International Journal of Latest Engineering Research and Applications (IJLERA) ISSN: 2455-7137

Volume –06, Issue – 10, October 2021, PP – 01-06

The Potential of Solar Energy for Generating Electricity in RatahanDistrict, North Sulawesi Indonesia

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Abstract: This research aims to calculate the electricity generated from solar energy in Ratahan District, North Sulawesi from 100 kW of an on-grid PV system.. Indonesia. The calculation was conducted by using HOMER 2.68 Beta. The required data for the calculation were the profile of daily electricity consumption in one of the villages in Ratahan district which was obtained from previous study and the monthly average radiation data which was acquired from NASA Surface Meteorology and Solar Energy. By the analysis using HOMER 2.68 Beta, it was found that a 100 kW on-grid PV system can produce electricity as much as168.817 kWh/year.
Keywords: solar energy, HOMER 2.68 Beta, Ratahandistrcit

1. Introduction

Solar energy is one of the renewables which is abundant, especiallyin tropical countries. However, the utilization of this energy to generate electricity is very low. For instance, in Indonesia, which has potential of generating electricity from solar power plants as much as 207,898 MW, there is only 0.05% of such amount of electrical energy that has been utilized [1].

Many studies on solar energy in Indonesia have been conducted. In 2017, Amin et al studied the potential of renewable energy in the eastern part of Indonesia, where they found that the potential of solar energy in Maluku is 5.43 kWh/m^2/day, in Papua is 4.97 kWh/m^2/day, and in West Sulawesi is 5.66 kWh/m^2/day [2]. In the same years, Maluegha et all conducted the similar study in Kilometer Tiga village in SourthMinahasa Regency, North Sulawesi Province. They found that the solar energy can produce 8,615 kWh/year [3].

2. Methods

This research was conducted in two main steps. Firstly, data collection. The required data were the profile of the daily electricity usage and the monthly average radiation in Ratahan district. The electricity usage profile was obtained from previous research carried out by Maluegha et al *(2019*) and the radiation data was acquired from NASA Surface Meteorology and Solar Energy.

The second step was data analysis and calculation. The data were inputted in HOMER 2.68 Beta. HOMER will analyze the data and then calculate the electricity that can be generated from the solar source by using 100 kW PV.

3. Results and Discussions

3.1 Daily electric load profile

As explained before, the daily electric load profile was obtained from previous research. In that research, the profile was generated from the daily electricity consumption of a typical household in one of the villages in Ratahandistrict that is West Tosuraya village. The profileis presented in the following table.

Table 1.Daily electric load profile of a determined residential house in West Tosuraya village [4]

No	Electrical Equipment	Power (Watt)	Operational Hours	Number of Operational Hours	Energy Consumption (Wh)
1	Lamp A	20	18.00 – 23.00	5	100
2	Lamp B	20	18.00 – 22.00	4	80
3	Lamp C	5	19.00 – 05.00	10	50
4	Lamp D	10	18.00 – 22.00	4	40
5	Iron	300	15.00 – 16.00	0,86	258
6	Televison	150	08.00 – 15.00	7	1050
7	Refrigerator	100	00.00 – 24.00	24	2400
8	Magic jar (cooking)	350	05.30 – 06.00	0,5	175
9	Magic jar (heating)	60	06.00 – 20.00	14	840
Total of Daily Electrical Energy Consumption of a Household					4,993

From the data above, the daily electric profile for every hour in a day can be generated. However, to conduct analysis using HOMER 2.68 Beta, at least, the daily electric profile of West Tosuraya village was required. Therefore, the data from table 1 were multiplied by the number of households in West Tosuraya village, that is 524 [5]. Finally, the daily electric load profile in West Tosuraya village for every hour in a day can be done as shown in Table 2.

Table2.Daily electric load profile in West Tosuraya village for every hour[4]

Hour in a day	Electrical consumption	
	(W)	(kW)
00.00 – 01.00	55.020	55,02
01.00 – 02.00	55.020	55,02
02.00 – 03.00	55.020	55,02
03.00 – 04.00	55.020	55,02
04.00 – 05.00	55.020	55,02
05.00 – 06.00	144.100	144,10
06.00 – 07.00	83.840	83,84
07.00 – 08.00	83.840	83,84
08.00 – 09.00	162.440	162,44
09.00 – 10.00	162.440	162,44
10.00 – 11.00	162.440	162,44
11.00 – 12.00	162.440	162,44
12.00 – 13.00	162.440	162,44
13.00 – 14.00	162.440	162,44
14.00 – 15.00	162.440	162,44
15.00 – 16.00	219.032	219,03
16.00 – 17.00	83.840	83,84
17.00 – 18.00	83.840	83,84
18.00 – 19.00	110.040	110,04
19.00 – 20.00	112.660	112,66
20.00 – 21.00	81.220	81,22
21.00 – 22.00	81.220	81,22
22.00 – 23.00	65.500	65,50
23.00 – 24.00	55.020	55,02
Total	2.616.332	2.616,33

Data from Table 1 can be presented in graph from as can be seen in Fig. 1.

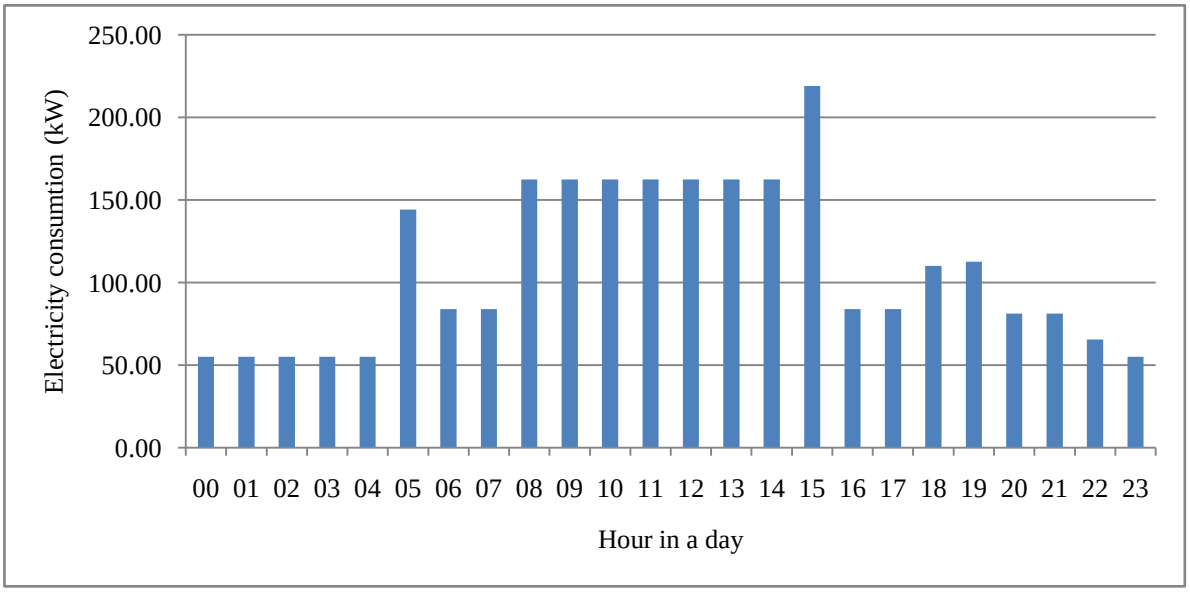

Figure 1. Daily electric load profile in WestTosuraya village for every hour[4]

Fig. 1 shows thatthe highest consumption in a day is 209.03 kW at 15.00. Conversely, the lowest is 55.02 kW that occurs from 23.00 to 04.00.

3.2 Solar radiation

Solar radiation data of Ratahan sub-distric was obtained from NASA Surface Meteorology and Solar Energy by inputting the coordinate of Ratahandistrict. The monthly average solar radiation in Ratahandistrict is presented in the following table.

Table 3. Monthly average solar radiation in Ratahandistrict

Month	Solar radiation (kWh/m^2/day)
January	4,45
February	5,68
March	5,83
April	5,62
May	6,18
June	5,21
July	5,23
August	6,64
September	6,92
October	6,21
November	6,08
December	5,44
Yearly average	***5,79***

As can beeseen, that the highest radiation is in September (6.92 kWh/m^2/day) and the lowest occurs in January (4.45 kWh/m^2/day). The yearly average of solar radiation in Ratahandistrict is 5,79 kWh/m^2/day.

3.2 Data analysis and calculation

As mentioned previously, the data analysis and calculation were carried out by using HOMER 2.68 Beta. At first, equipment to consider for constructing a power system from PV must be selected. In HOMER, “Primary Load 1" must be chosen, and components consist of PV and converter must be selected. Since the electricity in Ratahandistrict has been provided by State Electricity Company, the option “System in connected to grid” must be selected. Fig. 2 shows this step.

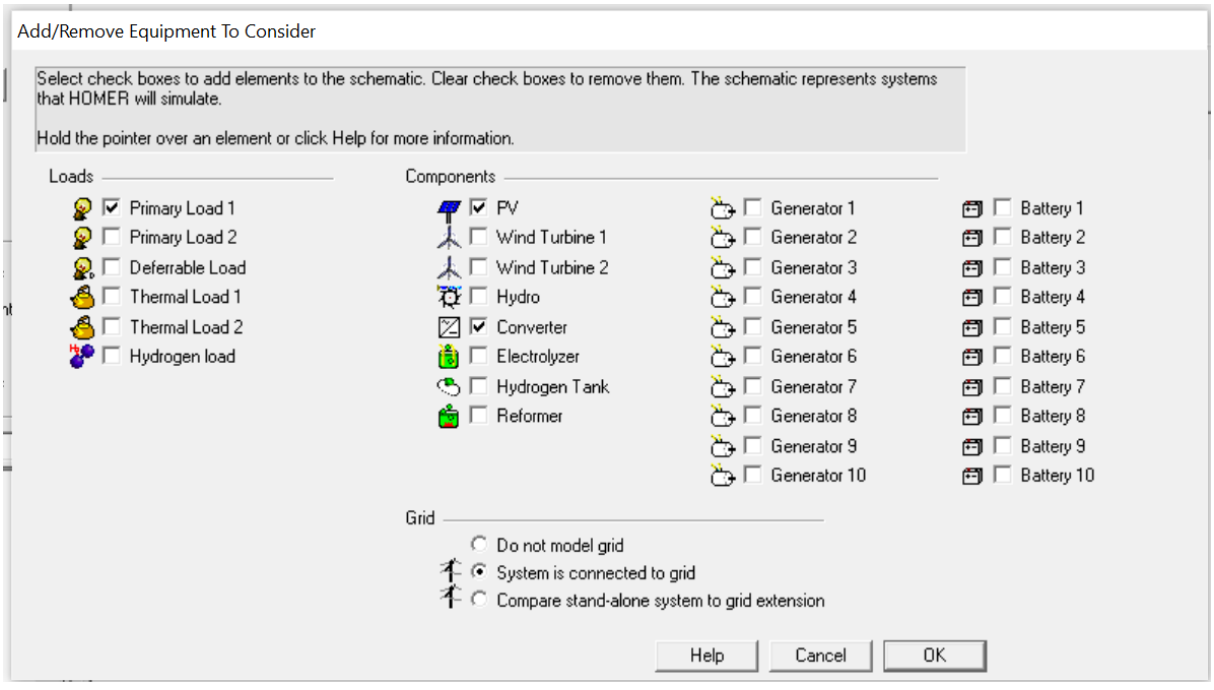

Figure 2 Components selection for power system from PV

Secondly, the primary load, which is the data in Table 2, was inputted to HOMER 2.86.Fig. 3 shows the result of primary load inputs.

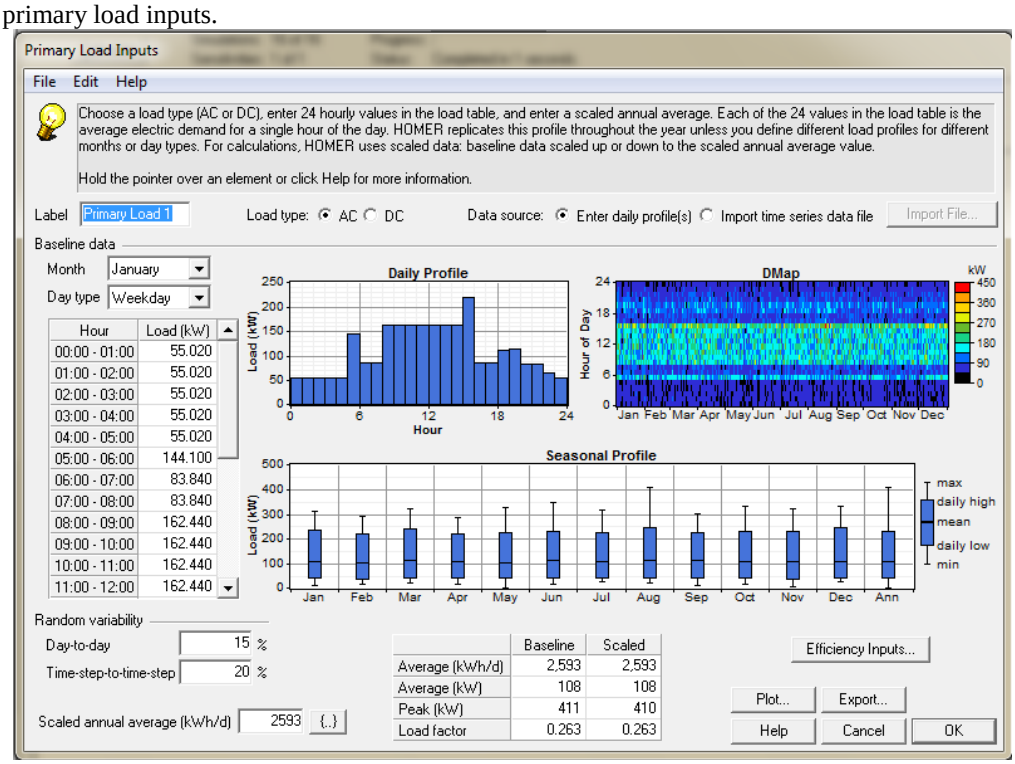

Figure 3. Primary load inputs

Thirdly, the data of PV were inputted into HOMER. Size to consider is 100 kW, where the cost of this PV is estimated $10,000/kW. The PV input is shown in Fig. 4.

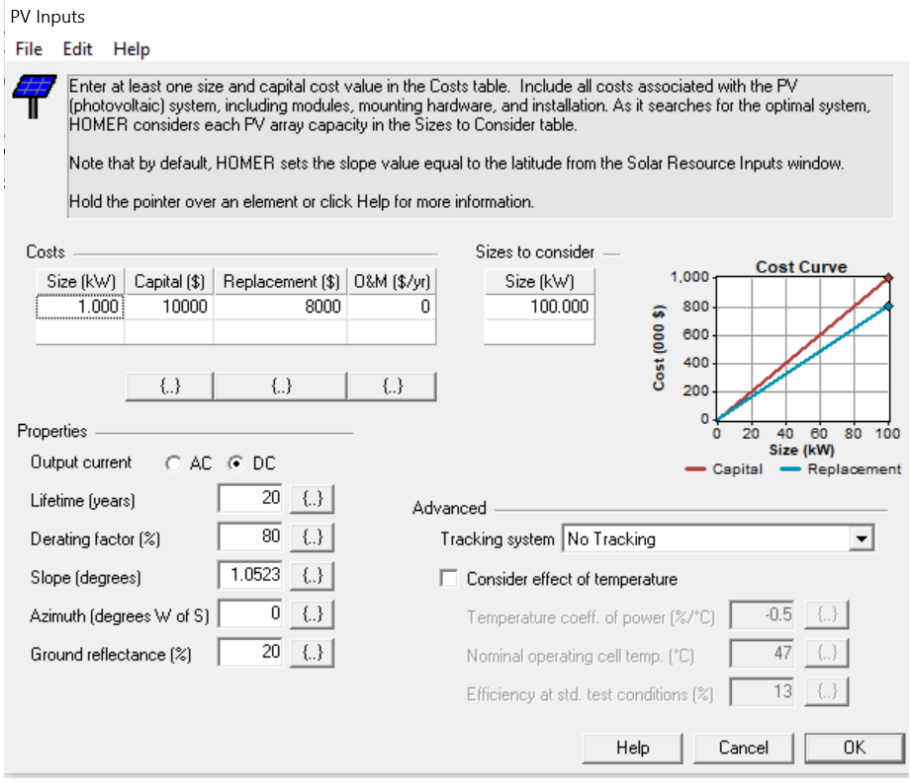

Figure 4. PV input

Fourthly, the data of converter is inputted. The selected capacity of converter is the same with the capacity of PV, i.e. 100 kW. The cost of the converter is estimated as much as $200/kW. The converter input is shown in Fig. 5.

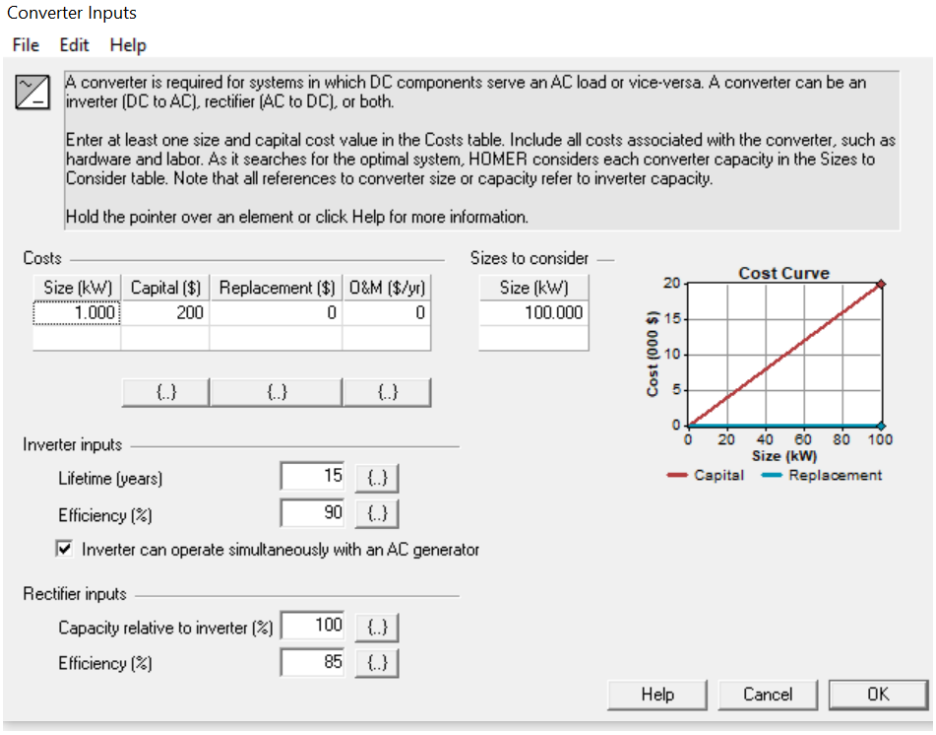

Figure 5. Converter input

Fifthly, the data of solar radiation was inputted to HOMER 2.86 Beta. The data were provided in Table. The result of the input is shown in the following figure.

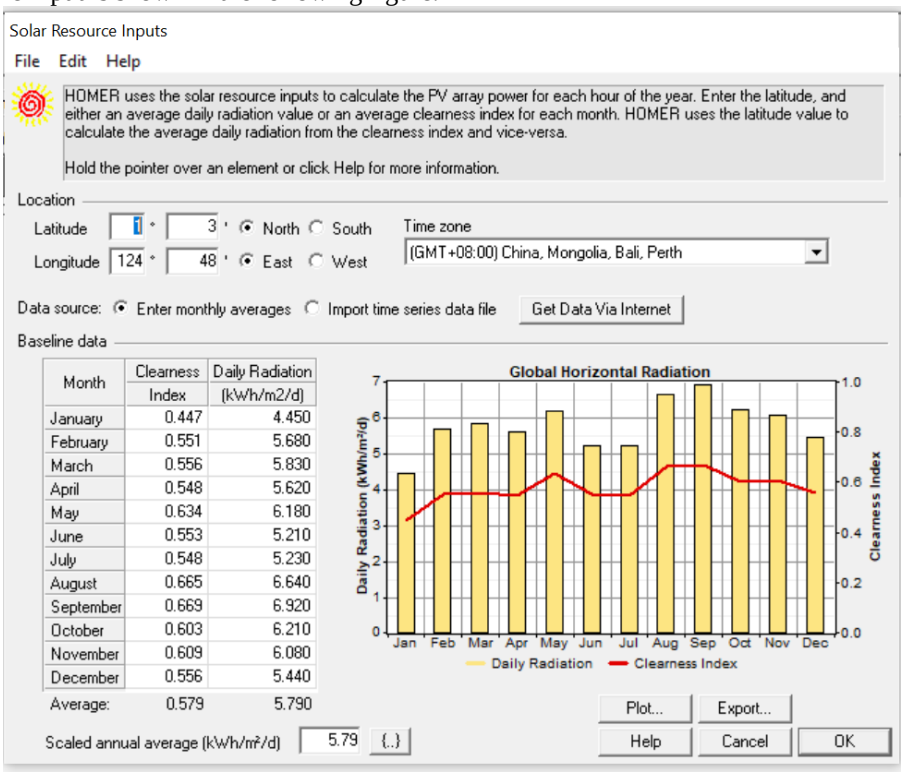

Figure 6. Solar resource input

After all data were inputted, then simulation and calculation were carried out by using HOMER 2.68 Beta. The result of simulation and calculation are shown in Fig. 7.

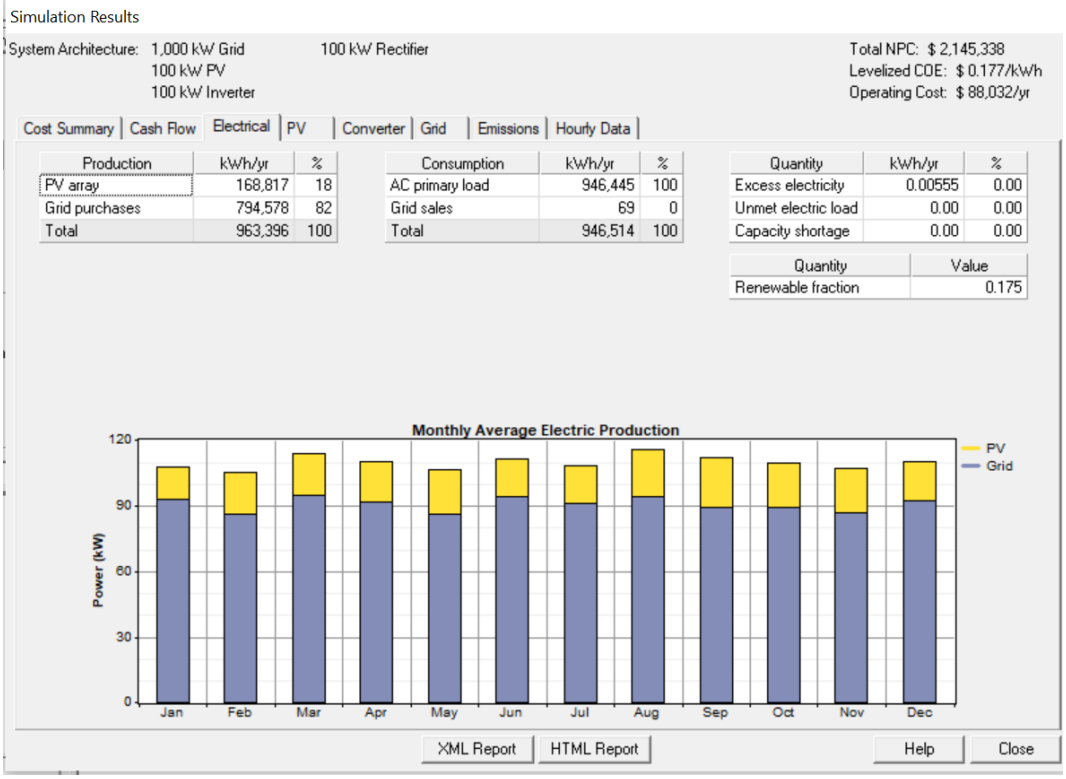

Figure 7. Calculation and simulation results

As can be seen in Fig. 7, the power system can produce 168.917 kWh/year from 100 kW PV.

4. Conclusion

The research in solar energy technology must be encouraged and supported because energy from the sun is abundant and environmentally benign. Accordingly, the utilization of this energy must be maximized.
Based on the simulation and calculation using HOMER 2.86 Beta, the electricity generated from a 100 kW PV system in Ratahandistrict is 168.917 kWh/year.

5. References

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