

Optimization and Simulation of Solar Photovoltaic cell using HOMER: A Case Study of a Residential Building

Mohit Jain¹, Neha Tiwari²

¹Suresh Gyan Vihar University, Jaipur, Rajasthan, India

Abstract: In most developing countries, the main solution for the sustainable electricity generation and supply is dependent on the proper utilization of renewable solar energy. For the solution to overcome dependency on the fossil fuel based energy, this paper deals with the optimization of the solar photovoltaic cell for a residential building of Malviya Nagar, Jaipur (India) that has total roof area of 576 m² which comprises of 16 flat. The whole system of photovoltaic cell is optimized and simulated by using HOMER simulation tool. The optimization result gives that total 160 kw PV cell is required and the cost of electricity generation would be \$0.184.

Keyword: Optimization, Simulation, Photovoltaic cell, HOMER, Solar energy

1. Introduction

In today's world, most of the equipments run on the electricity and the fossil fuel based energy. The limited sources of the conventional source of energy push most of the research on the renewable source of energy. The sun is the most prominent source because the energy radiated by it is, at the rate of around 3.8×10^{24} KW/sec. [1]. As this much amount of energy is radiated by the sun, so there is huge scope of generation of electricity through it. As for the optimization of the photovoltaic cell, a no. of simulation tool available [2]. In this research a case survey for the residential block is carried out for making the building, a renewable source dependent building which would not be connected through grid. For this, the photovoltaic cell is optimized and simulated by the HOMER simulation tool for getting the optimum condition for the electricity generation. The best condition, that is based on optimal PV sizing and cost of electricity generation is analysed through HOMER simulation tool.

2. Literature Survey

In the recent years, so many researches are going on for generating electrical energy from the solar radiant energy. Many researches for the residential and commercial building have done. For optimizing the PV cell, the total annual load profile has been analysed on the hourly basis for the various months [3]. The net average solar radiation of the area has been observed. Also the avg. temperature is also taken under consideration. A detailed survey of the cost of the PV, inverter, battery, and generator has been observed. In order to get the best optimum result, a survey of the simulation software has been done. There is much simulation software for the renewable energy are available in the market. HOMER (Hybrid Optimization Model for Electrical Renewable) software has been most commonly used [4]. In order to analyse the size and the sensitive performance of the PV cell, to obtain the best feasible condition configuration.

3. Material and Methodology

For the simulation and optimization of the photovoltaic cell, a case study of the residential building has been done. The total hourly load of the building for the different month has been observed. For the setup of the photovoltaic panels, the total available roof area has been calculated. The feasible condition for the setting up of the PV cell in the roof top area and the area taken by the PV has been analysed. For, the optimization by HOMER simulation tool, the average solar radiation data of the location is observed. The cost of the different component required for the set up has been observed. For getting the best optimum result, the HOMER simulation tool has been used, which gives the various condition of the result and best optimum case has been taken in consideration for setting up the system.

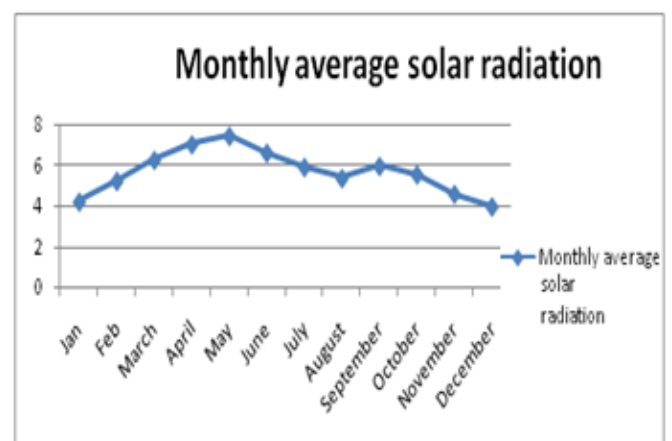


Figure 1: Monthly average solar radiation of Jaipur (kw/m²)

3.1. HOMER (Hybrid Optimization Model for Electric Renewable software)

The HOMER is a simulation tool that is used to optimize the system configuration mainly for the renewable system setup. With this simulation tool, the user has to feed the size, nature and the property of the component. Then it simulates and gives the detailed configuration of the system behaviour. By using this tool, it gives the optimize result of the different

feasible configuration with their net coasting. A comparative detail of the optimized table is carried out through this by its tabular and graphical simulation technique on the basis of technical and economical aspects. The overall cost can be analysed for the lifetime of the system setup by the HOMER.

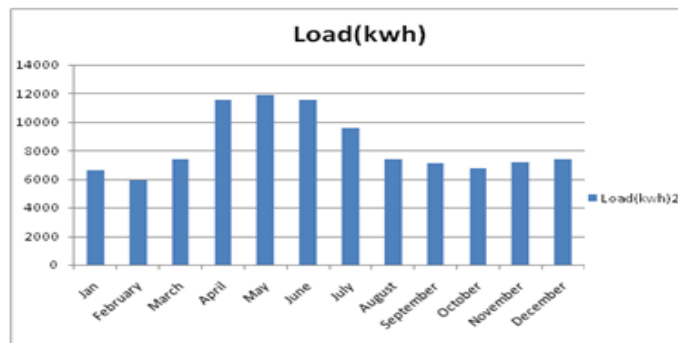


Figure 2: Average monthly load of the whole building for different month

4. Result

By simulating the system through HOMER, the result obtain is that, for the total load of the 284 kwh/day, there is requirement of 160 kw of the PV cell, 15 kw generator, 70 kw converter. The total initial cost is \$181,983. The operating cost would be \$4,776 per year. The cost of the electricity produced is \$0.184/kwh.

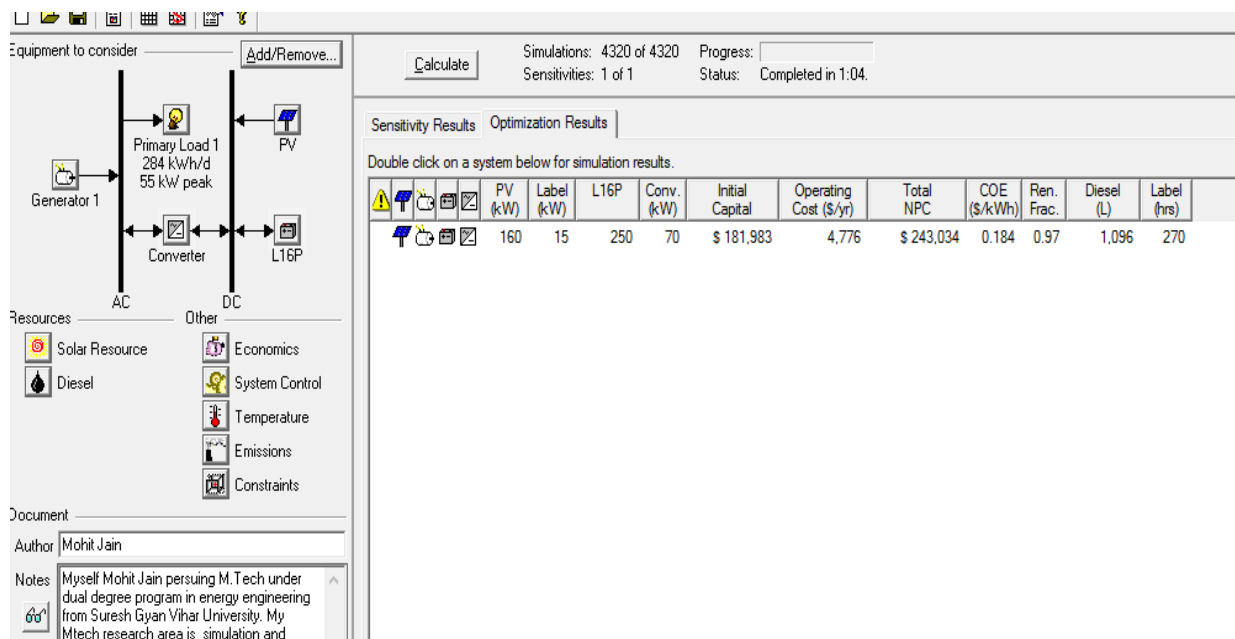


Figure 3: Sensitive Result of the system configuration

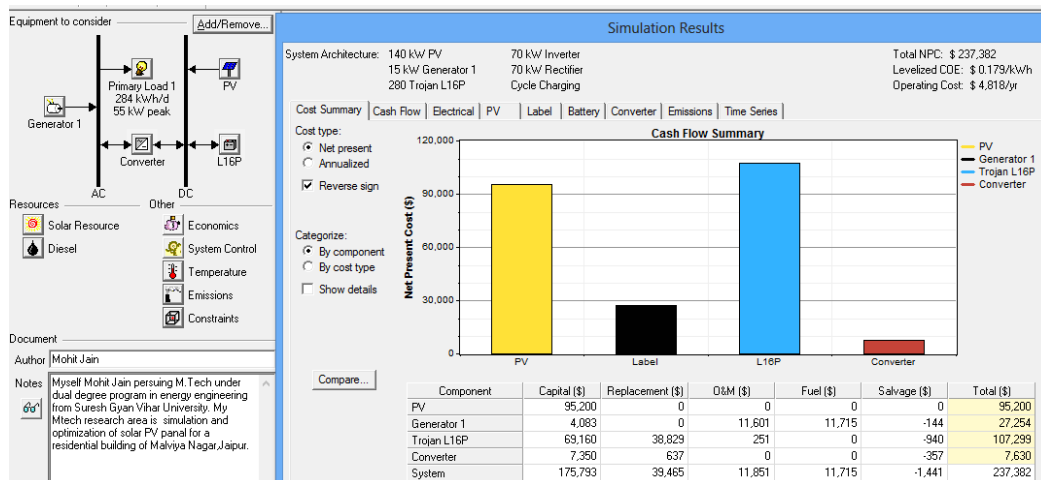


Figure 4: Simulation result of the cost summary of the different component

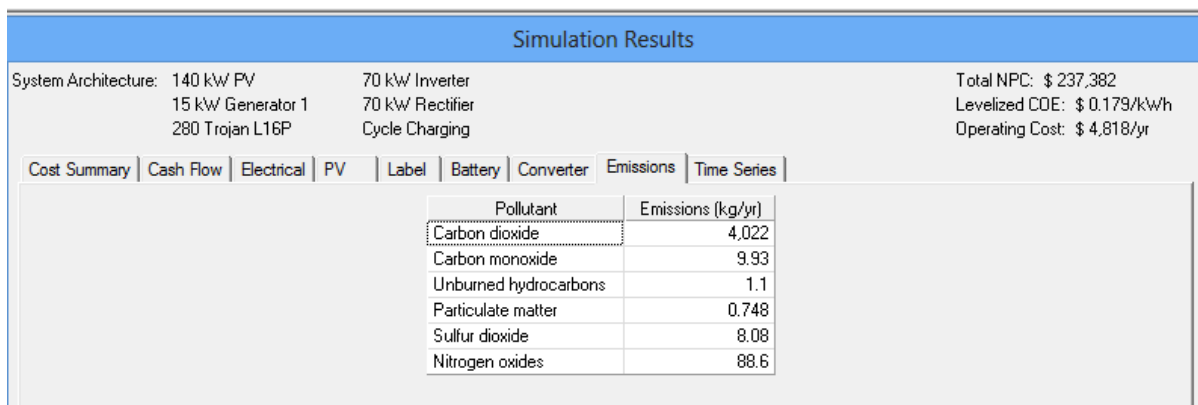


Figure 5: Total yearly emission of the pollutant

The total emission of pollutant like carbon dioxide, Carbon monoxide, Unburned hydrocarbons, particulate matter, sulphur dioxide, Nitrogen oxides are 4,022, 9.93, 1.1, 0.748, 8.08 and 88.6 kg/year respectively. The emission of the pollutant is very less, so it very efficient system for the environmental perspective for generating energy for the residential requirement.

5. Conclusion

After simulating the system and getting the result, it has been concluded that for setting up the PV panel for the residential building in the required roof area is feasible. As for the cost perspective, it is slightly costly than the hydro electricity. But for the environmental aspect, setting up the PV panel for the building for the required energy consumption is feasible. During the month of April, May, & June there is requirement of the generator, as there is much load at the peak hours of the month. The overall photovoltaic cell is optimized and the best feasible configuration result has been found out.

6. Future Scope

Due to the limitation of the conventional source of energy, so generating energy through PV cell in near future is very essential. For optimizing the PV cell, instead of HOMER simulation tool, other efficient tool could be used, which would give more optimum result. The hybrid system of wind and the solar would be used, so that in night through wind, the energy could also be generated. The solar PV tracking

system could be used for trapping more radiant energy of the sun for the more efficient result.

Reference

- [1] Majid Alabdul salam, Ahmed Aziz, Ali Haalwali, Hussein Akazem; "Optimal sizing of photovoltaic systems using HOMER for Sohar, Oman". IJRER, Vol. 3, 2013.
- [2] Mahendra Lalwani, D.P. Kothari, Mool Singh; "Investigation of solar photovoltaic simulation softwares". IJAER, Vol.1,2010
- [3] Ghassem Mokhtari, Ghavam Narbakhsh, Arindam Gosh, "optimal sizing of combined PV-energy storage for a Grid- connected residential building". AEE, Vol 1, 2013.
- [4] Ajay Sharma, Anand Singh, Manish Khemariya, "HOMER optimization based solar PV-wind energy and diesel generator based hybrid system". IJSCE, Vol. 3,2013

Author Profile



Mohit Jain, completed B.Tech in electrical engineering from Suresh Gyan Vihar University, Jaipur (India). Currently perusing M.Tech in energy engineering under dual degree program from Suresh Gyan Vihar University, Jaipur (India). My M.Tech research work is to optimize the solar photovoltaic cell using HOMER tool for a residential building of the Malviya Magar, Jaipur, Rajasthan, India