International Journal of Applied Engineering Research ISSN 0973-4562 Volume 13, Number 11 (2018) pp. 8894-8898

Simulation based Solar PV System: A Cost-Effective Study

Krishan Kumar[1], M. A. Ansari[2] and Vinaya Rana[3], Royal Singh[4]

[1,2,3,4]*Electrical Engineering Department, Gautam Buddha University, Greater Noida, India.*

Abstract

In this paper, the simulation of solar photovoltaic system and the cost analysis of these solar PV systems. This work is done with real time radiation of sun and actual output of solar PV system. The experiment has done at different locations. The selected sites have enough amount of solar irradiance at which we have proposed this solar PV system. Here, a framework associated PV system reproduction is performed with the assistance of simulation. The reproduction gives the complete points of concentration of occurrence radiation, power generation and execution proportion on month to month and yearly premise. This work also led to access the configuration and additionally establishment viewpoint to suit the family needs of electrical energy as input.

Keywords*:* Cost analysis, Geographical location, Grid, Solar PV system**,** simulation.

INTRODUCTION

Renewable energy is the future for the systems which requires electrical energy as input. Due to the high consumption and reduction in the availability of fossil fuel resource, renewable energy (solar, wind, hydro etc) is subject to great interest over decades. Solar energy is an emerging renewable energy source using all over the globe at micro and on utility scale. The power of sun intercept by earth is larger than the present utilization rate on earth of all energy sources. So solar energy can provide solutions of all the present and future problems related to electricity. Solar power is the transfer of sunlight into electric current, instantly using photovoltaic (PV), or indirectly using concentrated solar power (CSP). Photovoltaics' change light into an electric current by means of the photovoltaic.

A rooftop photovoltaic power plant is a photovoltaic system that has its power generating solar panels mounted on the top side of a residential or commercial building or structure. A complete PV system includes PV panels, storage devices and power conditioning units. Solar PV system is use to convert the sun light into the electrical power output in form of DC. If we have AC loads, we have to use inverters for supplying this output DC power to the AC loads [1-4].

Solar PV system can be used with grid connected mode or off grid mode. An off-grid or stand-alone system is a separate system which does not have any connection with main grid. While, a stand-alone system includes no connection with a utility grid, the generated power is straight forwardly appended to the heap. If there should be an occurrence of the PV array does not straight forwardly supply to the heap, a battery storage is required. The battery storage system works with some switching techniques that it takes power from PV when the generated power is greater than load demand and its supplies the power when the PV generation is less than the load demand. [4-6]. The off-grid PV system has its application to supply power for small individual loads. Grid connected PV systems work parallel with conventional power generating units. The performance of PV system depends on environment, location and inclination of panel and inverter technology. For the installation of PV system various design and simulation techniques are considered, along which simulation technique is mostly used for optimization [7-8]. The basic structure of grid connected solar PV system is given in Fig. 1.

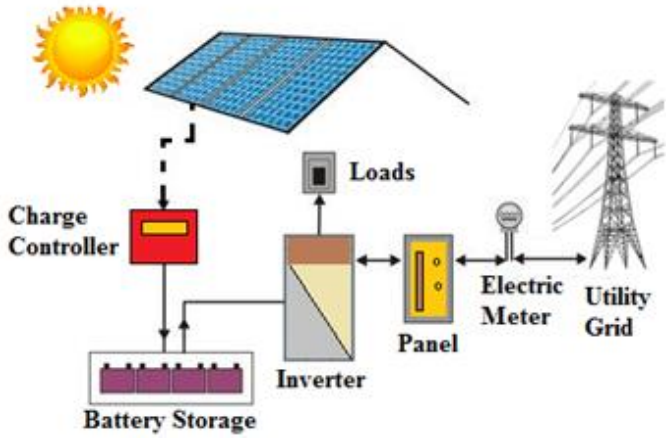

Figure 1. Structure of grid-connected solar PV system

RESEARCH METHODOLOGY

The Research approach begins with giving the area subtle elements to the software that is its Latitude, Longitude and height which characterizes the *(x,y,z)* co-ordinates of a site.[9] The study is led at New Delhi, Faridabad and Ghaziabad sites. Climate information is acquired from NASA-SSE Worldwide for simulation software re-enactment. Albedo values for urban circumstance is typically changes from 0.14 to 0.22. So, the albedo values taken for this re-enactment is 0.2.

A. Geographical Location and Meteorology

Land area (Latitude, Longitude, and Altitude) and Specification documents of all the three locales are given beneath in table I.

Table I. Location details for different sites

Location	New Delhi	Faridabad	Ghaziabad
Country	India	India	India
Latitude	28.2	28.40	28.66
Longitude	77.2	77.31	77.45
Altitude	215 meters	198 meters	214 meters

B. Orientation of Solar Panels

So as to get maximum irradiance or to create maximum power from PV arrays, PV panels ought to be in a particular direction. PV frameworks might be of various sorts basically two sorts of PV panel systems are utilized sunlight based following system and altered PV board framework. In this paper the study is led on an altered PV panel system, Orientation of sun-based panels covers two principle elements of PV system planning that are tilt point and azimuth edge. Tilt point is the edge of slant from flat bearing and azimuth edge is the edge between the south course and the panels confronting heading. For the nations which lies in the Northern half of the globe azimuth edge ought to be zero to get the greatest radiation for settled PV board frameworks. India is a nation which lies in Northern side of the equator, so the azimuth point ought to be zero in India at any area. The component is tilt point which must be set as episode radiation amplify with the assistance of software programming. Tilt edge at all the three destinations are appeared in Fig. 2, Fig. 3 and Fig. 4.

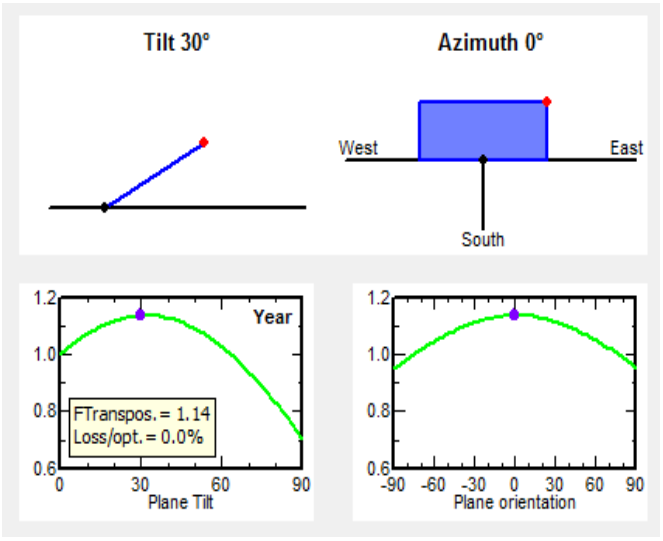

Figure 2. Tilt and Azimuth of New Delhi site

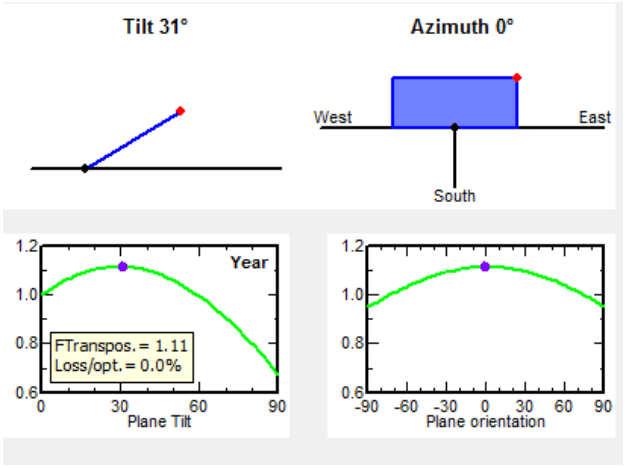

Figure 3. Tilt and Azimuth of Faridabad site

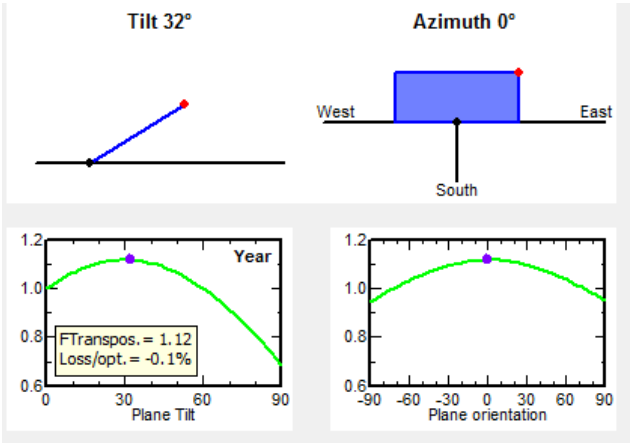

Figure 4. Tilt and Azimuth of Ghaziabad site

C. Solar Panel and Inverter Specifications

Specifications of solar panel and inverter used for the simulations are given in table II and table III.

Table II. Specification of inverter used

Manufacturer	**Delta Energy**
Model	Solar inverter SOLVIA 2.0 EU G4 TR
Nominal power	3kW
Frequency	50 Hz
Minimum Mpp voltage	125 V
Maximum Mpp voltage	480 V
Nominal AC current	8.70 Amp
Maximum AC current	10.70 Am
Maximum Efficiency	95.8%
Dimension (W x D x H)	410mmx182mmx418mm
Weight	21 Kg
Number of units Required	1

Table III. Specifications of PV panel

Manufacturer	**Ecosol PV tech**
Model mono 200 wp	48 cells
Type	Si-Mono
Rated voltage vmpp	24.30 v
Rated current impp	8.240 amp
Rated power	200 wp
Open circuit voltage Voc	30.10 V
Short circuit current Isc	8.780 Amp
Efficiency	17.60%
Dimension (l x b x t)	1324mmx992mmx45mm
Weight	16 Kg
Number of units	10

RESULTS AND DISCUSSIONS

The simulation of 3 KW grid connected system generates a lot of technical data. The main output technical data contains system production, performance ratio and system losses.

A. System Production

System production at all three sites are 4141.1 KWh/year (New Delhi), 3912.8 KWh/year (Faridabad), and 4136.7 KWh/year (Ghaziabad). From the above data the maximum power output is obtained from the PV system which is designed at New Delhi site by tilting it at an angle of 30^o and It is shown in tables given below.

Table IV. System production for New Delhi site

Months	**E_Grid kWh**
January	342.8
February	349.6
March	405.0
April	376.9
May	365.4
June	317.6
July	277.3
August	283.6
September	339.8
October	379.3
November	355.0
December	348.7
Year	4141.1

Table V. System production for Faridabad site

Months	**E_Grid kWh**
January	335.7
February	311.5
March	354.7
April	339.6
May	335.0
June	317.3
July	306.3
August	316.8
September	333.1
October	328.4
November	331.7
December	302.5
Year	3912.8

Table VI. System production for Ghaziabad site

Months	**E_Grid kWh**
January	337.1
February	353.0
March	410.0
April	395.8
May	365.9
June	320.3
July	281.1
August	298.6
September	322.5
October	371.7
November	337.1
December	343.6
Year	4136.7

With the assistance of bar outlines which are advance from the each of the three sites system which comprise yield helpful energy (Inverter yield), accumulation losses and system losses. It can obviously watch the full points of interest of creation and loses by the system from Fig. 5, Fig. 6 and Fig. 7 of separate sites.

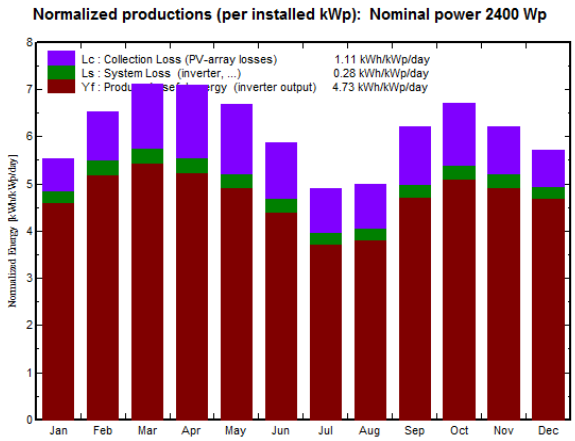

Figure 5. Total Energy Production and Losses for New Delhi Site PV System

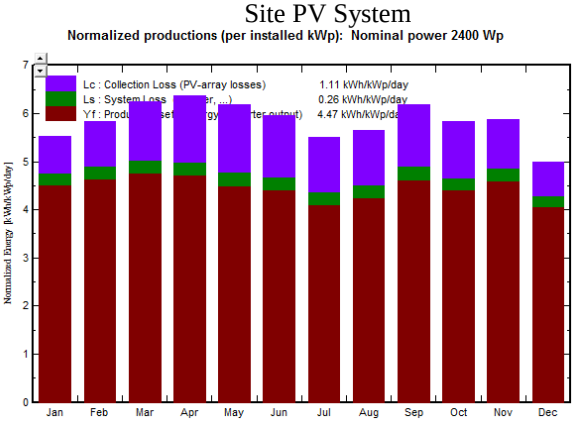

Figure 6. Total Energy Production and Losses for Faridabad Site PV System

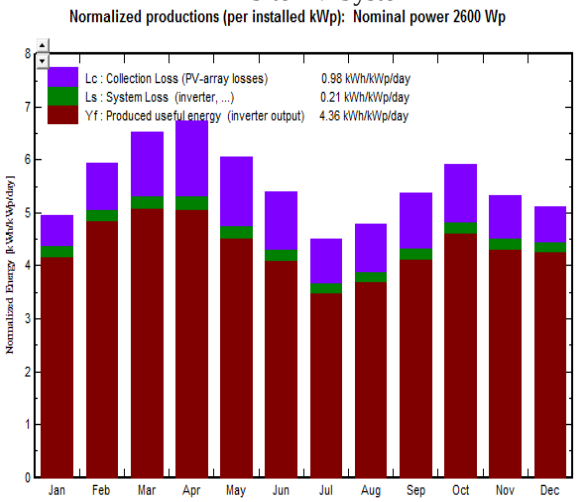

Figure 7. Total Energy Production and Losses for Ghaziabad PV System

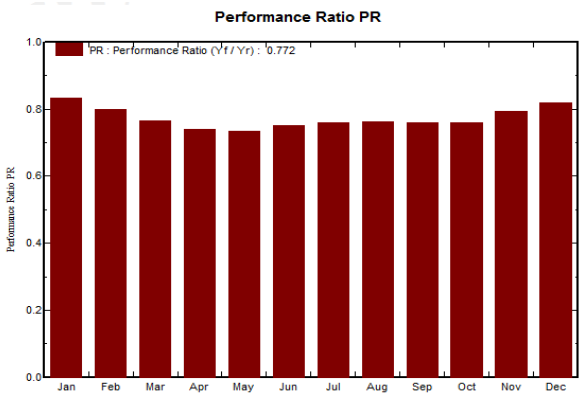

Figure 8. Performance Ratio of New Delhi Site PV System

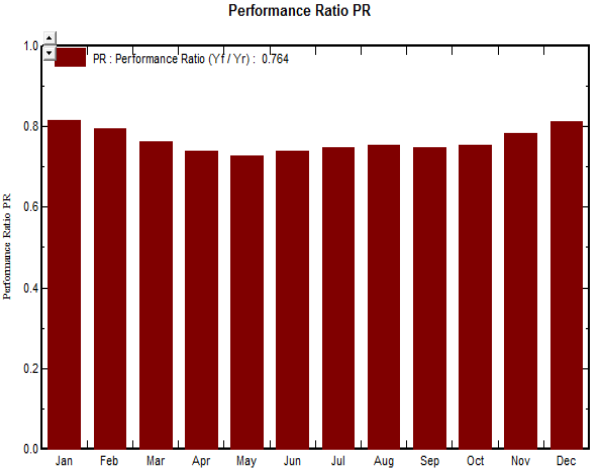

Figure 9. Performance Ratio of Faridabad Site PV System

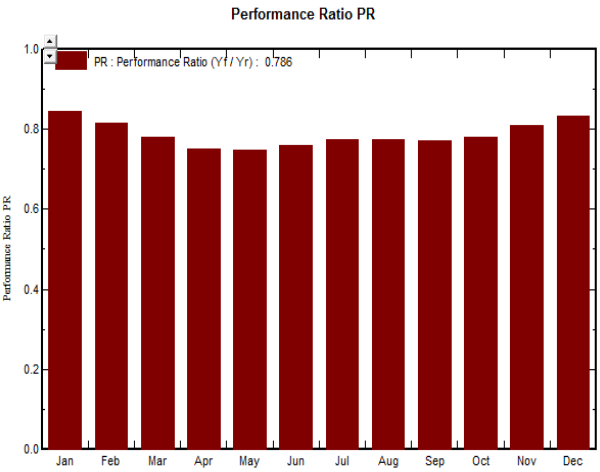

Figure 10. Performance Ratio Ghaziabad PV System

B. Performance Ratio

Performance ratio can be ascertained by separating the final yield and PV system yield. The figured proportions at tilt points 30º (at New Delhi site), 31º (at Faridabad site) and 32º (at Ghaziabad site) are 0.772, 0.764 and 0.786 individually. These watched ratios for every one of the three sorts of PV system are obviously noticeable in Fig. 8, Fig. 9 and Fig. 10.

COST ANALYSIS FROM THE RESULTS

A. Cost of rooftop Solar PV module

A rooftop solar PV module costly around Rs. 1 lakhs for 1 kWh. This cost includes PV panels, installation, inverter, cables, connectors and fitting charges. Battery charges are not included here. The detailed cost of individual parts is given in table VI [11].

Table VII. Individual components cost

Module	**Cost in rupees**	**Total investment (%)**
PV Panels	0.52 Lakh INR	52%
Inverter	0.23 Lakh INR	23%
Cables, connectors etc.	0.17 Lakh INR	17%
Fitting	0.08 Lakh INR	8%
Total	1 Lakh INR	

B. Accelerated Depreciation

Enhanced deflation of 80% is reachable under Income Tax denote house-top sun based solar PV systems. This may give significant reserve capitals to a sun-based plant designer which is a reachable assesses and has satisfactory aids in contrast to which the deflation may be fluctuates. This shows the outlined in the below table:

Table VIII. Enhanced Devaluation

Tax benefits from enhanced devaluation	
Details	**Rs.**
Cost of a 2 kW rooftop solar plant (A)	2 Lakh INR
Enhanced deflation @80%	0.8 Lakh INR
Corporate tax slabs	35 percent
Tax saved through depreciation (B)	0.28 Lakh INR
Net cost of rooftop solar plant (A)-(B)	0.72 Lakh INR

Table IX . The sub-sidy scheming

Benefits of grant	
Details	Rs.
Cost of a 2 kW rooftop solar PV plant with battery storage	3.20 Lakh INR
Bench-mark cost	1.7 Lakh INR
Sub-sidy with 30% of total cost	0.48 Lakh INR
Total cost after sub-sidy profit	1.12Lakh INR

CONCLUSION

Level global irradiance at three different sites New Delhi, Faridabad and Ghaziabad are 1973, 1822 and 1971 kWh/m2 individually. In the wake of tilting the panels at different points 30o, 31o, 32o for their particular locales favourable circumstances are concealment by 10.8%, 11.2%, 13.4% from which the produced power by the sunlight-based panel are expanded to the 2178, 2026, 2235 kWh/m2. From the above information it is clear that most extreme power yield from the PV panel was seen in New Delhi site while least power yield was in Ghaziabad PV panel, However the loses are less produced at Faridabad site subsequent to tilting the board at 32o. After enrolment of 15% productivity of STC the information power goes to inverter are 5234, 4734and 5233 kWh.

REFERENCES

[1] kandasamy c. P. Prabhu and k.niruba "solar potential assessment using pvsyst software" green compute, communication and exchange of energy (icgce), 2013 international conference on. Ieee, 2013.

[2] tarigan, elieser, and fitri dwi kartikasari. "techno-economic simulation of a grid connected pv system design as specifically applied to residential in surabaya, indonesia." energy procedia 65 (2015): 90-99.

[3] Chick. M., a. Mahrane, and f. Bauachri. "pvsyst 1.0 sizing and simulation tool for pv system." Energy procedia 6(2011):75-84.

[4] Axaopoulos, petros j., emmanouil d. Fylladitakis, and konstantinos gkarakis. "Accuracy analysis of software for the estimation and planning of photo voltaic installations." international journal of energy and environmental engineering 5.1(2014): 1-7.

[5] http://www.pvsyst.com/images/pdf/ pvsyst_tutorials.pdf

[6] Al ali, mona, and mahieddine emzaine. "Performance analysis of rooftops pv systems in abu dhabi. " energy procedia 42(2013) 689-697.

[7] Perers, bengt, et al. "long term testing and evaluation of pv modules with and without sunarc antireflective coating of the cover glass." international conference on solar heating and cooling for buildings and industry.

[8] Sharma, deepali, and anula khare. "Comparative analysis of solar pv modules." international journal on emerging technologies 5.2 (2014): 22.

[9] Okello, d., e. E. Van dyk, and f. J. Vorster. "Analysis of measured and simulated performance data of a 3.2 kwp grid-connected pv system in port elizabeth, south africa." energy conversion and management 100 (2015): 10-15.