International Journal of Engineering and Applied Sciences (IJEAS)
ISSN: 2394-3661, Volume-4, Issue-7, July 2017

A Comparative Analysis of Different Thermal Parameter Arrangements with Silicon Polycrystalline using PVSYST

Sujain Kumar, Deepika Chauhan, Devendra Kumar Doda

Abstract— **To maximize the power generation from a limited area is one of the major concern due to increased land cost and unavailability of lands in urban areas. The solar PV module directly converts the incident solar radiations into useful electrical energy. The variation of temperature and solar irradiance are the major factors which affects the performance of the solar PV module. Shading on solar PV modules reduces the life span of the system as well as reduce the performance of the system. Here, A comparative analysis has been done with silicon-polycrystalline module having free mounted with air circulation, semi-integrated with air duct behind and integration with fully insulated back for the climatic condition of Surat, Gujarat, India.**

Index Terms— **Solar PV Module, Grid-Connected Inverter, Grid-Connected PV System, modeling tools, PVSYST.**

I. INTRODUCTION

Energy is a vital requirement to sustain and improve the standard of our daily lives. With the exponential growth in population, rapid spread of technology and advancement of globalization, energy consumption in the developing countries like India, is rising at a very fast pace. Like many of the developing countries, India is also facing an immense shortage of energy.

The electricity sector in India had an installed capacity of 249.488 GW as of end June 2014[1]. Peak power deficit in the country fell to 5.4% at 7,556 megawatts (MW) in April from 7.4% a year ago due to increased capacity and lower electricity consumption by the country. The decline in consumption in certain north Indian states was due to a weak intra-state network for dissemination of electricity. According to the latest data by the Central Electricity Authority (CEA), the total requirement in the country last consumption was 2,49,998 MW, as against the supply of 2,42,442 MW a peak power deficit of 5.4%[1]. This shortfall necessitates load shedding. Suffering of the common people is nowhere more pronounced than in urban areas where electricity is a necessity in carrying out daily activities. Like most other places, solar energy has the promise and potential to solve the energy crisis of India as it is available throughout the country. It is projected that by the year 2030, the solar PV electricity will also dominate compared to other sources of energy[1]. From the study growth of photovoltaic, an average about 45% annual increase is noticed during the years 2000 to 2009. From the study of cost economics of a solar photovoltaic power plant, PV modules cost about 45% and the other 55% is due to components, like inverters, cables, transformers and civil works[2,3]. This work aims at solving this problem by introducing novel approach to arrange the solar panels in a way that minimizes the use of floor space and maximize the power generation.

In this paper we compare different types of thermal parameter arrangement to get a particular produced energy and to save the land cost is to adopt a new methodology to get maximum output from the solar power plant in a limited area[4]. Here, comparison has been done for climatic condition of surat For this purpose, the PVSYST[5] modeling software has been used, and a design with a new concept for the solar PV module is suggested, and its advantages over conventional design were discussed.

II. LITERATURE RVIEW

At the core of any PV system simulation model is the model on an individual PV cell. which describes the relationship between the current and voltage generated by a PV cell. A search of the literature has been performed to Grid connected system. D. Sharma et al. [7] shown grid connected systems generate clean electricity near the point of use, without the transmission and distribution losses or the need for the batteries. Stand-alone system involves no interaction with a utility grid. Climate and energy performance of technical shelter in different conditions. C.P. Kandasamy et al. [9] concluded that the simulation of a grid-connected solar photovoltaic system with the use of the computer software package Pvsyst and their performance was evaluated. K. Maharaja et al. [10] has investigated the sizing of the solar power plant in standalone mode of operation. Based on the load survey and the utilization factor, the capacity of the plant is determined for battery sizing and PV sizing. PVSYST are used for the sizing of the solar PV power plant. S. Jacques et al. [11] described a new, highly modular simulation tool named "PVLab" and developed by the GREMAN laboratory. It is designed to assist the designer in the sizing of PV (photovoltaic) installations. Jaydeep V. Ramoliya [12] concluded that the simulation of a grid-connected solar photovoltaic system using of the computer software package Pvsyst and their performance was evaluated. Jones K. Chacko et al. [13] investigated the major factors which affect the performance of the solar PV module three different thermal arrangements of solar PV modules and Compared si-poly

Sujain Kumar, M.Tech Scholar, (Power System Engineering), in Dept. of Electrical Engineering, Jaipur National University, Jaipur, Rajasthan, India.

Deepika Chauhan, Associate Professor in Dept. of Electrical Engineering, Poornima College of Engineering, Jaipur, Rajasthan, India.

Devendra Kumar Doda, Ph D. Scholar, Poornima University, Jaipur, Rajasthan, India. He is presently working as a Associate Professor in Dept. of Electrical Engineering, Jaipur National University, Jaipur, Rajasthan.

panel arrangement that will minimize the PV loss due to temperature and maximize power generation. By literature review it is clear that a comparative study of different thermal parameter and PV system needed for efficient use of PV systems.

III. METHODOLOGY

The basic characteristics of a solar panel will depends upon type of solar cell, temperature of the cell and the radiations incident on it. The conversion efficiency of PV system is important factor to be determined in the power generation technologies. In this paper we used to analysis the performance with the help of PVSYST software[5].

A. Pvsyst Software

PVSYST software[5] is used to design different types of solar application systems like DC grid, grid connected, standalone and DC pumping systems. Different solar PV module, battery and converter manufacture database for designing the system as it is included in the software package. Location details for the area of the experiment can be added with the help of software like NASA-SSE satellite data, Meteonorm, RETSCREEN etc[5]. This software helps to design the system with respect to the load and available area. It also helps to analyze the annual, monthly and weekly production and performance of the designed system.

PVSYST is designed to be used by architects, engineer, and researchers. It is also a very useful educative tool. It includes a detailed contextual help menu that explains the procedures and models that are used, and offers a user-friendly approach with guide to develop a project. PVSYST is able to import meteo data from many different sources, as well as personal data.

B. Grid Connected System

The Grid Connected system consisting of a solar PV module, a charge controller. In some cases extra diesel generator back up is used and it will be depends upon the type and behavior of the load[6]. In Grid Connected system, solar PV modules generates the current and it helps to meet the load demand during daytime. At the same time, some generated current is used to charge the battery and it is helpful to meet the load demand during night time. Charge controllers are used to control the flow of charging and discharging current into and from the battery[6]. Figure 1. shows the block diagram of Grid Connected PV system.

Operation:- Residential, grid-connected rooftop systems which have a capacity more than 100 kilowatts can meet the load of most consumers.[2] They can feed excess power to the grid where it is consumed by other users. The feedback is done through a meter to monitor power transferred. Photovoltaic wattage may be less than average consumption, in which case the consumer will continue to purchase grid energy, but a lesser amount than previously. If photovoltaic wattage substantially exceeds average consumption, the energy produced by the panels will be much in excess of the demand. In this case, the excess power can yield revenue by selling it to the grid. Depending on their agreement with their local grid energy company, the consumer only needs to pay the cost of electricity consumed less the value of electricity generated. This will be a negative number if more electricity is generated than consumed.[3] Additionally, in some cases, cash incentives are paid from the grid operator to the consumer. Connection of the photovoltaic power system can be done only through an interconnection agreement between the consumer and the utility company. The agreement details the various safety standards to be followed during the connection.[5]

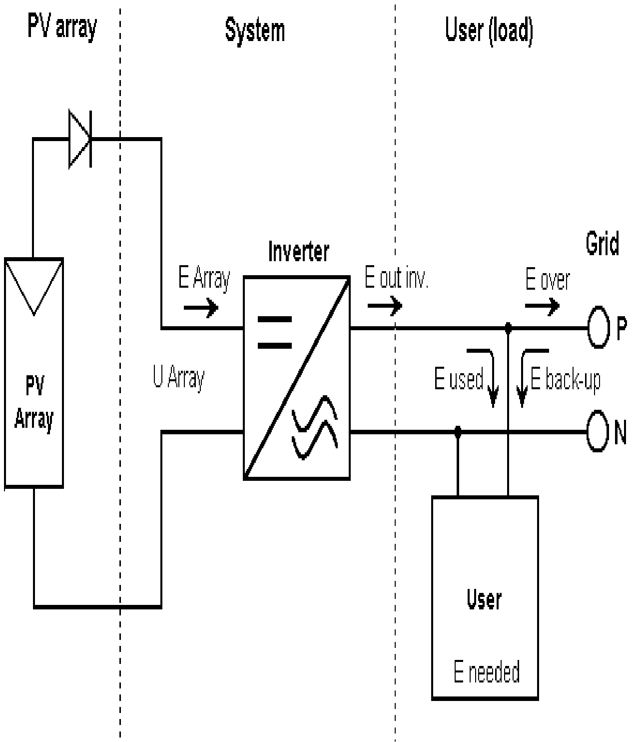


Figure 1. Block Diagram of Grid Connected PV system.

C. Technical Specification of Solar Power Plant Surat

Data Specification of the system:- Grid connected photovoltaic system for 100kWp power plant is simulated with the help of PVSYST software. The Geographical site selected is Surat and data of this site lies on 21.17° N latitude and 72.83° E longitude, 20° tilt, 0° Azimuth, 14 meters above sea level (i.e. Altitude is 14 m). From the simulation it was found that 399 module and 25kWac inverters are required in which Single Solar Panel Output is 250Wp. 21 PV modules are connected into series and 19 string of 21 PV models are used in the system. Required area for plant installation will be 649 m^2 . At the maximum power point , current and voltage of the system will be about 156 A, 573V respectively. The output of the PV system depends upon the received solar radiation and temperature.

PVSYST V6.63		15/07/17	Page 1/3

Free mounted modules with air circulation

Grid-Connected System: Simulation parameters

Project :	**SUJAIN JNU JAIPUR**				
Geographical Site		**Surat**		Country	**India**
Situation		Latitude	21.17° N	Longitude	72.83° E
Time defined as		Legal Time	Time zone UT+5.5	Altitude	14 m
		Albedo	0.20		
Meteo data:		**Surat**	NASA-SSE satellite data, 1983-2005 - Synthetic		
Simulation variant :	**New simulation variant**				
		Simulation date	15/07/17 14h31		
Simulation parameters					
Collector Plane Orientation		Tilt	20°	Azimuth	0°
Models used		Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon		Free Horizon			
Near Shadings		No Shadings			
PV Array Characteristics					
PV module	Si-poly	Model	**Poly 250 Wp 60 cells**		
Original PVsyst database		Manufacturer	Generic		
Number of PV modules		In series	21 modules	In parallel	19 strings
Total number of PV modules		Nb. modules	399	Unit Nom. Power	250 Wp
Array global power		Nominal (STC)	**99.8 kWp**	At operating cond.	89.2 kWp (50°C)
Array operating characteristics (50°C)		U mpp	573 V	I mpp	156 A
Total area		Module area	**649 m²**	Cell area	582 m²
Inverter		Model	**TPD-T250P6-TH_400**		
Original PVsyst database		Manufacturer	Thai Tabuchi		
Characteristics		Operating Voltage	500-800 V	Unit Nom. Power	25.0 kWac
Inverter pack		Nb. of inverters	19 * MPPT 17 %	Total Power	79 kWac
PV Array loss factors					
Thermal Loss factor		Uc (const)	29.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss		Global array res.	62 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss				Loss Fraction	-0.8 %
Module Mismatch Losses				Loss Fraction	1.0 % at MPP
Incidence effect, ASHRAE parametrization		IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05
User's needs :		Unlimited load (grid)			

Figure 2. Simulation parameter of 100KW grid connected system

IV. COMPARISON OF DIFFERENT SOLAR THERMAL PARAMETER ARRANGEMENTS

Although the study clearly demonstrate the maximum energy generation for the 100 KWp solar panel system as compared to different phases, like normalized production, performance ratio, efficiency and one should be careful about the PV loss due to temperature for such a system.

A. CASE 1 (free mounted module with air circulation)

The first case we were considered is a standard technical specifications as well as Free mounted module with air circulation. In this case, high amount of radiation of about 2011.5 kW/m^2 energy is received on the PV array in a year. By the proposed grid connected system 176.81 MW electricity will be generated out of that 170.23 MW electricity is available to the grid. 170.23 MW electricity will be supply to the grid throughout the year. Figure 3. shows the Performance ratio, nominal energy and monthly & yearly data of 100KW grid connected system(case 1). From the simulation it is found that performance ratio (PR) of the system is 82.44%. Here, the maximum PR is 80.5% in the month of January and minimum in the month of April (80.1%). System will produce 4.68 Wh/kWp/day electricity that is available to the grid. In which Global radiation is maximum on the March (204.2kW/m^2/month) and minimum on July (123.1kW/m^2/month) and also maximum electricity is produced on the March (17.56 MW/month) and minimum on July (11.07 MW/month).

SYSTEM LOSSES:- PV system is not able to convert 100% energy received from the solar radiation because of various losses Figure 4. represents detailed losses occur in the proposed grid connected PV system. Firstly about 1908 kWh/m^2 radiation is incident on the solar panels. Maximum losses takes place during PV array electric production. The module efficiency has been 15.46 % at the STC. By this, 201.8 MWh/year electricity will be produced by the PV array. After that PV losses due to irradiance, PV losses due to temperature, module quality loss, module array mismatch loss, wiring losses and Inverter losses , approximately 170.2MWh/yr of electricity is available to the grid. From figure 4 it is concluded that the maximum efficiency of the output array is 15.04% in the month of January and minimum in the month of April 14.27%.

PVSYST V6.63		15/07/17	Page 2/3

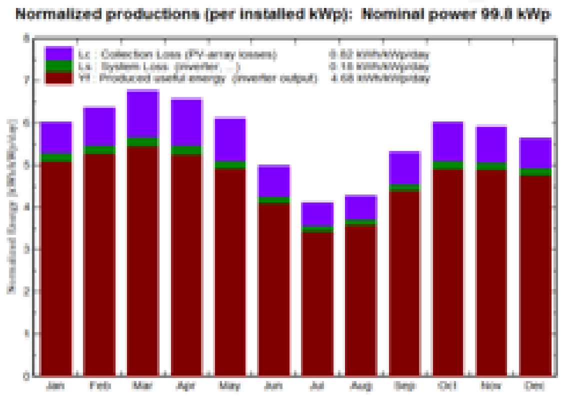
Free mounted modules with air circulation

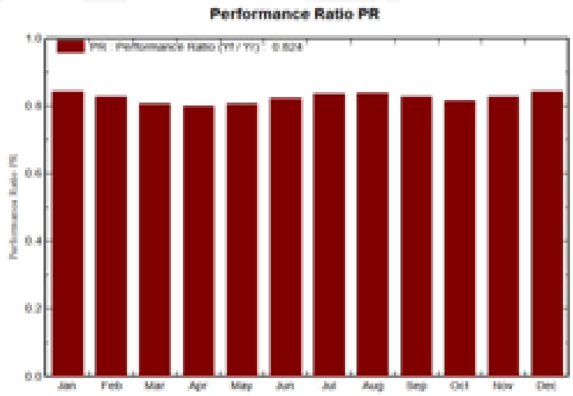
Grid-Connected System: Main results

Project : **SUJAIN JNU JAIPUR**
Simulation variant : **New simulation variant**

Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	tilt	20°	azimuth	0°
PV modules	Model	Poly 250 Wp 60 cells	Pnom	250 Wp
PV Array	Nb. of modules	399	Pnom total	**99.8 kWp**
Inverter	Model	TPD-T250P6-TH_400	Pnom	25.00 kW ac
Inverter pack	Nb. of units	3.2	Pnom total	**79.2 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results				
System Production	**Produced Energy**	**170.2 MWh/year**	Specific prod.	1707 kWh/kWp/year
	Performance Ratio PR	82.44 %		





New simulation variant

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	144.5	33.80	24.20	186.9	181.9	16.35	15.75	0.845
February	149.5	36.99	26.00	178.5	173.9	15.31	14.74	0.828
March	191.6	48.71	30.10	209.6	204.2	17.56	16.90	0.809
April	196.5	57.31	32.20	197.2	191.8	16.38	15.76	0.801
May	202.7	67.30	31.90	189.3	183.5	15.84	15.25	0.808
June	163.5	72.91	29.40	149.9	144.9	12.77	12.30	0.822
July	137.0	75.60	27.40	127.5	123.1	11.07	10.65	0.837
August	135.8	72.20	27.10	132.5	128.2	11.52	11.09	0.839
September	152.1	60.91	28.20	159.5	155.2	13.69	13.19	0.829
October	162.1	47.10	29.60	186.8	181.9	15.80	15.22	0.817
November	140.7	36.00	28.00	177.5	172.7	15.21	14.65	0.828
December	132.1	33.80	25.10	175.0	170.1	15.29	14.73	0.844
Year	1908.1	642.64	28.27	2070.2	2011.5	176.81	170.23	0.824

Legends:			
GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T Amb	Ambient Temperature	E_Grid	Energy injected into grid
GlobInc	Global incident in coll. plane	PR	Performance Ratio

Figure 3. Performance ratio, nominal energy and monthly & yearly data of 100KW grid connected system(Case 1)

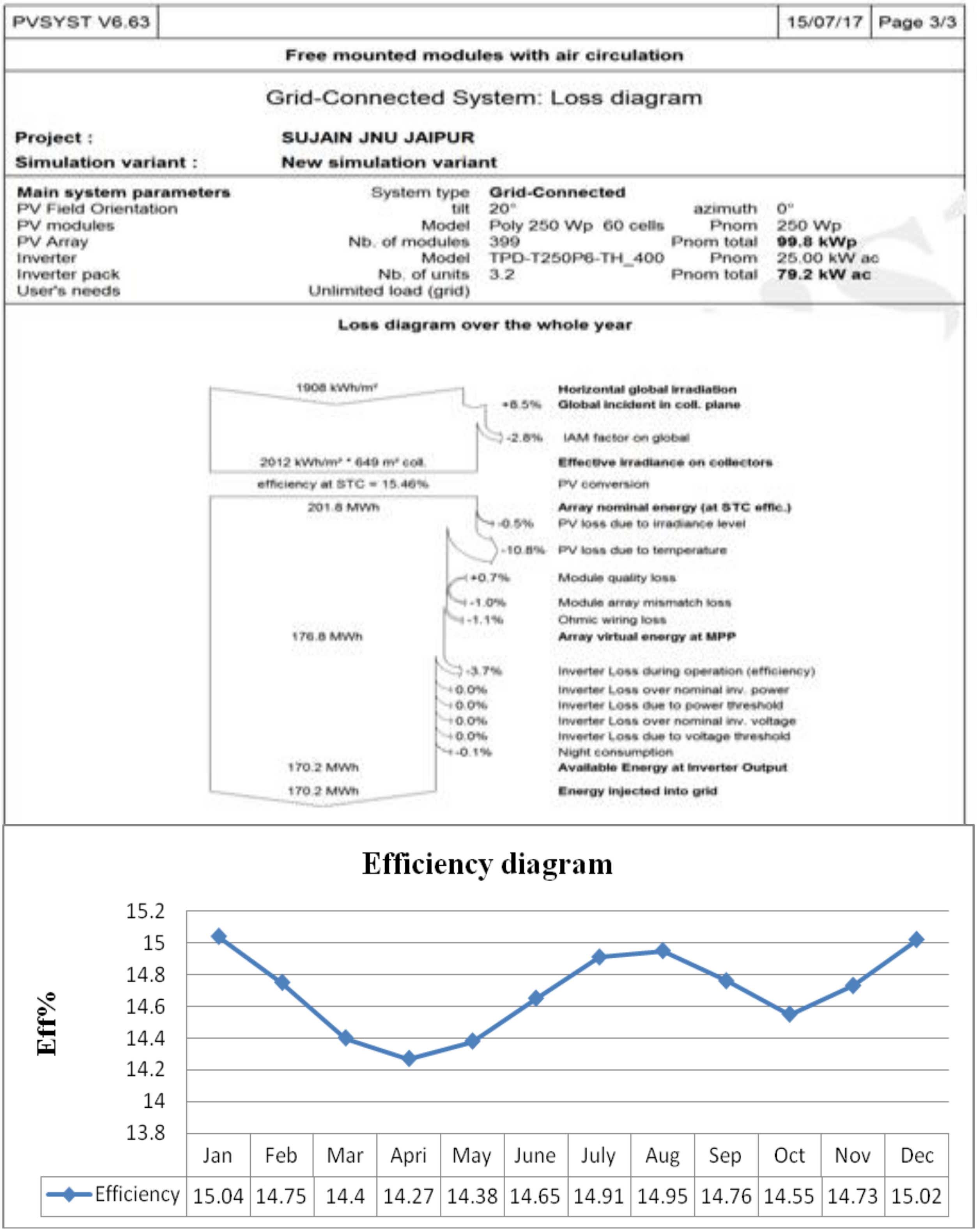


Figure 4. Loss diagram and efficiency of array of 100KW grid connected system(case 1)

B. CASE 2 (semi-integrated with air duct behind)

The second case we were considered is , standard technical specifications as well as Semi-integrated with air duct behind. In this case, a high amount of radiation of about 2011.5 kW/m^2 energy is received on the PV array in a year. By the proposed grid connected system 169.39 MW electricity will be generated out of that 163.11 MW electricity is available to the grid. 163.11 MW electricity will be supply to the grid throughout the year. Figure 5. shows the Performance ratio, nominal energy and monthly & yearly data of 100KW grid connected system(case 2). From the simulation it is found that performance ratio (PR) of the system is 78.99%. Here, the maximum PR 81.3% is found in the month of August and minimum in the month of April 76.4%. System will produce 4.48 kWh/kWp/day electricity that is available to the grid. Global radiation is maximum in the month of March (204.2kW/m^2/month) and minimum in July

(123.1kW/m^2/month) and also maximum electricity is produced on the March (16.71 MW/month) and minimum on July (10.73 MW/month).

SYSTEM LOSSES:- PV system is not able to convert 100% energy received from the solar radiation because of various losses. Figure 6. gives the detail of losses occur in the proposed grid connected PV system. Firstly about 1908 kWh/m^2 radiation is incident on the solar panels.. The module efficiency has been 15.46 % at the STC. By this, 201.8MWh/year electricity will be produced by the PV array. After that PV losses due to irradiance, PV losses due to temperature, module quality loss, module array mismatch loss, wiring losses and Inverter losses about 163.1MWh/yr of electricity is available to the grid. It can be concluded form figure 6. that the maximum efficiency of the output array 14.48% is found in the month of August and minimum in the month of April 13.60%.

PVSYST V6.63		15/07/17	Page 2/3

Semi - integrated with air duct behind

Grid-Connected System: Main results

Project : **SUJAIN JNU JAIPUR**

Simulation variant : **New simulation variant**

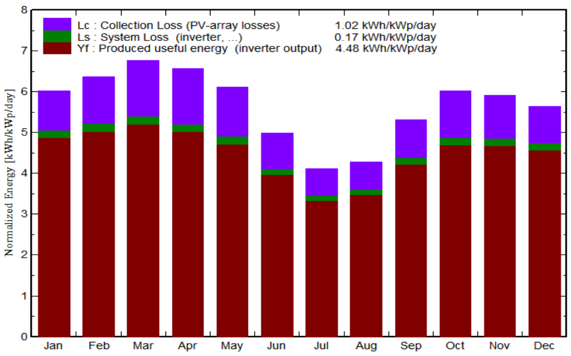
Main system parameters

Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	tilt	20°	azimuth	0°
PV modules	Model	Poly 250 Wp 60 cells	Pnom	250 Wp
PV Array	Nb. of modules	399	Pnom total	**99.8 kWp**
Inverter	Model	TPD-T250P6-TH_400	Pnom	25.00 kW ac
Inverter pack	Nb. of units	3.2	Pnom total	**79.2 kW ac**
User's needs	Unlimited load (grid)			

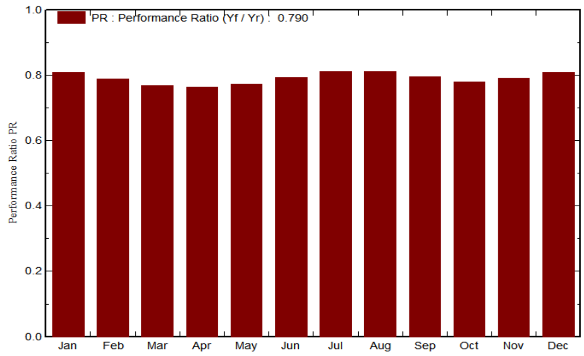
Main simulation results

System Production	**Produced Energy**	**163.1 MWh/year**	Specific prod.	1635 kWh/kWp/year
	Performance Ratio PR	78.99 %		

Normalized productions (per installed kWp): Nominal power 99.8 kWp



Performance Ratio PR



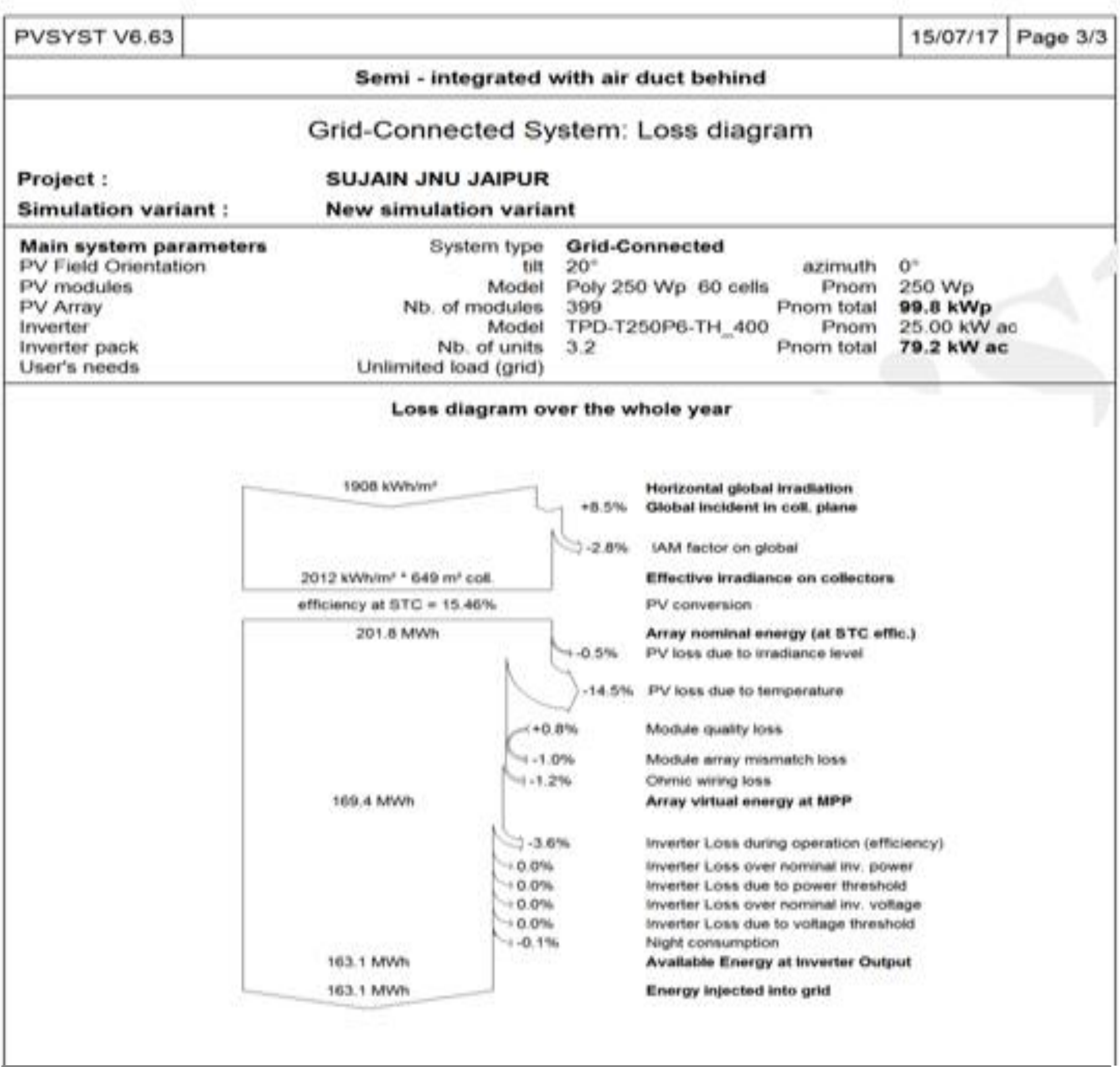
New simulation variant

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	144.5	33.80	24.20	186.9	181.9	15.66	15.08	0.809
February	149.5	36.99	26.00	178.5	173.9	14.59	14.05	0.789
March	191.6	48.71	30.10	209.6	204.2	16.71	16.09	0.769
April	196.5	57.31	32.20	197.2	191.8	15.61	15.02	0.764
May	202.7	67.30	31.90	189.3	183.5	15.17	14.61	0.774
June	163.5	72.91	29.40	149.9	144.9	12.32	11.86	0.793
July	137.0	75.60	27.40	127.5	123.1	10.73	10.33	0.812
August	135.8	72.20	27.10	132.5	128.2	11.16	10.74	0.813
September	152.1	60.91	28.20	159.5	155.2	13.14	12.66	0.796
October	162.1	47.10	29.60	186.8	181.9	15.08	14.53	0.780
November	140.7	36.00	28.00	177.5	172.7	14.55	14.02	0.792
December	132.1	33.80	25.10	175.0	170.1	14.67	14.14	0.810
Year	1908.1	642.64	28.27	2070.2	2011.5	169.39	163.11	0.790

Legends:				
	GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
	DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
	T Amb	Ambient Temperature	E_Grid	Energy injected into grid
	GlobInc	Global incident in coll. plane	PR	Performance Ratio

Figure 5. Performance ratio, nominal energy and monthly & yearly data of 100KW grid connected system(Case 2)



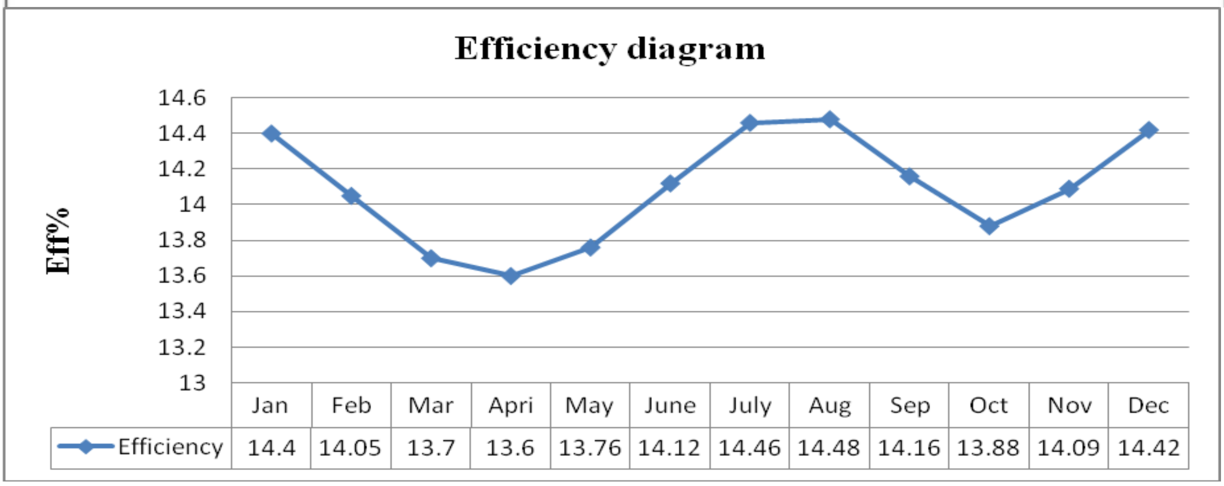


Figure 6. Loss diagram and efficiency of array of 100KW grid connected system(Case 2)

C. CASE 3 (integration with fully insulated back)

The third case we considered , a standard technical specifications as well as integration with Fully insulated back. In case third, Maximum radiation of about 2011.5 kW/m^2 energy is received on the PV array in a year. By the proposed grid connected system 161.19 MW electricity will be generated out of which 155.20 MW electricity is available to the grid. 155.20 MW electricity will be supply to the grid throughout the year. Figure 7. shows the Performance ratio, nominal energy and monthly & yearly data of 100KW grid connected system(case 3). From the simulation it is found that performance ratio (PR) of the system is 75.16%. Here, maximum PR is 78.4% in the month of July and minimum in the month of April 72.2%. System will produce 4.26 kWh/kWp/day electricity that is available to the grid. Global radiation is maximum on the March (204.2kW/m^2/month) and minimum on July (123.1kW/m^2/month) and also maximum electricity is produced on the March (15.76 MW/month) and minimum on July (10.37 MW/month).

SYSTEM LOSSES:- Figure 8. gives the detailed analysis of losses occur in the proposed grid connected PV system. Firstly about 1908 kWh/m^2 radiation is incident on the solar panels.. The module efficiency is found to be 15.46 % at the STC. By this, 201.8MWh/year electricity will be produced by the PV array. After that PV losses due to irradiance, PV losses due to temperature, module quality loss, module array mismatch loss, wiring losses and Inverter losses about 155.2MWh/yr of electricity is available to the grid. From Figure 8. it can be concluded that the maximum efficiency of the output array is 13.97% in the month of July and minimum in the month of April 12.85%.

PVSYST V6.63		15/07/17	Page 2/3

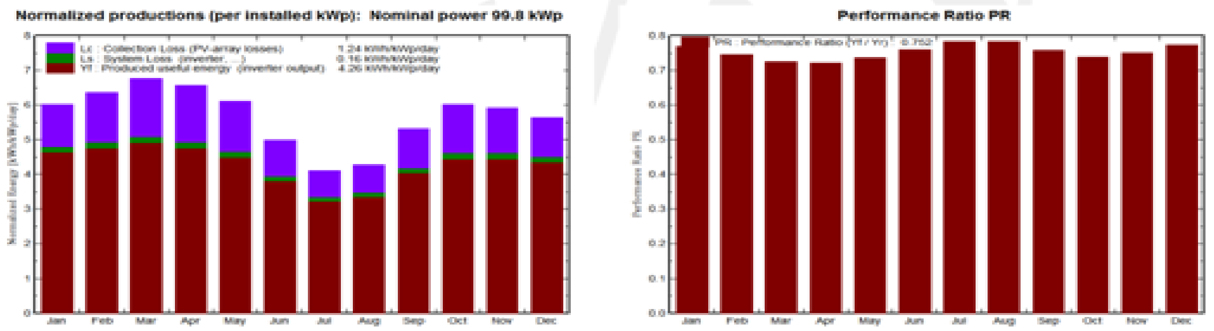
Integration with fully insulated back

Grid-Connected System: Main results

Project :	**SUJAIN JNU JAIPUR**
Simulation variant :	**New simulation variant**

Main system parameters	System type	**Grid-Connected**		
PV Field Orientation	tilt	20°	azimuth	0°
PV modules	Model	Poly 250 Wp 60 cells	Pnom	250 Wp
PV Array	Nb. of modules	399	Pnom total	**99.8 kWp**
Inverter	Model	TPD-T250P6-TH_400	Pnom	25.00 kW ac
Inverter pack	Nb. of units	3.2	Pnom total	**79.2 kW ac**
User's needs	Unlimited load (grid)			

Main simulation results				
System Production	**Produced Energy**	**155.2 MWh/year**	Specific prod.	1556 kWh/kWp/year
	Performance Ratio PR	75.16 %		



New simulation variant

Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR
January	144.5	33.80	24.20	186.9	181.9	14.88	14.34	0.769
February	149.5	36.99	26.00	178.5	173.9	13.79	13.28	0.746
March	191.6	48.71	30.10	209.6	204.2	15.76	15.18	0.726
April	196.5	57.31	32.20	197.2	191.8	14.75	14.20	0.722
May	202.7	67.30	31.90	189.3	183.5	14.44	13.90	0.736
June	163.5	72.91	29.40	149.9	144.9	11.82	11.37	0.760
July	137.0	75.60	27.40	127.5	123.1	10.37	9.97	0.784
August	135.8	72.20	27.10	132.5	128.2	10.76	10.35	0.783
September	152.1	60.91	28.20	159.5	155.2	12.54	12.07	0.759
October	162.1	47.10	29.60	186.8	181.9	14.28	13.76	0.739
November	140.7	36.00	28.00	177.5	172.7	13.81	13.31	0.752
December	132.1	33.80	25.10	175.0	170.1	13.99	13.48	0.772
Year	1908.1	642.64	28.27	2070.2	2011.5	161.19	155.20	0.752

Legends:	GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
	DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
	T Amb	Ambient Temperature	E_Grid	Energy injected into grid
	GlobInc	Global incident in coll. plane	PR	Performance Ratio

Figure 7. Performance ratio, nominal energy and monthly & yearly data of 100KW grid connected system(case 3)

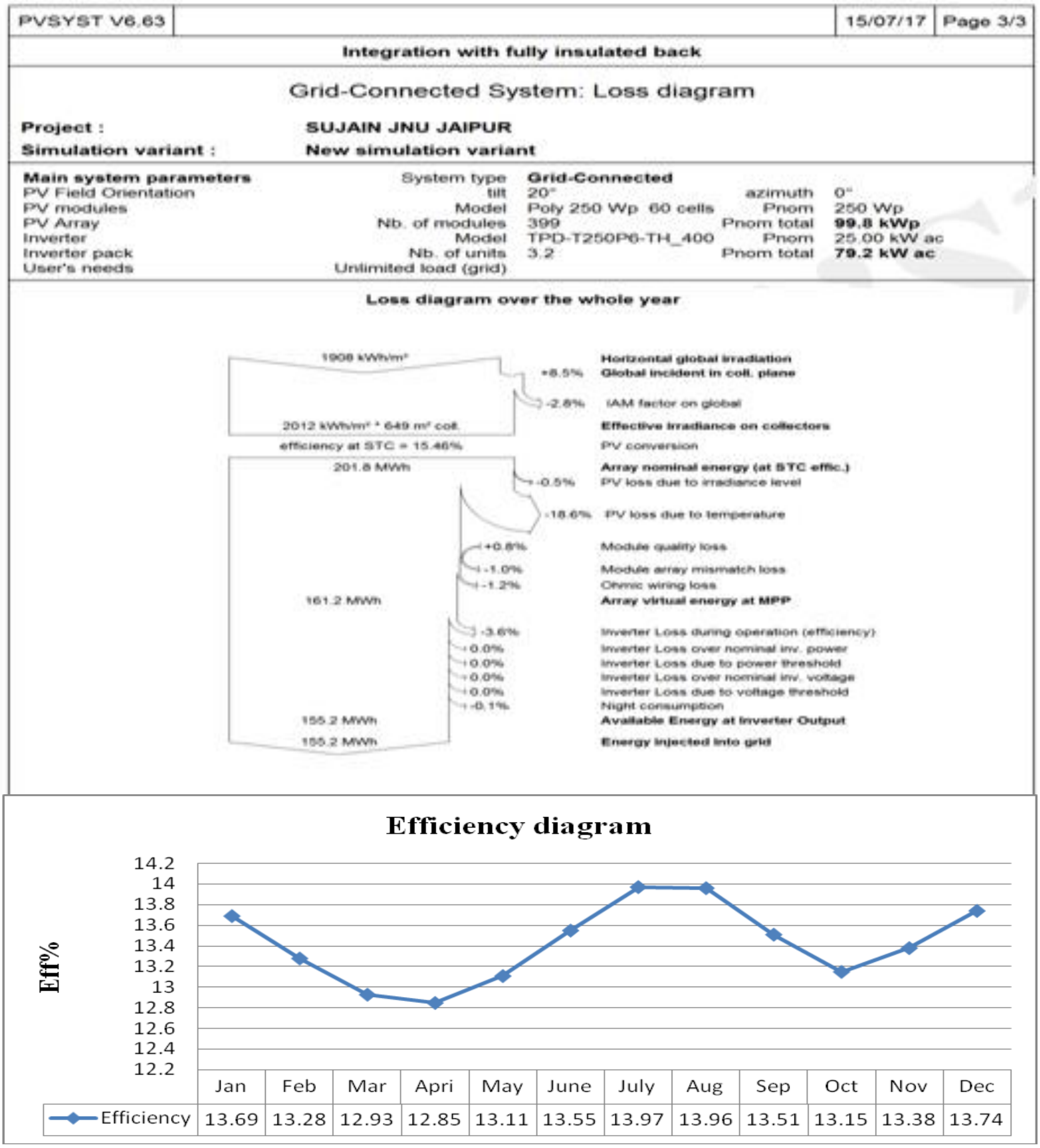
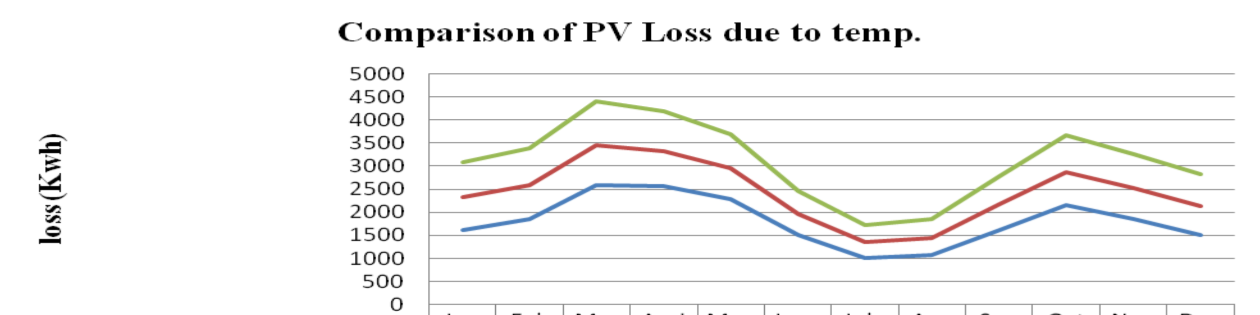


Figure 8. Loss diagram and efficiency of array of 100KW grid connected system(Case 3)

V. COMPARISONS

Figure 9. gives the detailed analysis of PV loss due to temperature. It can be concluded from the figure that Case 1 i.e. with free mounted air circulation has minimum loss as compare to Case 2 i.e. semi-integrated with air duct behind and Case 3 i.e. integration with fully insulated back. The comparative study on the basis of performance ratio (PR) of the system, energy injected into grid conclude that Case 1 is having maximum value as compare to other cases like semi-integrated with air duct behind and integration with fully insulated back (i.e. case 2 and case 3 respectively). Figure 10 shows the comparative study of Efficiency by taking all the three Cases. It can be concluded form the figure that as the losses are minimum in case 1 therefore the efficiency of the module will be maximum in Case 1 Therefore, Free mounted module with air circulation is best installation for solar Power Plant.



	Jan	Feb	Mar	Apri	May	June	July	Aug	Sep	Oct	Nov	Dec
PV Loss due to temp (Case 1)	1622	1854	2597	2556	2281	1502	1019	1082	1622	2151	1847	1509
PV Loss due to temp (Case 2)	2321	2579	3454	3332	2947	1958	1353	1445	2172	2875	2513	2129
PV Loss due to temp (Case 3)	3094	3382	4403	4191	3682	2461	1721	1845	2779	3677	3250	2815

Figure 9. Comparison of PV loss due to temperature

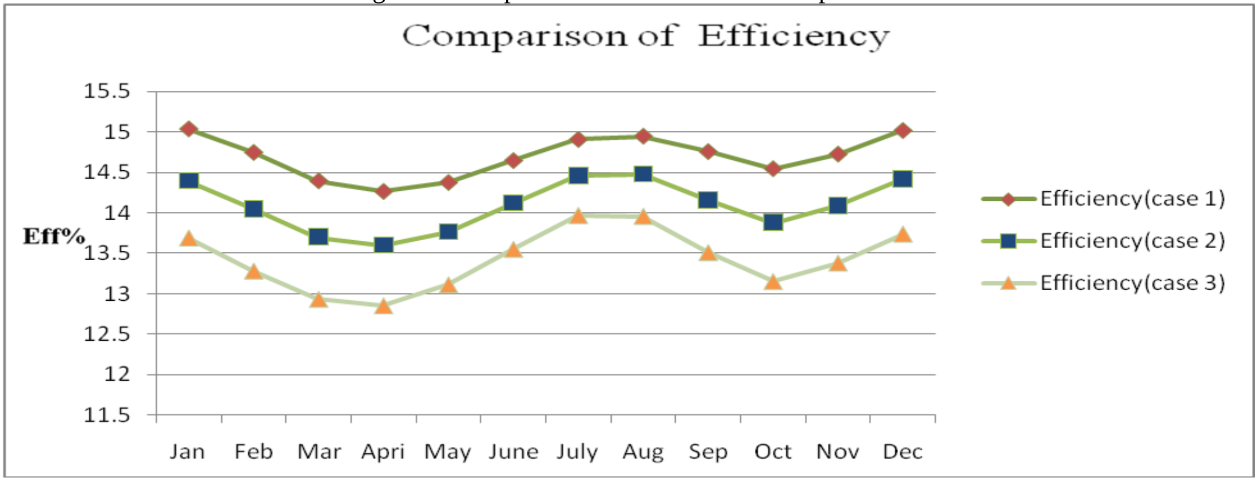


Figure 10. Comparison of efficiency of the output array.

VI. CONCLUSION

Electricity generation has now become a major challenge for a country like India with rising fuel price and worsening air pollution. Generating electricity using PV panels is a potential solution to the current energy crisis faced by India as it is renewable and climate friendly.

By the help of PVSYST software PV system configuration, output electricity and system losses are analyzed. The whole study is focused to design a grid connected photovoltaic system for climatic conditions of Surat, Gujarat, India. For design of this system suitable PV mode and inverter are selected. It is founded that 399 PV panels of 250Wp single solar panel output and inverter of 25kWac are the optimal solution for supplying the load of grid throughout the year. From the proposed system with free mounted air circulation, semi-integrated with air duct behind and integration with fully insulated back have been 170.23MWh, 163.11MWh and 155.20MWh electricity generated in a year and it will be available to the grid. Performance ratio of the system is about 82.44%, 78.99% and 75.16% respectively. Maximum efficiency is found in Case1 while minimum losses are also found for this case.

REFERENCES

[1] http://www.indianpowersector.com/about, accessed on 22 September 2015.

[2] Raman, P., Murali, J., Sakthivadivel, D., Vigneswaran, V.S., 2012. "Oppurtunities and challenges in setting up solar photovoltaic based micro grids for electrification in rural areas of india," Renew. Sustain, Energy Rev. 16(5), pp. 3320-3325.

[3] Sharma, P., Harinarayana, T., 2012. "Enhancement of energy generation from two layer solar panels," in International journal of energy and environment engineering, springer, pp. 3-12.

[4] Zenan, A.H., Ahmed S., Rhaman, M.K., Rahman, M., "A Multilevel Solar Panel System for Urban Areas", 39th IEEE Photovoltaic Specialists Conf. (39th IEEE PVSC), 16- 21 June 2013 Tampa, Florida, USA.

[5] http://www.pvsyst.com/images/pdf/PVsyst_Tutorials.pdf, accessed on 18 March 2015.

[6] Solanki, C.S., Solar Photovoltaics:Fundamen-tals, Technologies and Applications, PHI Learning Pvt Ltd. 2011.

[7] Sharma, D., Khare, A., 2014. Comparative analysis of solar PV module. International Journal on Emerging Technologies 5(2), pp. 22-26.

[8] Messenger, R.A., Ventre, J., Photovoltaic Systems Engineering., 2nd Edition. CRC Press LLC, 2004.

[9] Kandasamy, C.P., Prabu, P., Niruba, K., 2013. Solar potential Assessment using PVsyst Software. International conference on Green Computing, Comunication and conservation of Energy(ICGCE), 978-1-4673-6126-2/13.

[10] Maharaja, K., Sangeetha, S., Mareeswari, K., 2014. Sizing of Solar PV Power Plant in Stand-Alone Operation. International Journal of Engineering Research & Technology 3(6), pp. 51-55.

[11] Jacques, S., Bissey, S., 2014. New Software Package for Teaching and Learning the Basics of Photovoltaic System Sizing. wseas transactions on advances in engineering education (12), pp. 115-123.

[12] Jaydeep V. Ramoliya., 2015. Performance Evaluation of Grid-connected Solar Photovoltaic plant using PVSYST Software. Journal of Emerging Technologies and Innovative Research 2(2), pp. 372-378.

[13] Jones K. Chacko., Prof. K. J Thomas., Analysis of Different Solar Panel Arrangements using PVSYST. International Journal of Engineering Research and Technology 2015;Volume 4,Issue 4.ISSN:2278-0181.