



# Design and Performance Analysis of Solar PV system using PV-syst

---

It shines on us too and helps us all grow.

Kapil Sharma(21129408)

# CONTENT

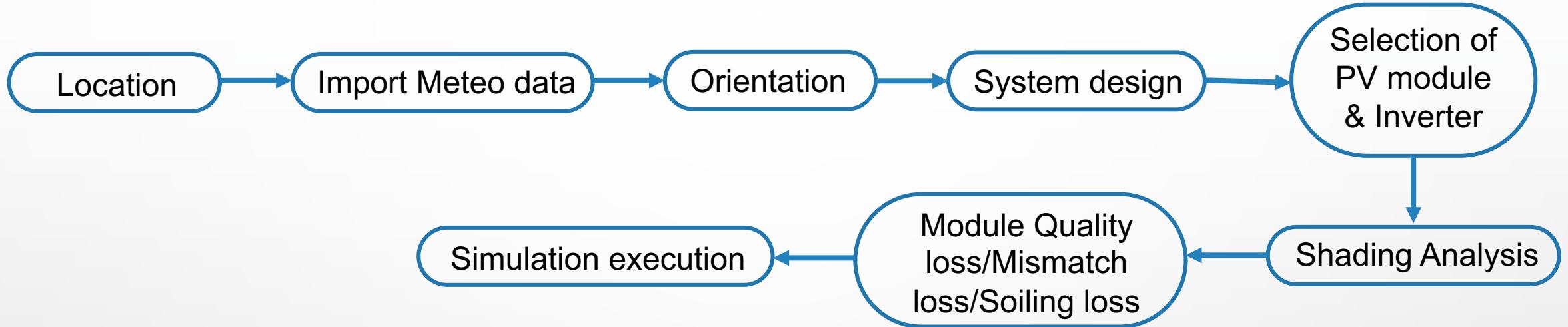
- INTRODUCTION
- STEPS IN ANALYSIS
- TYPES OF LOSSES
- RESULTS
- CONCLUSION
- REFERENCES

# INTRODUCTION

## What is PVsyst Software

- One of the oldest software, developed by University of Geneva.
- Main features:
  - Meteorological data analysis
  - Complete database of PV Module, Inverter, & Meteo data.
  - Import of solar radiation data from SolarGIS, Meteonorm, NASA-SSE and many more.
  - Also import files as .PAN files, .OND files, ,BAT files.
  - Shadow analysis using 3D models.
  - Design simulation of Grid connected, Standalone system.
  - Economic Evaluation.

# STEPS IN ANALYSIS



## 1) Location (geographical detail)

- Coordinates: Latitude & Longitude (26.51014267,80.23582628,157)
- Address: Department of Sustainable Energy Engineering.

## 2) Import Meteo data

- Used Meteonorm8.1 data for analysis from (1996 – 2015)

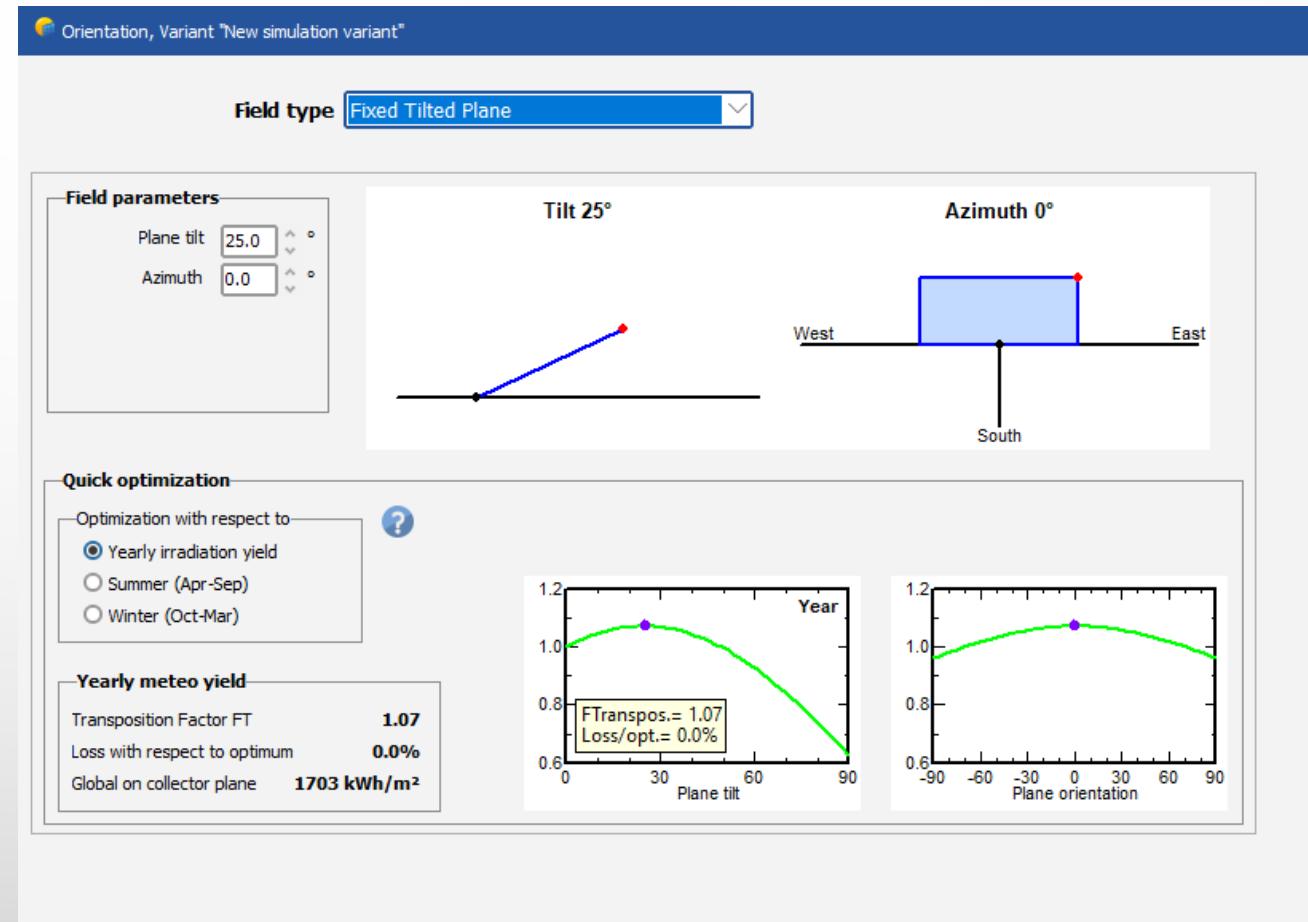
# STEPS IN ANALYSIS



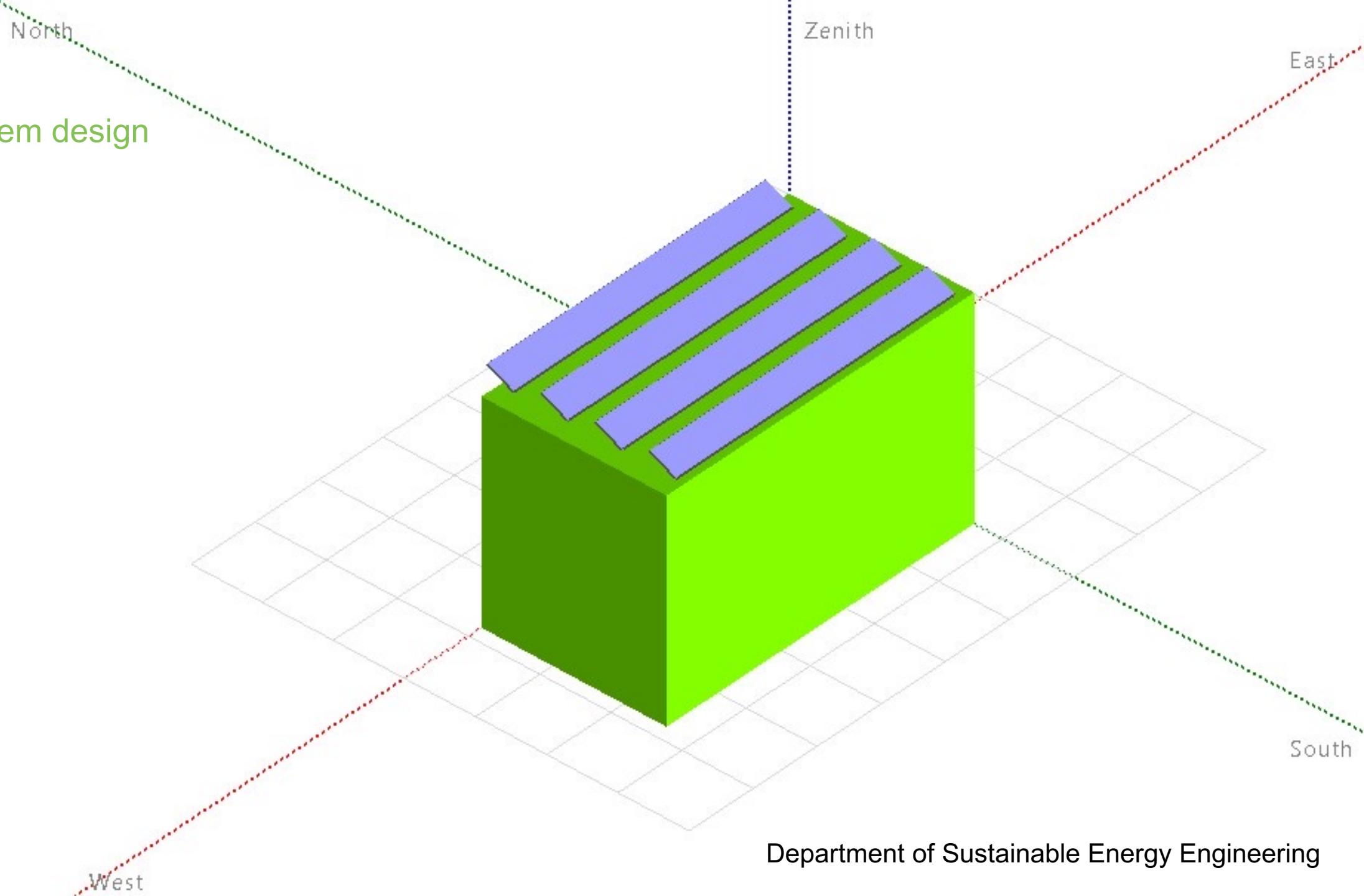
# STEPS IN ANALYSIS

## 3) Orientation

- In orientation part the field parameters includes azimuth angle, tilt angle.
- Quick optimization tools:
  - Yearly irradiance yield
  - Summer (Apr- Sep)
  - Winter (Oct-Mar)



#### 4) System design



# STEPS IN ANALYSIS

**Sub-array**

**Sub-array name and Orientation**

Name: PV Array      Tilt: 25°      Azimuth: 0°

Orient: Fixed Tilted Plane      Pre-sizing Help: No sizing      Enter planned power: 32.0 kWp

... or available area(modules): 172 m<sup>2</sup>

**Select the PV module**

Available Now      Filter: All PV modules      Maximum nb. of modules: 88

Vikram Solar      370 Wp 32V Si-mono Somera VSM.72.370.05 U Since 2017 Manufacturer TUV-F

Use optimizer

Sizing voltages : Vmpp (60°C) 34.0 V      Voc (-10°C) 53.4 V

**Select the inverter**

Available Now      Output voltage 230 V Mono 50Hz

GESolar      4.0 kW 200 - 550 V Trnsfo 50/60 Hz GES-4K Since 2011

Nb. of inverters: 8      Operating voltage: 200-550 V Global Inverter's power: 32.0 kWac

Input maximum voltage: 600 V "String" inverter with 4 inputs

**Design the array**

**Number of modules and strings**

Mod. in series: 11      Nb. strings: 8      Overload loss: 0.0 %      Pnom ratio: 1.02

Nb. modules: 88      Area: 170 m<sup>2</sup>

**Operating conditions**

Vmpp (60°C): 374 V      Vmpp (20°C): 446 V      Voc (-10°C): 588 V

Plane irradiance: 1000 W/m<sup>2</sup>      Impp (STC): 77.0 A      Isc (STC): 79.2 A

Isc (at STC): 79.2 A      Max. operating power (at 1070 W/m<sup>2</sup> and 50°C): 31.7 kW

**Array nom. Power (STC): 32.6 kWp**

**List of subarrays**

Name	#Mod #Inv.	#String #MPPT
PV Array	11	8
Vikram Solar - Somera VSM.72.370.05_U	11	8
GESolar - GES-4K	8	1

**Global system summary**

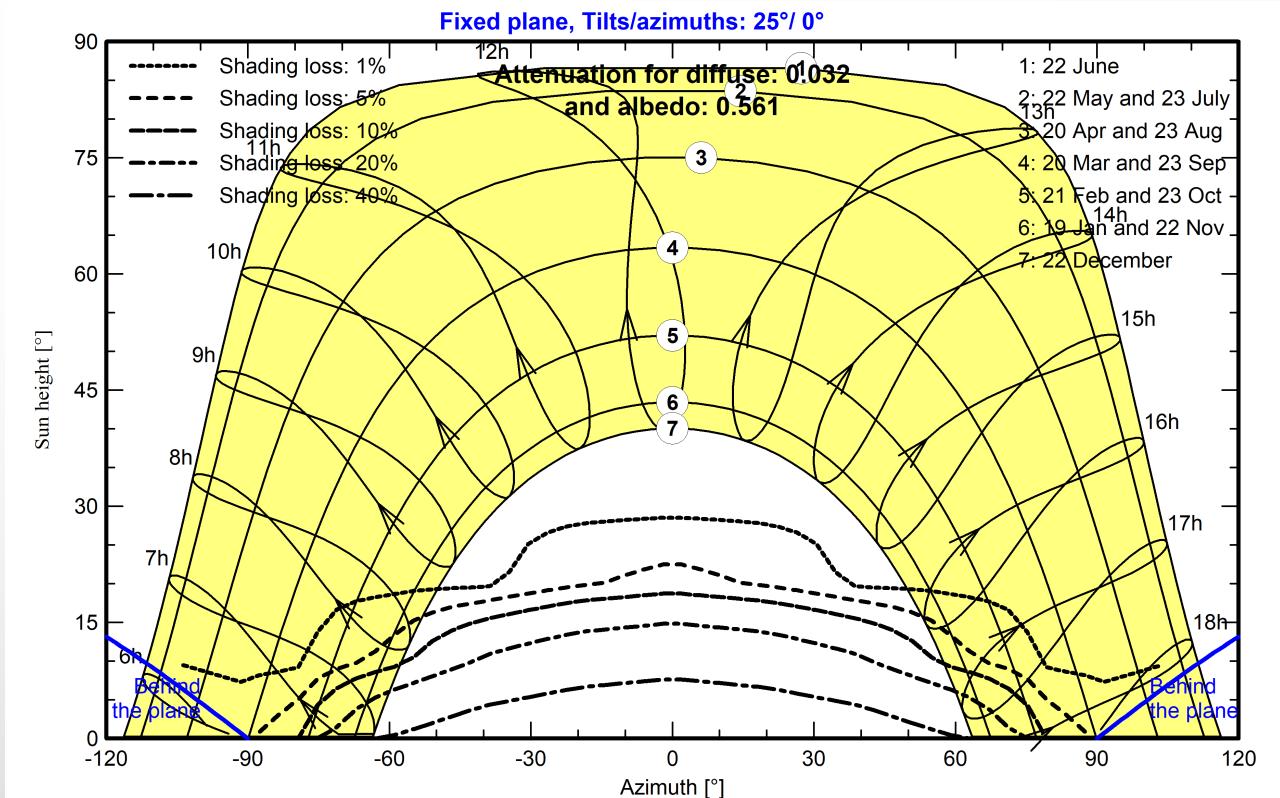
Nb. of modules	88
Module area	170 m <sup>2</sup>
Nb. of inverters	8
Nominal PV Power	32.6 kWp
Nominal AC Power	32.0 kWAC
Pnom ratio	1.018

**5) Selection of PV module & Inverter**

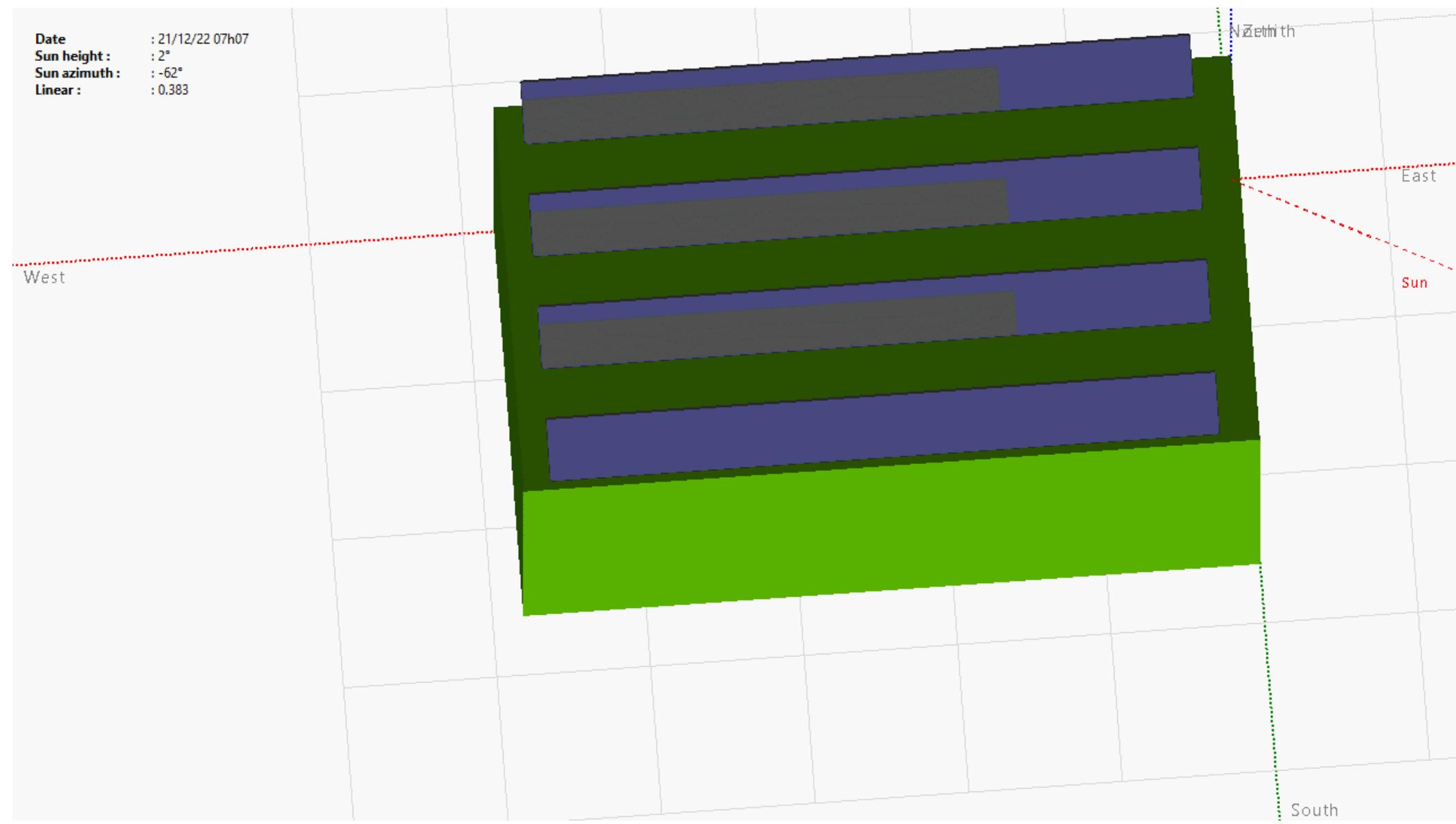
# STEPS IN ANALYSIS

## 6) Shading Analysis

- Near Shading
  - Shading caused by objects that are close to the solar panel array, such as buildings, trees, or other objects.
  - Significant impact on the performance of a PV system.
  - It creates "hot spots" on the solar panels and reduce the overall efficiency of the panel.



Date : 21/12/22 07h07  
Sun height : 2°  
Sun azimuth : -62°  
Linear : 0.383



# TYPES OF LOSSES

- Temperature Losses
  - With the increase in temperature of PV module the efficiency decreases.
- Reflection losses
  - Occur when sunlight reflects off the surface of a PV panel.
- Wiring losses
  - The electrical wiring and connections cause losses due to resistance, which can reduce the overall efficiency of the system.
- Mismatch losses
  - Mismatch losses occur when different PV panels in an array have different electrical characteristics
- Ohmic/Resistive Losses
  - Occur when electrical current flows through the internal resistance of the panel's cells and interconnections (metal contacts and busbars used to interconnect the cells).

# RESULTS

- The normalized productions of each month has been stated, It gives the three important parameters:

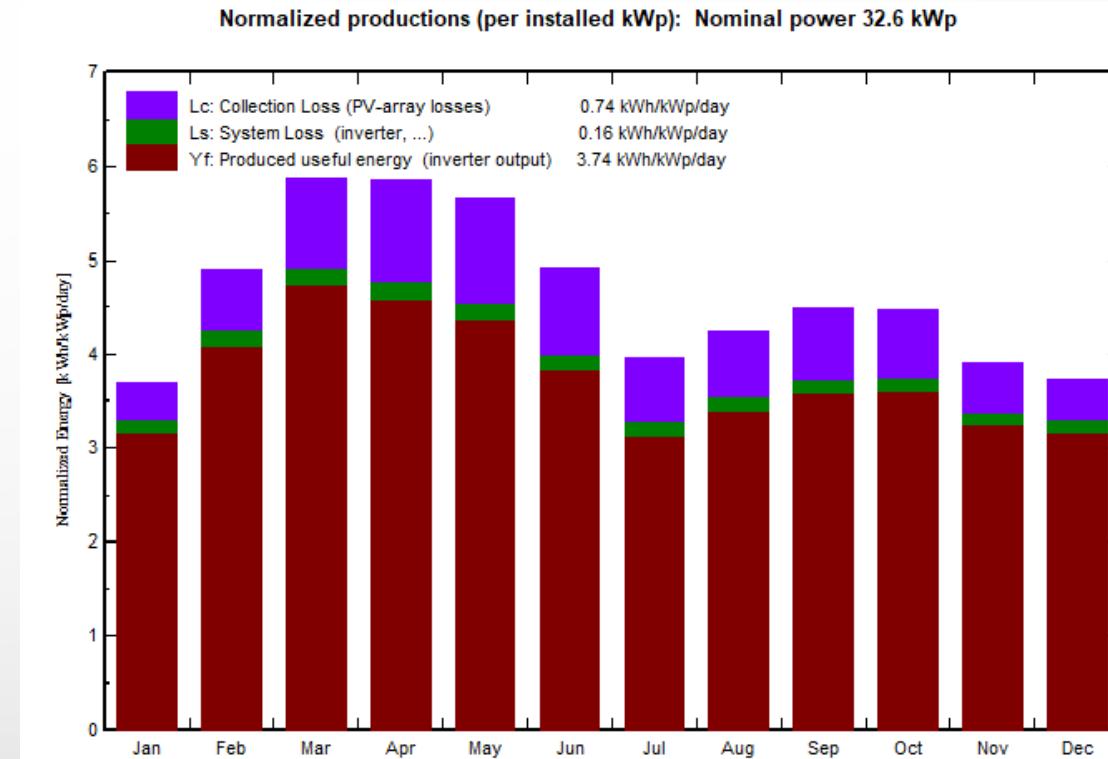
- Collection loss (PV-array losses):- Refers to the energy lost in the PV module itself :-  $0.74 \frac{kWh}{kWp-day}$

- System Loss:- Refers to the energy lost in the various components of the PV system outside of the PV module, such as the wiring, inverters, and

transformers :-  $0.16 \frac{kWh}{kWp-day}$

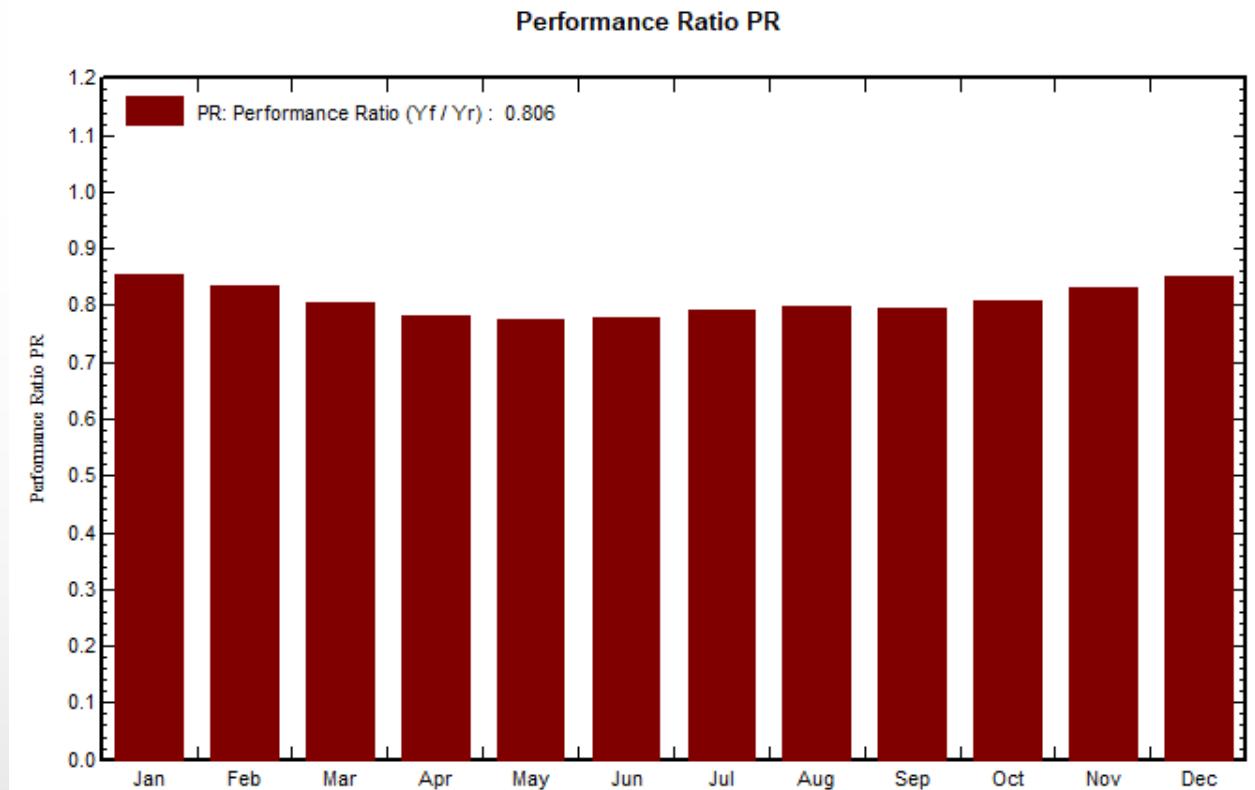
- Produced useful energy (Inverter output):-

$3.74 \frac{kWh}{kWp-day}$



# RESULTS

- The performance ratio of each month has been stated.
- It is a measure of the efficiency of a PV system.
- $PR = \left( \frac{Energy_{actual}}{Energy_{ideal}} \right)$
- Optimal Range **0.7 – 0.9**
- Obtained Value of **0.806**



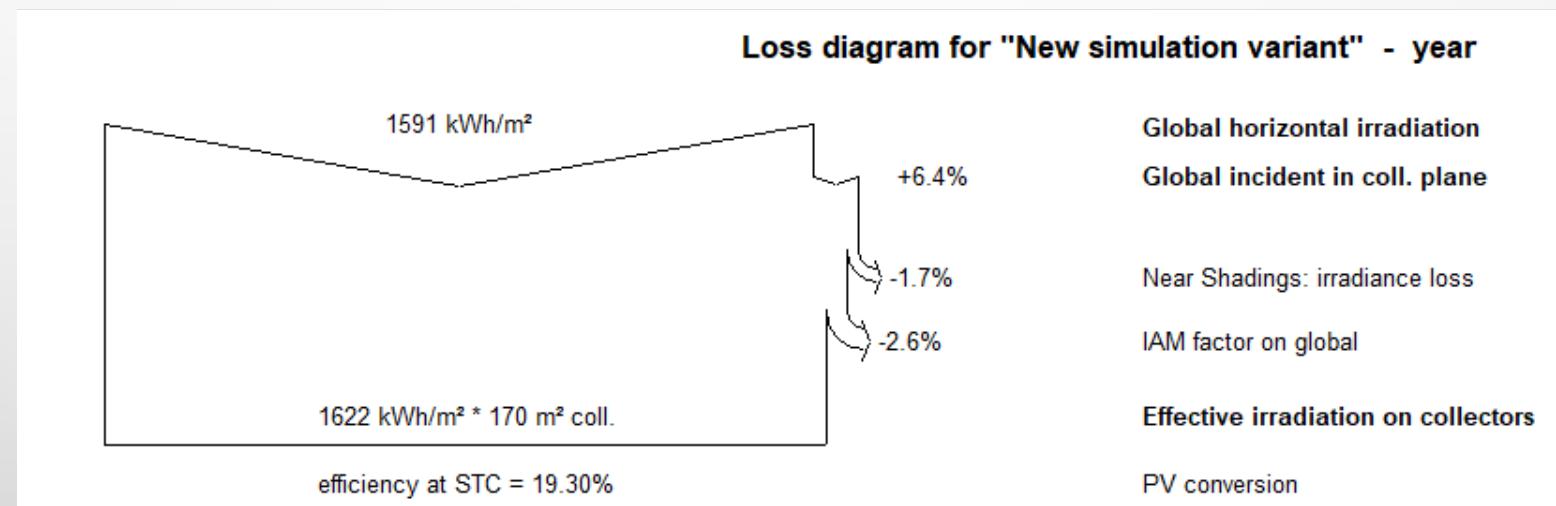
# RESULTS

global horizontal irradiation, horizontal diffuse irradiation, ambient temperature, and global incident radiation. performance ratio, energy injected into Grid, effective energy at the output of the array

	GlobHor kWh/m <sup>2</sup>	DiffHor kWh/m <sup>2</sup>	T_Amb °C	GlobInc kWh/m <sup>2</sup>	GlobEff kWh/m <sup>2</sup>	EArray kWh	E_Grid kWh	PR ratio
<b>January</b>	92.1	51.7	14.11	114.9	110.5	3332	3196	0.855
<b>February</b>	113.8	57.1	18.43	137.3	132.4	3883	3731	0.834
<b>March</b>	163.5	74.4	24.23	182.2	176.0	4963	4771	0.804
<b>April</b>	173.4	89.9	29.84	175.6	168.7	4659	4478	0.783
<b>May</b>	184.6	102.7	32.74	175.0	167.2	4590	4408	0.774
<b>June</b>	159.6	97.9	32.23	147.5	140.3	3901	3741	0.779
<b>July</b>	131.6	90.9	29.99	122.8	116.2	3308	3164	0.792
<b>August</b>	136.1	93.0	29.45	131.8	125.2	3573	3424	0.798
<b>September</b>	128.8	75.7	28.47	134.8	128.8	3645	3494	0.796
<b>October</b>	121.8	72.2	26.25	138.4	133.1	3791	3638	0.808
<b>November</b>	95.7	58.4	20.54	116.9	112.2	3299	3168	0.833
<b>December</b>	89.5	51.3	15.71	115.8	111.0	3338	3205	0.850
<b>Year</b>	1590.6	915.1	25.19	1692.8	1621.6	46284	44420	0.806

# RESULTS

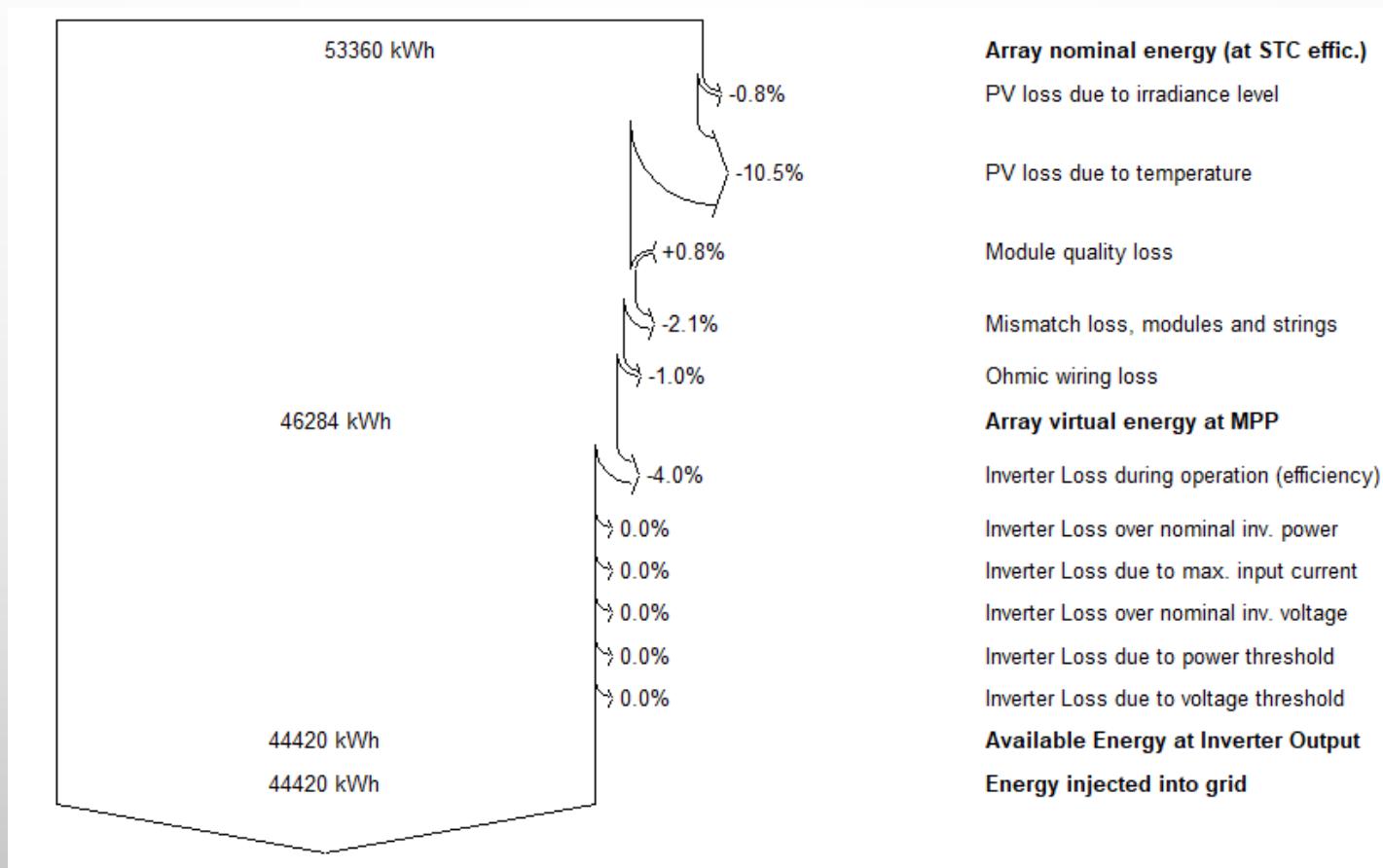
- Loss diagram shows all the losses that occur in the system step by step.
- $1591 \text{ kWh/m}^2$  is falling in this region to the PV system.
- Due to IAM losses and soiling losses the total energy generated in this system is  $53.36 \text{ MWh}$  where the efficiency is 19.30% at STC.



- Finally,  $44.42 \text{ MWh}$  and the rest of energy is lost due to mismatch loss, inverter loss during operation and Ohmic loss.

# RESULTS

- Finally, 44.42 Mwh and the rest of energy is lost due to mismatch loss, inverter loss during operation and Ohmic loss.



# CONCLUSION

- Design and performance analysis of grid-connected PV system in Department of Sustainable Energy Engineering at IIT Kanpur.
- The system production is  $44.42 \frac{MWh}{year}$  and the specific output is  $1364 \frac{kWh}{kWp-year}$ , the performance ratio is 0.8059, and the system losses is  $0.16 \frac{kWh}{kWp-day}$ .
- The software PV-syst examines any kind of losses.

# CONCLUSION

Project summary			
<b>Geographical Site</b> Department of Sustainable Energy Engineering India	<b>Situation</b> Latitude Longitude Altitude Time zone	26.51 °N 80.24 °E 132 m UTC+5.5	<b>Project settings</b> Albedo 0.20
<b>Meteo data</b> Department of Sustainable Energy Engineering Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic			

System summary			
<b>Grid-Connected System</b>	<b>Sheds, single array</b>		
<b>PV Field Orientation</b> Fixed plane Tilt/Azimuth	Near Shadings Linear shadings	<b>User's needs</b> Unlimited load (grid)	
25 / 0 °			
<b>System information</b>			
<b>PV Array</b> Nb. of modules Pnom total	88 units 32.6 kWp	<b>Inverters</b> Nb. of units Pnom total Pnom ratio	8 units 32.0 kWac 1.018

Results summary				
Produced Energy	44420 kWh/year	Specific production	1364 kWh/kWp/year	Perf. Ratio PR

# REFERENCES

- [https://www.google.com/intl/en\\_in/earth/](https://www.google.com/intl/en_in/earth/)
- [https://www.pvsyst.com/help/index.html?contents\\_table.htm](https://www.pvsyst.com/help/index.html?contents_table.htm)
- <https://www.sciencedirect.com/science/article/pii/S2214785321058259?via%3Dihub>