

# PVsyst - Simulation report

## Grid-Connected System

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Project: AL - Sheffield Utilities

Variant: 540W 35% Rev(A) with Shading Model

Tracking system with backtracking

System power: 12.51 MWp

AL - Tuscumbia - United States

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VC1, Simulation date:  
10/06/22 11:44  
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### Project summary

#### Geographical Site

**AL - Tuscumbia**

United States

#### Situation

Latitude 34.65 °N  
Longitude -87.65 °W  
Altitude 158 m  
Time zone UTC-6

#### Project settings

Albedo 0.20

#### Meteo data

AL - Tuscumbia  
Solar Anywhere V3.5 - TMY

### System summary

#### Grid-Connected System

#### PV Field Orientation

**Orientation**  
Tracking plane, horizontal N-S axis  
Axis azimuth 0 °

#### Tracking system with backtracking

**Tracking algorithm**  
Astronomic calculation  
Backtracking activated

#### Near Shadings

According to strings  
Electrical effect 100 %

#### System information

##### PV Array

Nb. of modules 23166 units  
Pnom total 12.51 MWp

##### Inverters

Nb. of units 40 units  
Pnom total 10000 kWac  
Pnom ratio 1.251

#### User's needs

Unlimited load (grid)

### Results summary

Produced Energy 23608963 kWh/year Specific production 1887 kWh/kWp/year Perf. Ratio PR 90.80 %

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### General parameters

#### Grid-Connected System

#### PV Field Orientation

##### Orientation

Tracking plane, horizontal N-S axis  
Axis azimuth 0 °

#### Tracking system with backtracking

##### Tracking algorithm

Astronomic calculation  
Backtracking activated

##### Backtracking array

Nb. of trackers 429 units  
Identical arrays

##### Sizes

Tracker Spacing 13.1 m  
Collector width 4.55 m  
Ground Cov. Ratio (GCR) 34.8 %  
Phi min / max. +/- 60.0 °

##### Backtracking strategy

Phi limits +/- 69.5 °  
Backtracking pitch 12.8 m  
Backtracking width 4.40 m

#### Models used

Transposition Perez  
Diffuse Imported  
Circumsolar separate

#### Horizon

Average Height 1.7 °

#### Near Shadings

According to strings  
Electrical effect 100 %

#### User's needs

Unlimited load (grid)

#### Bifacial system

Model 2D Calculation  
unlimited trackers

#### Bifacial model geometry

Tracker Spacing 13.06 m  
Tracker width 4.55 m  
GCR 34.8 %  
Axis height above ground 2.10 m

#### Bifacial model definitions

Ground albedo 0.30  
Bifaciality factor 70 %  
Rear shading factor 7.0 %  
Rear mismatch loss 2.4 %  
Shed transparent fraction 0.0 %

### PV Array Characteristics

#### PV module

Manufacturer CSI Solar Co., Ltd.  
Model CS6W-540MB-AG 1500V  
(Custom parameters definition)

Unit Nom. Power 540 Wp  
Number of PV modules 23166 units  
Nominal (STC) 12.51 MWp  
Modules 858 Strings x 27 In series

#### At operating cond. (50°C)

Pmpp 11.46 MWp  
U mpp 1003 V  
I mpp 11426 A

#### Total PV power

Nominal (STC) 12510 kWp  
Total 23166 modules  
Module area 59528 m²

#### Inverter

Manufacturer ChintPower  
Model CPS SCH275KTL-DO/US-800  
(Custom parameters definition)

Unit Nom. Power 250 kWac  
Number of inverters 40 units  
Total power 10000 kWac  
Operating voltage 500-1500 V  
Pnom ratio (DC:AC) 1.25

#### Total inverter power

Total power 10000 kWac  
Number of inverters 40 units  
Pnom ratio 1.25



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### Array losses

#### Array Soiling Losses

Average loss Fraction 0.5 %

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%

#### Thermal Loss factor

Module temperature according to irradiance

Uc (const) 40.0 W/m²K

Uv (wind) 0.0 W/m²K/m/s

#### DC wiring losses

Global array res.

0.96 mΩ

Loss Fraction

1.0 % at STC

#### LID - Light Induced Degradation

Loss Fraction

0.8 %

#### Module Quality Loss

Loss Fraction -0.5 %

#### Module mismatch losses

Loss Fraction

1.5 % at MPP

#### IAM loss factor

Incidence effect (IAM): User defined profile

20°	40°	60°	65°	70°	75°	80°	85°	90°
1.000	1.000	1.000	0.990	0.960	0.920	0.840	0.720	0.000

### AC wiring losses

#### Inv. output line up to MV transfo

Inverter voltage 800 Vac tri

Loss Fraction 2.00 % at STC

#### Inverter: CPS SCH275KTL-DO/US-800

Wire section (40 Inv.) Copper 40 x 3 x 50 mm²

Average wires length 111 m

#### MV line up to Injection

MV Voltage 12.5 kV

Average each inverter

Wires Copper 3 x 300 mm²

Length 990 m

Loss Fraction 0.10 % at STC

### AC losses in transformers

#### MV transfo

Grid voltage 12.5 kV

#### Operating losses at STC

Nominal power at STC 12261 kVA

Iron loss (24/24 Connexion) 2.45 kW/Inv.

Loss Fraction 0.10 % at STC

Coils equivalent resistance 3 x 2.61 mΩ/inv.

Loss Fraction 1.00 % at STC



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### Horizon definition

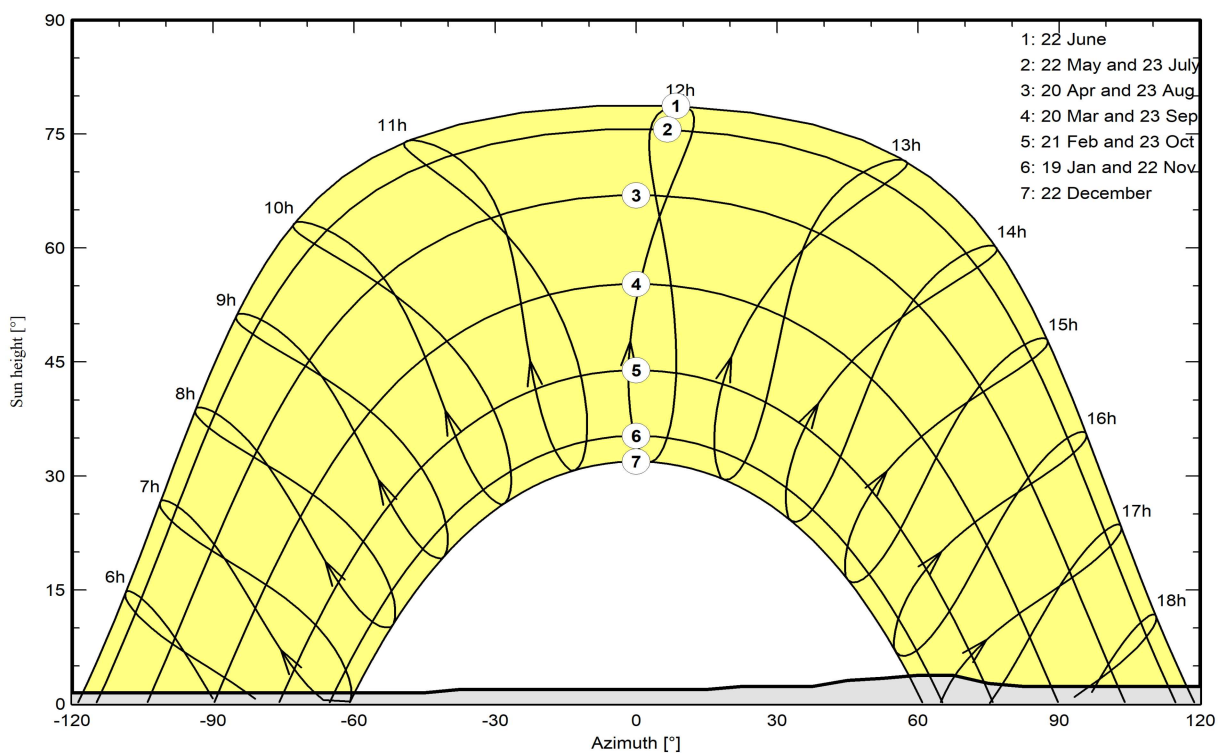
Horizon from PVGIS website API, Lat=34°41'58", Long=-87°41'33", Alt=158m

Average Height	1.7 °	Albedo Factor	0.88
Diffuse Factor	0.97	Albedo Fraction	100 %

### Horizon profile

Azimuth [°]	-180	-143	-135	-45	-38	15	23	38	45	53
Height [°]	0.4	0.4	1.5	1.5	1.9	1.9	2.3	2.3	3.1	3.4
Azimuth [°]	60	68	75	83	135	143	158	165	180	
Height [°]	3.8	3.8	2.7	2.3	2.3	1.1	1.1	0.4	0.4	

### Sun Paths (Height / Azimuth diagram)





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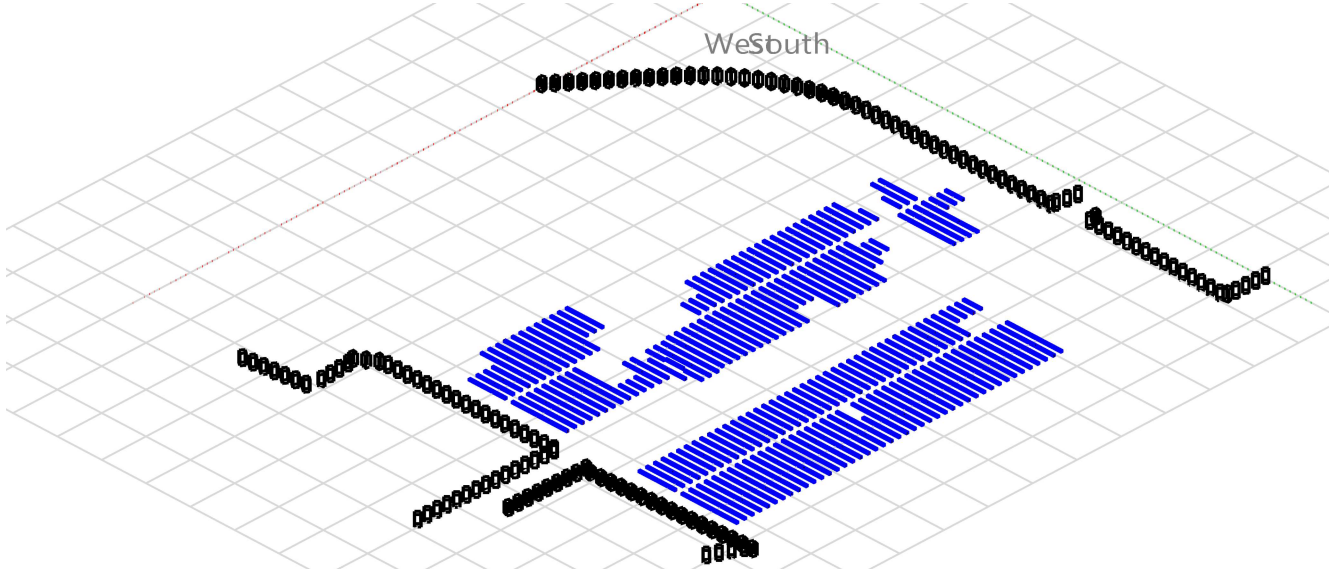
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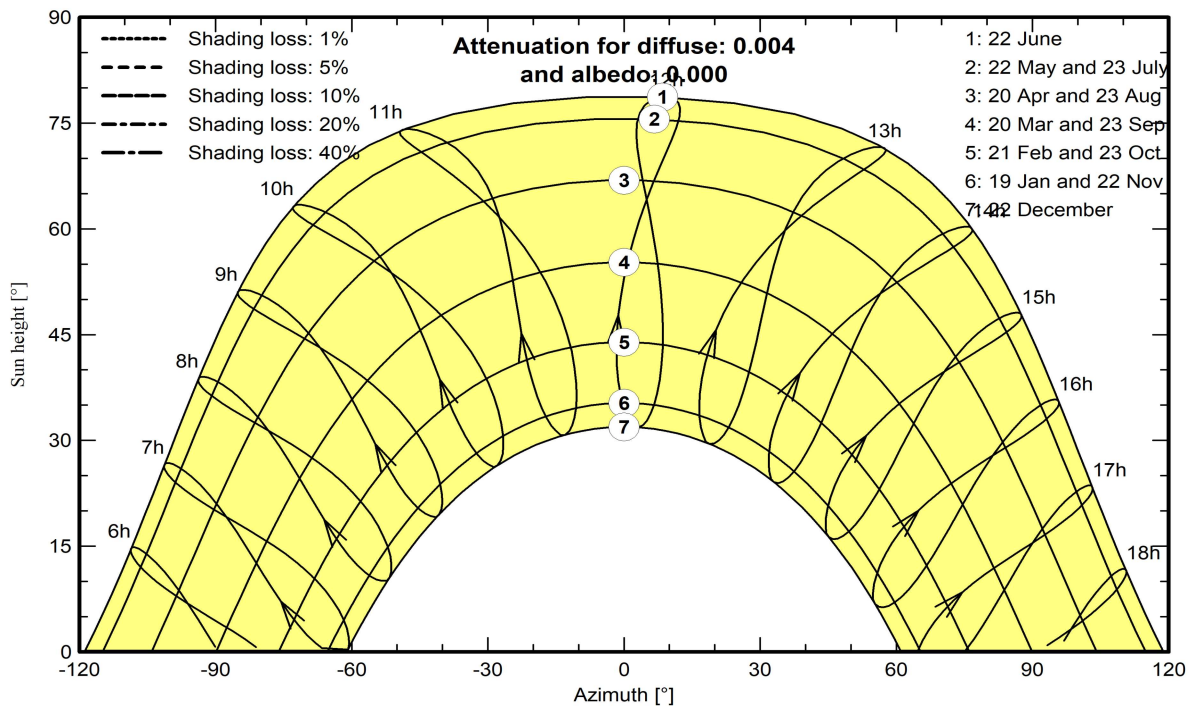
## Near shadings parameter

Perspective of the PV-field and surrounding shading scene



## Iso-shadings diagram

Orientation #1





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### Main results

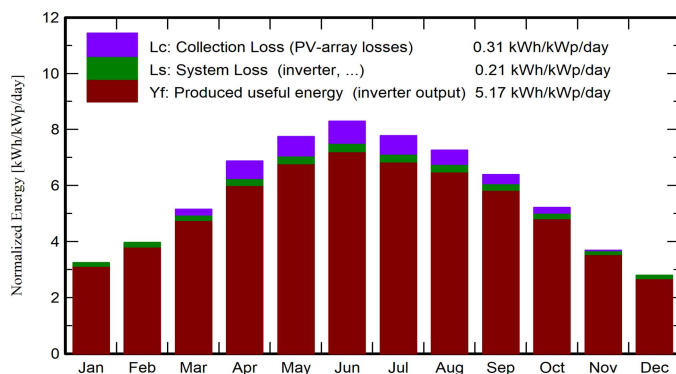
#### System Production

Produced Energy 23608963 kWh/year

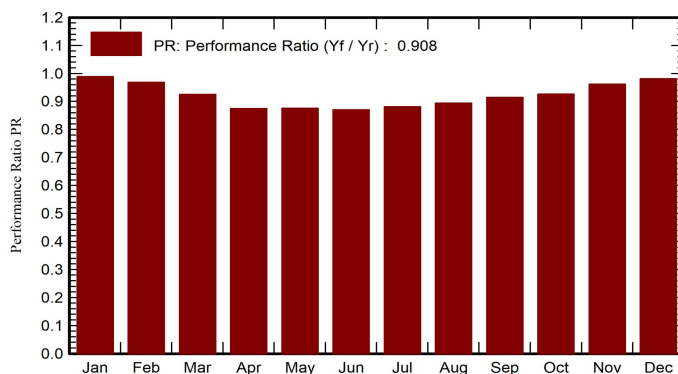
Specific production 1887 kWh/kWp/year

Performance Ratio PR 90.80 %

#### Normalized productions (per installed kWp)



#### Performance Ratio PR



### Balances and main results

	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
January	72.9	27.38	4.24	98.1	95.0	1260242	1212984	0.988
February	82.5	30.20	7.86	110.3	107.7	1390794	1336004	0.968
March	126.9	55.54	9.61	159.8	155.7	1923198	1848916	0.925
April	161.7	62.28	17.22	206.1	202.0	2349444	2256347	0.875
May	190.4	78.25	20.93	240.1	235.4	2739659	2631512	0.876
June	195.6	72.94	25.58	249.0	244.1	2823222	2710387	0.870
July	191.1	76.48	26.77	241.0	236.3	2766628	2655974	0.881
August	176.2	70.86	25.08	225.2	220.9	2623842	2518966	0.894
September	145.7	54.88	21.60	191.5	187.5	2282076	2191747	0.915
October	118.0	39.73	18.49	161.6	157.6	1949045	1872372	0.926
November	83.7	30.66	12.86	110.6	107.9	1381969	1330364	0.961
December	64.8	27.10	7.60	85.0	82.6	1083696	1043390	0.981
Year	1609.4	626.30	16.53	2078.4	2032.6	24573815	23608963	0.908

#### Legends

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



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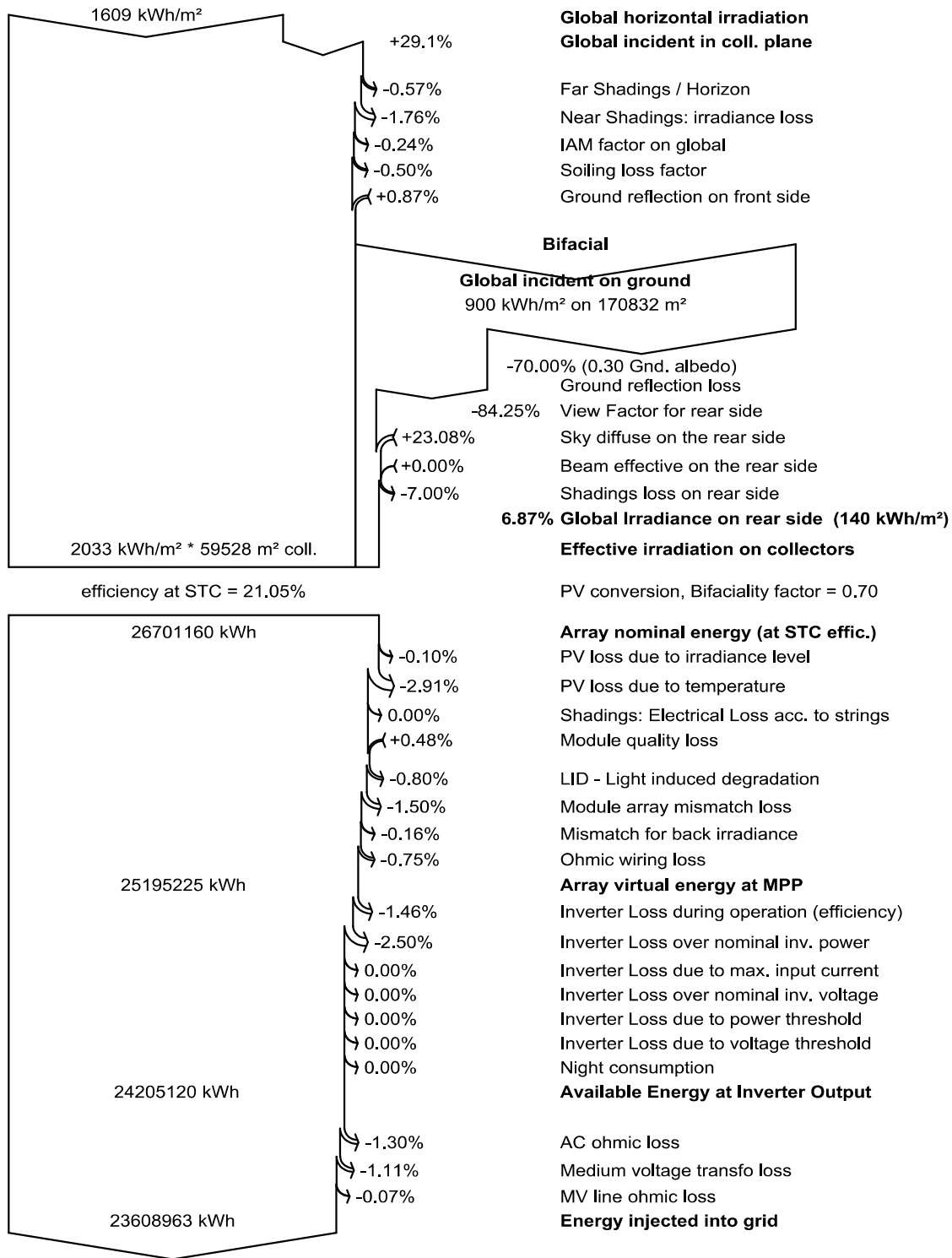
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### Loss diagram







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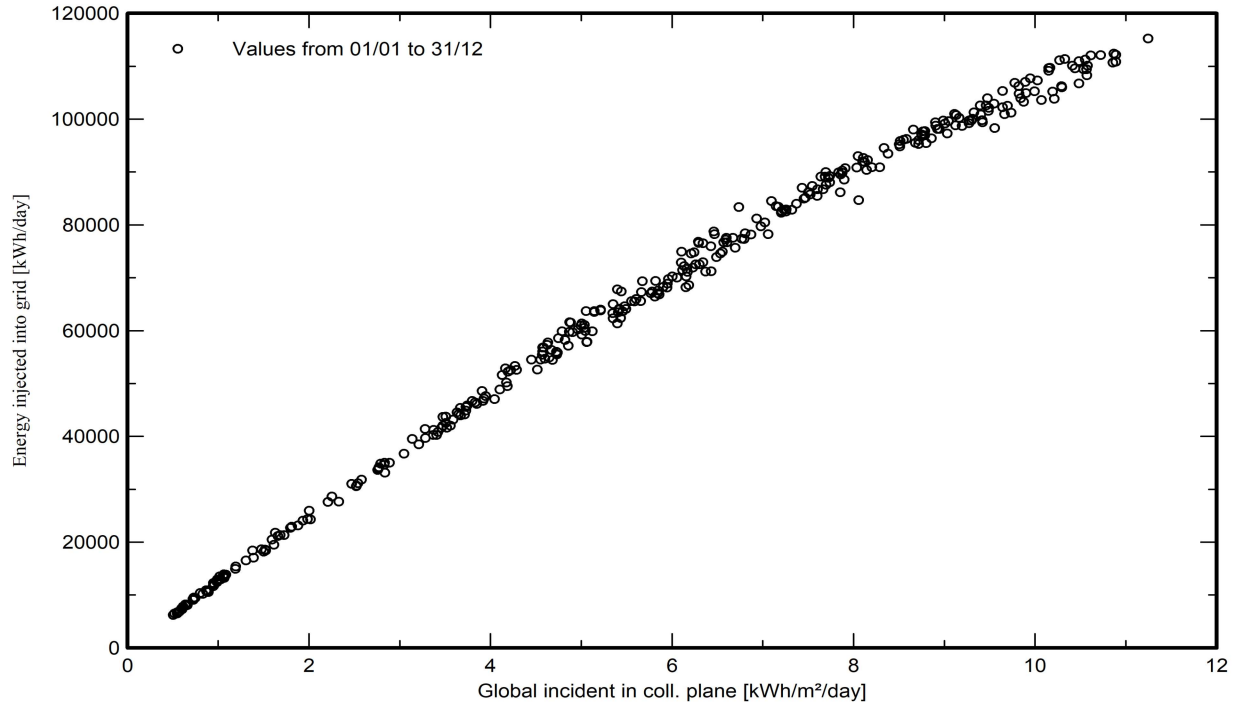
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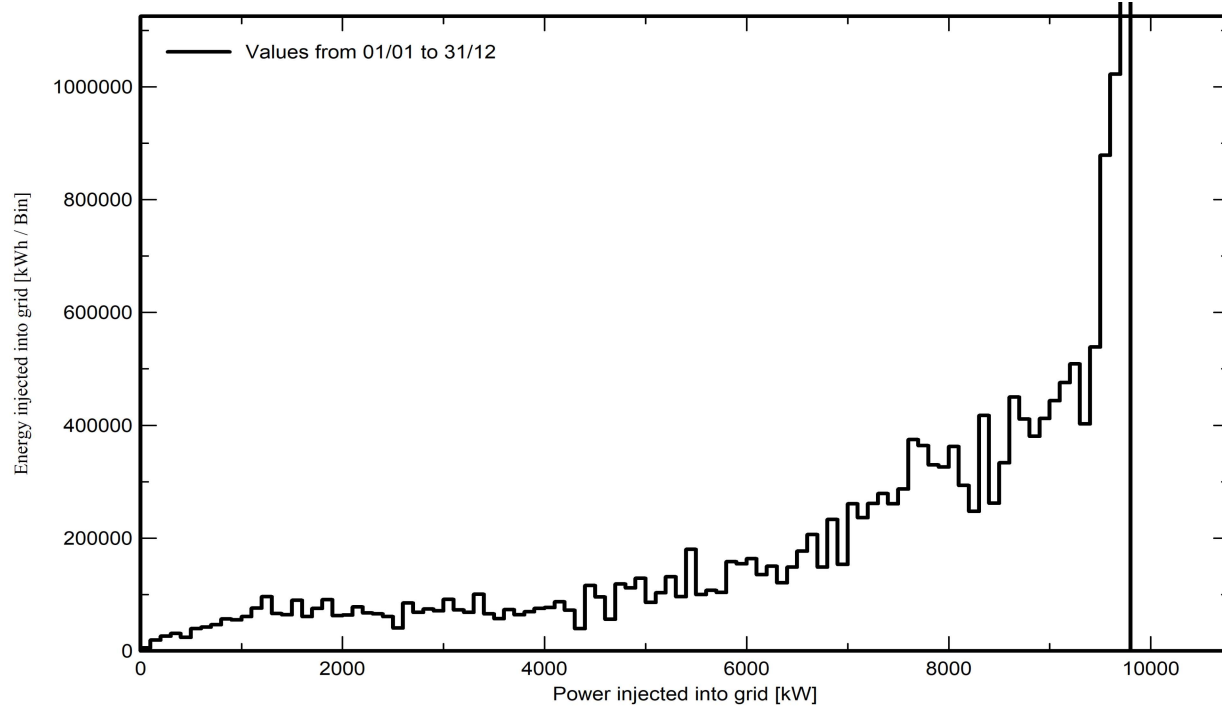
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### Special graphs

#### Daily Input/Output diagram



#### System Output Power Distribution





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#### P50 - P90 evaluation

##### Meteo data

Source Solar Anywhere V3.5  
Kind TMY, multi-year  
Year-to-year variability(Variance) 3.5 %  
**Specified Deviation**  
Climate change 0.0 %

##### Global variability (meteo + system)

Variability (Quadratic sum) 3.9 %

##### 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 0.92 GWh  
P50 23.61 GWh  
P90 22.43 GWh  
P95 22.09 GWh

#### Probability distribution

