The solar cell control system concept

Three interactive researches are PV systems, control Device or components, power price and Manufacturing, which provide a focus PV-systems Technology Laboratories. Optimal PV-system is necessary to realize an optimal operation of PV system. To hold an optimal energy must be realized in this by two methods, which are static and dynamic measurement.

This circuit in Figure 1 will describes, that: a. When photovoltaic module receives sunlight, then on the output terminal of photovoltaic module produces voltage; b. This Voltage is used to load supply and to charge battery via Battery Control Regulator (BCR), and as protection of battery to solar cell module; c. Inverter is used to charge DC voltage to AC; d. Load (Lamp) is used to know the output voltage function, beside it can be used a Metering to measure output voltage or current

Solar cell Module or Photovoltaic system is combining of solar cells, which they're being connected serially. A solar cell can produce 0,45Volt, which it's can be used practically too small. So, they are connected serially in a module. The standard solar cell consists of 36 or 49 cells of silicon semiconductor. Dimension of solar module is 10cm x 10cm and it can produce 38 ~ 50Watt, 12 Volt with the maximally intensity of sunlight. The configuration of solar cell with 18 bundles of silicon atom covalent is illustrated by figure 3. Also, a comparison between the ground mounted and floating PV systems is presented and the gaps of the reviewed subjects are indicated [20].

At the static system, the position of solar cell surface is match to sunlight, then silicon atom is changed doped phosphorous. The solar System Position is fixed and it can receive one period sun rotation. For Example, The system can receive sunlight in the morning only (from 06.00-12.00 o'clock) or in the afternoon only (12.00-17.00 o'clock). On the silicon technology, a process was used to realize solar cell mechanical structures in the fabrication [3.5]. A structured surface long conductor as electrical pads were serially and parallel designed [figure 4] and its characteristic (figure 5).

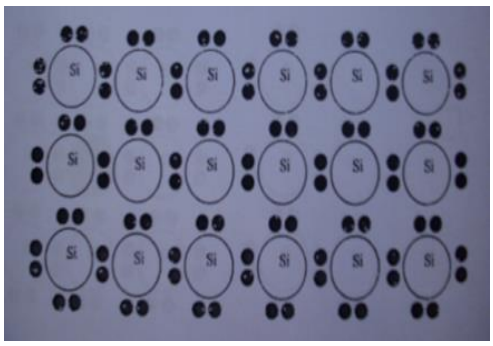
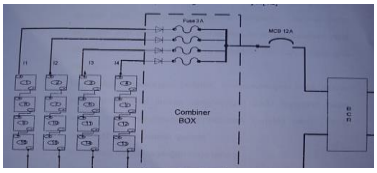


Figure 3: Bundle of Silicon Atom covalent.



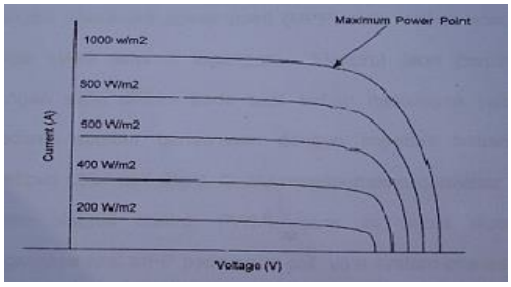


Figure 4: The solar cell system connecting. Figure 5: The V-I solar cell characteristic

As PV Technology continues to advance, an increasing fraction of Microsystems may be integrated on one or a few digital chips, for example, a layered surface electrode sensor substrate for sunlight monitoring system. The characterization of the PV with several used component will be described in this paper. The components are: Solar cell Module (PV), Batteries ACU 60A, Angle Iron with 30 x 30 mm, Motor DC 12 Volt. Pipe Dimensions 3 Inch and wheel with 8 cm. The structured surface of silicon material is used to realize the mechanical solar cell. This material surface must be oxidized to reduce corrosion process before next other processing in PV technology.

The important element of PV is a sensitive layered surface. In the most cases the sensitive layer surface of sensor hat not is covered, because the operating temperature of PV is high. The cover of sensitive layer surface presents a difficult problem to get maximally Intensity with dynamic method. But the Interaction of sensitive layer directly with environment can investigate any phenomena. Presently, to separate the interaction of sensitive layer surface of PV with environment and additional interfaces, a packaging module must be required to get more efficiency. To realize a dynamic method structured model can be used mechanically designed. Solar cell module is designed, the PV surface moves according sunlight moving. [See figure 6]. Figure 6 was illustrated a realization of package the dynamic PV system. The stand-alone or static model is illustrated in figure 7. However, a successful this research is caused by choosing the dynamic right method and compare with static the research process. The used configuration will be shown in below figure.

Figure 6: The Configuration of dynamic solar cell and design.

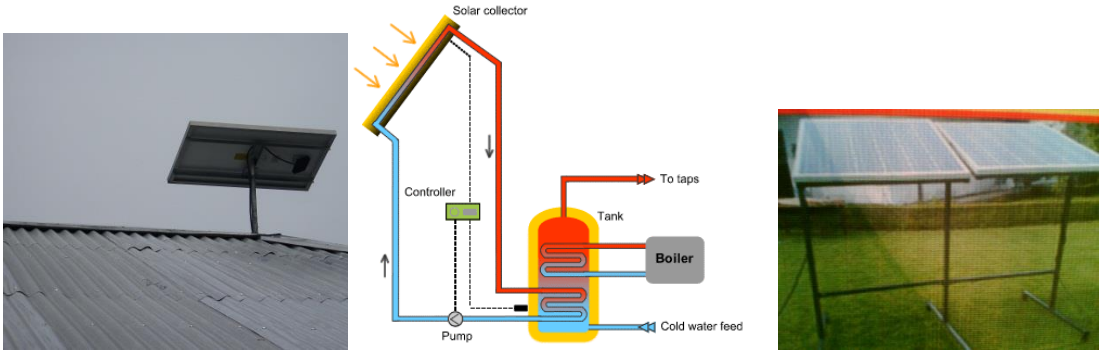


Figure 7: Static configuration concept and Prototype of static solar cell on the House

3.2 STATIC AND DYNAMIC MEASUREMENT

At the static measurement will be found the position of solar cell is one direction only. This position is important to be used for several household components The static solar cell system can be used for example as thermal source for household, which are Solar Hot Water, Heated Pools, Radiant Flooring, Dryer, Water Treatment and Cooking. [figure 6].From this figure will be found that the maximal value of solar cell Intensity a day (in Lux) at the time 11.00 until 13 pm. The used Module is applied on the House roof to receive directly sunlight. The sunlight will be absorbed by solar cell. An used Solar cell is solar cell silocon tipe P-N with 6,5cm^2 and 9,5cm^2, which it produces Vdc = 0,4 Volt/cell or Vdc-total = 18 V and I=0,8A with 62 x 45 cm^2 dimension. After solar cell can changed sunlight to be energy, which it's saved by wet accumulator 45 AH, 12 V-DC.

In Battery charging is used an automatic batery charger circuit. To get the characteristic of PV system is used two methods that are static and dynamic measurement. At the static solar cell can be shown in above figure 6. In this method, the position is statically on the roof. But by the dynamic method, the solar cell module moves always match vertically to sunlight. The measurement result will be shown in table 1 and table 2. The measurement result can be compared by two curves. The value of dynamic system curve will higher than value of static system curve. The registered measurement of solar cell starts from 07.00 until 17.00 o'clock. The condition of Intensity at the morning is directly increased until 12.00 o'clock and it is decrease after that. The peak Intensity of Solar cell is at the time 11.30. The varied parameter of Intensity, Voltage, Current and temperature were measured in this research.

4. RESULTS AND DISCUSSION

Therefore, this chapter is the most important part of your paper because it explains how you research, and how you analyze data obtained in the field, as well as how to synthesize data, research results and theories. These three elements must be objectively interconnected.

TABEL 1: Static measurement result.

No	Time (Hour)	I (Lux)	V (Volt)	I (Amp)	Temp (C)
1	07.00	272	12,9	0,30	27,4
2.	08.00	345	12,9	0,40	30,5
3.	09.00	588	13,3	0,80	30,5
4.	10.00	715	13,7	1,50	39,2
5.	11.00	819	14	1,80	39,8
6.	12.00	882	14	2,40	44,3
7.	13.00	596	12,9	1,25	40,9
8.	14.00	580	12,8	1,10	41,4
9.	15.00	412	13,2	0,80	40,6

10	16.00	401	12,6	0,2	36
11	17.00	107	12,7	0,2	32,4

Two method measurements are due from 07.00 until 17.00 in Padang as equator area. The methods are Static and dynamic measurement. Based on V-I static measurement result, that voltage on 7.00~11.00 o'clock is significant increase. Table 1 describes the static measurement result. The dynamic measurement will be shown in table 2. The two measurement results can be compared. The maximal sunlight Intensity (Lux) is at about 12.00 o'clock [see figure 8]. For the next research, the increased result measurement is very necessary, because it makes possible to get characteristic information of PV with current-voltage and power consumption. Beside that, the efficiency of energy utilization receives more attention.

TABEL 2: Dynamic measurement result

No	Time (Hour)	I (LUX)	V (Volt)	I (Amp)	Temp (C)
1	07.00	272	12,5	0,2	27,4
2.	08.00	345	12,6	0,2	30,5
3.	09.00	588	13	0,55	30,5
4.	10.00	715	13,3	0,9	39,2
5.	11.00	819	13,9	1,6	39,8
6.	12.00	902	13,5	2,3	44,3
7.	13.00	775	14	1,3	40,9
8.	14.00	675	13,7	1,3	41,4
9.	15.00	494	13,8	0,75	40,6
10.	16.00	466	13	0,2	36
11	17.00	147	13	0,2	32,4

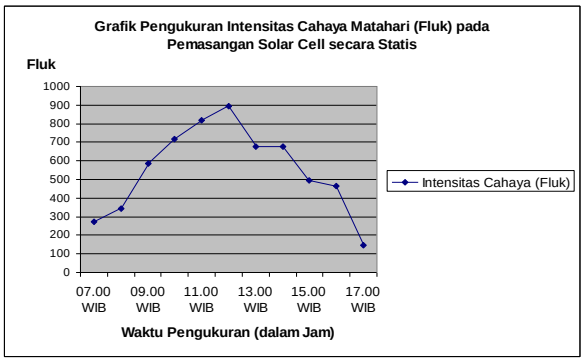


Figure 8: Intensity of solar cell a day (in Lux)

The voltage and the current static measurement are illustrated in figure 9. Two curves are combined with the dynamic work on PV with motor control. In this figure 9 will be showed 2 curves of voltage and current position. At 7.00 o'clock and 17.00 o'clock will be found that the lower current position and the output voltage is ca 12volt. The maximal increased current curve will be shown at the time ca. 12.30. But the voltage curve is relatively stable.

Based on the figure 10, the dynamic solar cell can optimize the current measurement result. By the dynamic method, the better result will be known and the dynamic measured current is better than static measured current. In this section, the various dynamic - static combinations that are able to obtain maximum PV-power output for varying positions solar cell are discussed.

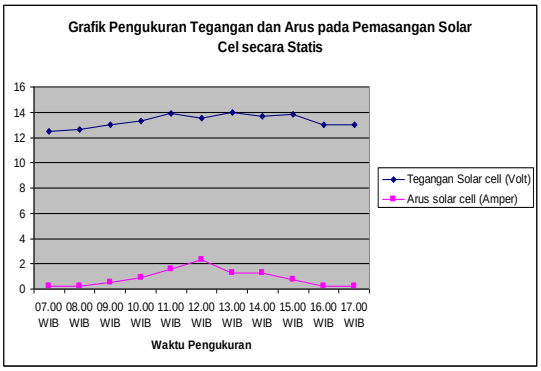


Figure 9: V-I Static Measurement result.

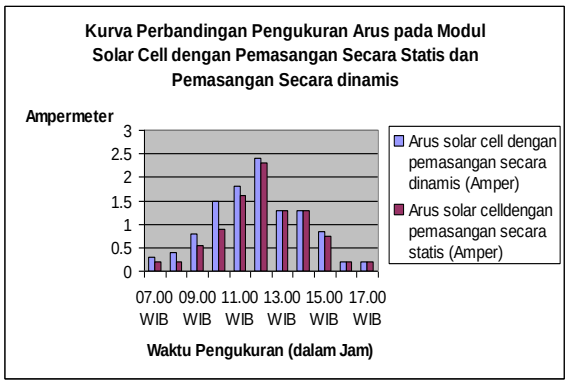


Figure 10: Result of static-dynamic method

CONCLUSION

The contents of the conclusions must summarize the entire research results. After fabrication and measurement of characteristic of PV System can be concluded:

The Optimal power of PV has done using a dynamic solar cell system, which it's moving vertically match on Intensity of sunlight. The exactly moving of solar cell module is done by DC motor, which is controlled by controller circuit. The maximum value (900Lux, 2,4A and 14V) is at about 12.00 o'clock. The dynamic solar cell module is better than the static method to get maximal energy of sunlight. It is match for rural area. The measurement location of this Prototype of Sunlight Searching is in Kabupaten Sijunjung, west Sumatera. Based on measurement result, can be found that the Voltage on 07.00-11.00 is significant increase and the maximum power output is at 12.00o'clock. The Usage of dynamic solar cell module can produce 14.7 % higher power output than statically method.

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