The Angle Adjustment System of The Solar Energy to Electrical Energy Converter Practice Tool

Stieven Netanel Rumokoy[*1], I Gede Para Atmaja[2], Adriyan Warokka[3], Yosua O. Sihombing[4], Christian O. Pelealu[5]
[1,2,4,5]Department of Electrical Engineering, Manado State Polytechnic, Manado, Indonesia
[3]Department of Mechanical Engineering, Manado State Polytechnic, Manado, Indonesia
E-mail: [*1]**rumokoy@polimdo.ac.id**, [2]Igedeatmaja69@gmail.com, [3]adryan.w@gmail.com, [4]yosuasihombing99@gmail.com, [5]christianpelealu14@gmail.com

Abstract

Practical tools need to be created to represent the conditions of a system to support the learning process. In the learning process, especially when studying the utilization of solar energy, a practical tool is required to describe the system of solar panel installation. The practical tool for converting solar energy to electrical energy needs to depict the installation system that occurs during the installation of solar panels.

This study aims to develop an angle adjustment system in the practical tool for converting solar energy to electrical energy that can represent the changes in angles and the amount of energy that can be obtained. The methodology begins with a literature study and is followed by the design and testing of the tool. The results obtained show that the Angle Adjustment System in the practical tool for converting solar energy to electrical energy has been able to represent the conditions of solar panel installation. The more perpendicular the light source is to the surface of the solar panel, the greater the amount of electrical energy that can be obtained.

Keywords *— Solar Energy, Solar Panel, Renewable Energy*

1. INTRODUCTION

Technological developments have encouraged the utilization of solar energy into massive electrical energy. Utilization of solar energy converted to electrical energy will continue to grow[1]. One of the uses of solar energy that is converted into electrical energy is to use solar panels. the function of this solar panel is to convert solar energy into electrical energy[2][3]. Utilization of solar energy as a power plant has been carried out by using solar panels[4][5].

In order to maximize the intensity of sunlight exposed to solar panels, the system design requires the most appropriate angle of inclination of the panel to receive the highest solar radiation[6][7][8]. The amount of energy that can be absorbed by solar panels begins with how much light is exposed to the surface of the solar panel. The greater the light that is exposed to the surface of the solar panel, it can be said that the greater the energy that can be converted into electrical energy. This is the challenge in setting up the installation of solar panels. Solar panels need to be installed in the right position in order to receive the maximum exposure to sunlight throughout the time of the sun's revolution to the earth.

Utilization of solar energy into electrical energy in a solar power plant needs to be designed properly. To meet the need for workers who are truly competent in installing this system, workers need to understand the working system of a Solar Power Plant. One of the ways to gain this competency is by training by experts. Experts need tools to explain this system in a simpler manner. The tools that can be made are Practice Tools to understand the conversion of solar energy into electrical energy. To understand the solar power plant system, a simplified practical tool is needed that can describe the working system of the power plant[9][10][11]. This practical tool can help the practitioner learn a complex system more simply[12][13][14]. One of the parts that is important to study is the effect of installing the angle of the solar panel on the yield of electrical energy that can be obtained.

2. RESEARCH METHOD

The practice tool created is a practical tool for converting solar energy into electrical energy. This practical tool is designed to simulate the installation conditions of solar panels in a position with the sun so that the results of the energy obtained can be compared. This practical tool was created specifically to represent the angle changes that can occur during the installation of solar panels. The angle adjustment system is designed in such a way as to meet the desired rules. The methodology used in this research begins with a literature study. Literature studies are conducted to collect information on scientific developments that have developed over the years. Based on the information that has been obtained, the next stage is to test the system that has been created. Testing is carried out to see whether the design results meet the desired criteria. The stages of the research carried out can be seen in Figure 1.

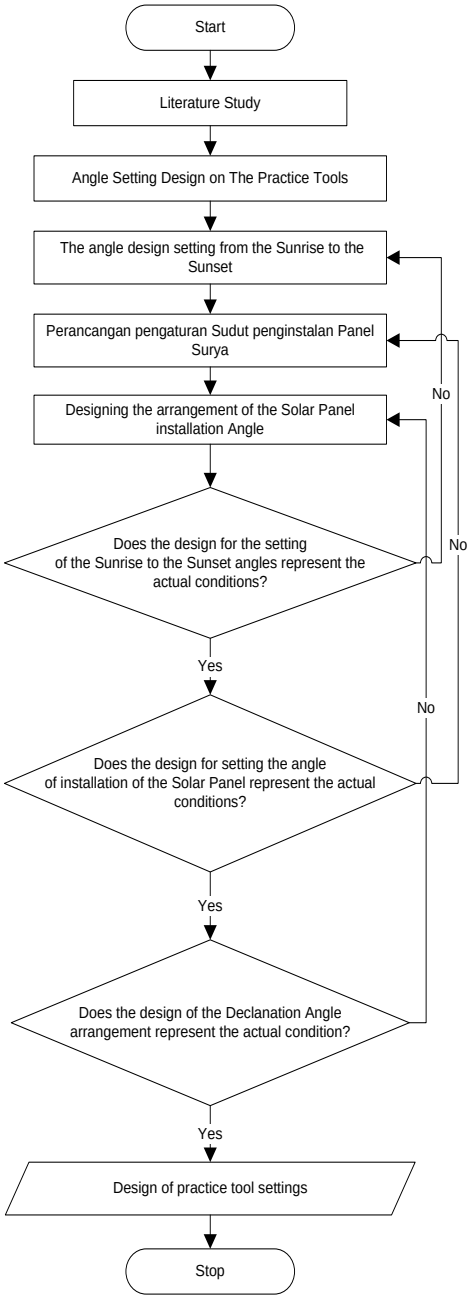

Figure 1. Research Flowchart

3. RESEARCH RESULTS AND DISCUSSION

The practical tool design that is made is a practical tool that can represent the conditions of installing solar panels with the influence of the sun's revolution. The angle control system in this practical tool is a manual control system. Manual means that changes in the angle settings of this tool are changed and regulated by practitioners without an automation system. This manual system has a specific purpose, namely to develop psychomotor skills for practitioners so that when they are about to use advanced practical equipment, participants have started to get used to this work. The tools that are made are also designed to be used by more than one practitioner. The aim is to train teamwork in achieving existing competencies.

3.1. Angle Setting System on practice tools

There are three angle settings on the designed practice tool. The three angle settings are “Sunrise Sunset Setting”, “Solar Panel Installation Angle Setting” and “Declanation Angle Setting”. The settings for each of these angles that have been mentioned can be seen in Figure 2.

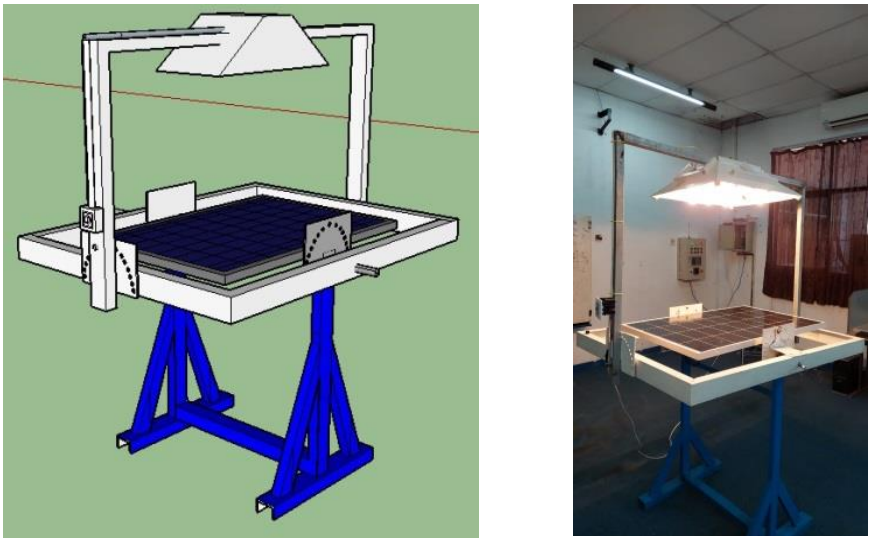

Figure 2. Practical Tool for Converting Solar Energy to Electrical Energy

3.1.1. Sunset - Sunrise Setting

In the practice tool that is designed, for setting the angle of sunrise and sunset, the components of the lamp are likened to the sun which is the source of light/energy source and solar panels are likened to a solar panel system installed on the earth's surface. In the simulation, the solar panels are arranged parallel to the earth's surface (arranged horizontally) while the angle of the lights is changed following the angle settings available in the practical tools that are made.

Figure 3. Simulation of Sunrise Conditions

In simple terms, the concept of using this tool is setting the sunrise and sunset by adjusting the direction of the light. The light is obtained from the existing lamp on this practice tool. for setting the light begins by setting the lamp parallel to the surface of the solar panel. Setting the direction of light that is set parallel to the surface of the solar panel is likened to the condition of the sun just rising. Then the direction of the light is changed using the angle setting on the tool until the position of the light source is perpendicular to the surface of the solar panel. In this condition, the system is likened to the sun's condition at noon (the sun's condition is exactly perpendicular to a surface area on the earth). Then proceed until the condition of the light source is parallel to the surface of the solar panel in the opposite condition when starting the experiment. This condition is likened to the sun has set. The experimental conditions can be seen in the Figure 3..

3.1.2. Solar Panel installation Angle setting

In a practical tool that is designed, for setting the installation angle of the solar panel, the lamp component is likened to the sun which is the source of light/energy source and the solar panel is likened to a solar panel system that is installed on the earth's surface. In the simulation, the lights are set perpendicular to the surface of the earth, while the surface of the solar panel is changed - changing the angle by adjusting the surface from parallel to perpendicular. This setting is likened to getting the optimum angle of solar panel installation or often called the tilt angle.

In simple terms, the concept of using this tool is for setting the optimum angle of the solar panel. The solar panels on this tool are arranged using the existing angle settings. In principle, the more perpendicular the direction of light to the surface of the solar panel, the greater the energy that will be converted to electrical energy.

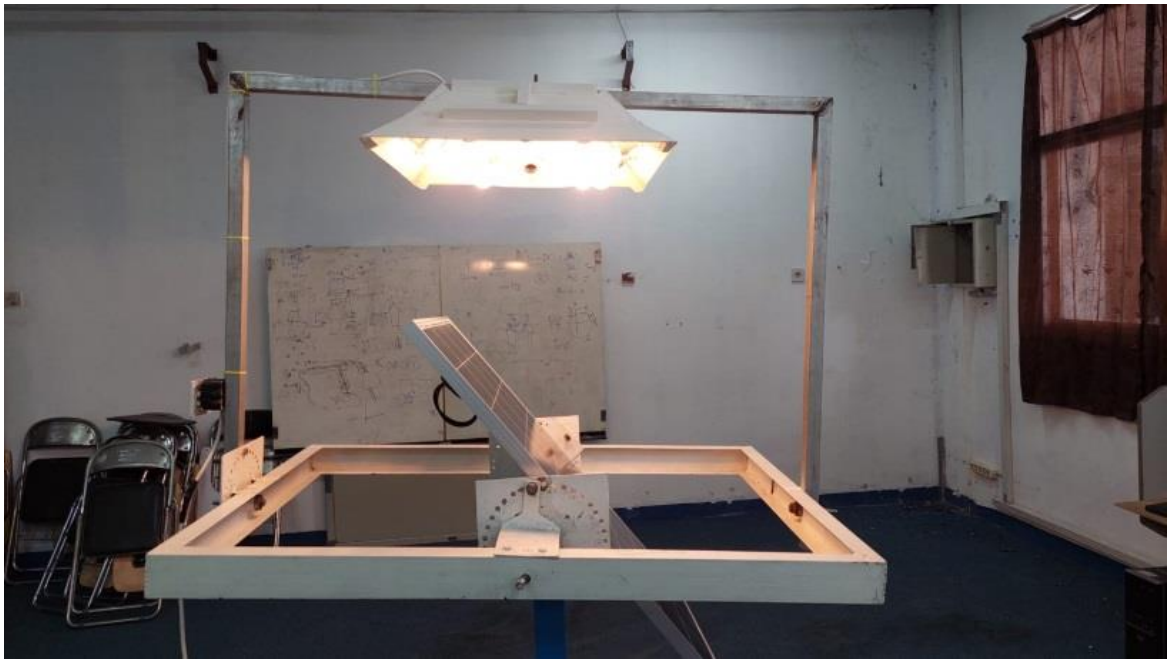

Figure 4. Simulation of the angle setting on solar panels installation

3.1.3. Declination Angle Setting

In the practice tool that has been designed, for setting the declination angle, the lamp component is likened to the sun which is the source of light/energy source and solar panels are likened to a solar panel system that is installed on the earth's surface. There is an additional angle setting that is to set another perspective from the light source. The addition of this setting is to describe the position of the sun to a point on the earth's surface.

Figure 5. Simulation of the declination angle setting

The concept of using this tool is to describe differences in lighting conditions in certain hemispheres. By simulating this angle setting, the differences in lighting conditions in the tropical and subtropical hemispheres can be described. Setting the difference in lighting conditions is by adjusting the sun setting angle, the solar panel setting angle and the declination setting angle.

3.2. Equipment Testing

3.2.1. The Effect of the angle setting at Sunrise and Sunset.

By adjusting the simulation of the control device for setting the angle of sunrise and sunset, the following measurement results are obtained:

Table 1. Output power data on sunrise-sunset simulation

The angle of the lamp position as the sun (^{o})	**output power P_{out} (Watt)**
0	5,85
10	6,60
20	7,47
30	8,16
40	8,63
50	9,01
60	9,23

The angle of the lamp position as the sun (°)	output power P_{out} (Watt)
70	9,35
80	9,43
90	9,47
100	9,43
110	9,38
120	9,25
130	8,98
140	8,63
150	8,02
160	7,24
170	6,54
180	5,96

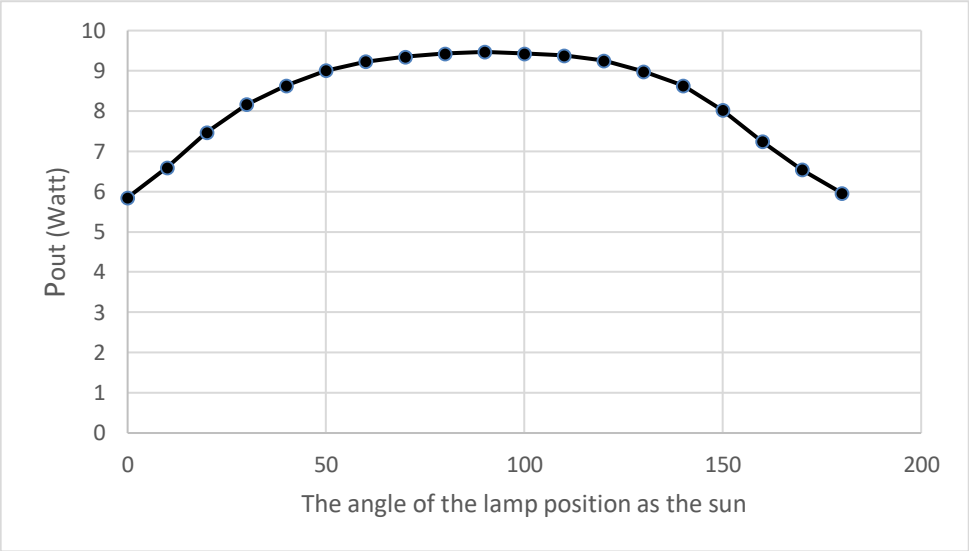

Figure 5. Output power to simulate sunrise and sunset

3.2.2. The effect of Solar Panel installation Angle setting.

By adjusting the simulation of the practice tool to the installation angle of the solar panel, the measurement results are obtained as follows:

Table 2. Output power data on Solar Panel installation Angle setting

The tilt angle position of the PV installation (°)	output power P_{out} (Watt)
10	9,59
40	9,34
60	8,73
90	6,81

From the results obtained, it can be seen that the tendency of energy gain when the position of the light source is perpendicular to the surface of the solar panel. This has proven the theory so that this practical tool can be used to simulate of this part.

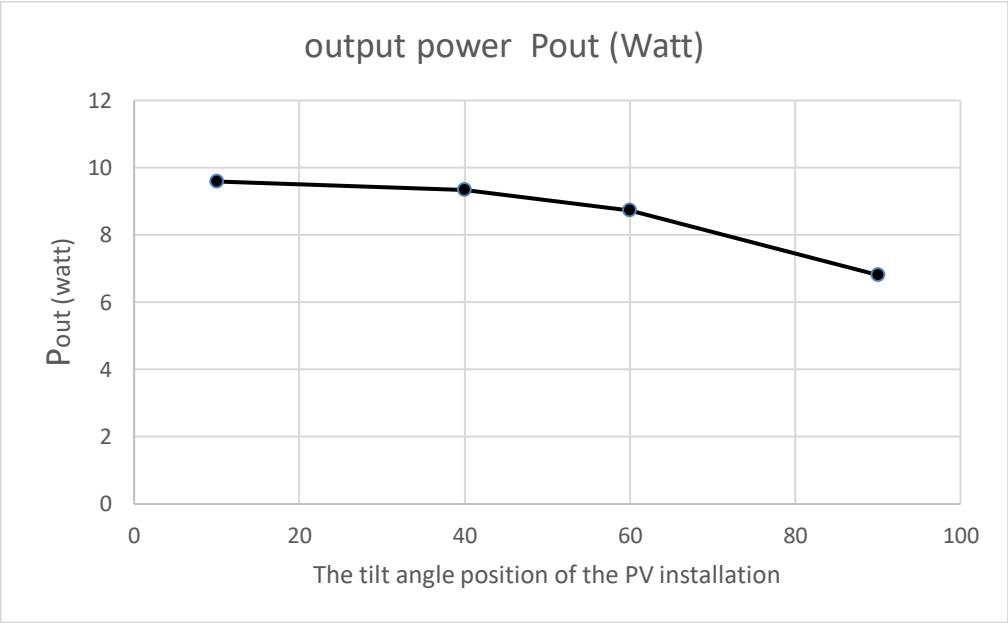

Figure 6. Output power to of Solar Panel installation Angle setting

From the results obtained, it can be seen that the more it is not perpendicular to the solar panel installation to the light source due to the influence of the installation angle of the solar panel, the lower the energy yield obtained.

3.2.3. The effect of the Declination Angle Setting

In the declination angle simulation settings, it can be simulated as if solar panels had been installed in a certain area of the hemisphere. In the simulation, the area determined is the Indonesian territory as part of the tropics which is at latitude 0o, the China area as part of the northern sub-tropical region of the earth with latitude +30o and the Australian area as part of the southern sub-tropical region of the earth from the which is at -30o latitude. From the simulation results, it is obtained:

Table 3. Output power data on Declination Angle Setting

Area	Declination Angle	PV angle	Output Power (Watt)	Total Power (Watt)
Indonesia 0º equator	+20º	0º	4,73	16,44
	0º		7,22	
	-20º		4,49	
China +20º NL	+20º	+30º	6,95	15,23
	0º		5,22	
	-20º		3,06	
Australia -20º SL	+20º	-30º	2,98	15,05

From the simulation results on the earth's revolution, the more perpendicular the sun is to the solar panel installation area, the greater the amount of energy that can be obtained.

4. CONCLUSION

The practical tool of the converting solar energy into electrical energy that has been made with the Angle Setting System can represent the conditions for installing solar panels. By setting an angle that can reflect the installation conditions of the solar panels, the practitioner can differentiate the amount of energy that can be obtained. The more perpendicular the light source is to the surface of the solar panel, the greater the energy that can be obtained.

5. SUGGESTED

Based on the system that has been made, the angle adjustment system that is made can be carried out with a more precise system and the difference in angles that are more closely spaced. This condition can enrich the experimental sample that can be carried out.

6. REFERENCES

[1] H. Kristiawan, I. N. S. Kumara, and I. A. D. Giriantari, "Potensi Pembangkit Listrik Tenaga Surya Atap Gedung Sekolah di Kota Denpasar," J. SPEKTRUM, vol. 6, no. 4, pp. 66–70, 2019.

[2] F. Mbakurawang, J. Teknik, E. Fakultas, T. Universitas, and N. Cendana, "ANALISIS KINERJA PLTS 25 KWP DI GEDUNG LABORATORIUM RISET TERPADU LAHAN KERING KEPULAUAN UNDANA TERHADAP VARIASI BEBAN," J. Media Elektro, vol. VII, no. 1, pp. 13–21, 1995.

[3] D. L. Pangestuningtyas, "ANALISIS PENGARUH SUDUT KEMIRINGAN PANEL SURYA TERHADAP RADIASI MATAHARI YANG DITERIMA OLEH PANEL SURYA TIPE LARIK TETAP," TRANSIENT, vol. 2, no. 4, pp. 0–7, 2013.

[4] P. Harahap, "Implementasi karakteristik arus dan tegangan plts terhadap peralatan trainer energi baru terbarukan," SEMNASTEK UISU, pp. 152–157, 2019.

[5] R. Sianipar, "DASAR PERENCANAAN PEMBANGKIT LISTRIK TENAGA SURYA," JETri, vol. 11, no. 2, pp. 61–78, 2014.

[6] Samsurizal, A. Makkulau, and Christiono, "ANALISIS PENGARUH SUDUT KEMIRINGAN TERHADAP ARUS KELUARAN PADA PHOTOVOLTAIC DENGAN MENGGUNAKAN REGRETION QUADRATIC METHOD," J. ENERGI KELISTRIKAN, vol. 10, no. 2, pp. 137–144, 2018.

[7] Y. H. Anoi, A. Yani, and W. Yunanri, "Analisis sudut panel solar cell terhadap daya output dan efisiensi yang dihasilkan," TURBO, vol. 8, no. 2, pp. 177–182, 2019.

[8] S. Ali and T. M. A. Pandria, "Penentuan Sudut Kemiringan Optimal Panel Surya Untuk Wilayah Meulaboh," J. Mekanova, vol. 4, no. 1, pp. 21–29, 2018.

[9] I. Bagus, K. Sugirianta, I. G. Ngurah, and A. Dwijaya, "Modul Praktek PLTS On-Grid Berbasis Micro Inverter," J. MATRIX, vol. 9, no. 1, pp. 19–26, 2019.

[10] Darno, Y. M. Simanjuntak, and M. Taufiqurrahman, “STUDI PERENCANAAN MODUL PRAKTIKUM PEMBANGKIT LISTRIK TENAGA SURYA (PLTS),” 2017.
[11] K. V. Kumara, I. N. S. Kumara, W. G. Ariastina, P. Studi, T. Elektro, F. Teknik, U. Udayana, and D. Bali, “TINJAUAN TERHADAP PLTS 24 KW ATAP GEDUNG PT INDONESIA POWER PESANGGARAN BALI,” SPEKTRUM, vol. 5, no. 2, pp. 26–35, 2018.
[12] R. Hidayat and J. Fadil, “MODUL PEMBANGKIT LISTRIK TENAGA SURYA UNTUK APLIKASI BEBAN RENDAH (600 W),” J. INTEKNA, vol. 17, no. 1, pp. 29–36, 2017.
[13] S. Akbar, “Rancang Bangun Sistem Mini Pembangkit Listrik Tenaga Surya (PLTS) Portable,” J. Teknol. TERPADU, vol. 9, no. 1, pp. 65–70, 2021.
[14] M. Syahwil and N. Kadir, “Rancang Bangun Modul Pembangkit Listrik Tenaga Surya (PLTS) Sistem Off-grid Sebagai Alat Penunjang Praktikum Di Laboratorium,” J. Pengelolaan Lab. Pendidik., vol. 3, no. 1, pp. 26–35, 2021.