AN EFFECTIVE STUDY ON PERFORMANCE ANALYSIS OF GRID CONNECTED PV SYSTEM

Jignesh L. Rohit [1], Prof. K.D. Panchal[2]

[1] *P.G. Student, M. E. (Energy Engineering), Government Engineering College, Valsad, Gujarat (India)*

[2] *Associate Professor, Mechanical Engineering Department Government Engineering College, Valsad, Gujarat (India)*

ABSTRACT

This study aims at developing a standard procedure for the design of grid-connected solar Photovoltaic (PV) systems using the roofs of buildings and car parks. Energy is an important aspect in the today's world. Due to the increase in the population and the decrease in oil and other energy resources the power generation using renewable energy has become more popular. The proper paper presents the feasibility analysis of implementing the photovoltaic system for a residential house.

Keyword:- *Photovoltaic system, PV Cell*

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1. INTRODUCTION:

Renewable energy today is becoming more and more popular because of the fluctuation in the oil prices. Photovoltaics and Wind mill are today very popular alternate energy sources as it is a clean energy and abundant in supply. The costs of the PV cells are also decreasing day by day.

Photovoltaic system mainly uses PV cells which when incident with photons from sun light break the bonds and releases electrons. These electrons flow in the circuit as DC current. The inverters are used to convert the DC to AC for residential power. Today solar technology has developed in many ways ranging from multiple tracking PV system where the sun is tracked by dual axis.[1] Today concentrating solar cells are used in which the sunlight is focused using dish to concentrate the light and when the light falls in to the cells part of the energy is converted to electrical energy. The rest of the energy is either reflected or absorbed. The efficiency of the PV cells range from 15% to 20% and hence more number of panels have to be added to get the required power. There are lots of research going on to bring the efficiency higher.[4] Some of the other areas of research include thin film cells, flexible panels, building integrated PV systems.

The figure 1 below shows the equivalent circuit for PV cell in which the current source indicates that the current flow when the light falls on the PV cell. The Rs and Rsh are the series and parallel resistance appearing across the cell. These are the resistance by the conductors.

The figure 2 shows that the characteristics of PV in which it is seen that the voltage and current varies according to the variation in the incident sunlight and the red indicates the another set of V-I characteristics for different temperature which is 56 degree centigrade. [2] It is seen that as the temperature increases above 25 degree centigrade the performance is reduced. The optimal working condition of PV cell is 25 degrees centigrade.

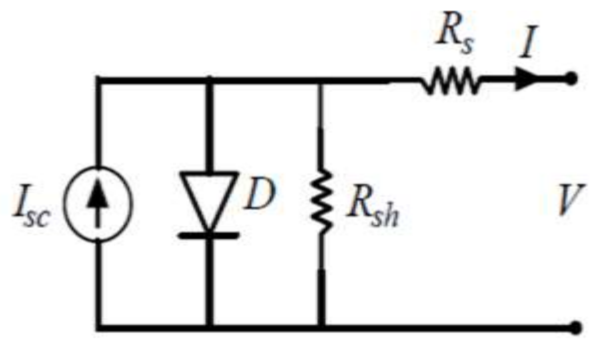

Fig. 1: Equivalent circuit of array.

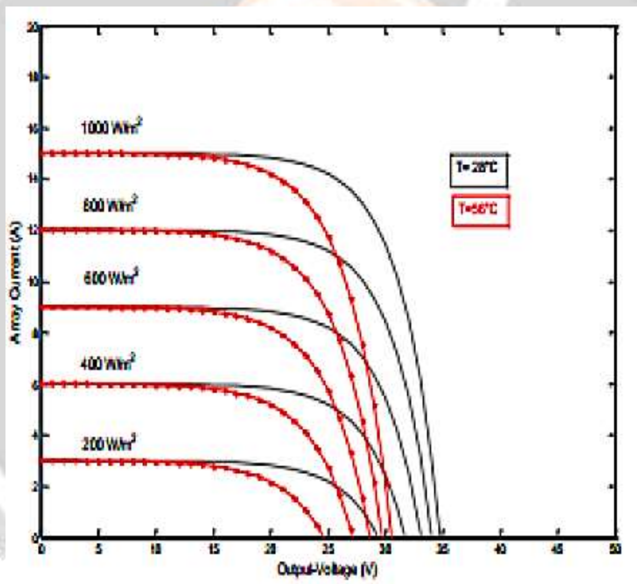

Fig 2: Characteristics of PV for different irradiance and temperature

2. Grid-Connected PV Systems

Grid-connected PV systems are systems connected to a large independent grid usually the public electricity grid and feed power directly into the grid. These systems are usually employed in both decentralised grid-connected PV applications and centralized grid-connected PV applications. Decentralised grid-connected PV applications include rooftop PV generators, where the PV systems are mounted on rooftops of buildings and building integrated system in which the PV systems are incorporated into the building. In the case of residential or building mounted grid connected PV systems, the electricity demand of the building is met by the PV system and the excess is fed into the grid; their capacities are usually in the lower range of kilowatts.

A typical grid-connected PV system comprises the following components:

- Solar PV Modules: these convert sunlights directly to electricity.
- Inverter: converts the DC current generated by the solar PV modules to AC current for the utility grid.
- Main disconnect/isolator Switch
- Utility Grid

Central grid-connected PV applications have capacities ranging from the higher kilowatts to the megawatt range.

3. DESIGN OF PHOTOVOLTAIC SYSTEM

The figure 3 shows the variation of average earth and air temperature every month. It can be seen that the temperature rises in the month of June July and august. The temperature affects the performance of photovoltaic as the ambient temperature to get the maximum efficiency is 25 degree centigrade.

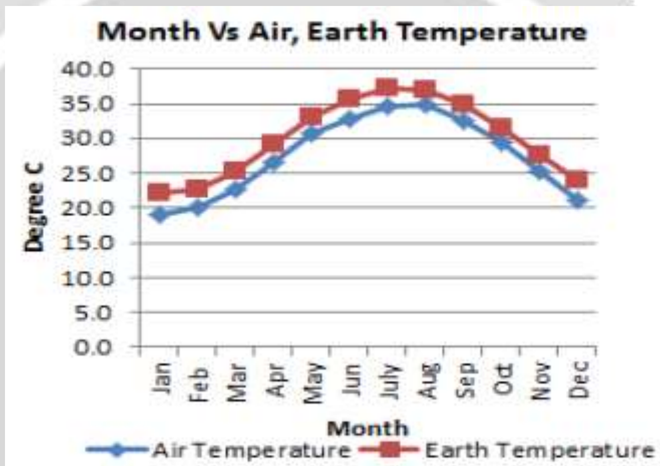

Fig 3: Month Vs Air temperature

The figure 4 shows the variation of solar radiation and wind speed for every month and it can be observed that the solar radiation is high and also the wind speed is almost constant. The wind speed also affects the performance of the panels.

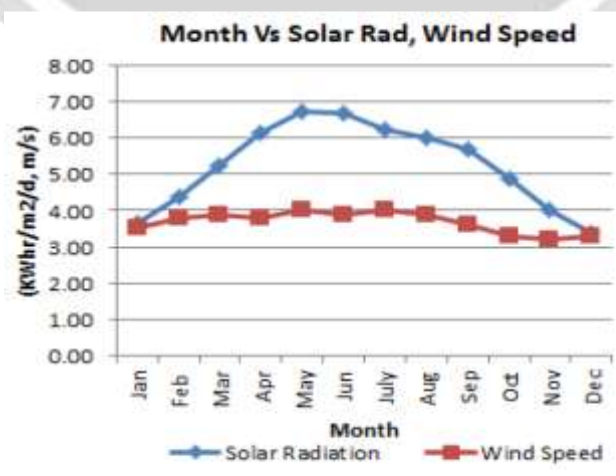

Fig 4: Month Vs Solar radiation

The wind between the panels and roof creates pressure on the panels which creates force and finally damage the panels. The effect of snow is not considered in this paper but the snow also significantly affects the panel performance one is the deposit and the other is the weight of snow deposited in the panels. The figure 5 shows the load for every month to be connected to the PV system. The average load is approximately 4KW. The load varies as per the climatic situations. The typical load from the month of May to September is high due to summer and it shows low in august.

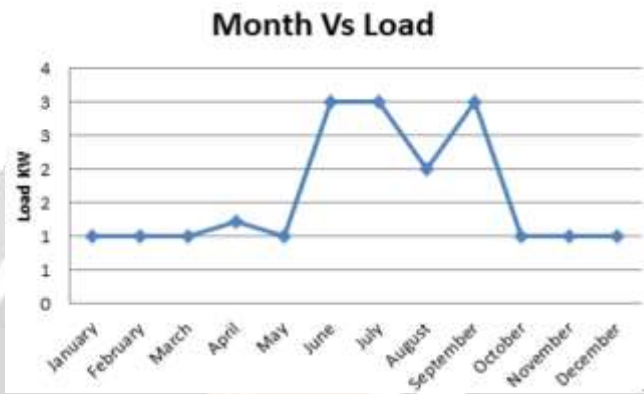

Fig 6: Month Vs Load

4. DESIGN USING RET SCREEN SOFTWARE

The economic analysis of the grid-connected solar PV system was carried out to assess the cost and intended benefits of the project. It was carried out with the help of RETScreen software. The software is easy to use and has the capability of simulating the net present value and simple payback period as well as estimating the greenhouse gas saving potential of renewable energy projects over their entire operational life. The NPV and simple payback period will help determine how feasible the project will be. The total investment cost comprises the following components; module, inverter, cables, mounting structures, engineering and project management, labour and miscellaneous costs. The module and inverter cost alone makes up about 76% of the total investment cost. Table 3 below shows a breakdown of the total investment cost.[3]

Month	Daily solar radiation horizontal kWh/m^2/d	Daily solar radiation tilted kWh/m^2/d	Electricity export rate Rs/MWh	Electricity exported t grid MWh
January	3.65	4.53	230.0	0.913
Feb	4.37	5.06	230.0	0.912
March	5.21	5.56	230.0	1.096

April	6.15	6.07	230.0	1.136
May	6.71	6.24	230.0	1.186
June	6.69	6.05	230.0	1.105
July	6.22	5.71	230.0	1.073
August	6.02	5.79	230.0	1.082
Sept	5.67	5.87	230.0	1.068
Oct	4.88	5.53	230.0	1.057
Nov	4.00	4.91	230.0	0.929
Dec	3.39	4.29	230.0	0.859
Annual	5.25	5.47	230.0	12.416

Table 1- Electricity exported to grid and the solar radiation

Photovoltaic Type		Mono-si
Power capacity	kW	14.72
manufacturer		Sunpower
Model		Mono-Si-SPR-320E-WHT(46 unit)
Efficiency	%	19.6%
Nominal operating cell temperture	˙C	45
Temperature coefficient	%/˙C	0.40%
Solar coefficient area	m^2	75

Table 2: PV details

The table 2 shown above shows that the mono silicon PV is used due to its high efficiency and cost. Here 46 units of PV panels each with 320W are used making it to 14.7KW. Though the average power required is around 4KW the

PV system is designed for 14KW as the efficiency of panels is around 20% and any extra power generated is connected to grid. In this case inverter with a capacity of 15KW is used to convert the obtained DC to AC voltage.

5. CONCLUSION:

In this paper the design of photovoltaic system for an green house is implemented. Optimum numbers of panels, inverters are selected. The analysis of the RETScreen simulation results reveal that, the PV system generate 14.72 kw and its efficiency 19.32%. The project also stands the chance of saving about tonnes of CO_2 which would have been emitted by a crude oil fired thermal power plant generating the same amount of electricity. There are also some benefits like the greenhouse gas emissions savings which can in the long run help mitigate the adverse effects of the climate change problem.

6. REFERENCES

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