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

Kapil Sharma(21129408)

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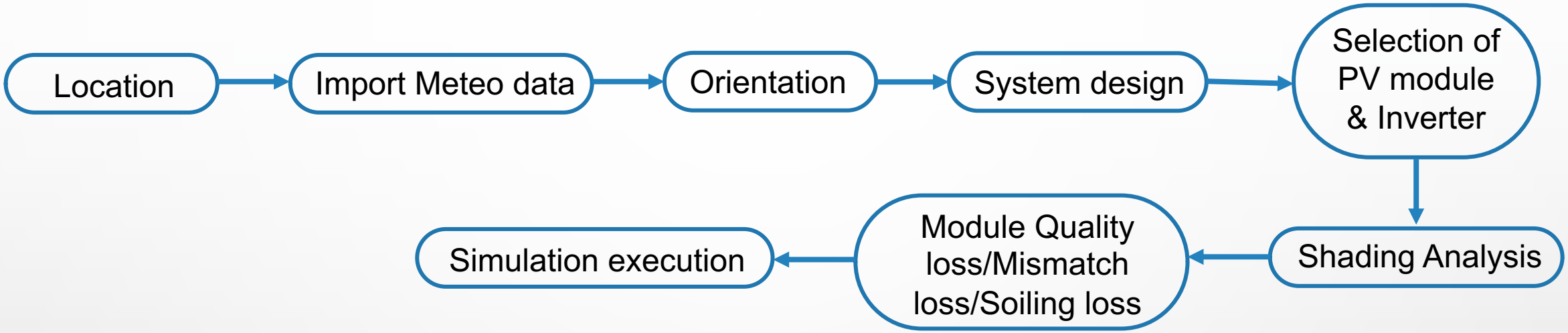
INTRODUCTION

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



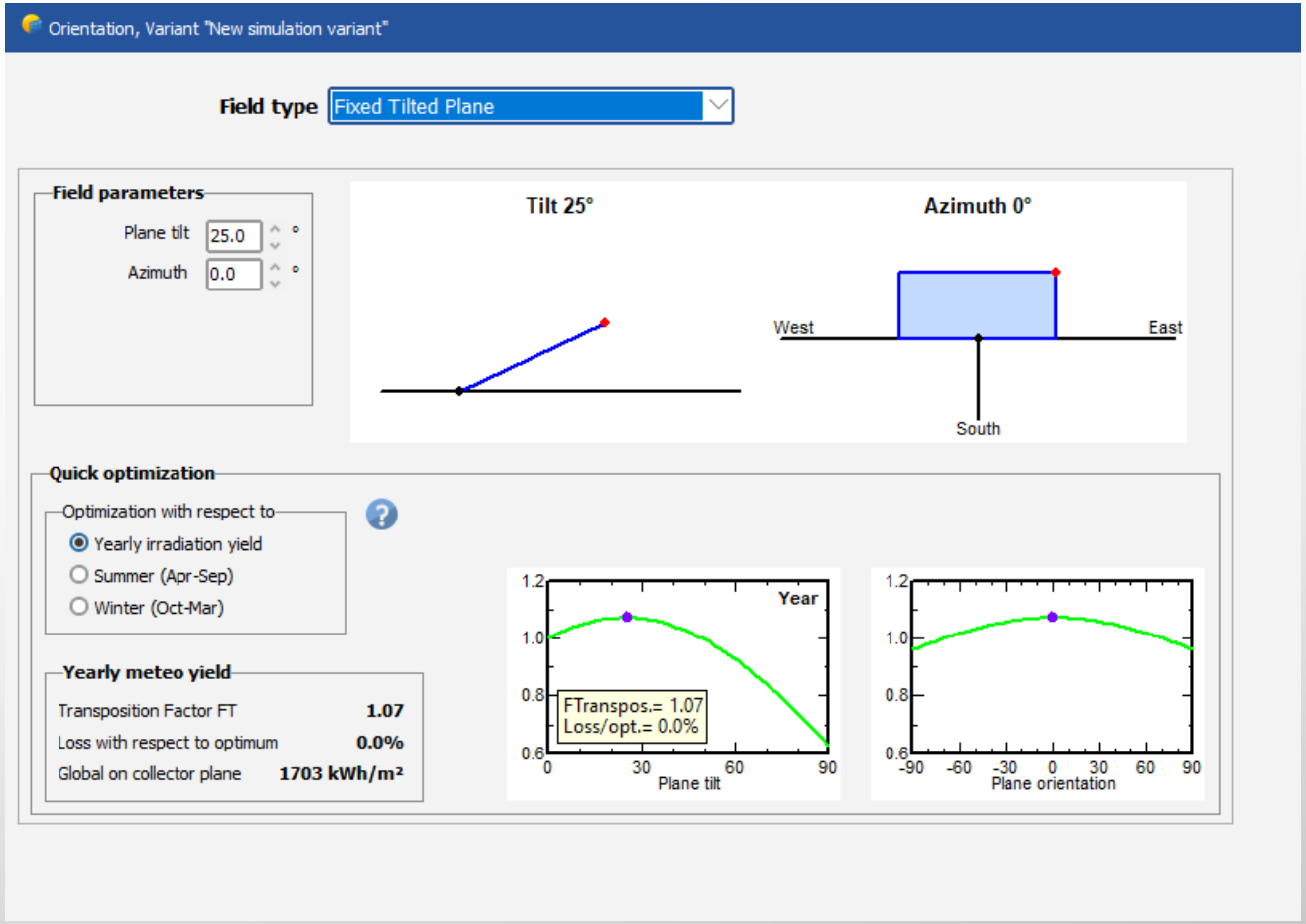
1) Location (geographical detail)
   - Coordinates: Latitude & Longitude $(26.51014267, 80.23582628, 157)$
   - Address: Department of Sustainable Energy Engineering.
2) Import Meteo data
   - Used Meteonorm8.1 data for analysis from $(1996 - 2015)$

STEPS IN ANALYSIS

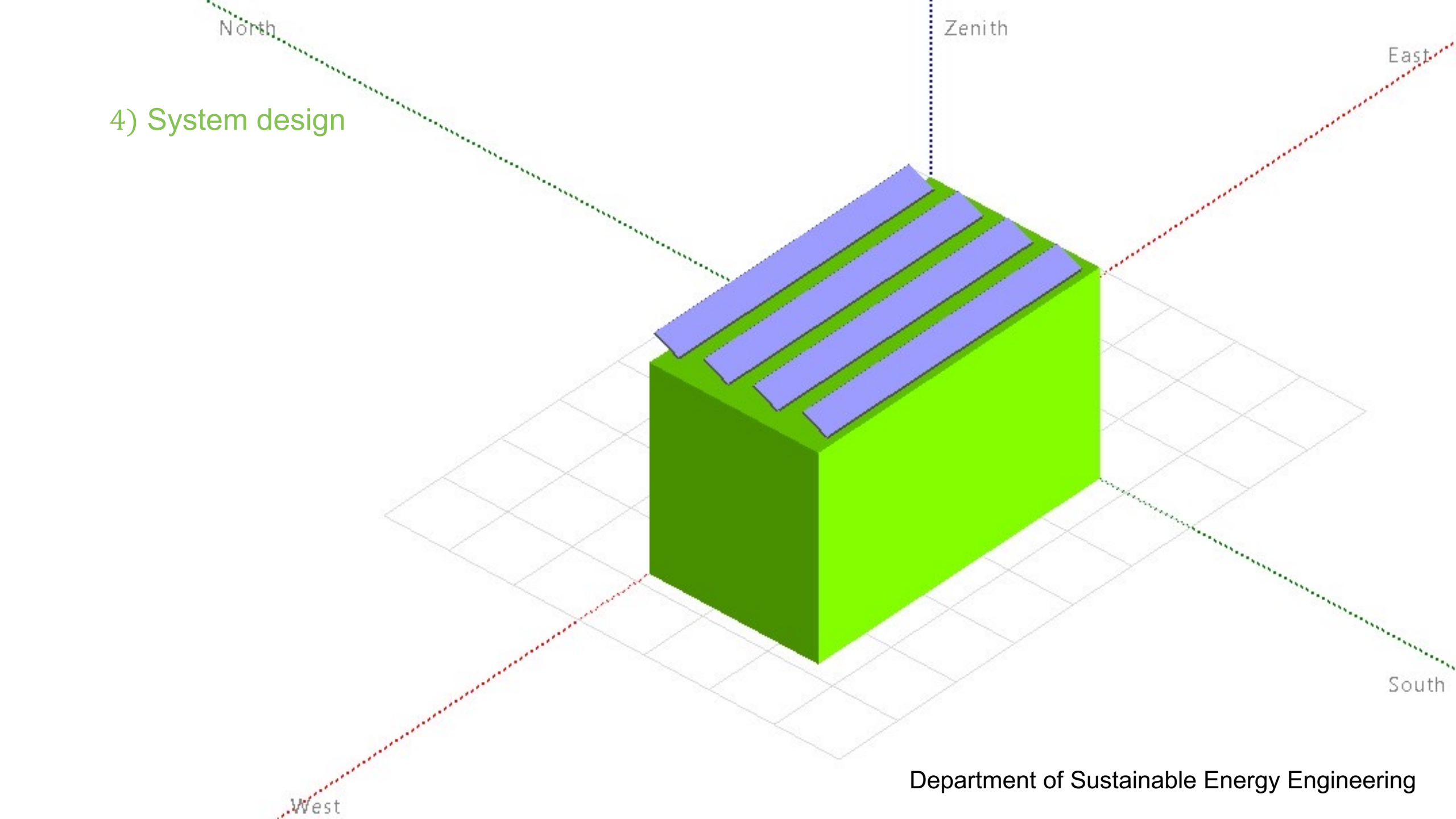
STEPS IN ANALYSIS

3) Orientation

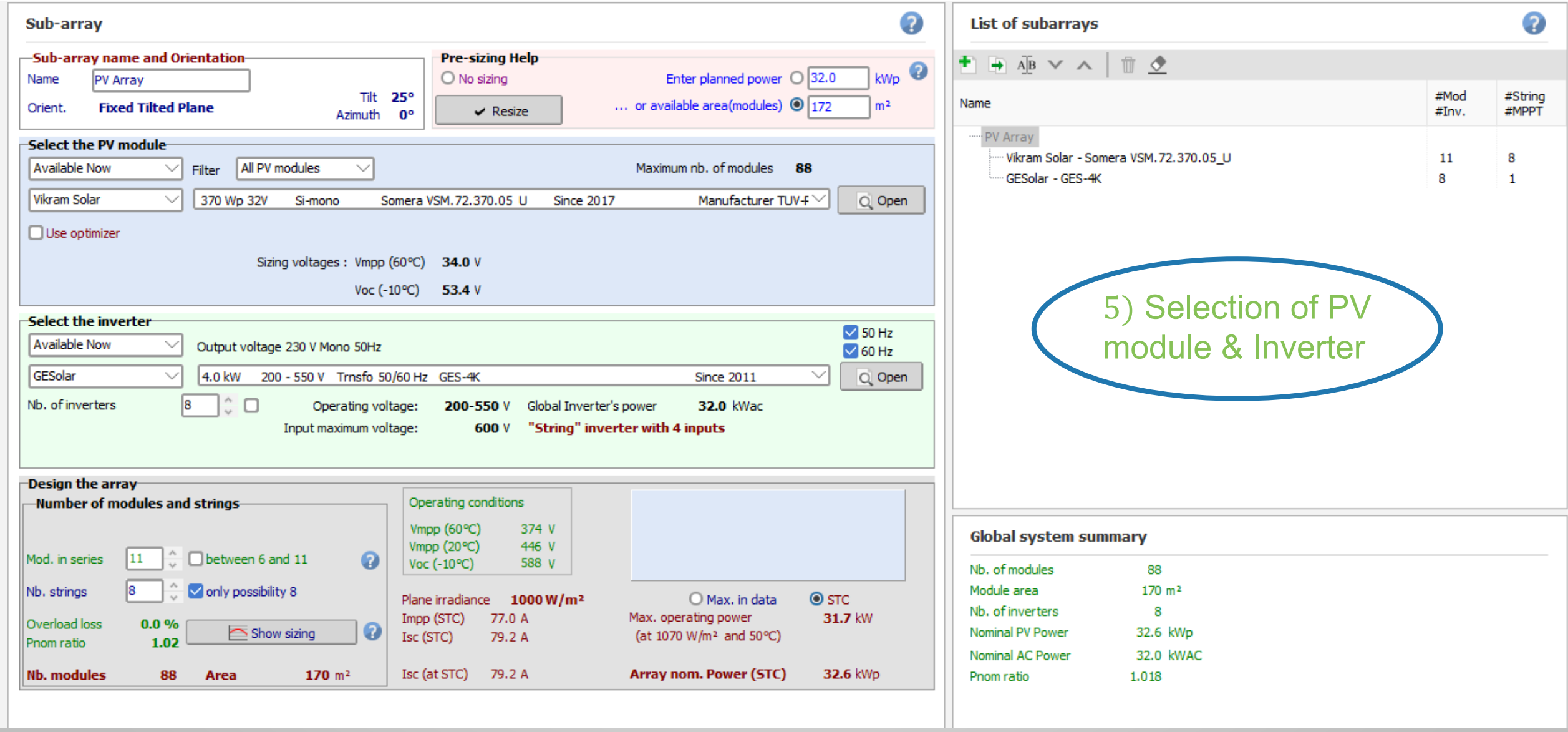
- In orientation part the field parameters includes azimuth angle, tilt angle.
- Quick optimization tools:
  - Yearly irradiance yield
  - Summer (Apr- Sep)
  - Winter (Oct-Mar)



4) System design



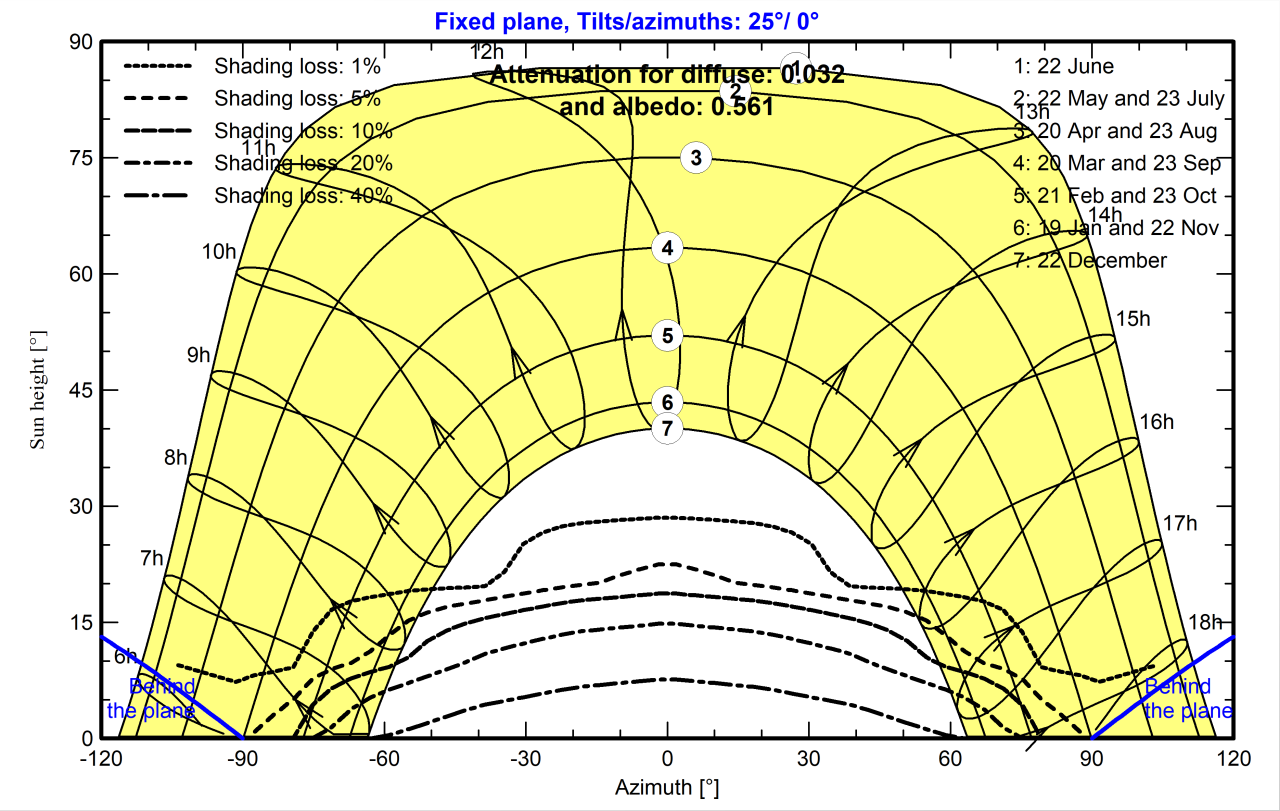
STEPS IN ANALYSIS

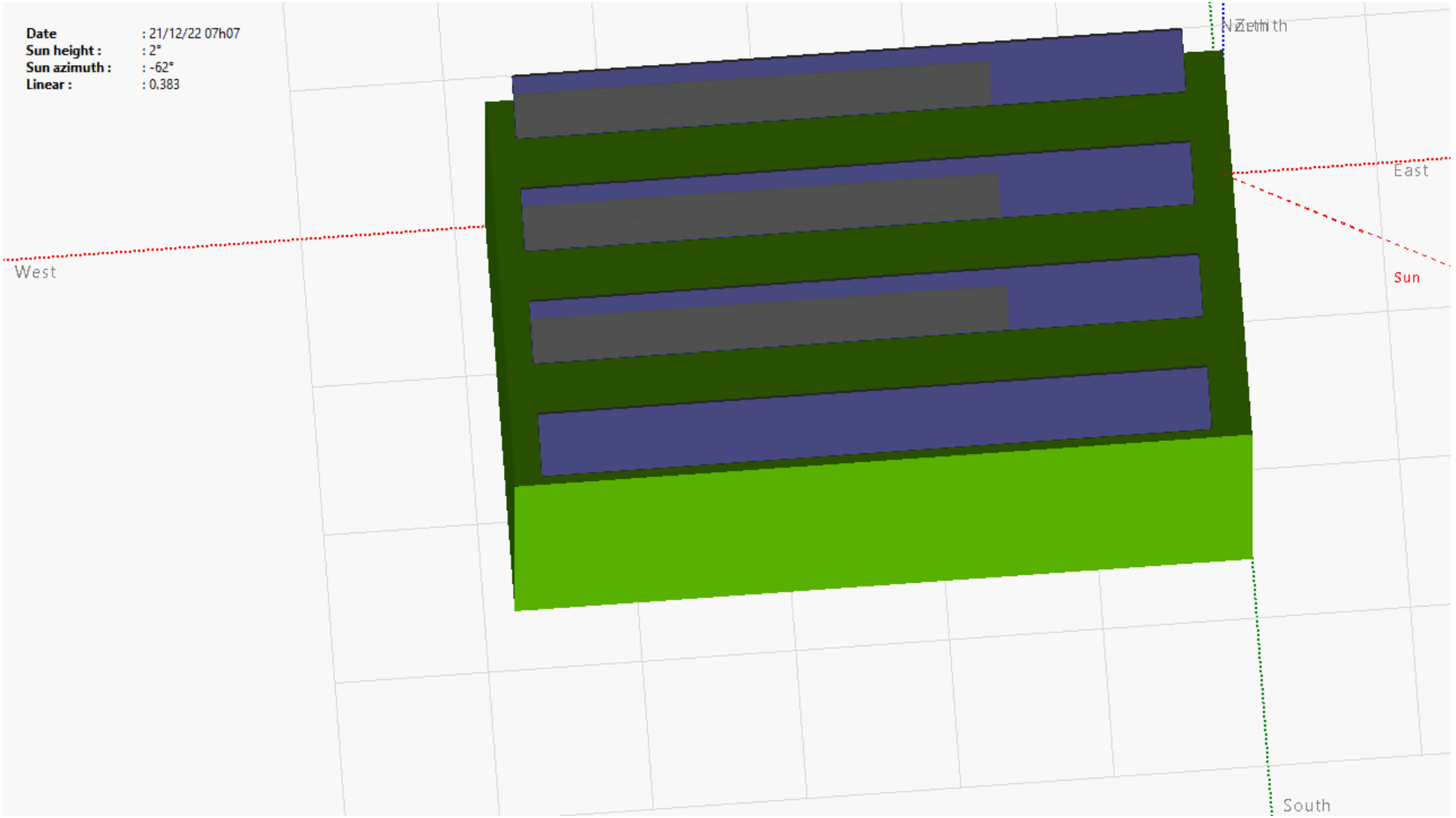


STEPS IN ANALYSIS

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 create "hot spots" on the solar panels and reduce the overall efficiency of the panel.



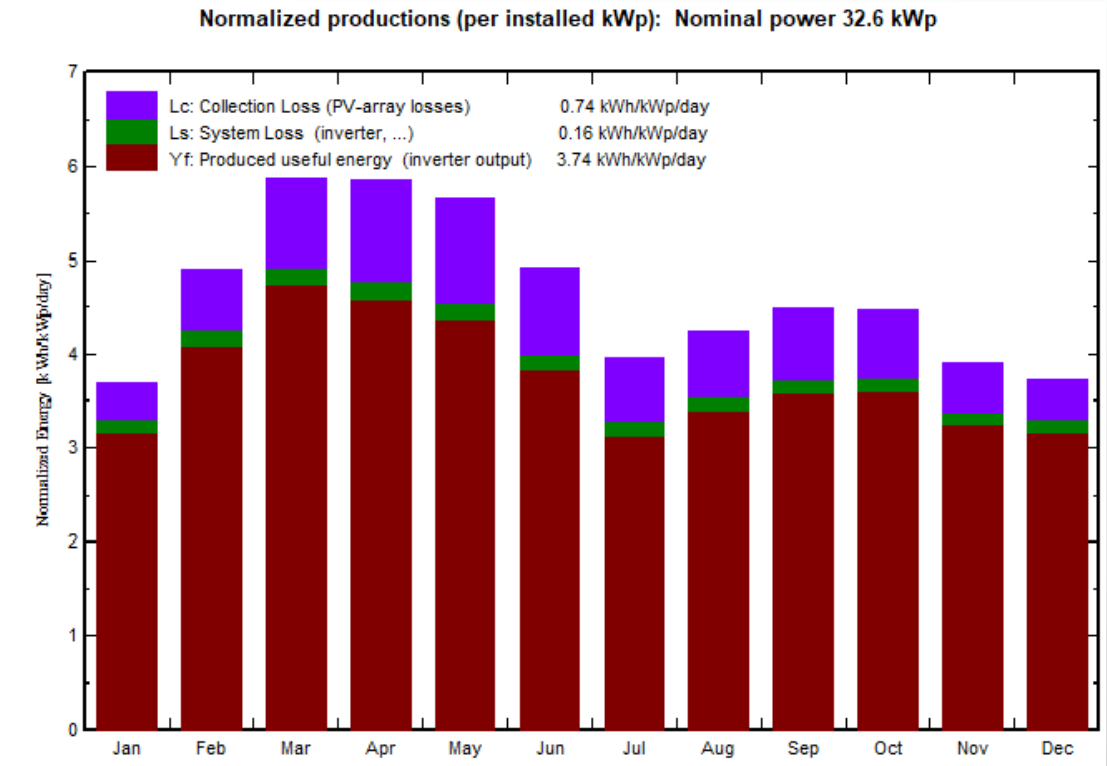

Date : 21/12/22 07h07
Sun height : : 2°
Sun azimuth : : -62°
Linear : : 0.383
Zenith
East
West
Sun
South

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).

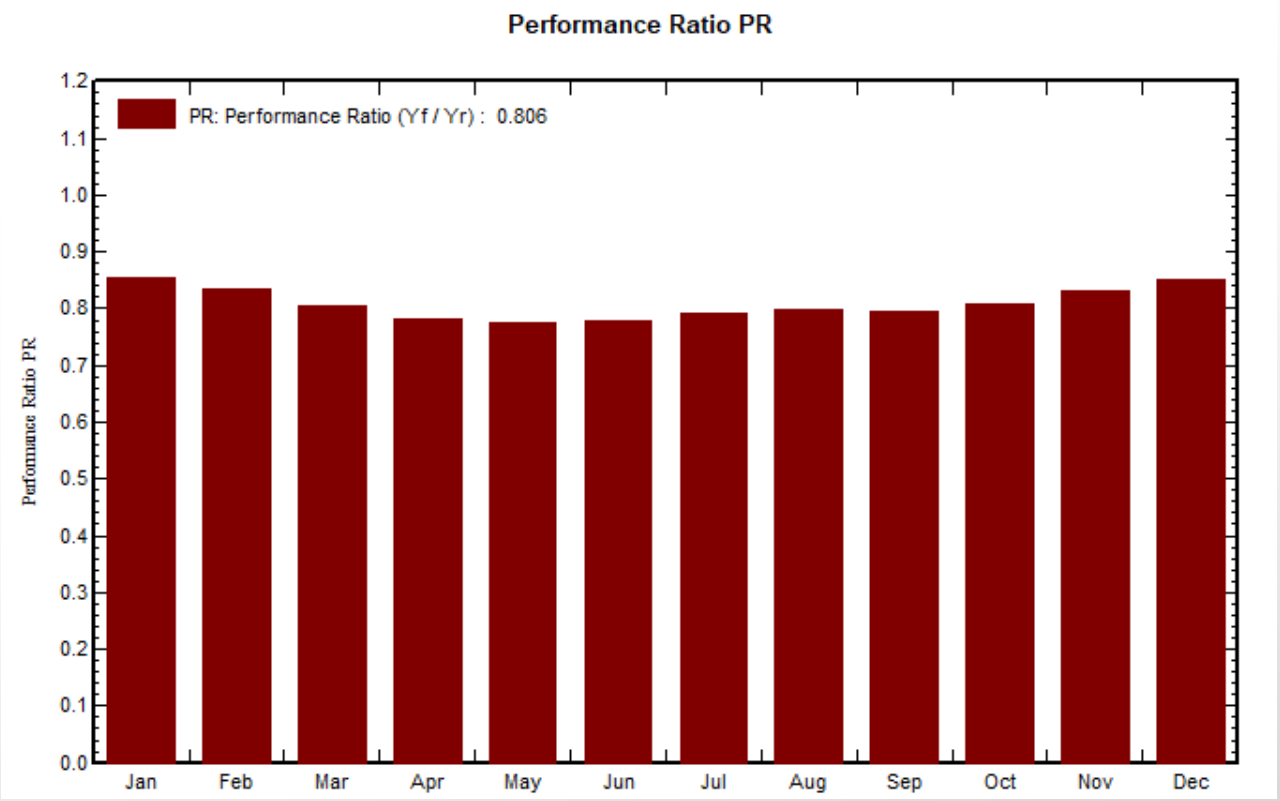
RESULTS

- 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



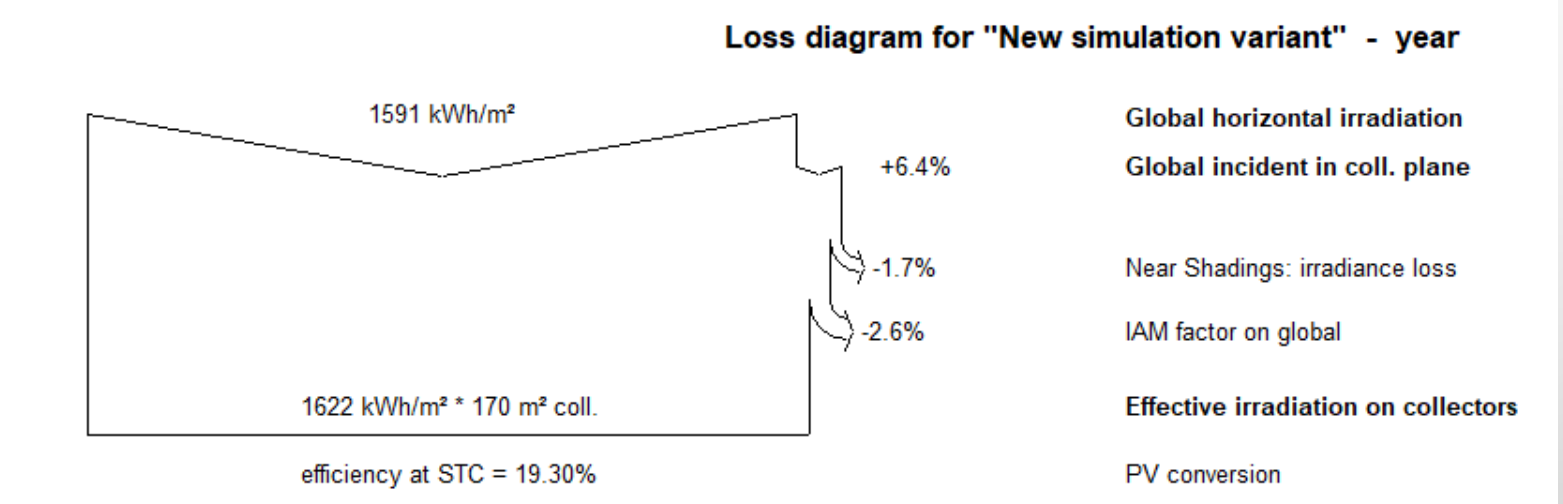
RESULTS

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/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	92.1	51.7	14.11	114.9	110.5	3332	3196	0.855
February	113.8	57.1	18.43	137.3	132.4	3883	3731	0.834
March	163.5	74.4	24.23	182.2	176.0	4963	4771	0.804
April	173.4	89.9	29.84	175.6	168.7	4659	4478	0.783
May	184.6	102.7	32.74	175.0	167.2	4590	4408	0.774
June	159.6	97.9	32.23	147.5	140.3	3901	3741	0.779
July	131.6	90.9	29.99	122.8	116.2	3308	3164	0.792
August	136.1	93.0	29.45	131.8	125.2	3573	3424	0.798
September	128.8	75.7	28.47	134.8	128.8	3645	3494	0.796
October	121.8	72.2	26.25	138.4	133.1	3791	3638	0.808
November	95.7	58.4	20.54	116.9	112.2	3299	3168	0.833
December	89.5	51.3	15.71	115.8	111.0	3338	3205	0.850
Year	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.
- $1591\ kWh/m^2$ is falling in this region to the PV system.
- Due to IAM losses and soiling losses the total energy generated in this system is $53.36\ MWh$ where the efficiency is 19.30% at STC.



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

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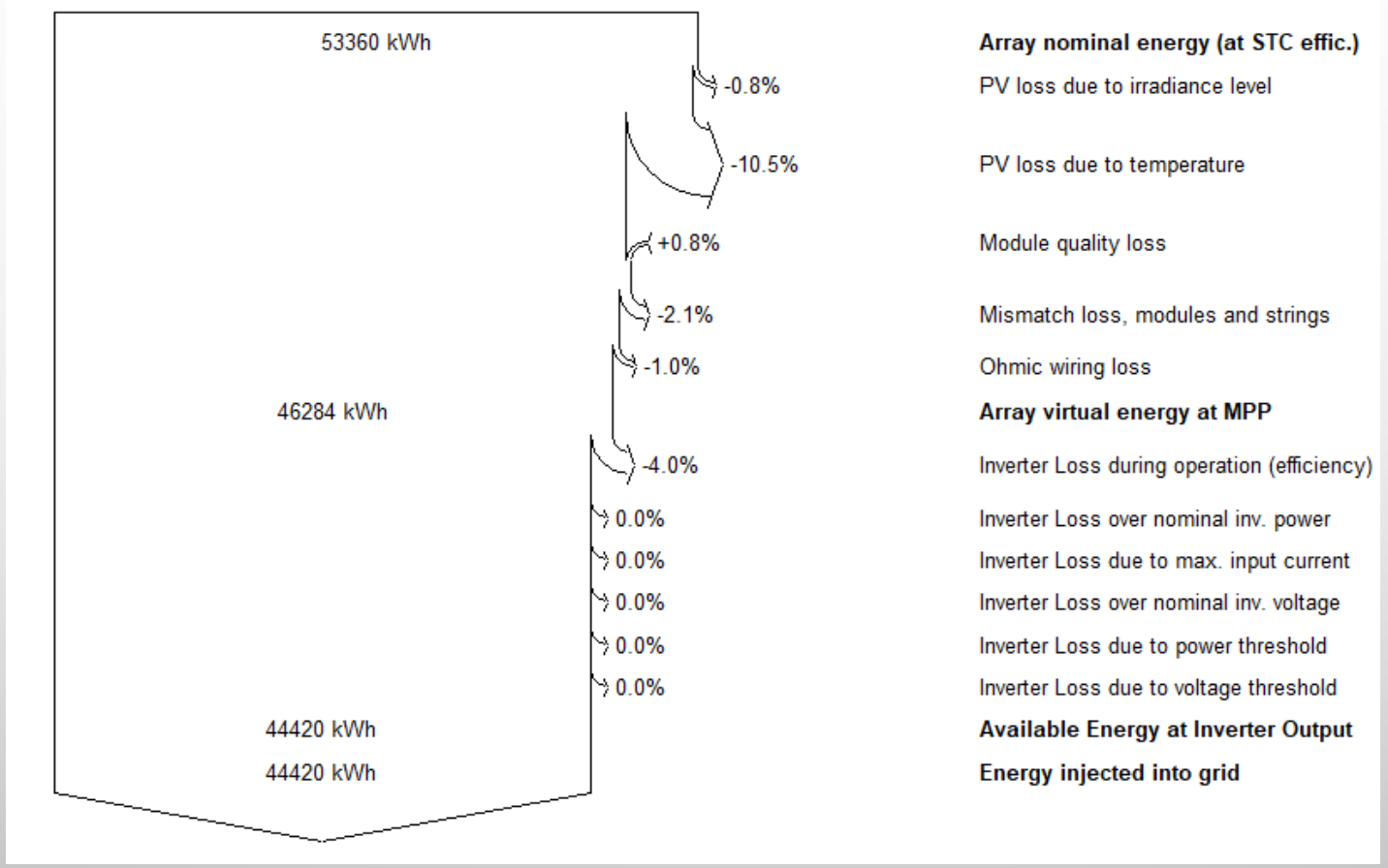

CONCLUSION

- 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

Geographical Site
Department of Sustainable Energy Engineering
India

Situation

Latitude	26.51 °N
Longitude	80.24 °E
Altitude	132 m
Time zone	UTC+5.5

Project settings

Albedo	0.20

Meteo data
Department of Sustainable Energy Engineering
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System

Sheds, single array

PV Field Orientation
Fixed plane
Tilt/Azimuth 25 / 0 °

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	88 units
Pnom total	32.6 kWp

Inverters

Nb. of units	8 units
Pnom total	32.0 kWac
Pnom ratio	1.018

Results summary

Produced Energy	44420 kWh/year	Specific production	1364 kWh/kWp/year	Perf. Ratio PR	80.59 %

REFERENCES

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- https://www.pvsyst.com/help/index.html?contents_table.htm
- https://www.sciencedirect.com/science/article/pii/S2214785321058259?via%3Dihub