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Design and Simulation of Grid Connected Solar Photovoltaic Plant for Munnar, India Location

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Abstract - *The increasing usage of fossil fuel products increases the greenhouse gas (GHG) emission in the environment, thereby increasing the global temperature. According to the Indian Meteorological Department, the average temperature is increased by 0.6 degree Celsius in the last decade. In Kerala remote tribal settlements are usually located in the midst of dense forest. Hence it is difficult to extent the conventional grid lines due to existing forest regulations. Solar electrification of these tribal settlements can be practiced by installation of PV micro grids. This project selects one of the tribal villages of Munnar as the site location for Solar Photovoltaic installation. Solar panel with 100Kw capacity is installed to electrify 48 houses in the area*.

Key Words: Photovoltaic System, Solar Radiation, PVsyst

1.INTRODUCTION

One of the major energy sources used in Kerala is electricity. The State has been importing power from other states to meet the increasing demand. The major share of electricity is being consumed by domestic consumers. In 2017-18 total electricity consumption of Kerala was 21,258 MU and 50% of total electricity was consumed by the domestic sector.

The total installed capacity of Kerala state as on 2018 is 2830.972 MW. The major share of installed capacity is hydroelectric power plants followed by thermal power plants. But hydroelectric power utilization by construction of dams causes environmental damage as a result of deforestation. The state has total installed capacity of 2980.086MW, out of which 2089.31MW is from hydroelectric power plants, 710.67MW from thermal power plants, 110.831MW from solar PV power plants, 59.275MW from wind and 10MW from co-generation [2]. In this scenario there is a need to increase the energy consumption from solar photovoltaic (PV) systems.

There are a plenty of site suitable for solar panel installation in Kerala. The climatic conditions of Kerala are also suitable for solar power plant installation. Except rainy seasons, most of the days in other seasons are sunny in Kerala. Thus, energy generation from solar energy has a greater potential. Approximately the solar radiation is 5 to 6 kWh/m2 in Kerala [2].

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2. OBJECTIVE

The objective of this project to design a PV System and Simulation of it using the PVsyst software which includes:

- Input of the various data base such as geographical site location to get the global horizontal radiation and horizontal diffuse radiation corresponding to the given area
- Selection of modules and inverters based on the power required
- Evaluating the efficiency of the solar panel and the loss due to various factors

3. CLASSSIFICATION OF PV SYSTEM

The Photovoltaic systems are classified into 3 types, namely, Grid-connected system, Stand alone and pumping system. In this project the grid connected system is designed.

3.1. Grid Connected PV System

A grid-connected photovoltaic system is an electricity generating system that is connected to the utility grid [6]. A grid-connected PV system consists of solar panels, one or several inverters, a power conditioning unit and grid connection equipment [6]. A grid-connected system allows to power the house and if any excess electricity produced can be fed back to the utility grid. This eliminates the used of electricity storage systems like batteries.

3.2. Stand Alone Photovoltaic (PV) System

A stand-alone PV system is an automatic solar system which consist of a battery to store the suns energy during the day for use at night. The batteries are normally rechargeable to store the electrical energy supplied by a PV panels or array. Stand-alone PV systems are used in rural areas where it is difficult to provide conventional electrical grid systems. It is also cost effective as the local power lines need not be extended. A stand-alone photovoltaic system is an electrical system consisting of array of one or more PV modules, conductors, electrical components, and one or more loads.

3.3. Solar pumping system

In this system the solar energy converted to electrical energy is used to run the pump set. The pump system draws water from the open well, bore well, stream pond etc.

4. METHODOLOGY

The design and simulation of the PV system is carried out using PVsyst software. The meteorological database is availed when the location of the area is input into the software.

4.1. Simulation software: PVsyst

PVsyst is a simulation software for the study, sizing and data analysis of complete PV systems [5]. It deals with grid-connected, stand-alone, pumping and DC-grid (public transportation) PV systems, and includes extensive meteo and PV systems components databases, as well as general solar energy tools [5].

4.2. Site Assessment

The site assessment is carried out to determine the area available for solar panel installation, the solar radiation available per m^2 in the area and the influence of nearby shadings of the area. The proposed location is situated at Munnar, Kerala, India.

Table 1: Geographical Location

Latitude	Longitude	Altitude	Time zone
10.0877 N	77.0590 E	1480 m	5.5

4.3. Meteorological Data

The monthly meteo files contains the geographical coordinates such as latitude, longitude, altitude and time zone. It also includes monthly Global Horizontal Irradiation (GHI or GlobHor), Diffuse Horizontal Irradiation (DiffHor), averages of the ambient temperature and the monthly average of Wind Velocity.

The meteorological data files can be chosen from one of the data files included in the PVsyst which are NASA-SSE and Meteonorm 7.1. The table 2 shows the meteorological data acquired from specific site based on Meteonorm 7.1 database.

Table 2: Monthly meteo data

Month	Horizontal Global Radiation (kWh/m2)	Horizontal diffuse radiation (kWh/m2)	Temperature (°C)	Wind velocity (m/s)
January	164.5	53.9	19.4	1.89
February	159.6	64.1	20.8	1.90
March	179.0	73.8	22.6	1.90
April	175.4	74.9	23.1	2.00
May	167.0	70.6	22.9	2.71
June	143.9	72.3	21.1	3.30
July	142.8	80.1	21.0	3.40
August	138.5	80.4	20.7	3.20
September	148.4	69.7	20.7	2.70
October	143.3	71.4	20.7	1.89
November	131.8	61.9	19.7	1.60
December	140.1	64.8	19.4	1.80
Year	1834.3	837.9	21.0	2.4

4.4. Selection of Modules and inverters

A solar photovoltaic module is an assembly of connected solar cells that will absorb sunlight as a source of energy to develop electricity. There are different types of solar photovoltaic modules namely mono-crystalline solar modules, poly-crystalline solar modules and thin-film solar modules. The size of the solar photovoltaic module depends on the area of site location and the power to be generated. Selecting a module to use may be challenging as there are numerous modules available in sizes, power, types, prices and efficiency from multiple manufacturers. The model used for design of solar PV system is Poly 80 Wp 36 cells.

Table 3: Solar panel properties

Technology	Si-poly
Nom. Power	80Wp
Vmpp	18.10 V
Voc	22.6 V
No. of cells	36 in series
Vmax	1500V
Efficiency	37.06%

The main function of the inverter is to convert the DC power of the PV array into AC power compatible with the grid requirements. Three units of 30kWac inverters were used.

Table 4: Inverter input and output parameters

Input side (DC PV Field)	
Minimum MPP Voltage	450 V
Maximum MPP Voltage	700 V
Absolute Max. PV Voltage	900 V
Output side (AC grid)	
Tri-phased	50 Hz
Grid Voltage	400 V
Nominal AC Power	30.0 kW
Maximum Efficiency	94.00%

5. SIMULATION RESULTS

The simulation was carried out using PVsyst software for the selected location. Various results were obtained as output values for different parameters such as performance ratio, losses from different stages. Performance Ratio is defined as the energy output EAC divided by the nameplate D.C. power EDC obtained in Standard test condition.

Performance Ratio (PR) = EAC / (EDC stc * Irradiation)

Table -5: Result overview

System Production	142.3 MWh/year
Specific Production	1425 79.16 kWh/kWp/year
Performance Ratio	79.16 %
Normalized Production	3.9 kWh/kWp/day
Array Losses	0.73 kWh/kWp/day
System Losses	0.29kWh/kWp/day

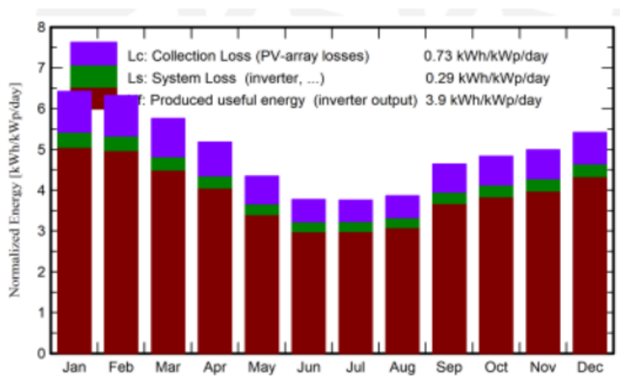

Fig 1: Normalized productions (per installed kWp)

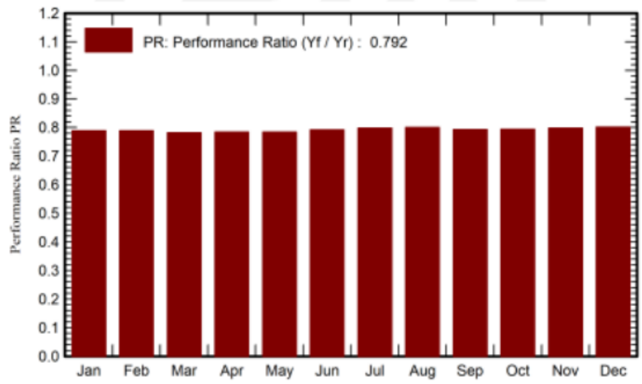

Fig 2: Performance Ratio

System losses: The solar radiation incident on the photovoltaic system experience some energy losses. The PV system is not 100% efficient due to some losses in energy conversion. The detailed loss diagram is shown in fig. 3. Initially global horizontal radiation of about 1834 kWh/m² incident on the solar panels. The efficiency at the STC was found about 15.52%. Thus, the annual energy production is about 174.2 MWh. But due to PV array loss, inverter loss and wiring the output energy was about 143.3MWh.

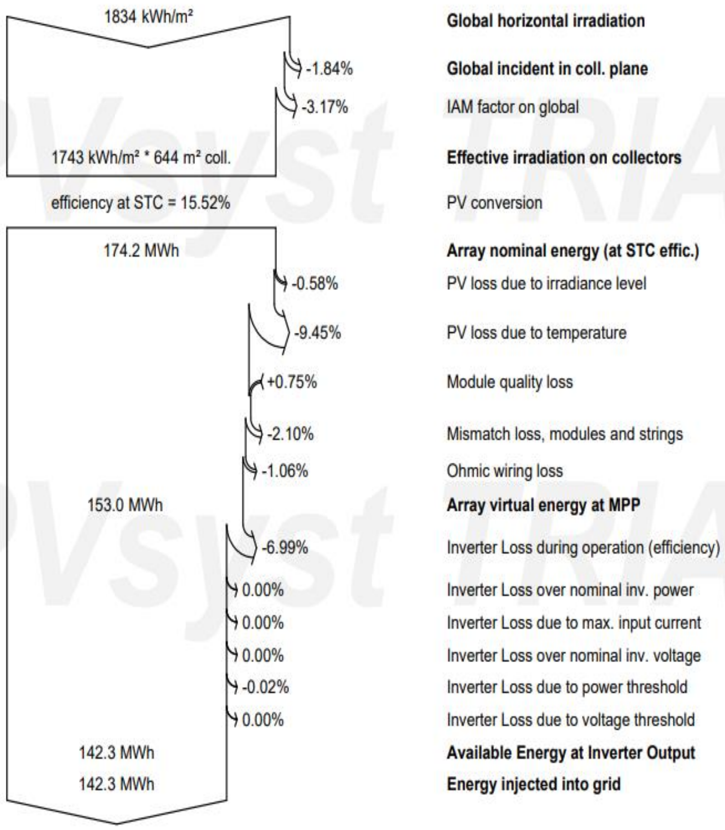

Fig. 3: Loss diagram over the whole year

6. CONCLUSIONS

A grid connected photovoltaic system is designed using PVsyst software. Using the PVsyst software, the meteorological data was taken by inputting the site location. Other parameters such as system configuration, output power and losses where also analyzed. It was found that the PV system is capable of an annual system production of 142.3MWh. The performance ratio of the system is about 79.16%.

The implementation to the grid connected PV system to the microgrids would help to electrify the rural areas where conventional grid system is difficult to extent. Although PV system design is only discussed in this paper, configuration of other components such as wind turbine and energy storage system connected to the smart grid is within the future scope.

REFERENCES

[1] Jake Lomansoc, Ricard Jun Roloma, Kim Seer Paller, "Design and Simulation of 100 kWp Solar Photovoltaic (PV) Grid Connected Power Plant Using PVsyst," Research Gate December 2018 DOI: 10.13140/RG.2.2.22886.27209

[2] Ajithgopi, K. Sudhakar, Ngui Wai Keng, "Solar PV Microgrids Implementation model: A case study of Local Self Governments in the Indian State of Kerala

[3] Rachit Srivastava and Vinod Kumar Giri,R. "Design of grid connected PV system using PVsyst," African J. Basic & Appl. Sci., 9 (2): 92-96, 2017

[4] Akash Kumar Shukla, K. Sudhakar, Prashant Baredar, "Simulation and performance analysis of 110 kWp grid-connected photovoltaic system for residential building in India: A comparative analysis of various PV technology" A.K. Shukla et al. / Energy Reports 2 (2016) 82–88

[5] https://www.pvsyst.com

[6] https://en.wikipedia.org/wiki/Grid-connected_photovoltaic_power_system