

Real Time Monitoring and Performance Evaluation of 5WP Off Grid Solar Rooftop Photovoltaic Power Plant Using PVsyst

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Abstract— Energy demand in India and especially in Telangana state is continuously increasing, however the electric utilities failed to meet this load demand. Photovoltaic (PV) solar power plant is used for larger development of solar power generation. In a solar roof top system, the solar panels are installed on the roof of any residential, commercial, institution and industrial building. The solar roof top system may come up with storage facility using battery or grid connected. The roof top system with storage facility has a battery to store solar electricity and can be utilized during night when sunlight is not available. In this research paper, real time monitoring and Simulation analysis of 5WP off grid connected photovoltaic solar roof top power plant at Hyderabad city is carried out using software PV Syst V5.74 and simulation results of energy output of PV module are presented.

Keywords— Roof top system, solar photovoltaic panel, solar radiation, grid.

I. INTRODUCTION

Telangana state being located between $15^{\circ} 54'$ and $19^{\circ} 37'$ North latitude and the geographical location favors the harvesting and development of solar energy. Telangana state is having good solar radiation of 4.9 KWh/square-meter /day. Hyderabad city comes under Telangana state in India. The yearly average solar radiation on horizontal surface is 4.9 KWh/m²/day at latitude of 17.4° N and longitude of 78.5° E [6].

Electric utilities are finding it difficult to meet rise in peak demand and as a result, most of cities and towns are facing severe electricity shortages. Most of commercial establishments use one or more diesel generator for back-up power. In order to utilize the existing roof space of buildings, the scheme proposes to promote rooftop solar PV systems on buildings to replace diesel generator sets.

II. OFF GRID / STANDALONE ROOF TOP SOLAR POWER PLANTS

Solar PV cells converts sunlight to generate electricity through a photovoltaic process. There are two types of solar PV systems: standalone and grid connected. Standalone solar PV systems work with batteries [5].

In off Grid rooftop solar power plant, the DC power generated from solar photovoltaic (SPV) panel is converted to AC power using inverter and is fed to the load through single phase lines and at the same DC power is stored in Battery during day time and loads are served by Battery back in night hours[3]. A schematic sketch of a typical off grid solar rooftop photovoltaic power plant is shown in Fig1.

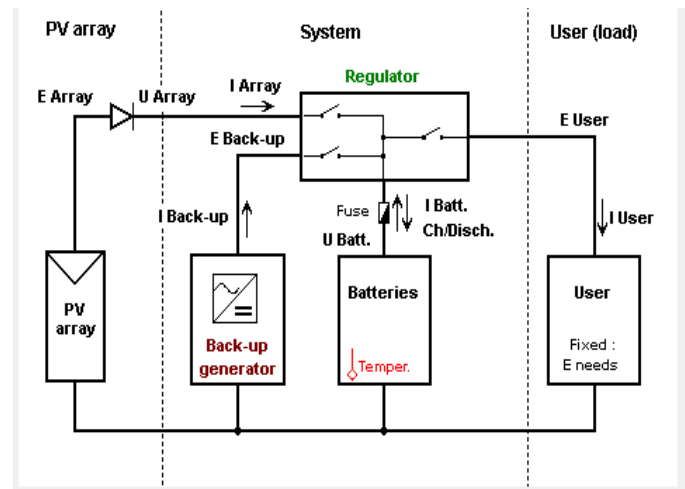


Fig1. A Schematic sketch of a Typical off Grid Solar Roof Top Photovoltaic Power Plant.

III. COMPONENTS OF SOLAR PV SYSTEM

A Grid-connected solar PV system consists of following main components [1]:

A. Solar photovoltaic (PV) modules

Solar PV modules are mounted on the roof of buildings and convert sunlight into direct current. To achieve a required voltage and current, a group of PV modules are wired into large array called PV array.

B. Solar PV array support structure

These are galvanized steel structures secure the solar PV modules on the roof of building. The mounting structures require roof to be penetrated and mounting solar panels correctly is part of maximizing power generation.

C. Solar grid inverter

Solar grid inverter converts generated direct current into alternating current which is required for all electrical appliances through a charge controller. It also regulates battery charging if required.

D. Balance of system

All other components considered for solar rooftop power plant are cables, junction boxes, fuses etc.

The size of solar plant require depends on requirement of electrical load, number of KWh consumption.

IV. REAL TIME SYSTEM DESIGN

.The main target is to design and install 5WP solar rooftop solar power plant [4].

A. Key facts of solar rooftop power plant

Plant capacity in Wp : 5Wp Rooftop Solar power plant

PV Technology/Module: Mono crystalline modules

Power conditioning unit: 100VA

Power evacuation : 240V Single phase, 50HZ

The real time module of 5WP Solar Roof Top Power Plant at is shown in Fig 2.

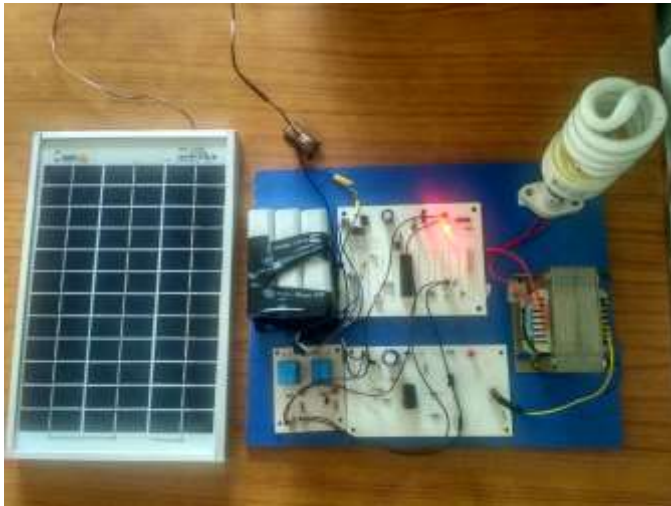


Fig 2. The real time module of 5WP Solar Roof Top Power Plant

B. Number of PV panels for the system

- Capacity of each module: 5Wp
- Number of PV panels or modules required = 01
- Module area = 0.083 sq.m
- Nominal PV Power = 5Wp
- Maximum PV Power =5Wdc
- Fixed Tilted plane = Tilt :45⁰; Azimuth :0⁰

The maximum power of this module is 5Wp; hence it requires 01 module to design 5WP PV system. The selected PV is manufactured by JighiSol systems Pvt.Ltd.

The PV module parameters and ratings [2] are given in Table 1.

Table1. PV module parameters and ratings

Electrical Characteristics	
Rated Maximum power (Pmax)	5Wp
Maximum power voltage (Vmp)	17.4V
Maximum power current (Imp)	0.26A
Open circuit voltage (Voc)	21.5V
Short circuit current (Isc)	0.32A
Module efficiency	15%
Operating temperature	25°C

C. Solar off Grid Inverter rating

For this system, solar off grid inverter designed is 100VA is shown in Fig 2.

The inverter parameters are given in Table 2

Table 2. Inverter parameters

Inverter specifications	
1-phase inverter chosen	100VA off grid inverter
Maximum efficiency	92%
Maximum ac output power	100W
Rated ac power	86W
Rated ac off grid voltage	12V

D. Battery Back up

The battery maker is Akari classic Ltd has following ratings.

- Each Battery rating : 1.5 Ah
- Total Number of batteries: 03
- Total Capacity : 4.5Ah
- Battery Voltage : 12V

E. Daily House Hold Consumptions

- Total daily house hold energy needed = 15 Wh/day
- Total monthly house hold energy needed = 0.5 KWh/month

V SIMULATION ANALYSIS RESULTS

For simulation purpose, the considered PV module capacity is 5WP, 15V Si-mono with array current of 0.3A from Sainity Solar Ltd. The Considered battery capacity is 5Ah, 12V with stored energy of 0.1KWh from Sonnenschein Ltd. Due to non-availability of correct make, it is considered from other manufacturers with appropriate ratings. The global system configuration of the PV array is shown in Fig.3

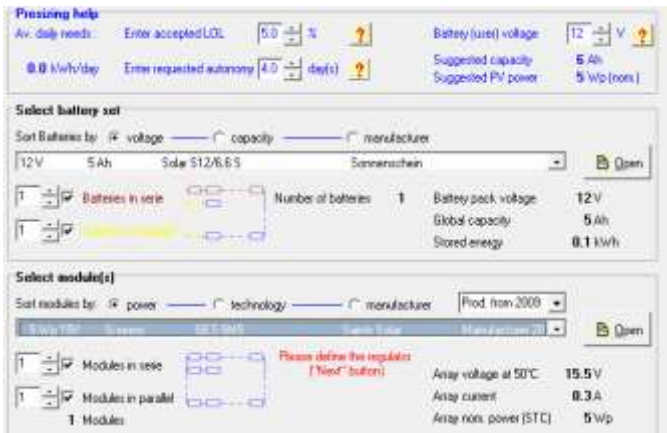


Fig.3 The global system configuration of the PV array

The mateo for Hyderabad, synthetic data is shown in Fig. 4

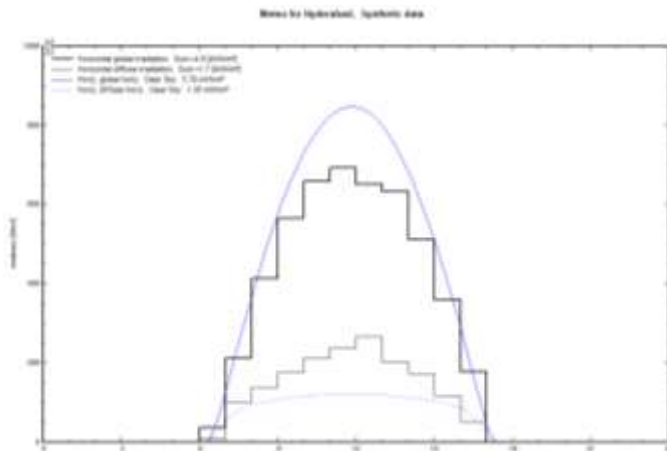


Fig.4 Mateo for Hyderabad city.

The solar paths at Hyderabad city is shown in Fig 5.

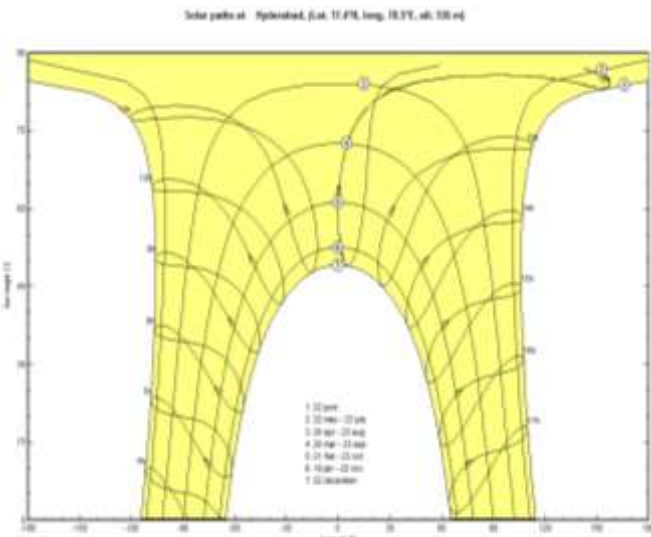


Fig.5 Solar paths at Hyderabad City.

The Available solar energy KWh/day and user need of energy Kwh/day is presented in Fig.6

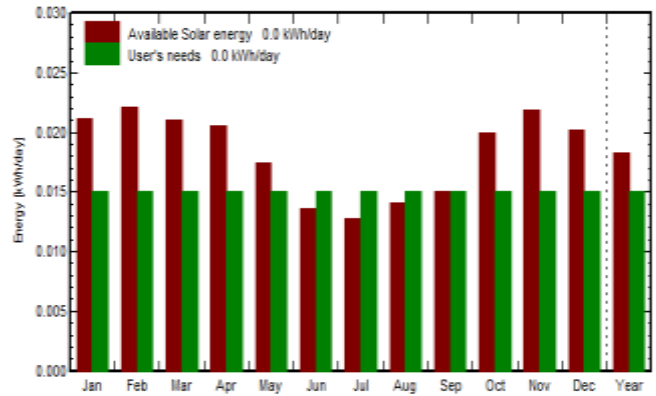


Fig.6 Available solar energy KWh/day and user need of energy Kwh/day

The Average state of charge of batteries in % and probability of loss of load in % is presented in Fig.7

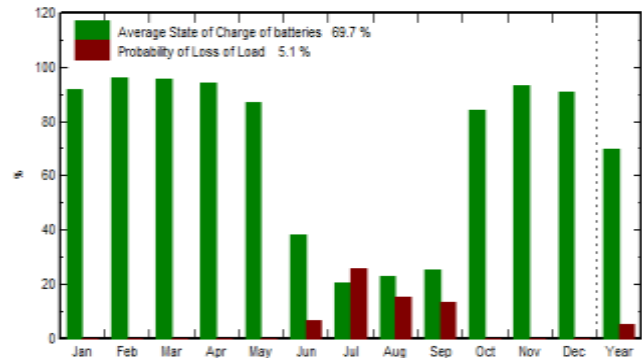


Fig.7 The Average state of charge of batteries in % and probability of loss of load in %.

The Main Simulation results of 5WP Project are given in Table 3.

	Incid. kWh/m ² .day	PV avail. kWh	Demand kWh	Excess kWh	Missing kWh	SOC %	Pr. LOL %	Fuel liter
Jan.	5.3	0.7	0.5	0.1	0.0	92	0.0	0.0
Feb.	5.5	0.6	0.4	0.1	0.0	96	0.0	0.0
Mar.	5.2	0.7	0.5	0.1	0.0	96	0.0	0.0
Apr.	5.1	0.6	0.5	0.1	0.0	94	0.0	0.0
May	4.3	0.5	0.5	0.0	0.0	87	0.0	0.0
June	3.4	0.4	0.5	0.0	0.0	38	6.3	0.0
July	3.2	0.4	0.5	0.0	0.1	20	25.8	0.1
Aug.	3.5	0.4	0.5	0.0	0.1	23	15.1	0.0
Sep.	3.7	0.5	0.5	0.0	0.1	25	13.3	0.0
Oct.	5.0	0.6	0.5	0.1	0.0	84	0.0	0.0
Nov.	5.4	0.7	0.5	0.1	0.0	93	0.0	0.0
Dec.	5.0	0.6	0.5	0.1	0.0	91	0.0	0.0
Year	4.5	6.7	5.5	0.8	0.3	70	5.1	0.2

Table 3 Main Simulation results of 5WP Project

VI. CONCLUSIONS

The real time monitoring and performance evaluation of 5WP solar PV power plant located on the roof of a residential building in Hyderabad city is carried out by building a hardware model of 5 Wp solar roof top PV plant and by simulating 5Wp plant using PV syst Software. From the simulation results, the horizontal global irradiation is 4.5-4.9 Kwh/m².day in different months in a year and the available PV module energy at inverter output is 0.4-0.7 Kwh /day in different months in a year. In Jan-Apr and oct-Dec, the PV module output is more than the load demand so we get excess energy in these months and in remaining months PV module output is equal to or less than the demand. The energy supplied to the user is 0.5KWh/day in Jan month while energy output of PV module is 0.7 KWh/day and excess energy is 0.1 KWh/day. These outputs of PV module vary with respect to irradiation. The future growth can be enhanced to larger scale PV modules.

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