

Available online at: <http://ajceet.ft.unand.ac.id/>

# Andalas Journal of Electrical and Electronic Engineering Technology

ISSN 2777-0079

**AJEEET**  
 Andalus Journal of Electrical and Electronic Engineering Technology

Research Article

## Home Industry Powered Grid-Connected PV System an Economic Feasibility Study

*Kartika Sri Kumala Sari<sup>1</sup>, Wati<sup>2</sup>, Syafii<sup>1</sup>*
<sup>1</sup> *Electrical Engineering Department, Engineering Faculty, Universitas Andalas, Indonesia*
<sup>2</sup> *Accounting Education Department, Universitas PGRI Sumatera Barat, Indonesia*

### ARTICLE INFORMATION

Received: November 26, 2021

Revised: December 6, 2021

Available online: December 10, 2021

### KEYWORDS

Grid-connected PV, Home Industry, Feasibility Study

### CORRESPONDENCE

Phone: -

E-mail: [syafii@eng.unand.ac.id](mailto:syafii@eng.unand.ac.id)

### A B S T R A C T

This paper presents an analysis and feasibility of grid-connected PV System for small scale home industry of welding workshop in Kambang Pesisir Selatan, Indonesia. This paper aims to analyze the feasibility of the on-grid PV system and compare the simulation results between the PV connected and only grid. The optimization results show that a feasible and optimal design configuration is a grid-connected PV system consisting of a Grid, PV system 3 kW, and a 3 kW inverter because it has a significant intensity of solar radiation, which produces an economic generating system with a COE of Rp. 715/kWh, smaller than the essential cost of electricity provision that has been determined by the Ministry of Energy and Mineral Resources, which is IDR 1,058/kWh, by the criteria, the project is feasible to build.

### INTRODUCTION

The utilization of renewable energy is a critical issue in reducing the use of fossil energy which is currently running low [1]. Renewable energy comes from nature, and the amount is unlimited. In addition, the use of renewable energy is very friendly to the environment. Several types of renewable energy can be converted into electrical energy, namely water, wind, sunlight, ocean waves, biomass, and others [2]. Renewable energy can be applied anywhere, including in the household sector. In addition, renewable energy can help home industry players, such as small and medium-sized businesses (SMEs) based at home, which require electricity above-average to save production costs that must be incurred [3].

One of the home industry activities is a welding workshop business in Kambang Pesisir Selatan. Still, the electricity needs for homes originating from the State Electricity Company (PLN) are generally not sufficient for industrial activities to be carried out, so they must add electrical power and increase expenses. That must be paid for electricity at home. PLN as an electricity supplier cannot meet electricity needs all the time because PLN cannot be separated from disturbances and damage, especially in the South Coast itself; the quality of PLN's service is still not good, as seen from the frequent blackouts because from time to time the number of customers continues to increase, so that

electricity supply needs to be provided. To be improved. So the need for backup generators to cover if PLN is experiencing interference.

Indonesia is one of the countries that get sunshine all year round. This can be massive potential for utilizing solar energy as an environmentally friendly renewable electrical energy source. One form of utilization is to use solar cells or PV systems to supply household electricity in Indonesia. Generally, solar energy for residential homes in Indonesia is used in isolated areas from the electricity network with an SHS (Solar Home System) system. It requires a battery as a store of electrical energy. Still, for areas that have an available electricity network (on-grid), it can be replaced with PV connected to the grid. PLN grid does not require batteries as the most expensive component in the generating system [1].

Several studies show that the cost of solar power plants has been stated that it will be cheaper in the future because the government has made several tax cuts, and so on for the supporting components of EBT to make it more economical and attract investors, consumers, electrical energy. So, this gives hope for the use of solar energy on a broader scale [4]. This study uses a grid-connected PV system without a battery to supply the welding workshop home industry in Kambang Pesisir Selatan using the HOMER software.

Table 1. Profile Home Industry Electric Load

Electric load type		Power Load (Watt)	Amount	Usage (hour)	Total Load (watts/day)
Household	LED TV	35	1	8	280
	Refrigerator	125	1	24	3000
	Rice Cooker	350	1	4	1400
	Water pump	150	1	2	300
	Iron	125	1	2	250
	Fan	20	1	4	80
	Dispenser	85	1	4	340
	One lamp	20	2	10	400
Welding workshop	Two lamp	40	2	10	800
	Welding machine	450	5	5	2250
	Hand Grinder	300	4	4	1200
	Hand Drill	300	4	4	1200
	Sitting Drill	150	3	3	450
Transformer	450	5	5	2250	
<b>Total consumption</b>					<b>14.2 KWh/day</b>
<b>Total consumption a month @ 30 days</b>					<b>426 kWh</b>

### Data Description

The home industry selected for the research is a home-based welding workshop in this study. This welding workshop business is located on Jl. Ujung Padang Gambang, West Kambang, Lengayang, Pesisir Selatan Regency, West Sumatra with coordinates 1°41.2'S, 100°42.5'E as shown in Figure 1. The business was founded in 2016; this welding workshop is a home-based business that uses electricity as the main supplier with a PLN connection power of 2200 VA to supply household electricity and its welding workshop business.

The lack of electricity supply in the Pesisir Selatan area due to the imbalance between the amount of electric power and the number of consumers from time to time has resulted in frequent blackouts in the Kambang and surrounding areas, so it is very worrying for small communities whose businesses are very dependent on electricity.



Figure 1. Location of Home Industry under study

The load data in this study are household electrical energy consumption data and welding workshop businesses, as shown in Table 1. Based on usage, the average energy consumed by the load is 14.2 kWh/day, with a peak load of 2.14 kW.

### Weather Data under study

The location under study can be seen in Table 2 below for solar radiation data and average temperature. The average value of annual solar radiation is 5.23 kWh/m<sup>2</sup>/day where the maximum average solar radiation was recorded in February at 5,540 kWh/m<sup>2</sup>/day and the lowest in November at 4,780 kWh/m<sup>2</sup>/day while the average temperature in the area was 25,500C [5].

Table 2. Average radiation and temperature average

Month	Average radiation (kWh/m <sup>2</sup> /day)	Average temperature (°C)
January	5,220	25,350
February	5,540	25,450
March	5,480	25,590
April	5,540	25,750
May	5,340	25,940
June	5,280	25,810
July	5,120	25,610
August	5,090	25,600
September	5,280	25,340
October	5,110	25,280
November	4,780	25,180
December	4,960	25,140
<b>Average</b>	<b>5.23</b>	<b>25,50</b>

### System Configuration

On-Grid PV mini-grid system modeling on Home Industry researched using three components: the grid, photovoltaic, and converter. As shown in Figure, all parts are connected via AC-DC bus.

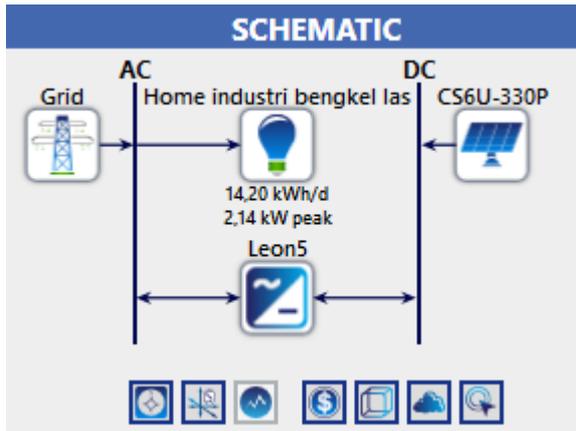


Figure 2. Grid Solar Power Generation System.

Specification data on-grid PV system components in Home Industry are presented in Table 3 below. The input of the project's economic parameters for the inflation value and the nominal discount value is 1.38% [6] and 3.50% [7], respectively.

Table 3. Cost of on-grid PV system components

Component	Capital (IDR/kW)	Substitute (IDR/kW)	O&M Fees
PV system	18,920,000	0	1,892,000
Inverter	14,699,951	14,699,951	1,469,995

## RESULTS AND DISCUSSION

In the simulation process, HOMER will estimate the cost and determine the feasibility of the on-grid PV system by displaying the optimization of the on-grid PV mini-grid system design and capacity sorted by the lowest COE and NPC. The results of the on-grid PV System Optimization in the home industry are shown in Table 4. The feasible and optimal design configuration of the system. The design consists of a Grid, 3 kW PV, and a 3 kW inverter.

Table 4. Optimization of on-grid PV System Design.

Architecture			System
PV (kW)	Grid (kW)	Inverter (kW)	Ren Frac (%)
3	999.99	3	63.4%
	999.99		0

The electrical energy generated from PV per month is very dependent on the intensity of solar radiation each month. The graph of electrical energy produced by PV per month in a year can be seen in Figure 3.

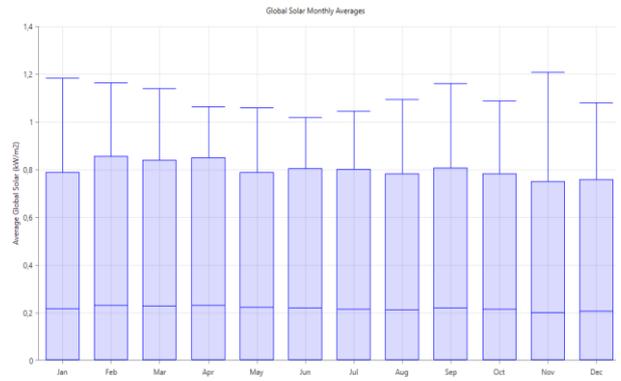


Figure 3. Graph of Electrical Energy produced by PV per month in a year

The picture above shows that the electrical energy produced by PV in February is the highest while the lowest is in November caused by solar radiation each month. The average electrical energy produced per month from the lowest to the highest is between 0.20 kW (November) – 0.23 kW (February), and the maximum daily electrical energy produced per month in a year from the lowest to the highest between 0.75 kW (November) – 0.86 kW (February)

The output power management of the on-grid PV system is taken from several samples during the week in the form of a variation of the power analysis curve from each generator in meeting the load demand, as shown in Figure 4.

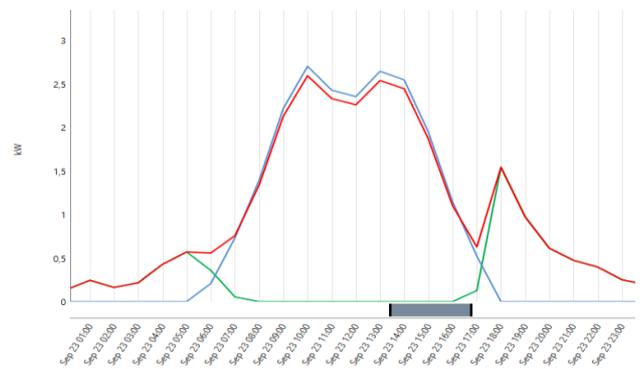


Figure 4. On-grid PV output power management

In Figure 4. Shows the results of the output power graph for on-grid PV systems for the Home Industry. One sample, on September 23, shows that solar radiation is only available during the day from 06.00 am to 6.00 pm, depending on weather conditions. Based on the graph, it can be seen that the contribution of PV to meet the load needs because the average solar radiation in the home industry is feasible to be used as a solar power plant, and the grid is operated when PV cannot meet the load demand.

The results of the economic comparison of on-grid PV system generators with PLN power plants are shown in Table 5. Total energy production at PLN plants is lower than the on-grid PV system. The on-grid PV generating system looks more economical than the PLN generating system because the fraction of renewable energy generation in the on-grid PV system is 63.4%.

Table 5. Comparison of the Economic Value of on-grid PV System with PLN.

Criteria	Grid	On-grid PV
Production (kWh)	5,183	7.529
NPC (IDR)	110.127.229	100.663.575
CoE (IDR/kWh)	1.100	715
RF (%)	0	63.4

Based on the economic feasibility analysis of the on-grid PV system shown in Table 6, this study uses three methods to determine the feasibility of developing on-grid PV in the Home Industry; these methods include Net Present Cost Payback Period and Cost of Energy. It can be seen that the project is feasible to be realized because it meets the economic feasibility criteria, where the NPC is positive [8]. Then the Payback Period is shorter than the planned project life of 25 years [9]. Furthermore, the COE is worth less than the Basic Cost of Electricity Provision that has been determined by the Ministry of Energy and Mineral Resources, which is Rp. 1,058/kWh [10], by the criteria, the project is feasible to build.

Table 6. Analysis of the economic feasibility of the on-grid PV system

Eligibility Method	The calculation results
Net Present Cost (NPCs)	IDR 100.663.575
Payback period (PP)	12 Years 2 Months
Cost of Energy (COE)	Rp. 715 /kWh

. Based on Table 6 above, it can be seen that the project is feasible to be realized because it has met the economic feasibility criteria, where the first NPC of Rp. Then the second method of Payback Period is declared feasible because it meets the criteria of the Payback Period method where the length of time required for the initial return on capital is obtained for 12 years two months, shorter than the project life of on-grid PV in Home Industry which is planned for 25 years. Furthermore, the third value of Cost of Energy from the system obtained based on HOMER is Rp. 715 / kWh, which is worth less than the Basic Cost of Electricity Provision that has been determined by the Ministry of Energy and Mineral Resources, which is Rp. 1,058 / kWh, by the criteria, the project is feasible to build.

## CONCLUSIONS

The analysis and economic feasibility of the on-grid solar power generation system in the home industry of a welding workshop in Kambang Pesisir Selatan have been carried out using the HOMER software. The parameters of the intensity of sunlight and the load data of electrical energy consumption affect the amount of electrical energy produced from the on-grid PV system, where Photovoltaic in generating electrical energy depends on the intensity of sunlight and load data is used to determine the amount of electrical energy generated by the grid.

From the results of the HOMER simulation, it is known that the NPC results in on-grid PV are IDR. 100,663,575 turns out to be cheaper than scenario one, which only relies on PLN. Likewise, the COE results from the on-grid PV system obtained are 35% lower than the generating system that only relies on PLN, and the on-grid PV on-grid PV and renewable fraction generating system obtained by 63.4%.

## REFERENCES

- [1] K. Kananda and R. Nazir, "The Concept of Power Flow Management for PV Connected to a Grid System in Residential Houses," *J. Nas. Tech. Electrical*, vol. 2, no. 2, pp. 65–71, 2013.
- [2] Razak, Ibn.2019. Feasibility Study on the Installation of a Hybrid Renewable Energy Power Plant (Case Study: Gadingsari Village, Wonoroto Hamlet, Bantul). Department of Electrical Engineering, Islamic University of Indonesia, Yogyakarta
- [3] Haryanto, Bobby. 2018. Final Project of Optimizing PLN-Solar Cell Hybrid Generators in Home Industry Applications. Department of Electrical Engineering, Islamic University of Indonesia, Yogyakarta
- [4] Son, Bayu. 2018. Final Project of Techno-Economic Analysis of 1.25kWp PV System Connected to the PLN Electricity Network. Andalas University Electrical Engineering
- [5] NASA Surface Meteorology and Solar Energy Data. (2021, 15 Maret). Monthly Averaged Insolation Incident On a Horizontal Surface [Available Online] <http://www.data.nasa.gov/surface-meteorology-and-solar-energy>
- [6] BI, "Inflation Report (Consumer Price Index)," 2021. <https://www.bi.go.id/en/moneter/inflasi/data/Default.aspx> (accessed Feb. 25, 2020).
- [7] Bank Indonesia, "BI 7-day (Reverse) Repo Rate." <https://www.bi.go.id/en/moneter/bi-7dayRR/data/Contents/Default.aspx> (accessed Feb,25, 2020).
- [8] A. Soba, V. A. South, and H. S. Kolibu, "Optimizing the Capacity of 42 Hybrid Power Generation (PLTH) on Bunaken Island Using HOMER Software," *J. MIPA*, vol. 8, no. 1, p. 7, 2019, doi:10.35799/jm.8.1.2019.22370.
- [9] M. Saifi. "Investment Feasibility Analysis of Plans for Additional Fixed Assets (Case study at PT Pelabuhan Indonesia III (Persero) Tanjung Perak Terminal Branch," vol. 46, no. 1.
- [10] Ministry of Energy and Mineral Resources of the Republic of Indonesia "EMR Regulation No. 55 K/20/MEM/2019 Concerning the Amount of Cost of Provision for PLN Generation"