Analysis of Energy Needs in the Small and Medium Enterprise (SME) Businesses Base on the Photovoltaic Cell

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Abstract: World's business is rapidly growing, impacting the volume of energy usage that strongly related to money budget. This study aims to carry out load analysis and PV planning towards low-energy buildings at PT PSI. The methods used for this research are energy/load survey, documentation data and literature study. Primary data related to 2020 Electricity Bill, is used to calculate the load requirement of the bending tool. The result showed that the power requirement of the bending tool was 7.4 kwd or 59.888 kwm. Electrical energy savings is IDR 891,048 monthly or IDR 10,692,576 annually within 47 PV units of 385 wp capacity.

1 INTRODUCTION

From year to year, energy consumption has increased - mostly fossil energy - that followed by increasing number of residents. The growth of MSME still relies on electrical supply from PLN while fossil energy prices are sky-rocketed, and is not balanced by the usage of Renewable Energy. This cause a disadvantage for MSME. Thus to cover that, renewable clean energy resources are essential (Ariodarma, 2016).

One of the widely used renewable energy is solar energy, commonly applied for houses and buildings--a building that entirely supplied by solar energy is called Zero Energy Building. For preparing and mantaining the building in proper energy efficacy, it is necessary to analyse the PV usage and the existing load. (Effendi. A., 2016).

This study aims to design an proper use of PV and to analyse load input to DC equipment resulted a more efficient load usage.

2 MATERIALS AND METHODS

The methods used in this research are energy/load survey, documentation data and literature study. Based on complete data, a thorough analysis applied in order to preview the efficacy level of PLTS on bending tools at PT. (Gunawan W, 2018).

2.1 Analysis and Comprehension of Electrical Energy Data

Table 1: Installed.

88.021	Average Electricity Consumption	Average Bills 2020
9 KVA	kWh	309.204.843

Table 1 depicted: installed power of PT PSI set on 69 KVA with average electricity consumption of 188.021 kwh and monthly cost IDR 309,204,843--the building categorized as B3 (business) for its quite large installed power due to heavy equipments operation e.g. cutting machine. Apart for its assembly panels space, there are also spaces for non-formal education activities, a study center for electrical training. However, in specific moment like pandemic times, some installed powers are used partly or in low usage. (Garcia Martinez, 2018).

2.2 Existing Condition

Currently, 4 units PVs are installed, each of 380 wp with total power output of 1,520 watt, operating by grid system with inverter (no batteries). The inverter used directly connected to incoming supply from PLN, it can optimaly absorbs 7-8 watt of power. Due to its usage during working hour, the inverter might reserves up to 1,520 watt, but only 1,512 watt be ready to utilized.

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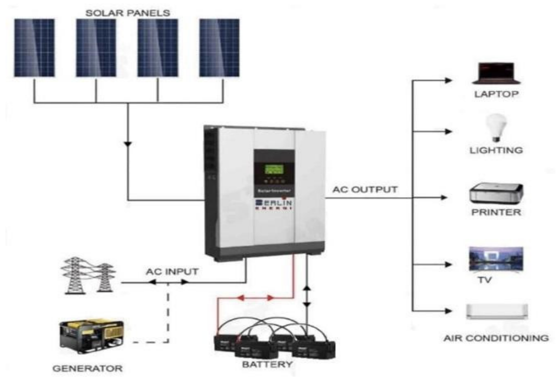


Figure 1: Existing PLTS.

2.3 Lighting-AC Power Requirements

Power consumption average for 4 lamps (in the training room) is approx. 400 watt, so there is still a plenty of energy reserved (1,112 watt). The 4 PVs are installed only to support power for workshop activities in training room. This is an evidence of how a small power may efficiently generating power for a room lighting. Further, the reserved 1,112 watt will support energy for 1 unit air conditioner (1 pk) utillized on training course every Saturday. The total power load of entire activities is 1,060 watt, means there is still 452 watt remaining that accumulated as power surplus or power savings. Quite a cost-saving for monthly bill.

2.4 AC Power Requirements

From the remaining power generated of 1,112 w, it is also used for the needs of 1 room ac with a specification of 1 pk. The use of this air conditioner is only when training is carried out, generally it is used on Saturdays every week. From the total assumption that the power generated is 1,512 watts with a total load of 1,060 watts of power usage, there is a difference of 452 watts. The remaining power is automatically accumulated by PLN as a power surplus, meaning that there is a power saving of 452 watts, thus quite helpful in lowering monthly bills even though it is not significantly large.

2.5 Bending Tool

The bending tool has a base-load of 59.9 kwd or 1,797 kwm. The average of power, voltage and current of the bending tool are specified on Table 2.

Table 2: Average current requirement.

Item	I	II	III	IV	Day V	Average
Power (w)	4750	3000	5400	4400	5600	4630
Voltage (v)	378	377	378	368	378	376
Current (I)	12,56	7.95	14.28	11.95	14.81	12

Table 2 depicted: the average power 4,630 watt, voltage 376 volt and average current 12 ampere per day. The data was obtained from the measurement of 5 consecutive working days of the bending tool.

Figure 2: Bending tool.

PV mini-grid configuration generally requires three elements: PV, baterry and inverter. The inverter used is an off-grid inverter.

2.6 Photo Voltaic

To determine the amount of PV required for the bending tool, see the following detailed calculation:

Wp: watt peak
E0: energy to produce
Psh: peak sun hour (3-5 hours for tropics)
Ef: system efficacy (0.67-0.75)
Cf: temperature correction factor (1.1 - 1.5)

$$Wp = \frac{59{,}888 \frac{wh}{day}}{5\ hx\ 0.67} 1.1 \quad (1)$$

Wp = 17,877

The required PV is 47 units of 385 wp each.

2.7 Solar Cells

This simulation uses Canadian solar cell 260CS6P-260M-EA with 385 wp per unit. The design is to installed 47 unit solar cells with total capacity of 18 kwp for 30-year lifespan, required total cost of IDR 16,093,637 (or approx. IDR 2,299,091 per panel).

2.8 Batteries

PLTS system design uses 8 unit of LGChem RESU10 batteries with 9.8 kwh capacity for 10-year lifespan, estimated cost of IDR 13,200,000 (or approx. IDR 1,650,000 per unit. (Hilton all, 2015).

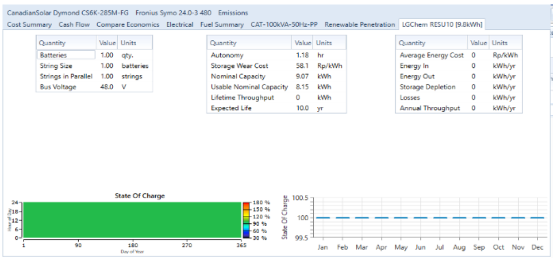


Figure 3: Battery settings window.

2.9 Converter

The schematic PV mini-grid system uses 5 unit converters Fronius Primo USA 5.0-1 208-240 (208 volt) with capacity of 150 kw for 15-year lifespan, with estimated cost around IDR 5,906,363

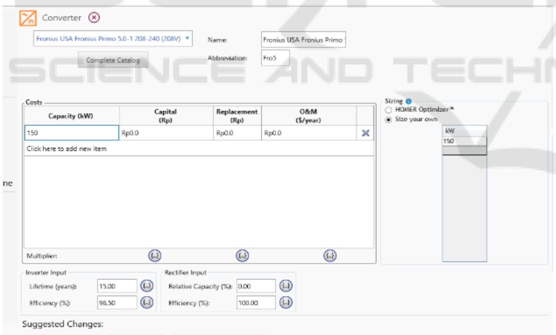


Figure 4: Converter setting window.

2.10 Solar Radiation Converter Settings Window Sun

exposure data is obtained from the NASA website through an online website. Data that used is the average solar radiation per month in a year

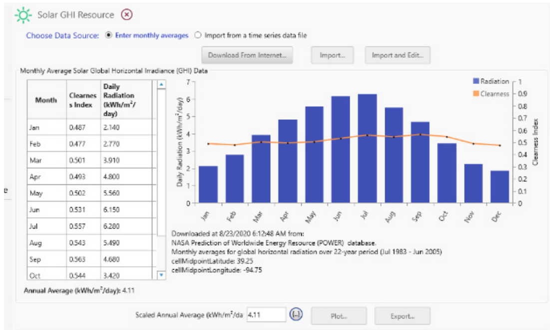


Figure 5: Air temperature.

The image above shows the air temperature. The average air temperature caused by solar radiation for a year ranges from -2 to 25°C. The resulting air temperature is not more than the nominal temperature value of the solar cell used. The nominal temperature of the solar cells used is 45°C. The value of air temperature resulting from the intensity of sunlight must not exceed the nominal value of the solar cell temperature. If this happens, it will cause damage to the solar cell. (Jovanovic et al., 2017).

Figure 6: Solar radiation.

setting window Image of solar radiation setting window in *HOMER software*. The average solar radiation in a year ranges from 2 to 6 kWh/m2/day. The largest solar radiation is in July, which is 6,280 kWh/m2/day and the smallest in December is 2,550 kWh/m2/day.

2.11 Load

Electrical load data used in this study was obtained from PLN with an average usage in 2020. After the electrical load data was obtained, it was then inputted into the Homer software. (Kabir all, 2018).

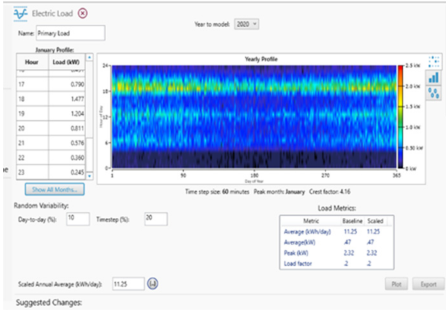
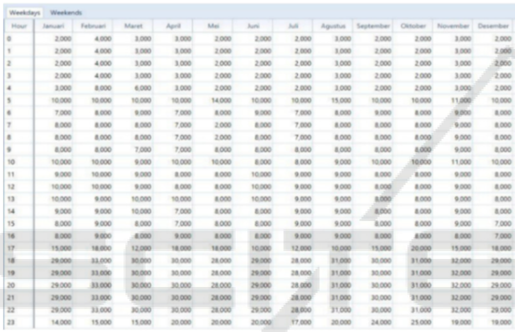


Figure 7: Load setting window.

After the electrical load is input into the homer system, then load settings are carried out for every hour or every day. However, before setting the hourly load usage, it is necessary to do a calculation to find out the average load usage in a month.



Weekdays | Weekends

Hour	Januari	Februari	Maret	April	Mei	Juni	Juli	Agustus	September	Oktober	November	Desember
0	2,000	4,000	3,000	3,000	2,000	2,000	2,000	3,000	2,000	2,000	3,000	2,000
1	2,000	4,000	3,000	3,000	2,000	2,000	2,000	3,000	2,000	2,000	3,000	2,000
2	2,000	4,000	3,000	3,000	2,000	2,000	2,000	3,000	2,000	2,000	3,000	2,000
3	2,000	4,000	3,000	3,000	2,000	2,000	2,000	3,000	2,000	2,000	3,000	2,000
4	3,000	8,000	6,000	3,000	2,000	2,000	2,000	3,000	2,000	2,000	3,000	2,000
5	10,000	10,000	10,000	10,000	14,000	10,000	10,000	15,000	10,000	10,000	11,000	10,000
6	7,000	8,000	9,000	7,000	8,000	9,000	7,000	8,000	9,000	8,000	9,000	8,000
7	8,000	8,000	8,000	7,000	2,000	8,000	7,000	8,000	8,000	8,000	9,000	8,000
8	8,000	8,000	8,000	7,000	2,000	8,000	7,000	8,000	8,000	8,000	9,000	8,000
9	8,000	8,000	7,000	7,000	8,000	8,000	8,000	8,000	8,000	8,000	9,000	8,000
10	10,000	10,000	9,000	10,000	10,000	8,000	8,000	9,000	10,000	10,000	11,000	10,000
11	9,000	10,000	9,000	8,000	8,000	10,000	9,000	9,000	8,000	8,000	9,000	8,000
12	10,000	10,000	9,000	8,000	8,000	10,000	9,000	9,000	8,000	8,000	9,000	8,000
13	10,000	9,000	10,000	10,000	8,000	10,000	9,000	9,000	8,000	8,000	9,000	8,000
14	9,000	9,000	10,000	7,000	8,000	8,000	9,000	9,000	8,000	8,000	9,000	8,000
15	8,000	9,000	8,000	7,000	8,000	8,000	9,000	9,000	8,000	8,000	9,000	7,000
16	8,000	9,000	8,000	9,000	8,000	8,000	9,000	9,000	8,000	8,000	8,000	7,000
17	15,000	18,000	12,000	18,000	18,000	10,000	12,000	10,000	15,000	20,000	15,000	18,000
18	29,000	33,000	30,000	30,000	28,000	29,000	28,000	31,000	30,000	31,000	32,000	29,000
19	29,000	33,000	30,000	30,000	28,000	29,000	28,000	31,000	30,000	31,000	32,000	29,000
20	29,000	33,000	30,000	30,000	28,000	29,000	28,000	31,000	30,000	31,000	32,000	29,000
21	29,000	33,000	30,000	30,000	28,000	29,000	28,000	31,000	30,000	31,000	32,000	29,000
22	29,000	33,000	30,000	30,000	28,000	29,000	28,000	31,000	30,000	31,000	32,000	29,000
23	14,000	15,000	15,000	20,000	20,000	20,000	17,000	20,000	24,000	25,000	19,000	19,000

Figure 8: Hourly load regulation window in a year.

3 DISCUSSION

3.1 Analysis of Solar Cell Usage Parameter Effect on *Hybrid*

results of this simulation aim to determine the efficiency level of solar cells while operating. Where, the optimization results are obtained when the simulation process is finished running. (Mikita all, 2016).

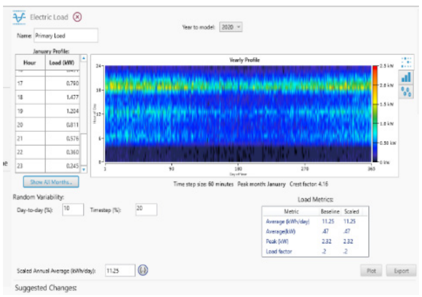


Figure 9: Simulation display of solar cell production.

The energy produced by solar cells depending on the solar radiation each month.

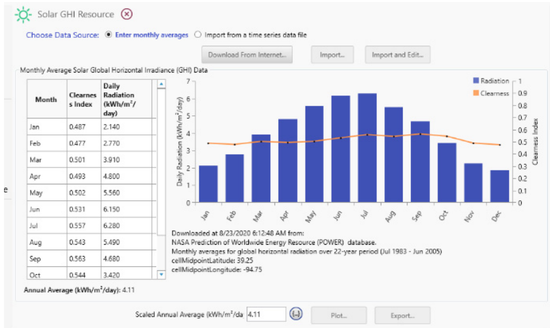


Figure 10: Graph of electrical energy generated by PLTS per month in a year.

Based on the picture above, it can be explained that the energy produced by solar cells in July is the highest, while the lowest is in December. This is because the solar radiation in July is the highest while in December it is the lowest (Djunaedy all, 2019).

The average electrical energy produced per month from the lowest to the highest is between 5.59 kW (December) -12.33 kW (July) and the maximum daily electrical energy produced per month in a year from the lowest to the highest is between 22 ,28 kW (December) - 41.95 kW (July). Meanwhile, the maximum annual electrical energy produced per month from the lowest to the highest is between 45.83kW (in December) - 50.22 kW (November).

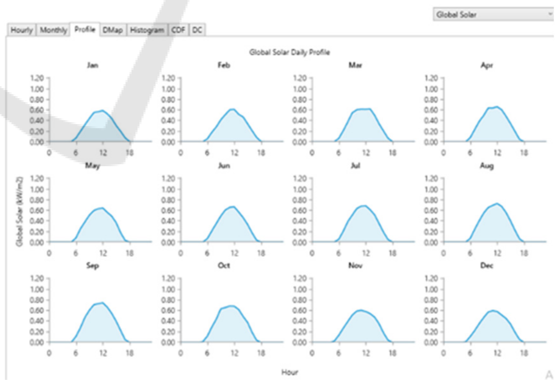


Figure 11: Daily graph of electrical energy generated by PV per month in a year.

3.2 Payback Period

To be able to find out *payback period*, first calculate the amount of income per year from the simulation system. (Nawaitulah & Natsir, 2018). Annual income can be determined by calculating the amount of electrical energy produced at the current selling price of electrical energy. The selling price of renewable electricity for the Cilengsi area as a whole is Rp. 1,644.52 per kWh, so that the annual revenue generated by the generator is:

$$\begin{aligned}\text{Revenue} &= \text{Total energy production (kwh)} \times \text{electricity selling price} \\ &= 542 \times 1{,}644.52 \text{ x } 12 \\ &= \text{Rp.}10{,}692{,}576 \text{ per year.} \qquad (2)\end{aligned}$$

The total investment is Rp. 127.163.640 obtained from the price of PV, Batteries and inverters. After knowing the income earned per year, then calculate the value of the *payback period*. The time required for the return of capital costs incurred on the construction of this PV is 11 years and 8 months. With the calculation of 127.163.640 /10.692.576 = 11.8.

4 CONCLUSIONS

Based on the results of the analysis and discussion, the following conclusions are drawn from this research: the power requirement for bending tools is 59.9 kw/day or 1.797 kw per month, 7 PLTS designs with a capacity of 385 wp/unit produce 18.06 kw/day or 542 kw/month. and electricity savings per month of Rp.891,048.

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