

Assessment Of Solar Energy Capacity And Performance Evaluation Of A Standalone Pv System With Pvsyst

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Abstract: In today's time photo-voltaic systems are emerging fast due to its high sustainability and viability. It is necessary to assess the performance of these systems to understand various aspects related to its operation. The study analyses the usefulness of a pv system installation that supplies electricity to an academic institution. This paper aims at evaluating the performance of a grid connected silicon-poly pv system that has a peak power of 20.0 kWp and voltage of 17v. The software used for analysis is PVsyst(7.1.7 version). PVsyst is a widely used simulation software for estimating the energy yield and for optimizing the system design. The PVsyst software has been used to design a grid connected pv system for Karunya Institute of technology. The simulated system has silicon-poly pv modules assembled in it. Each module consists of numerous photo-voltaic cells interconnected. Each module has a power rating of 180wP and voltage sizing of Vmpp(60 degree celsius)17.5v Voc(-10degree)28.9v. The photo voltaic modules are assembled in a total of 13 strings. Modules in a string are series-connected. Each string in the system consists of 10 pv modules connected in series with power rating of 20.8 kWp. The arrangement is grid-connected with a utility meter. The weather dataset used for evaluation is extracted from PVsyst's database and has the attributes, solar radiation and ambient temperature..

Keywords: Performance ratio, Photovoltaic, PVSYST, Tilt angle, Si-poly PV Mod ule, performance ratio, Optimization

1. Introduction

The use of photovoltaic systems for electricity generation is becoming very prominent in recent times. This rise is mainly due to shortage of other energy resources e.g fossil fuels. So there is a need to switch to reliable and sustainable resources such as photovoltaic system. It taps the inexhaustible energy from sunlight and converts it into electrical energy [1]-[3]. It is cost effective as it has only purchase and installation costs. PV systems are eco-friendly as it does not emit any hazardous gases. Hike in fuel prices is also one of the reasons for pv systems to gain popularity. Since India is a tropical country it tends to be warm throughout the year and has solar energy in abundance. So usage of solar panels has widened in countries like India. Government has also promoted the use of pv systems by offering incentives and exemptions from tax[4]-[5]. In addition to these pros, pv systems also have certain demerits. The efficiency of a pv system is mainly based on climatic conditions of a particular place. Not all counties around the globe have hot climates. So the installation of the solar panels in these regions might be impractical. Also the cyclic variations of the seasons are a prime factor that has to be considered.

The overall efficiency of a pv system is influenced by various factors such as material of the photo-voltaic cell, installation method, inclination or orientation of the system, arrangement of the pv cells in the system, climatic conditions of the location etc [6]-[7]. Therefore, it is necessary to study or analyse these factors to gain knowledge on the characteristics that affect the power generation of a pv system. Analysis can be done manually but technology has paved way for the development of various simulation software's such as pv Planner, Homer Pro, PVsyst etc. These software's have proven to be advanced and rapid.

2. About Pvsyst:

PVsyst is considered as one of the standard simulation software's that is in use. It was designed and developed by a Swiss scientist Andre Mermaid & Co. It is used by most engineers world-wide as it provides rapid results and it is handy too. It carries out elaborate and explicit study on numerous parameters that influence the efficiency of a system[8]-[10]. In addition to this it has the ability to perform periodic estimations and report generation. The accuracy of PVsyst software is very close to the real/actual values. It also has other salient features such as colour coding to display error messages, warnings etc.

3. Design Methodology:

The steps involved in simulation design are illustrated in the form of flow chart in figure.1. The below step-by-step diagram depicts the procedure that has to be followed or simulating a design using PVsyst[11]-[13]. Various steps involved in designing a grid-connected PV system in PVsyst's platform are as follows:

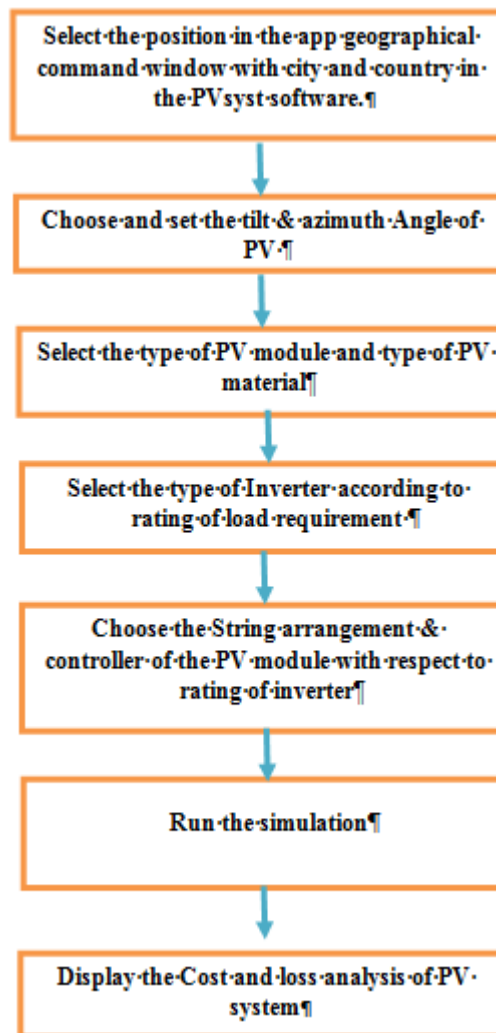


Figure .1. Step by step Algorithm for Analysis of PVsyst

1. Set out the geographical location:

Choose the geographical location for which the analysis has to be carried out for installing the pv system. The software provides options to choose to existing sites or new site. PVsyst can identify and analyse any location on earth. The selected location has to be then associated with any satellite data source that is provided by the software(e.g. NASA-SSE satellite data). The parameters affecting the selected location will be displayed in a tabular form or in some cases be stored as a file. The below table illustrates the parameters of Coimbatore, TamilNadu over a year. In PVsyst the coordinates (latitudes and longitudes) are taken from NREL and is updated.

2. Fixing of Tilt and Azimuth angle:

The tilt angle is the angle of inclination of the system. This depends on the geographic location. The tilt angle must be in such a way that the system yields maximum output. The azimuth angle is defined as the angle between the south/north and the collector plane. In this simulation the tilt angle and azimuth angle is 35 and 5 degrees respectively.

3. Selecting a suitable pv module:

Based on the panel material, panel quality, power output and robustness different PV modules can be selected from the list provided by the software. This simulation is carried out using generic solar IR-45 BP 295M Bifacial PV model.

Objective:

1. To estimate whether installation of PV system in a academic institute is achievable or not.
2. Simulate the grid connected pv system using PVsyst software.
3. Determine explicit design, output and wastage of the PV system.

Figure 2. represents the introduction to project. The title of the project is entered. The site file box the site file can be chosen the map is available. City and country can be entered. The meteo file can be chosen with help of NREL. Then in the main parameters page orientation and system can be given.

Figure 3 shows the basic block diagram represents the PVsyst software could be used. The simplified sketch of PV array system (inverter) to user (load) is represented.

In this page the orientation is done. The simulation is done with help of choosing the field type, field parameters and optimization. The field type can be chosen with help of fixed tilted plane, tracking plane, vertical or horizontal plane. The field parameters plane tilt and azimuth can be chosen. The period of optimization can be chosen yearly, summer or winter.

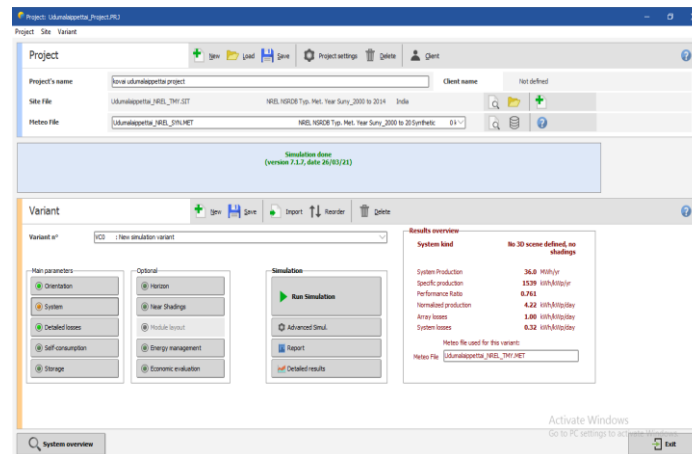


Fig 2 project page

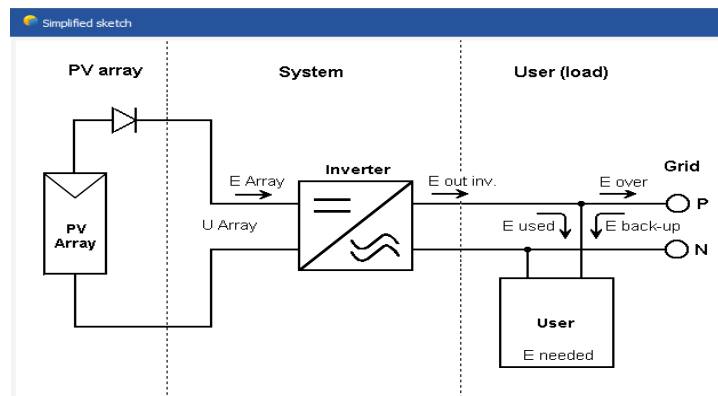


Fig 3: simplified sketch of blockdiagram

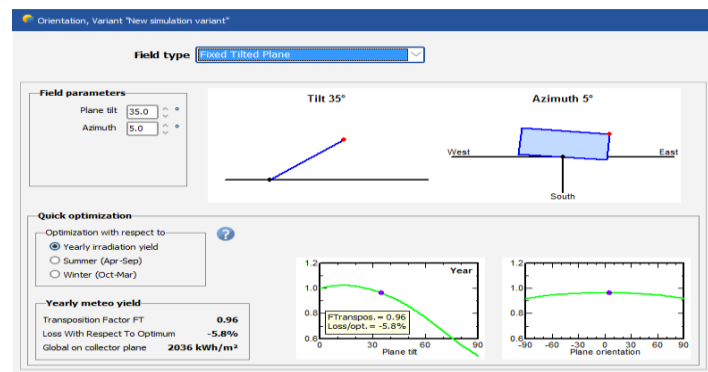


Fig 4: orientation simulation page

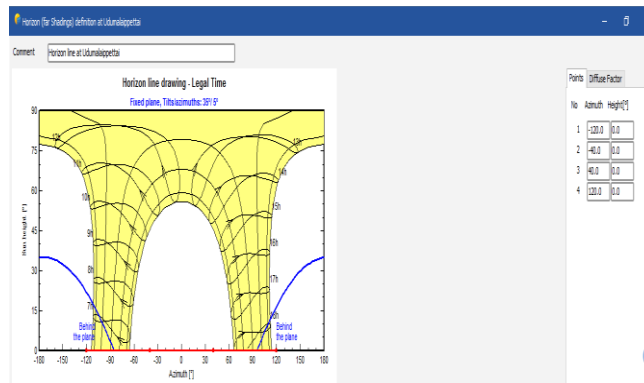


Fig 5: Sun path moving direction

This horizon line drawing represents the legal time. The shunt triangle and azimuth angle can be represented. The azimuth height and diffuse factor can be done.

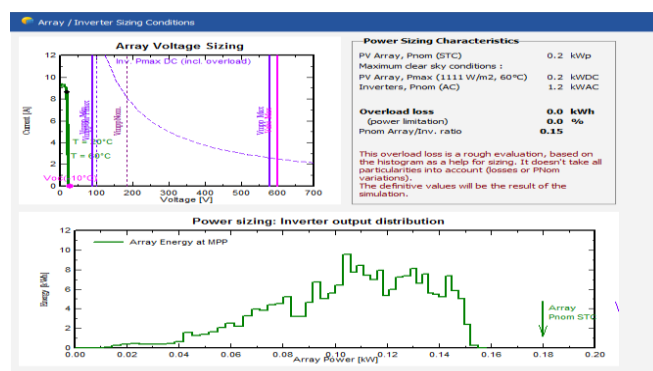


Fig 6: array/ inverter sizing conditions

The array voltage sizeig can be done with current[A] and voltage [V]. power sizing: inverter output distribution can be done with energy[kWh] and array power[kW]. The power sizing characterizes PV array Pnom(stc) Pnom(ac) Pmax.

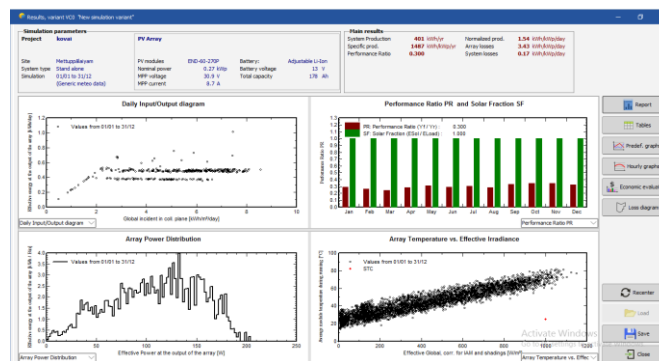


Fig 7: Performance ratio and Array power distribution

The simulation output can be taken. There are four output graphs that are daily input/output, performance ratio and solar fraction SF, array power distribution, array temperature vs effective irradiance.



Fig 8. Normalised Production and system output power distribution

The simulation output can be taken. There are four output graphs that are daily input/output, performance ratio and solar fraction SF, array power distribution, array temperature vs effective irradiance.

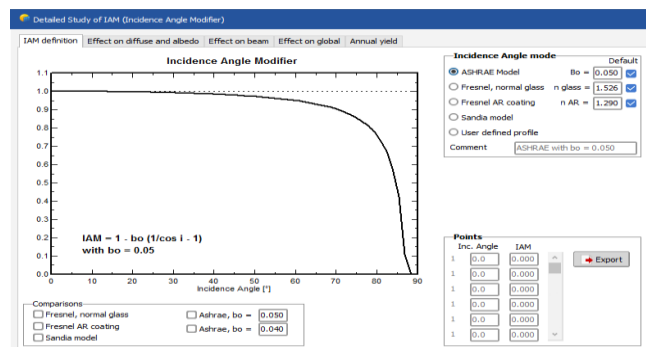


Fig 9: detailed study of IAM(incidence angle modifier)

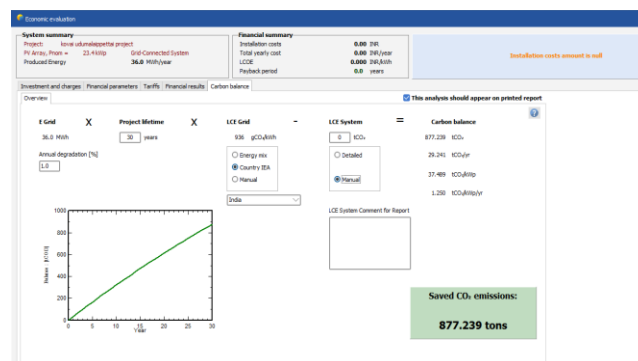


Fig 10: economic Analysis

System summary and financial summary, PV module, inverter, installation and load then it could be calculated regarding currency.

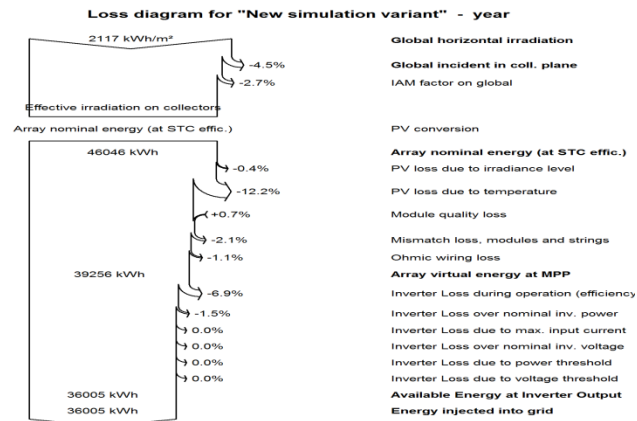


Fig 11: the energy loss diagram

This diagram represents the energy losses in PV panel such as global horizontal irradiation, global incident in panel, array nominal energy (STC), array virtual energy of MPP, available virtual energy at inverter output, energy injection into grid.

Table 1: comparative study of four town’s located in and around Coimbatore

	Kovai-chettipalayam	Kovai-udumalaipettai	Kovai-sulur	Kovai-pollachi
	Split cells	Split cells	Split cells	Split cells
Global horizontal irradiation(kWh/m²)	2117.2	2146.9	2145.9	2135.5
Global incident Irradiation(kWh/m²)	738.74	845.16	846.16	821.8
Ambient temperature(°c)	23.58	25.60	25.61	26.57
Efficiency global. Corr. For IAM and shadings(kWh/m²)	2141.8	2062.1	2191.0	2974.0
Energy injected into (MWh)	2086.2	2003.9	2137.0	2029.5

4. Conclusion

The feasibility of building a photovoltaic device to supply an educational institution's electric load can be simulated and implemented based on the results. The pvsyst software is used to model a stand-alone photovoltaic device. Based on the simulation results, the sizing of the solar panel and inverter model can be selected with

required load demand. The sizing method is highly dependent on the geographic location of the site. The system's detailed configuration, performance, and losses diagram have all been developed.

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