Version 7.3.1

PVsyst - Simulation report

Grid-Connected System

Project: VANAZ METRO STATION - PUNE

Variant: New simulation variant

Tables on a building

System power: 311 kWp

Bavdhan - India

Client

Maharashtra Metro Rail Corporation Ltd

Signature

Author

Consortium of M/s.Jhamtani Prosumers Solar Private Limited

Signature

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06/06/23 11:26
with v7.3.1

Project summary

Geographical Site
Bavdhan
India

Situation

Latitude	18.51 °N
Longitude	73.81 °E
Altitude	587 m
Time zone	UTC+5.5

Project settings

Albedo	0.20

Meteo data
Bavdhan
Meteonorm 8.1 (1996-2015), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Tables on a building

PV Field Orientation

Fixed planes	2 orientations
Tilts/azimuths	2 / -7.9 ° 2 / 171.9 °

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	546 units
Pnom total	311 kWp

Inverters

Nb. of units	2 units
Pnom total	250 kWac
Pnom ratio	1.244

Results summary

Produced Energy	462.5 MWh/year	Specific production	1486 kWh/kWp/year	Perf. Ratio PR	81.81 %

Table of contents

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General parameters

Grid-Connected System

Tables on a building

PV Field Orientation

Orientation		Sheds configuration		Models used	
Fixed planes	2 orientations	Nb. of sheds	546 units	Transposition	Perez
Tilts/azimuths	2 / -7.9 ° 2 / 171.9 °	Several orientations		Diffuse	Perez, Meteonorm
				Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Jinkosolar
Model	JKM570N-72HL4-V
(Custom parameters definition)	
Unit Nom. Power	570 Wp
Number of PV modules	546 units
Nominal (STC)	311 kWp

Inverter

Manufacturer	Sungrow
Model	SG125CX-P2
(Custom parameters definition)	
Unit Nom. Power	125 kWac
Number of inverters	2 units
Total power	250 kWac

Array #1 - Inverter 1

Orientation	#1		
Tilt/Azimuth	2/-8 °		
Number of PV modules	240 units	Number of inverters	10 * MPPT 8% 0.8 unit
Nominal (STC)	137 kWp	Total power	104 kWac
Modules	12 Strings x 20 In series		
At operating cond. (50°C)		Operating voltage	180-1000 V
Pmpp	127 kWp	Pnom ratio (DC:AC)	1.31
U mpp	770 V		
I mpp	164 A		

Array #2 - Sub-array #2

Orientation	#1		
Tilt/Azimuth	2/-8 °		
Number of PV modules	18 units	Number of inverters	1 * MPPT 8% 0.1 unit
Nominal (STC)	10.26 kWp	Total power	10.4 kWac
Modules	1 String x 18 In series		
At operating cond. (50°C)		Operating voltage	180-1000 V
Pmpp	9.49 kWp	Pnom ratio (DC:AC)	0.98
U mpp	693 V		
I mpp	14 A		

Array #3 - Sub-array #3

Orientation	#1		
Tilt/Azimuth	2/-8 °		
Number of PV modules	15 units	Number of inverters	1 * MPPT 8% 0.1 unit
Nominal (STC)	8.55 kWp	Total power	10.4 kWac
Modules	1 String x 15 In series		
At operating cond. (50°C)		Operating voltage	180-1000 V
Pmpp	7.91 kWp	Pnom ratio (DC:AC)	0.82
U mpp	578 V		
I mpp	14 A		

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PV Array Characteristics

Array #4 - Inverter 2

Orientation	#2		
Tilt/Azimuth	2/172 °		
Number of PV modules	240 units	Number of inverters	10 * MPPT 8% 0.8 unit
Nominal (STC)	137 kWp	Total power	104 kWac
Modules	12 Strings x 20 In series		
At operating cond. (50°C)		Operating voltage	180-1000 V
Pmpp	127 kWp	Pnom ratio (DC:AC)	1.31
U mpp	770 V		
I mpp	164 A		

Array #5 - Sub-array #5

Orientation	#2		
Tilt/Azimuth	2/172 °		
Number of PV modules	18 units	Number of inverters	1 * MPPT 8% 0.1 unit
Nominal (STC)	10.26 kWp	Total power	10.4 kWac
Modules	1 String x 18 In series		
At operating cond. (50°C)		Operating voltage	180-1000 V
Pmpp	9.49 kWp	Pnom ratio (DC:AC)	0.98
U mpp	693 V		
I mpp	14 A		

Array #6 - Sub-array #6

Orientation	#2		
Tilt/Azimuth	2/172 °		
Number of PV modules	15 units	Number of inverters	1 * MPPT 8% 0.1 unit
Nominal (STC)	8.55 kWp	Total power	10.4 kWac
Modules	1 String x 15 In series		
At operating cond. (50°C)		Operating voltage	180-1000 V
Pmpp	7.91 kWp	Pnom ratio (DC:AC)	0.82
U mpp	578 V		
I mpp	14 A		

Total PV power

Nominal (STC)	311 kWp
Total	546 modules
Module area	1410 m²
Cell area	1298 m²

Total inverter power

Total power	250 kWac
Number of inverters	2 units
Pnom ratio	1.24
Power sharing defined	

Array losses

Thermal Loss factor

Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

Serie Diode Loss

Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

Module Quality Loss

Loss Fraction -0.8 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.1 %

Module average degradation

Year no 1
Loss factor 0.4 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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Array losses

IAM loss factor

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	1.000	1.000	0.989	0.971	0.931	0.737	0.000

DC wiring losses

Global wiring resistance 10 mΩ
Loss Fraction 1.5 % at STC

Array #1 - Inverter 1
Global array res. 76 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Sub-array #2
Global array res. 825 mΩ
Loss Fraction 1.5 % at STC

Array #3 - Sub-array #3
Global array res. 688 mΩ
Loss Fraction 1.5 % at STC

Array #4 - Inverter 2
Global array res. 76 mΩ
Loss Fraction 1.5 % at STC

Array #5 - Sub-array #5
Global array res. 825 mΩ
Loss Fraction 1.5 % at STC

Array #6 - Sub-array #6
Global array res. 688 mΩ
Loss Fraction 1.5 % at STC

System losses

Unavailability of the system

Time fraction 1.0 %
3.7 days,
3 periods

AC wiring losses

Inv. output line up to injection point

Inverter voltage 400 Vac tri
Loss Fraction 0.00 % at STC

Inverter: SG125CX-P2
Wire section (2 Inv.) Copper 2 x 3 x 120 mm²
Average wires length 0 m

Inverter: SG125CX-P2
Wire section (1 Inv.) Copper 1 x 3 x 70 mm²
Wires length 0 m

Inverter: SG125CX-P2
Wire section (1 Inv.) Copper 1 x 3 x 50 mm²
Wires length 0 m

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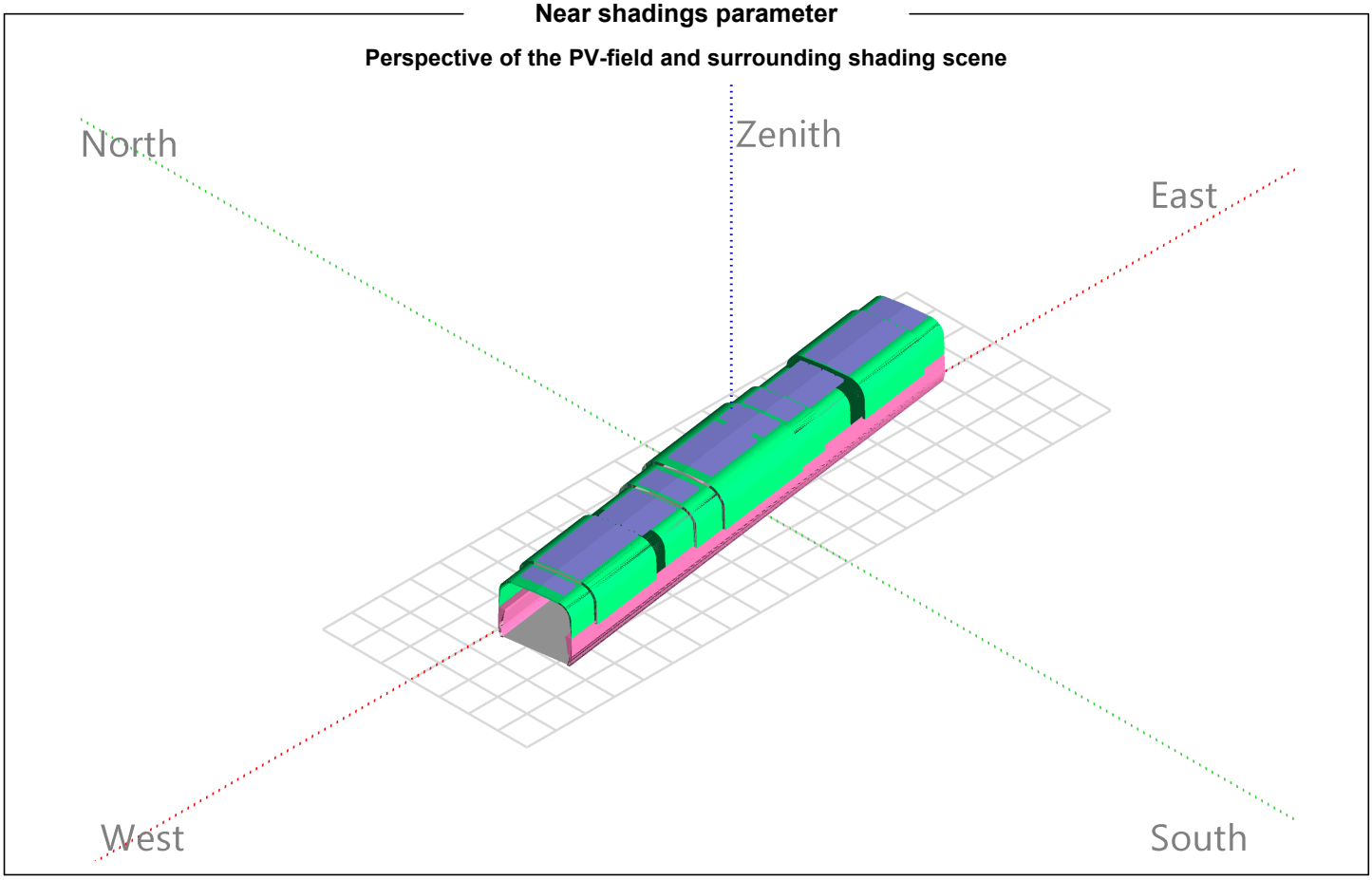
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



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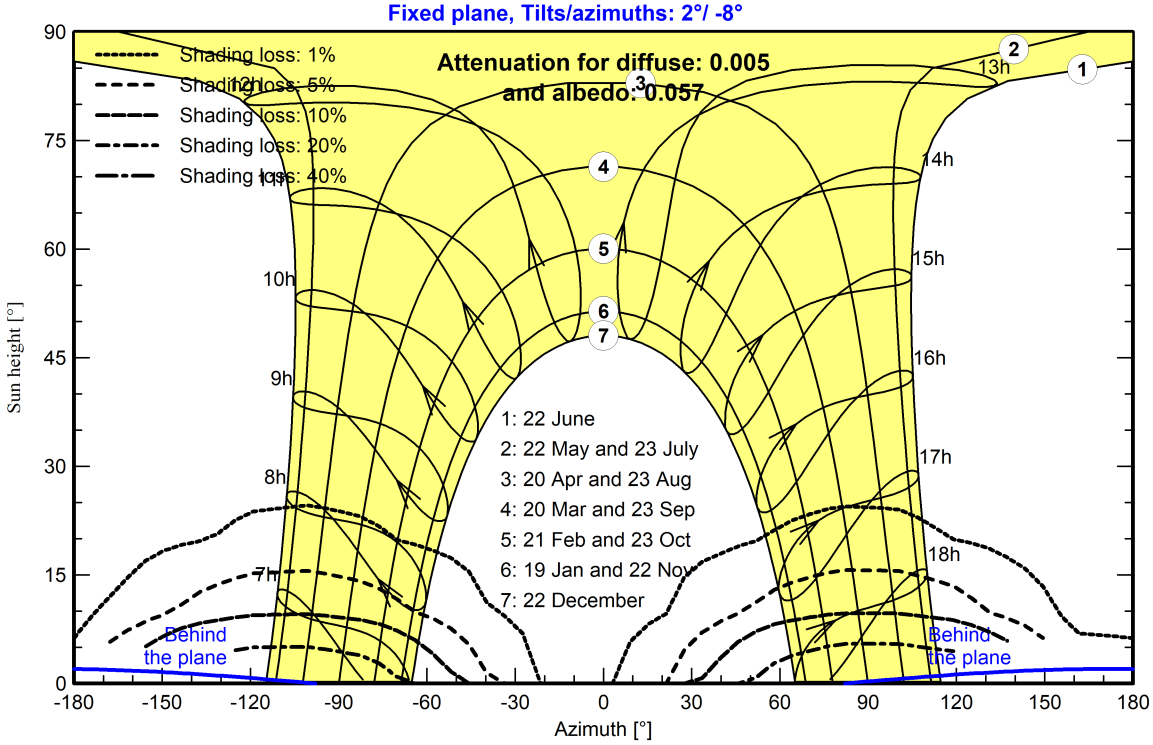
Iso-shadings diagram

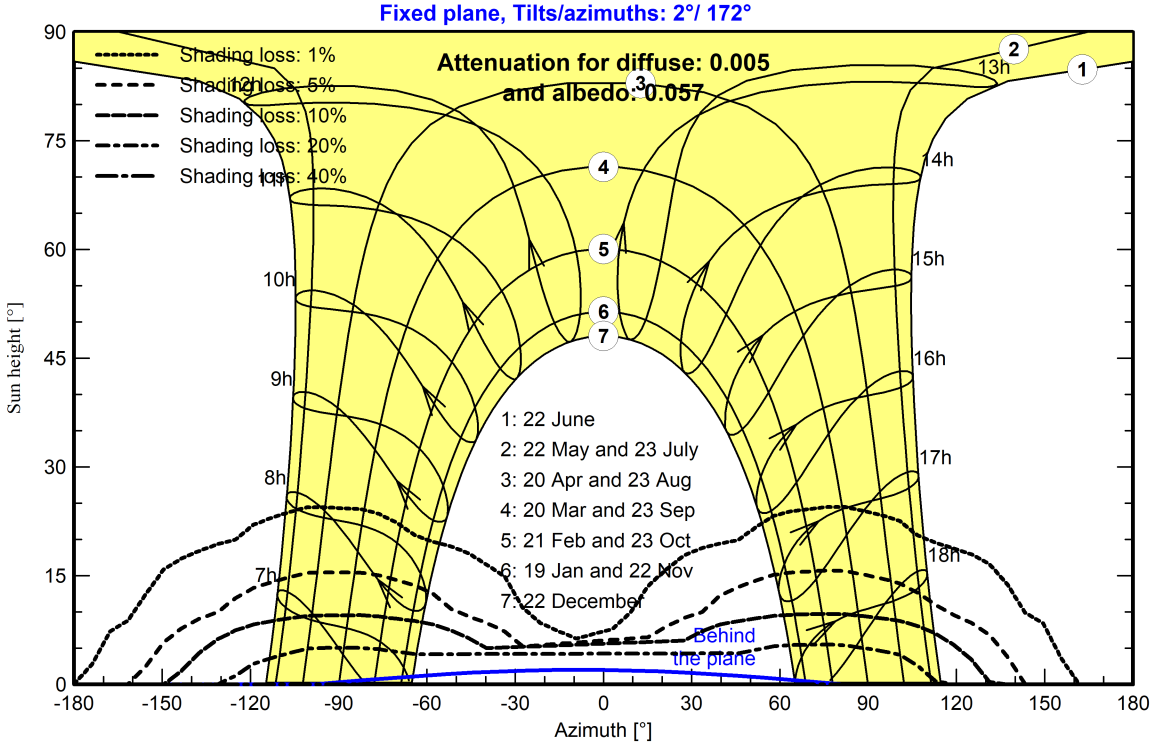
Orientation #1

Fixed plane, Tilts/azimuths: 2°/ -8°



Orientation #2

Fixed plane, Tilts/azimuths: 2°/ 172°



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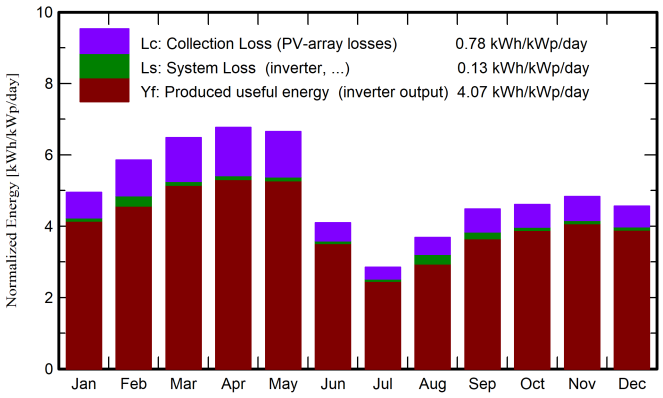
Main results

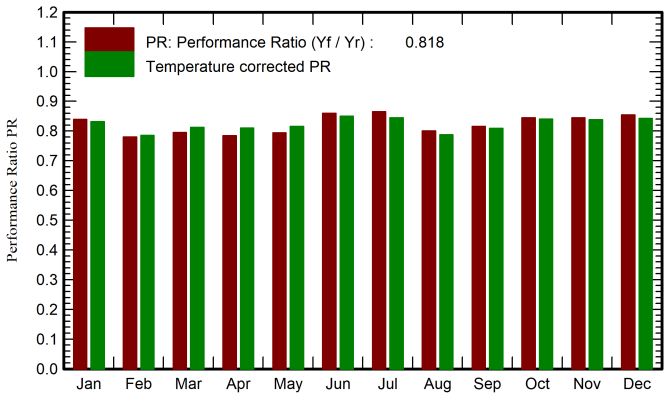
System Production

Produced Energy	462.49 MWh/year	Specific production	1486 kWh/kWp/year
		Performance Ratio PR	81.81 %

Normalized productions (per installed kWp)



Performance Ratio PR



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 ratio
January	153.2	40.14	20.02	153.3	152.3	40.91	40.03	0.839
February	164.0	42.18	22.75	164.0	163.2	42.35	39.81	0.780
March	200.8	62.58	26.52	201.0	199.9	50.75	49.70	0.795
April	203.0	69.38	29.35	203.2	202.3	50.64	49.61	0.785
May	206.1	80.34	29.88	206.2	205.3	52.00	50.94	0.794
June	122.8	87.90	26.43	122.8	121.8	33.57	32.83	0.859
July	88.4	62.93	25.06	88.3	87.5	24.33	23.76	0.865
August	114.4	74.06	24.19	114.3	113.4	31.00	28.46	0.800
September	134.6	73.71	24.48	134.4	133.4	35.93	34.12	0.816
October	142.8	77.05	25.05	142.8	141.8	38.36	37.54	0.845
November	144.7	52.74	22.36	144.8	143.9	38.90	38.06	0.845
December	141.3	45.36	20.25	141.4	140.5	38.46	37.62	0.855
Year	1816.2	768.35	24.70	1816.5	1805.2	477.19	462.49	0.818

Legends

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

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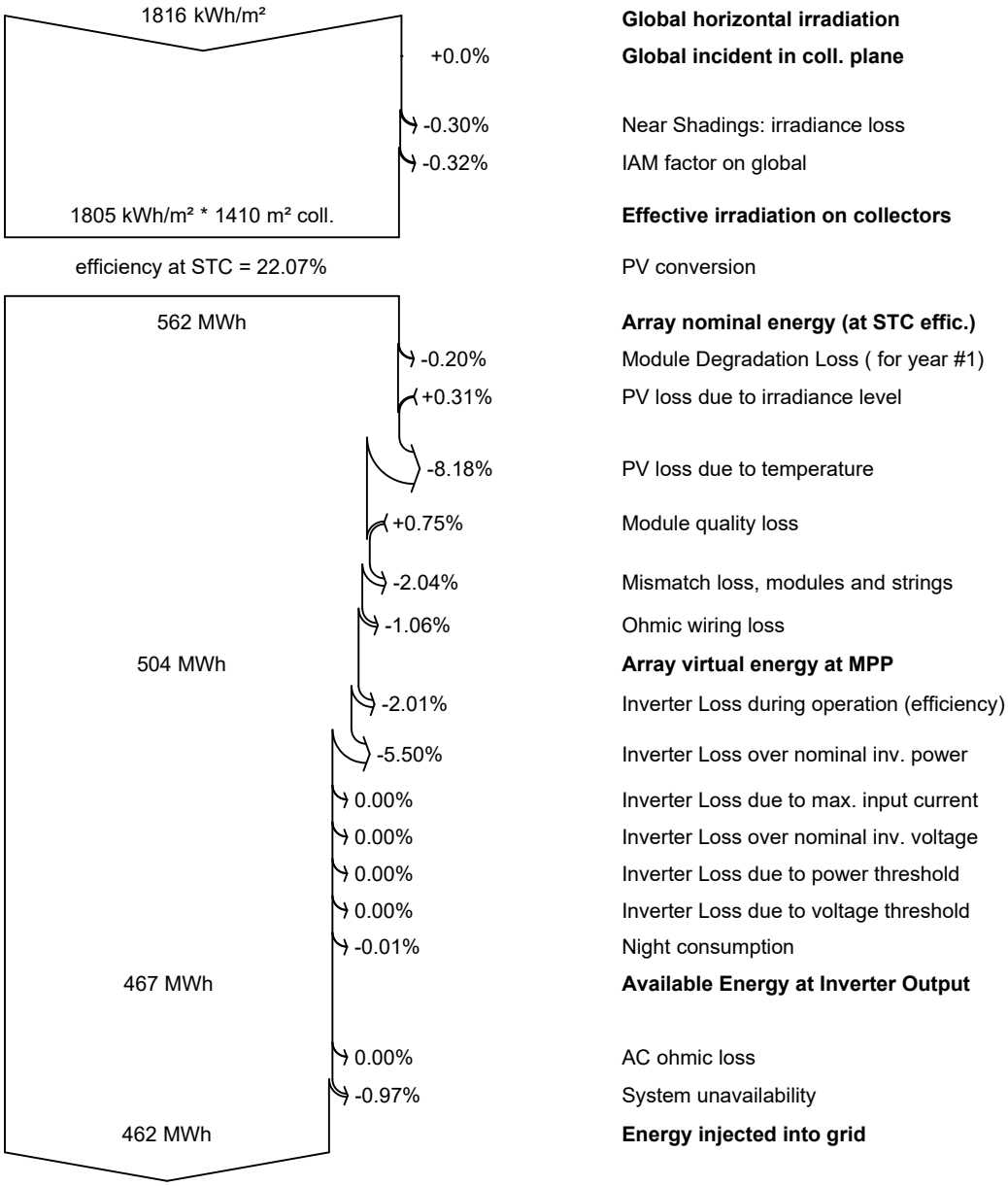
Loss diagram



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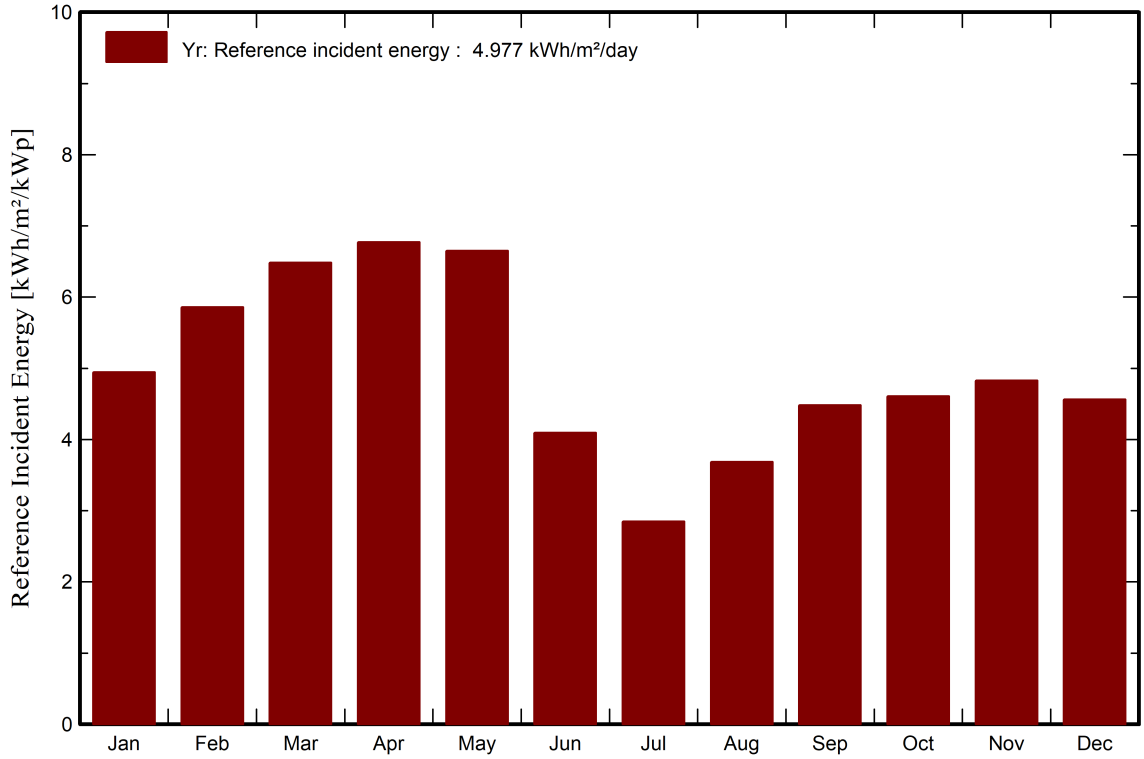
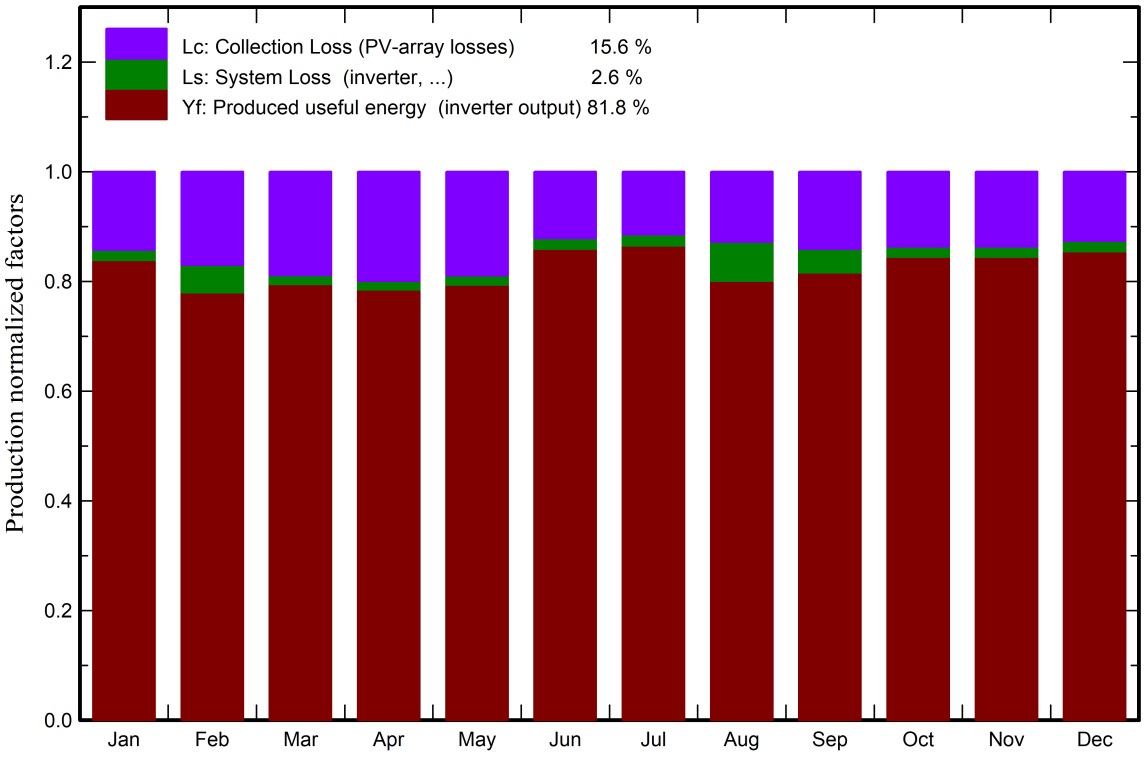
Predef. graphs

Reference Incident Energy in Collector Plane



Normalized Production and Loss Factors



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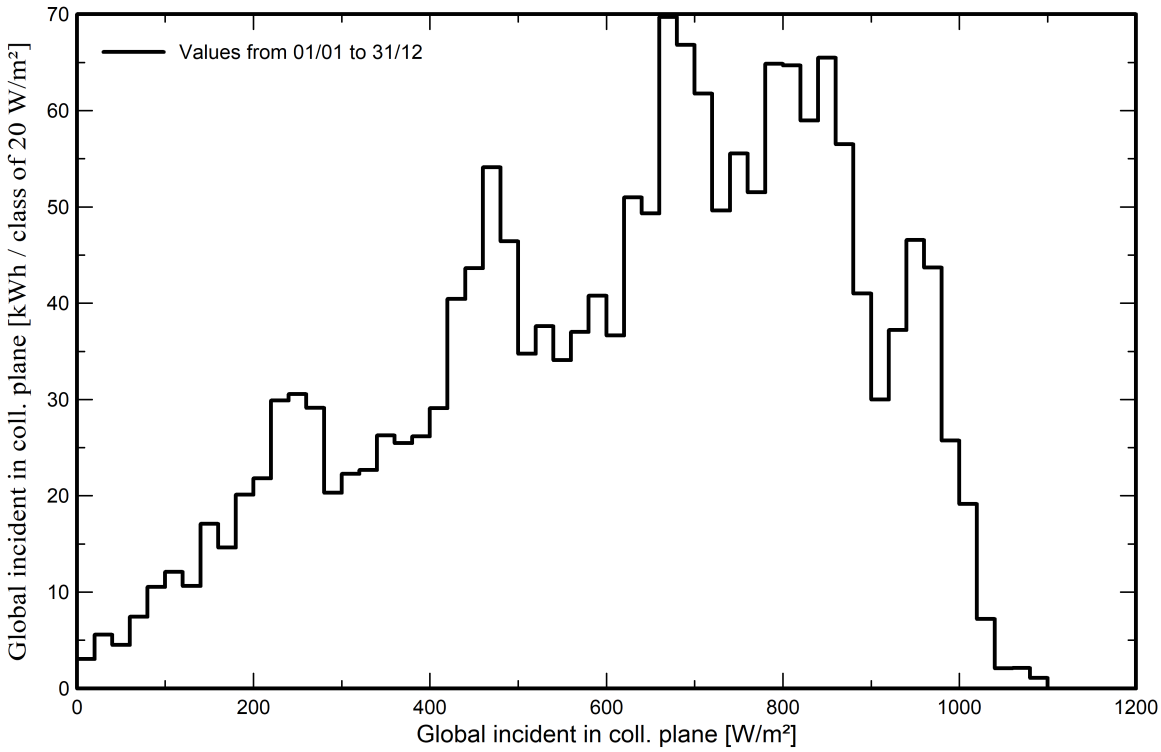
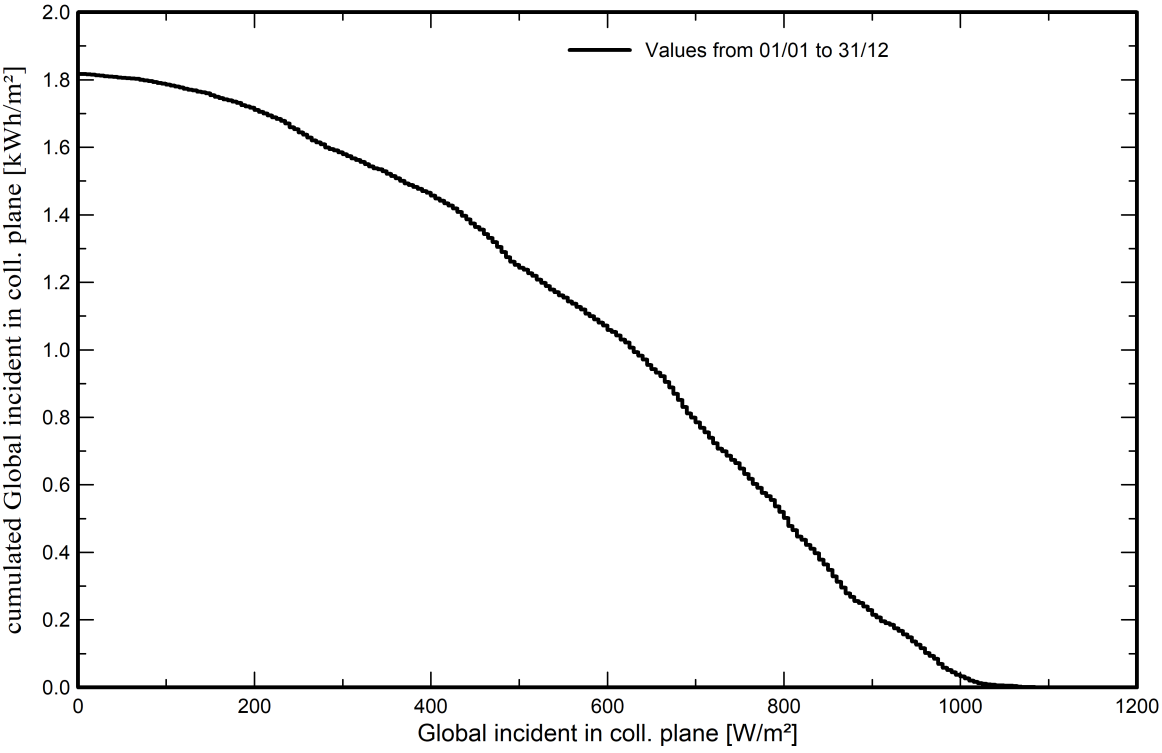
Predef. graphs

Incident Irradiation Distribution

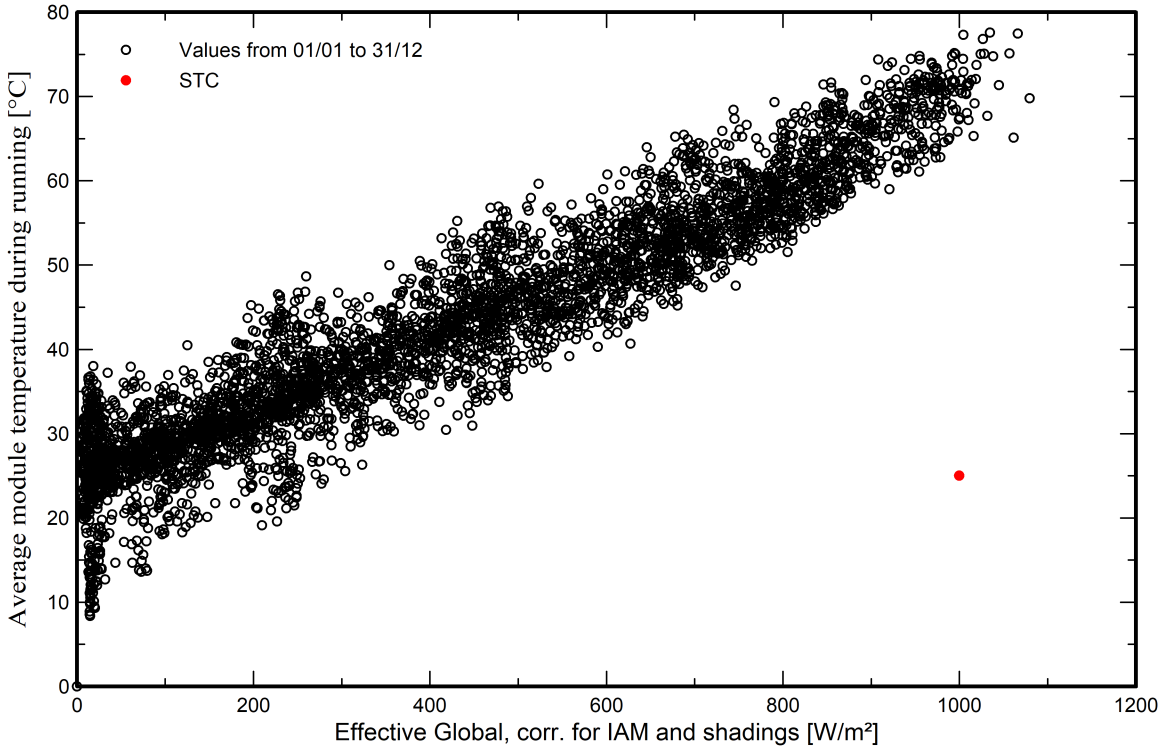


Incident Irradiation cumulative distribution

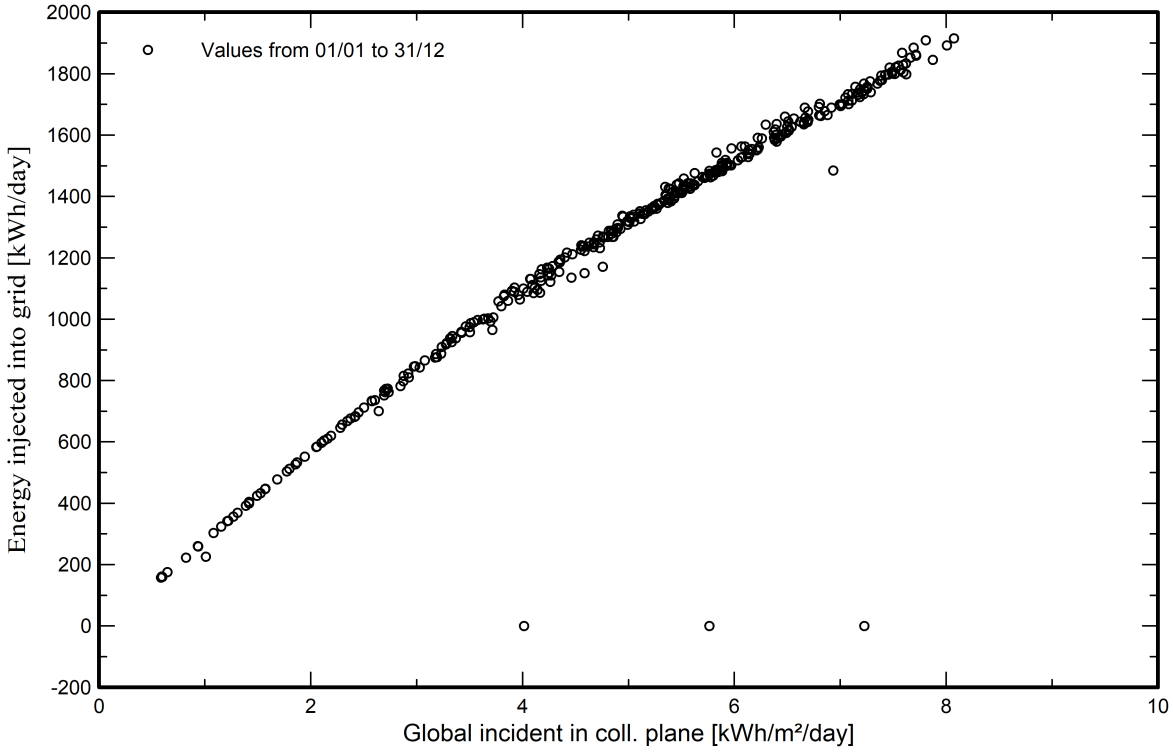


Predef. graphs

Array Temperature vs. Effective Irradiance



Daily Input/Output diagram



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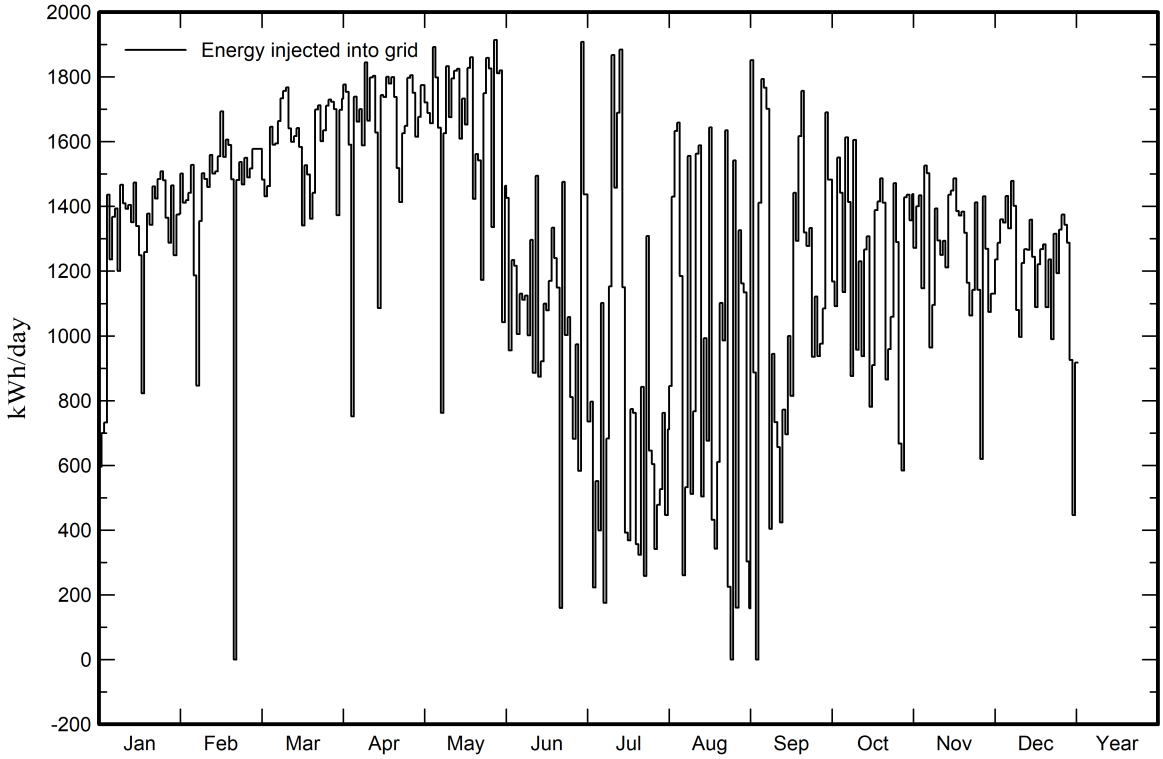
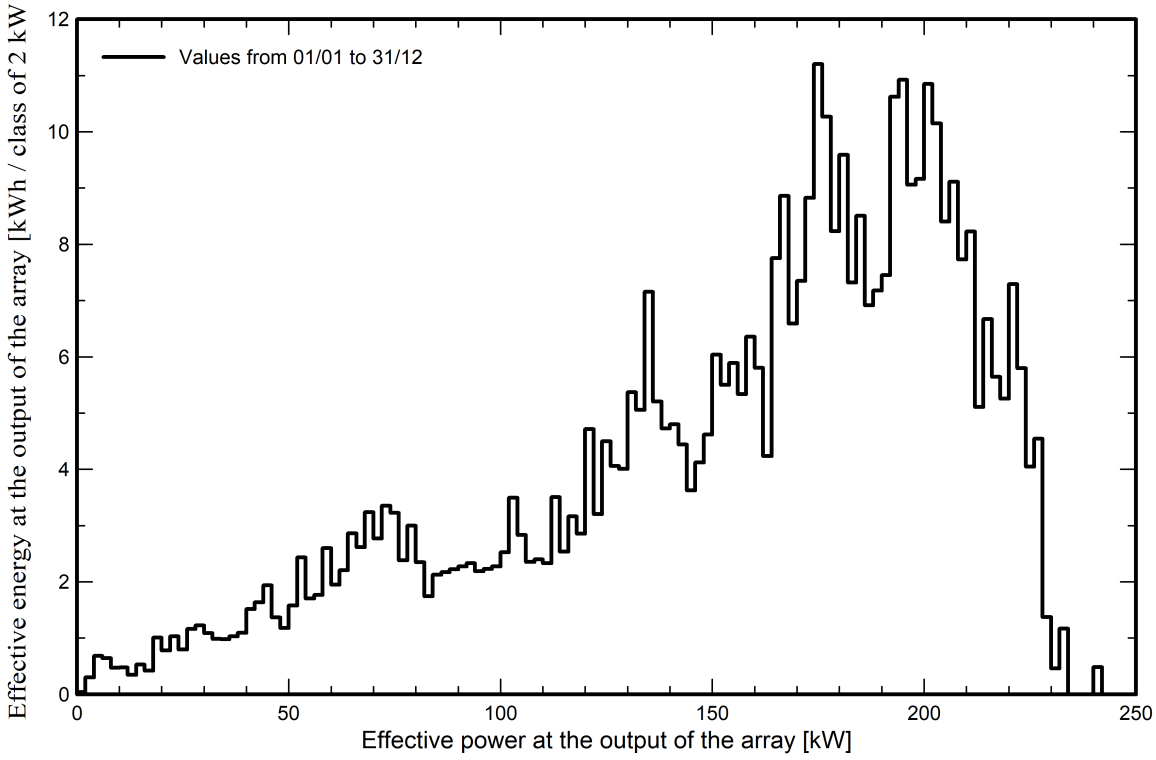
Predef. graphs

Daily System Output Energy



Array Power Distribution



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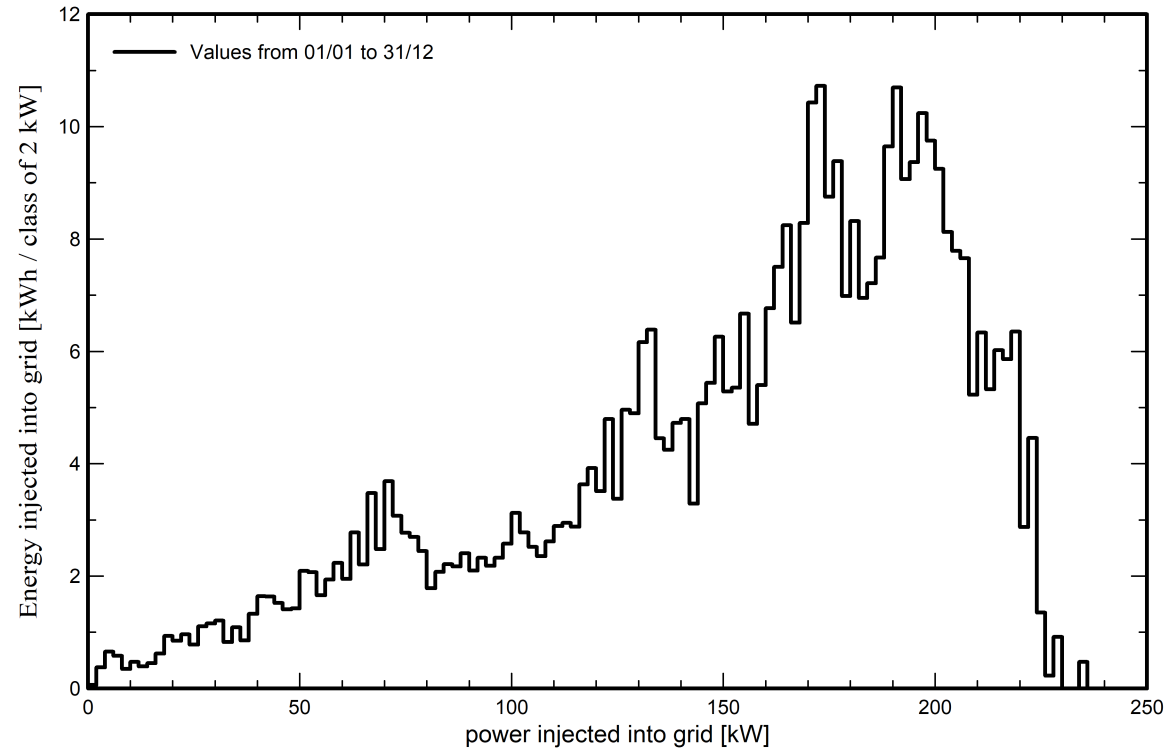
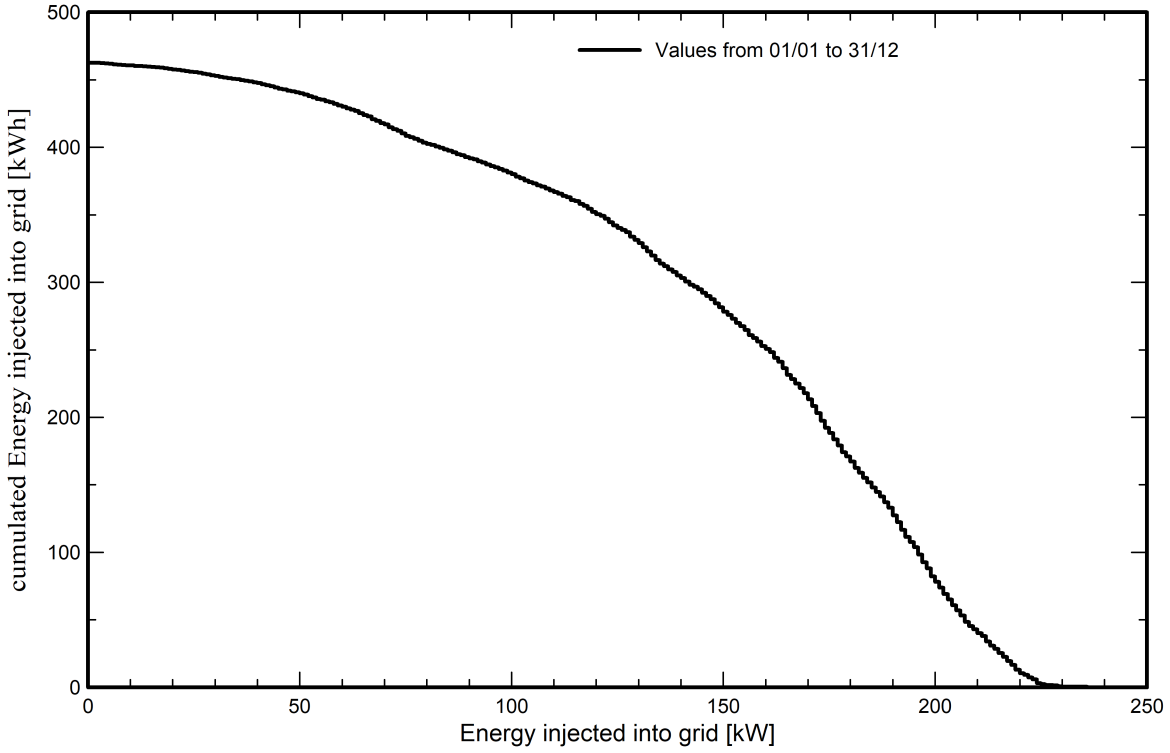
Predef. graphs

System Output Power Distribution



System Output Power cumulative distribution



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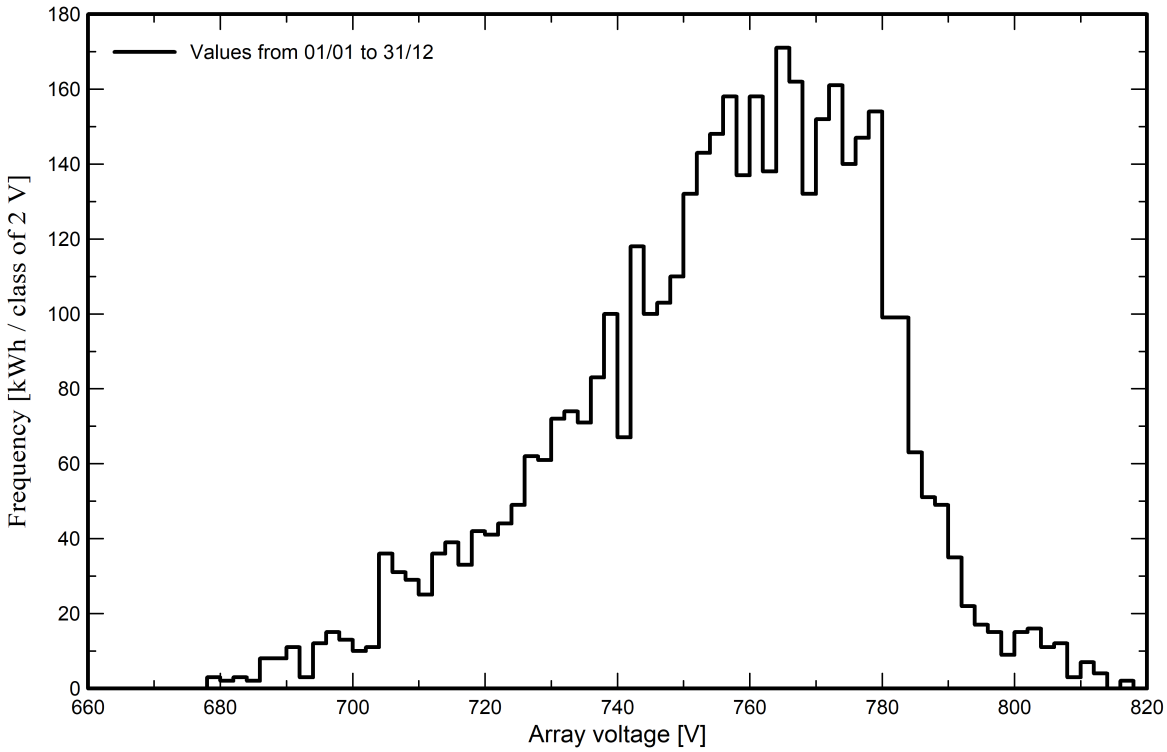
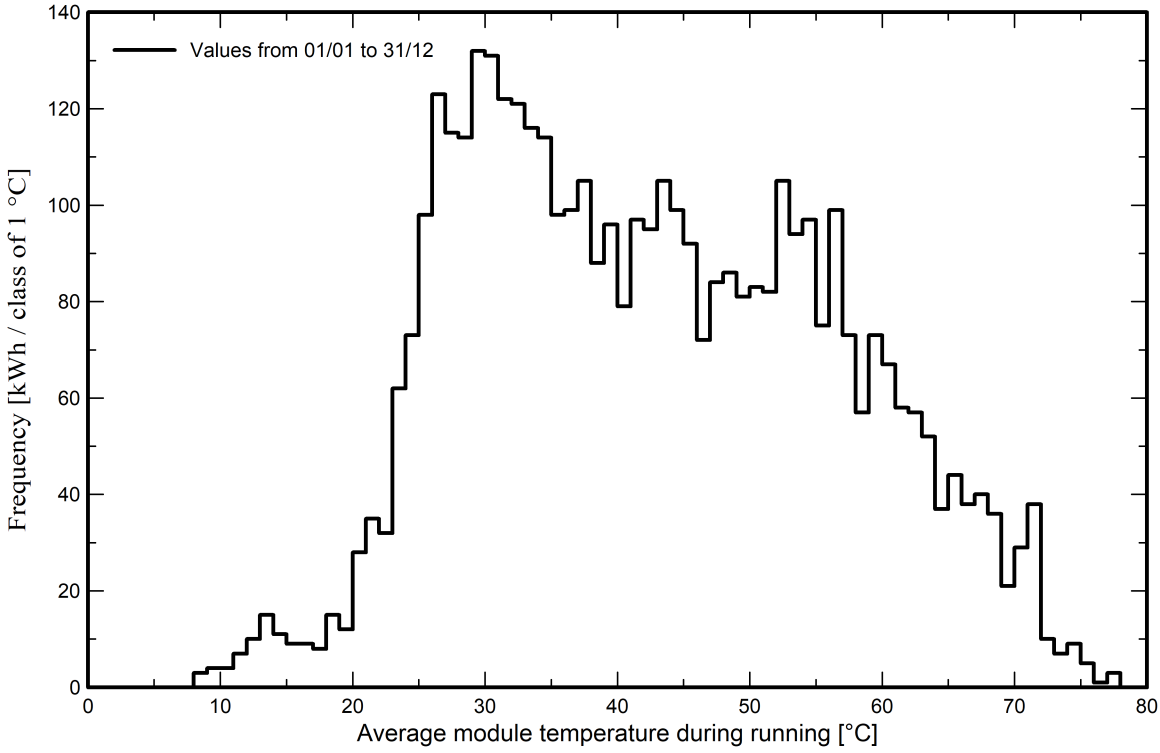
Predef. graphs

Array Voltage Distribution



Array Temperature Distribution during running



Aging Tool

Aging Parameters

Time span of simulation 25 years

Module average degradation

Loss factor 0.4 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

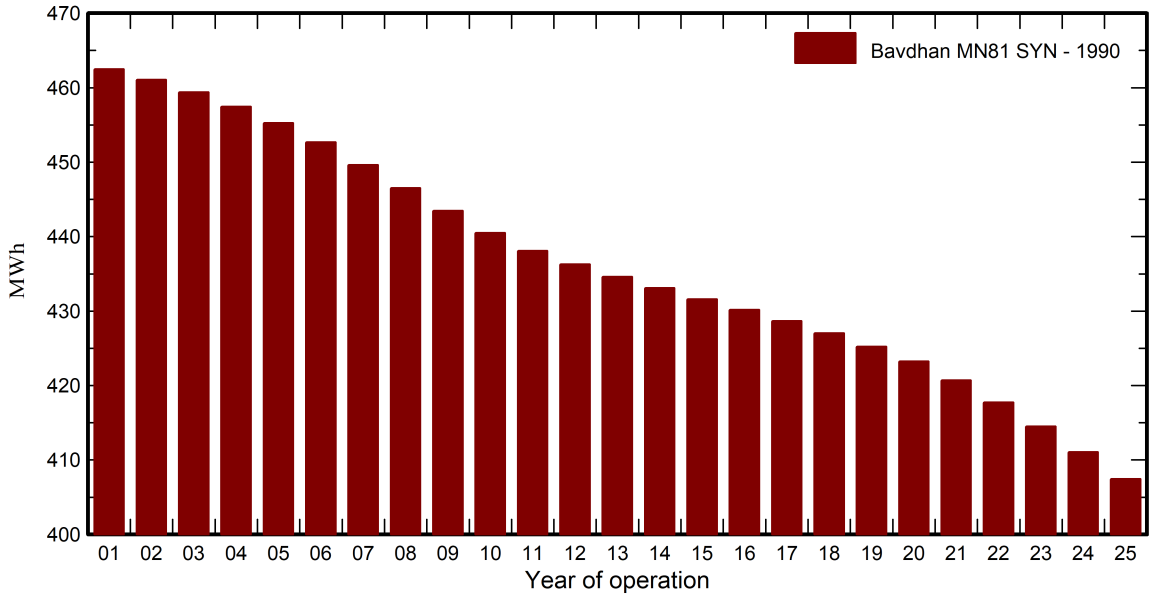
Meteo used in the simulation

#1 Bavdhan MN81 SYN

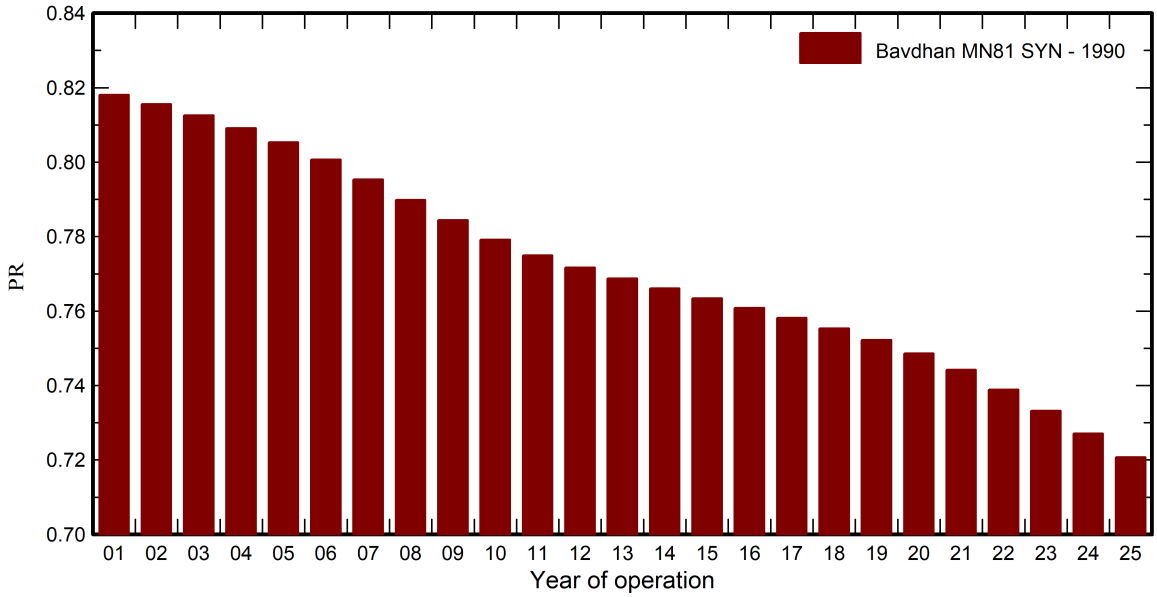
Years 1990 (reference year)

Years simulated 1-25

System output energy



Performance Ratio



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Meteo used in the simulation

#1 Bavdhan MN81 SYN

Years 1990 (reference year)

Years simulated 1-25

Bavdhan MN81 SYN

Year	System output	PR	PR loss
	MWh		%
1	462.5	0.818	0%
2	461.0	0.816	-0.3%
3	459.4	0.813	-0.7%
4	457.4	0.809	-1.1%
5	455.3	0.805	-1.6%
6	452.6	0.801	-2.1%
7	449.6	0.795	-2.8%
8	446.5	0.79	-3.5%
9	443.4	0.784	-4.1%
10	440.5	0.779	-4.8%
11	438.1	0.775	-5.3%
12	436.3	0.772	-5.7%
13	434.6	0.769	-6%
14	433.1	0.766	-6.4%
15	431.6	0.763	-6.7%
16	430.1	0.761	-7%
17	428.6	0.758	-7.3%
18	427.0	0.755	-7.7%
19	425.2	0.752	-8.1%
20	423.2	0.749	-8.5%
21	420.7	0.744	-9%
22	417.7	0.739	-9.7%
23	414.5	0.733	-10.4%
24	411.0	0.727	-11.1%
25	407.4	0.721	-11.9%

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P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1996-2015), Sat=100%
Kind	TMY, multi-year
Year-to-year variability(Variance)	7.0 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	7.2 %

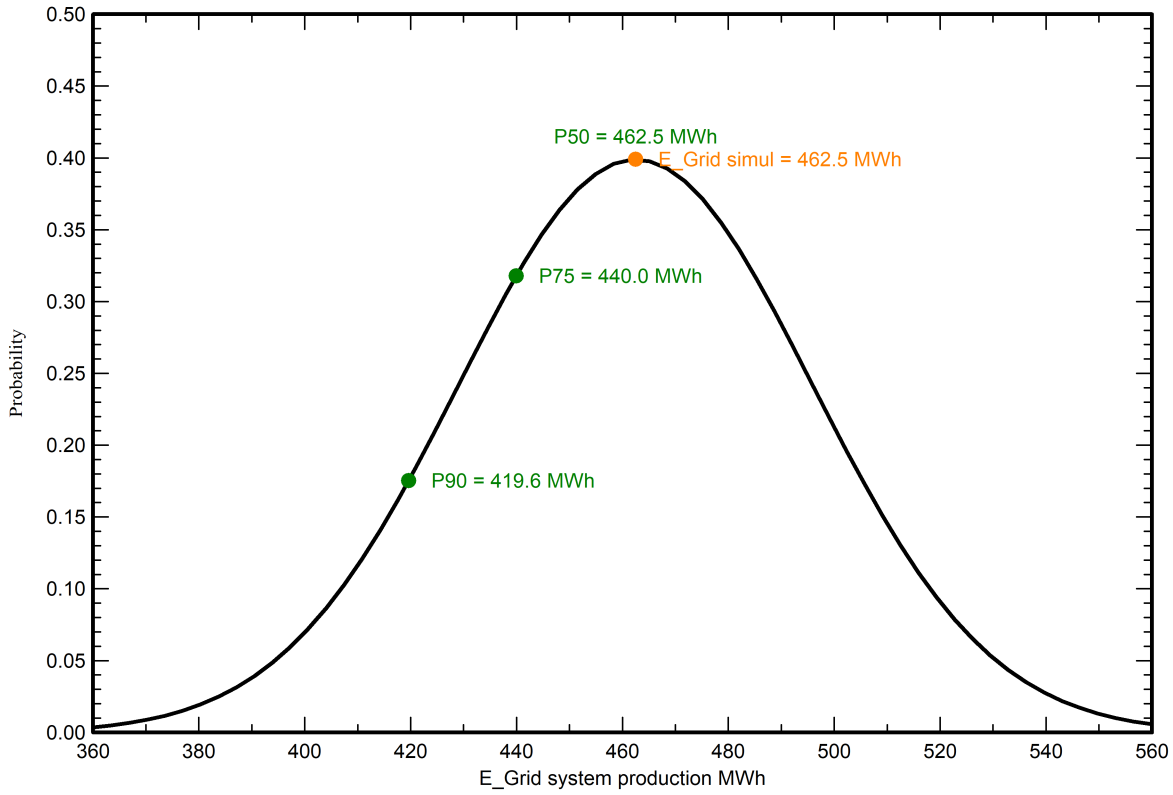
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

Annual production probability

Variability	33.4 MWh
P50	462.5 MWh
P75	440.0 MWh
P90	419.6 MWh

Probability distribution



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CO_2 Emission Balance

Total: 10699.7 tCO_2

Generated emissions

Total: 568.36 tCO_2

Source: Detailed calculation from table below:

Replaced Emissions

Total: 12986.6 tCO_2

System production: 462.49 MWh/yr

Grid Lifecycle Emissions: 936 gCO_2/kWh

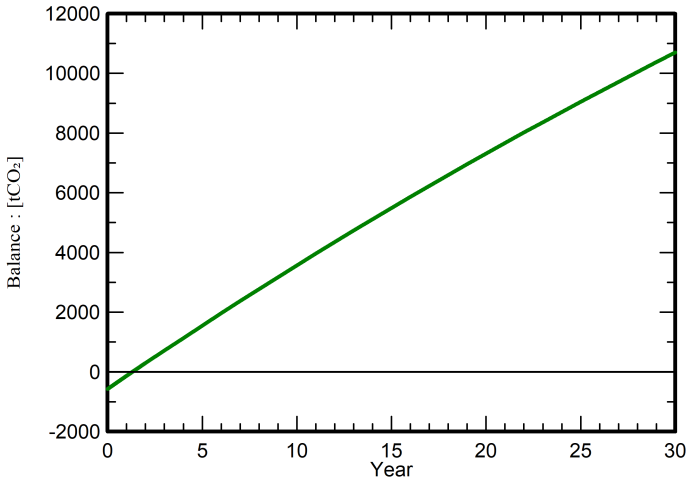
Source: IEA List

Country: India

Lifetime: 30 years

Annual degradation: 1.0 %

Saved CO_2 Emission vs. Time



System Lifecycle Emissions Details

Item	LCE	Quantity	Subtotal
			[$kgCO_2$]
Modules	1713 kgCO2/kWp	311 kWp	533033
Supports	6.24 kgCO2/kg	5460 kg	34087
Inverters	619 kgCO2/units	2.00 units	1237