

Comune di Santa Croce di Magliano, Rotello  
Provincia di Campobasso, Regione Molise

## SANTA CROCE SOLAR PARK S.R.L.



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### Impianto Agrivoltaico "SANTA CROCE 27.0"

PD01\_21 – SIMULAZIONE ENERGETICA (PVSYSY)

PROGETTISTI		IL PROPONENTE
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NOVEMBRE 2023

# PVsyst - Simulation report

## Grid-Connected System

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Project: ITS3SC - Santa Croce

Variant: RA-Santa Croce\_Tracker.1P(15-30)\_660Wp.Bif\_Pitch=8,15m\_3D

Tracking system with backtracking

System power: 33.46 MWp

Santa Croce di Magliano - Italy

Autor(a)



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**Project summary**

<b>Geographical Site</b>		<b>Situation</b>		<b>Project settings</b>	
Santa Croce di Magliano		Latitude	41.71 °N	Albedo	0.20
Italy		Longitude	15.03 °E		
		Altitude	293 m		
		Time zone	UTC+1		
<b>Meteo data</b>					
Santa Croce di Magliano					
Solcast TMY					

**System summary**

<b>Grid-Connected System</b>		<b>Tracking system with backtracking</b>			
Simulation for year no 1					
<b>PV Field Orientation</b>		<b>Tracking algorithm</b>		<b>Near Shadings</b>	
<b>Orientation</b>		Irradiance optimization		According to strings	
Tracking plane, tilted axis		Backtracking activated		Electrical effect	100 %
Avg axis tilt	-0.4 °			Diffuse shading	Automatic
Avg axis azim.	0 °				
<b>System information</b>					
<b>PV Array</b>					
Nb. of modules	50700 units	<b>Inverters</b>		Nb. of units	
Pnom total	33.46 MWp			106 units	
				Pnom total	
				34.98 MWac	
				Grid power limit	
				27.00 MWac	
				Grid lim. Pnom ratio	
				1.239	
<b>User's needs</b>					
Unlimited load (grid)					

**Results summary**

Produced Energy	53349.45 MWh/year	Specific production	1594 kWh/kWp/year	Perf. Ratio PR	83.24 %
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**General parameters**

<b>Grid-Connected System</b>		<b>Tracking system with backtracking</b>	
<b>PV Field Orientation</b>		<b>Tracking algorithm</b>	<b>Backtracking array</b>
Orientation		Irradiance optimization	Nb. of trackers 921 units
Tracking plane, tilted axis		Backtracking activated	Averages of diff. arrays
Avg axis tilt	-0.4 °		<b>Sizes</b>
Avg axis azim.	0 °		Tracker Spacing 8.32 m
			Collector width 4.91 m
			Ground Cov. Ratio (GCR) 59.0 %
			Phi min / max. -/+ 38.7 °
			<b>Backtracking strategy</b>
			Phi limits for BT -/+ 53.7 °
			Backtracking pitch 8.15 m
			Backtracking width 4.91 m
<b>Models used</b>		<b>Near Shadings</b>	<b>User's needs</b>
Transposition	Perez	According to strings	Unlimited load (grid)
Diffuse	Imported	Electrical effect 100 %	
Circumsolar	separate	Diffuse shading Automatic	
<b>Horizon</b>			
Average Height	3.7 °		
<b>Bifacial system</b>			
Model	2D Calculation unlimited trackers		
<b>Bifacial model geometry</b>		<b>Bifacial model definitions</b>	
Tracker Spacing	8.32 m	Ground albedo	0.20
Tracker width	4.91 m	Bifaciality factor	80 %
GCR	59.0 %	Rear shading factor	0.0 %
Axis height above ground	3.82 m	Rear mismatch loss	10.0 %
		Shed transparent fraction	0.0 %
<b>Grid power limitation</b>			
Active power	27.00 MWac		
Pnom ratio	1.239		

**PV Array Characteristics**

<b>PV module</b>		<b>Inverter</b>	
Manufacturer	Trina Solar	Manufacturer	Huawei Technologies
Model	TSM-660NEG21C.20	Model	SUN2000-330KTL-H1-Preliminary V0.1
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	660 Wp	Unit Nom. Power	330 kWac
Number of PV modules	50700 units	Number of inverters	106 units
Nominal (STC)	33.46 MWp	Total power	34980 kWac
Modules	1690 Strings x 30 In series	Operating voltage	500-1500 V
<b>At operating cond. (49°C)</b>		Pnom ratio (DC:AC)	0.96
Pmpp	31.00 MWp	Power sharing within this inverter	
U mpp	1067 V		
I mpp	29057 A		



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**PV Array Characteristics**

<b>Total PV power</b>		<b>Total inverter power</b>	
Nominal (STC)	33462 kWp	Total power	34980 kWac
Total	50700 modules	Number of inverters	106 units
Module area	157492 m <sup>2</sup>	Pnom ratio	0.96
Cell area	147567 m <sup>2</sup>		

**Array losses**

<b>Array Soiling Losses</b>		<b>Thermal Loss factor</b>		<b>DC wiring losses</b>				
Loss Fraction	2.5 %	Module temperature according to irradiance		Global array res.	0.60 mΩ			
		Uc (const)	29.0 W/m <sup>2</sup> K	Loss Fraction	1.5 % at STC			
		Uv (wind)	0.0 W/m <sup>2</sup> K/m/s					
<b>Serie Diode Loss</b>		<b>LID - Light Induced Degradation</b>		<b>Module Quality Loss</b>				
Voltage drop	0.7 V	Loss Fraction	0.5 %	Loss Fraction	-0.8 %			
Loss Fraction	0.1 % at STC							
<b>Module mismatch losses</b>		<b>Strings Mismatch loss</b>		<b>Module average degradation</b>				
Loss Fraction	1.0 % at MPP	Loss Fraction	0.1 %	Year no	1			
				Loss factor	0.4 %/year			
				<b>Mismatch due to degradation</b>				
				Imp RMS dispersion	0.4 %/year			
				Vmp RMS dispersion	0.4 %/year			
<b>IAM loss factor</b>								
Incidence effect (IAM): User defined profile								
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	1.000	1.000	0.987	0.963	0.891	0.672	0.000

**System losses**

<b>Auxiliaries loss</b>	
constant (fans)	20.0 kW
0.0 kW from Power thresh.	
Night aux. cons.	10.0 kW

**AC wiring losses**

<b>Inv. output line up to MV transfo</b>	
Inverter voltage	800 Vac tri
Loss Fraction	1.27 % at STC
<b>Inverter: SUN2000-330KTL-H1-Preliminary V0.1</b>	
Wire section (106 Inv.)	Alu 106 x 3 x 240 mm <sup>2</sup>
Average wires length	200 m
<b>MV line up to Injection</b>	
MV Voltage	36 kV
Wires	Alu 3 x 1200 mm <sup>2</sup>
Length	10988 m
Loss Fraction	0.73 % at STC



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**AC losses in transformers**

**MV transfo**

Medium voltage 36 kV

**Transformer parameters**

Nominal power at STC 32.88 MVA

Iron Loss (24/24 Connexion) 34.85 kVA

Iron loss fraction 0.11 % at STC

Copper loss 309.07 kVA

Copper loss fraction 0.94 % at STC

Coils equivalent resistance 3 x 0.18 mΩ



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Horizon definition

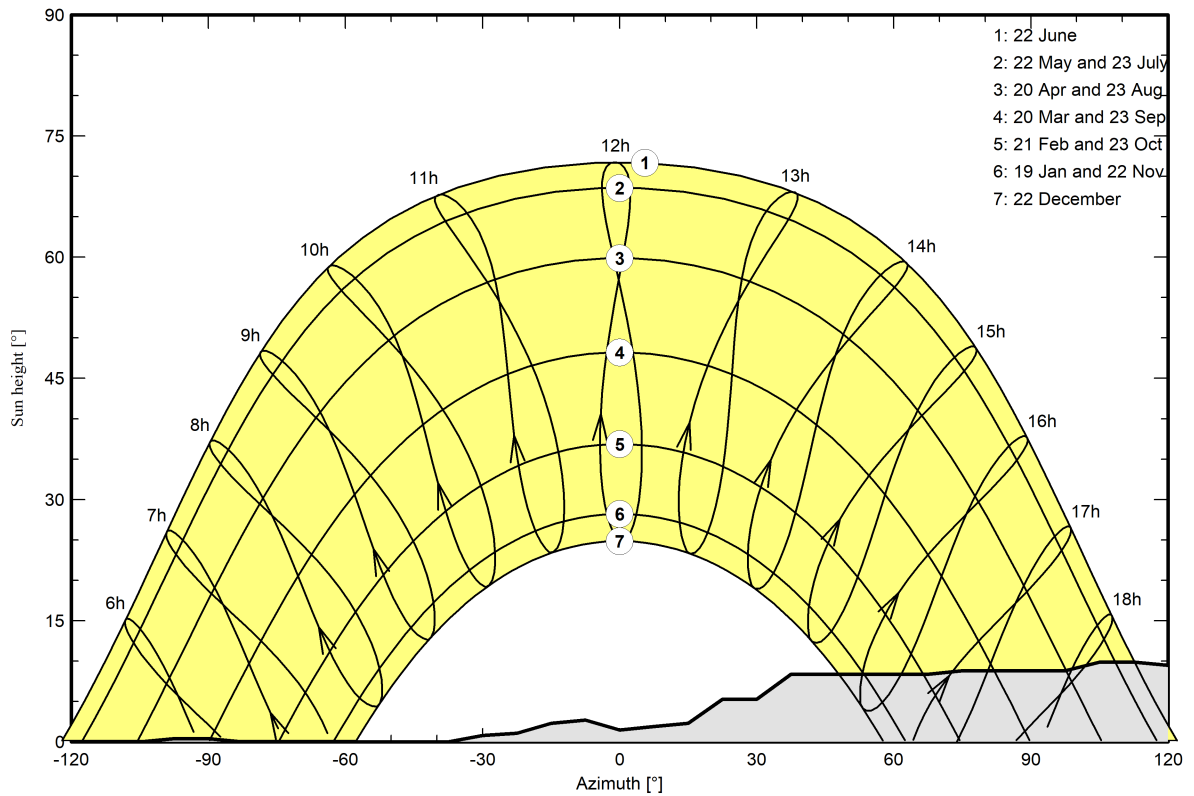
Horizon from PVGIS website API, Lat=41°42'22", Long=15°1'55", Alt=293m

Average Height	3.7 °	Albedo Factor	0.58
Diffuse Factor	0.93	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-143	-135	-105	-98	-90	-83	-38	-30
Height [°]	1.9	1.1	1.5	1.1	0.4	0.0	0.0	0.4	0.4	0.0	0.0	0.8
Azimuth [°]	-23	-15	-8	0	8	15	23	30	38	68	75	98
Height [°]	1.1	2.3	2.7	1.5	1.9	2.3	5.3	5.3	8.4	8.4	8.8	8.8
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180	
Height [°]	9.9	9.9	9.5	9.5	8.4	8.4	6.1	5.3	3.1	1.9	1.9	

Sun Paths (Height / Azimuth diagram)

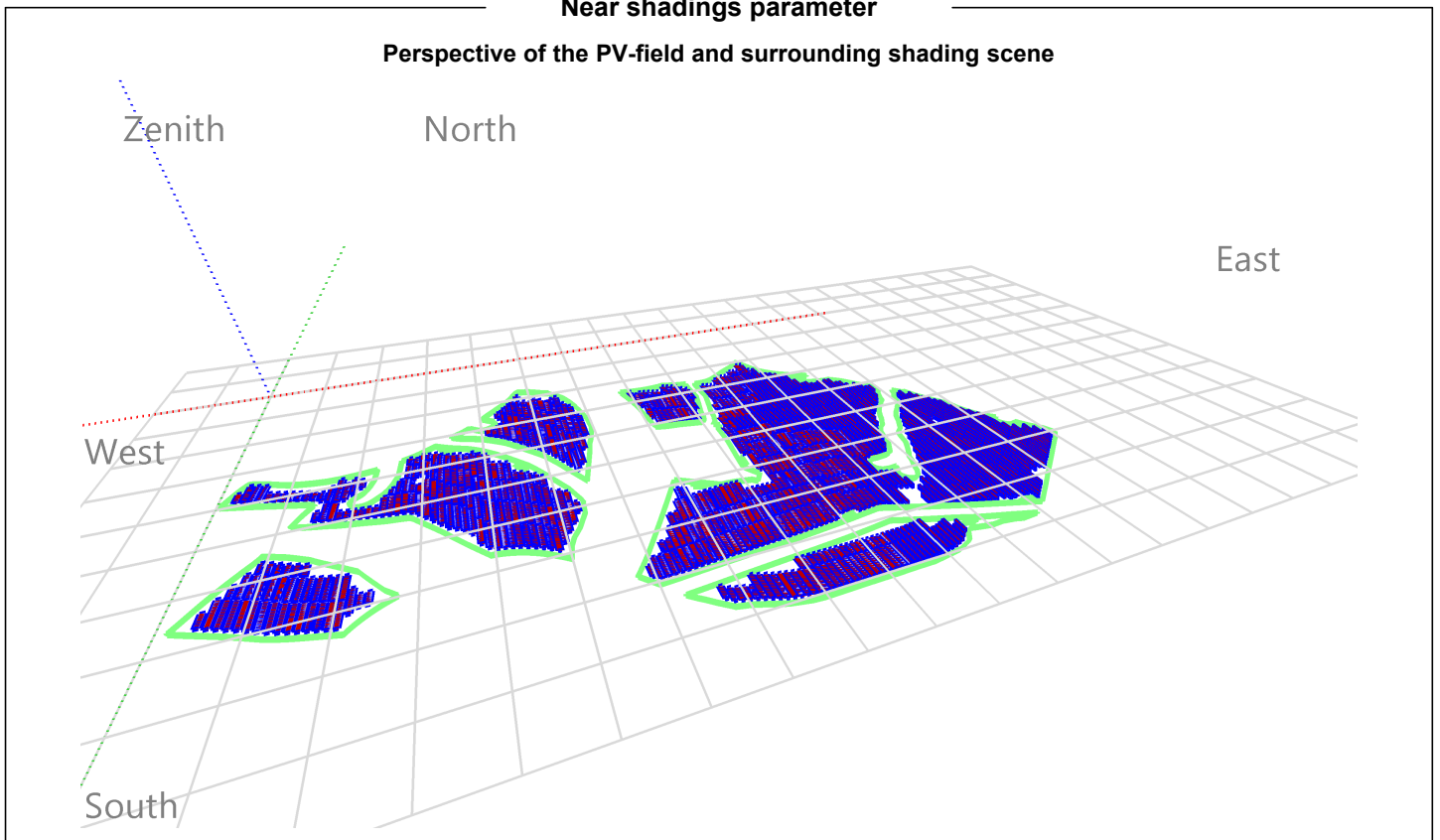




**PVsyst V7.4.0**

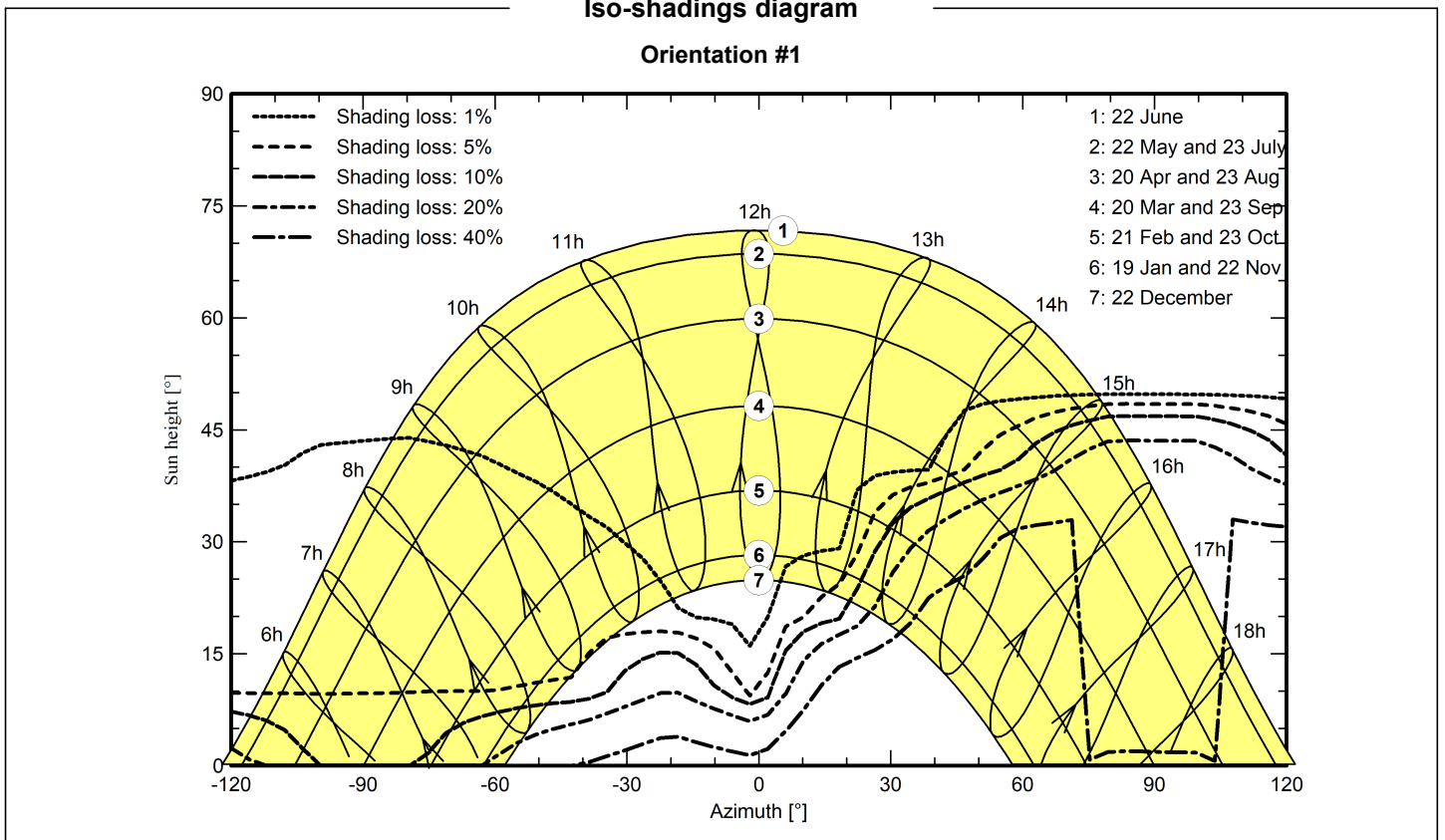
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**Near shadings parameter**



**Iso-shadings diagram**

**Orientation #1**







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**Main results**

**System Production**

Produced Energy 53349.45 MWh/year

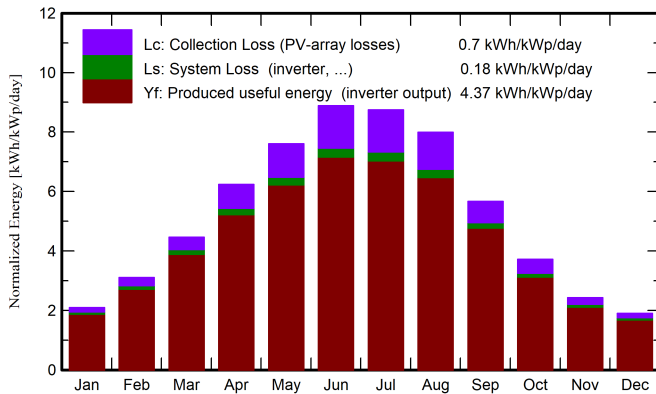
Specific production

1594 kWh/kWp/year

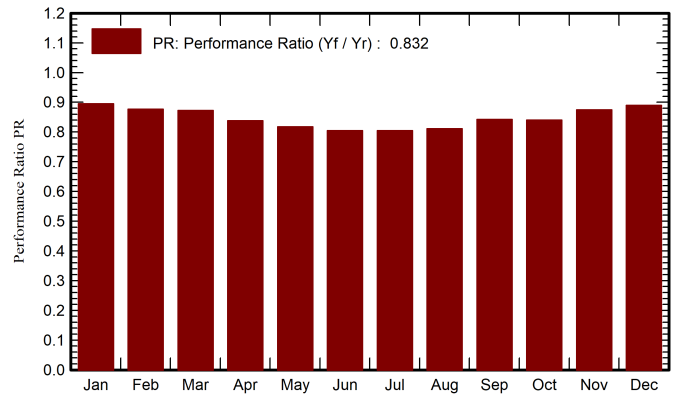
Perf. Ratio PR

83.24 %

**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 MWh	E_Grid MWh	PR ratio
<b>January</b>	54.7	28.00	7.68	64.9	60.1	2027	1944	0.895
<b>February</b>	71.3	30.12	3.95	86.8	80.6	2653	2549	0.877
<b>March</b>	113.6	48.04	10.52	138.4	129.5	4203	4042	0.873
<b>April</b>	151.9	50.75	14.02	187.0	175.4	5465	5244	0.838
<b>May</b>	196.1	67.87	18.35	235.9	222.6	6724	6455	0.818
<b>June</b>	218.4	69.63	24.39	266.8	251.8	7491	7187	0.805
<b>July</b>	219.2	59.58	25.56	271.1	255.6	7609	7294	0.804
<b>August</b>	199.7	53.73	25.52	247.7	233.6	7007	6722	0.811
<b>September</b>	138.7	56.57	20.04	170.0	159.1	4980	4792	0.842
<b>October</b>	94.2	39.09	15.70	115.4	107.0	3373	3242	0.840
<b>November</b>	60.5	29.31	12.53	72.7	67.4	2217	2127	0.874
<b>December</b>	49.7	24.56	9.01	58.8	54.4	1829	1752	0.890
<b>Year</b>	1567.9	557.25	15.68	1915.4	1797.2	55579	53349	0.832

**Legends**

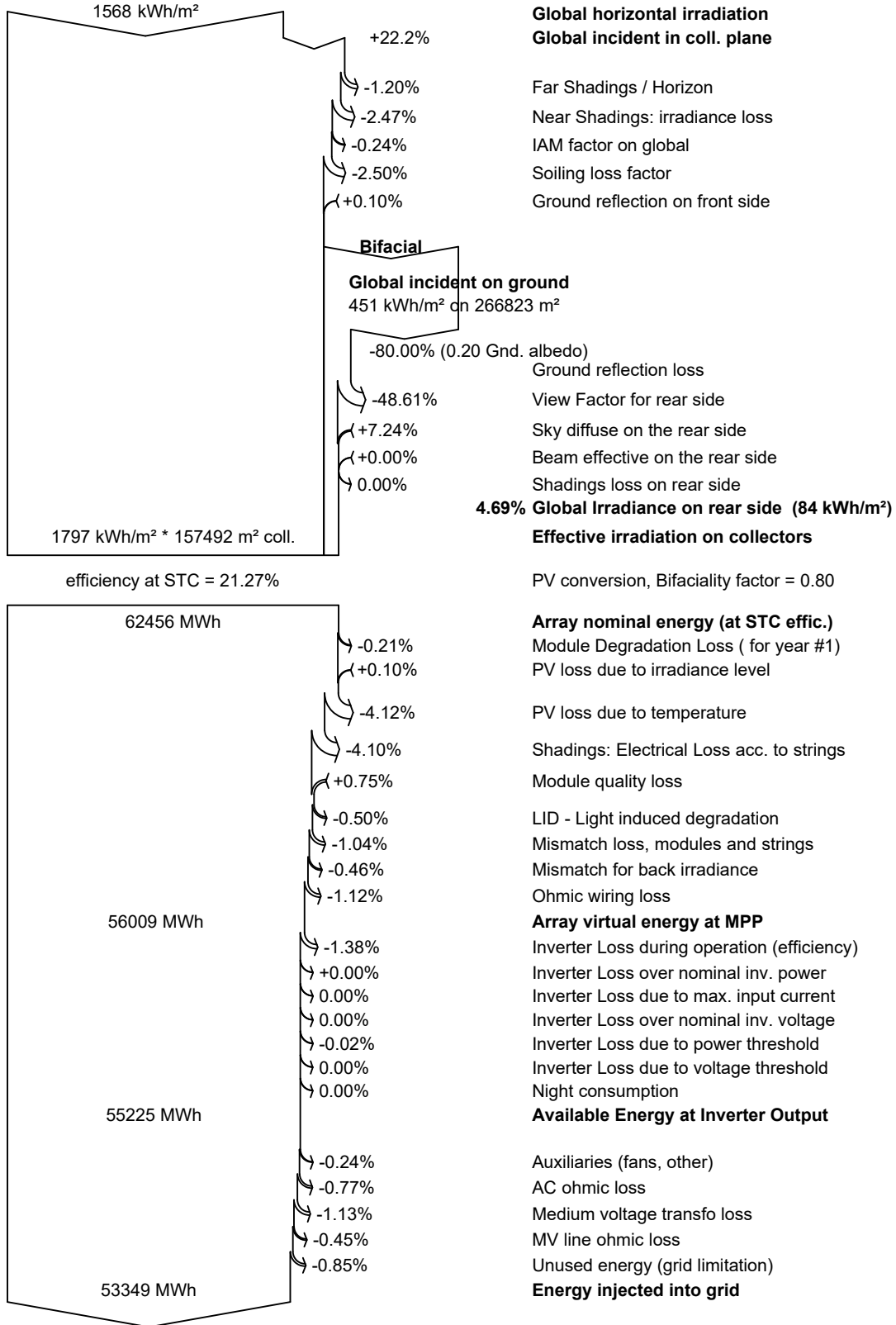
- GlobHor Global horizontal irradiation
- DiffHor Horizontal diffuse irradiation
- T\_Amb Ambient Temperature
- GlobInc Global incident in coll. plane
- GlobEff Effective Global, corr. for IAM and shadings
- EArray Effective energy at the output of the array
- E\_Grid Energy injected into grid
- PR Performance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



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Loss diagram



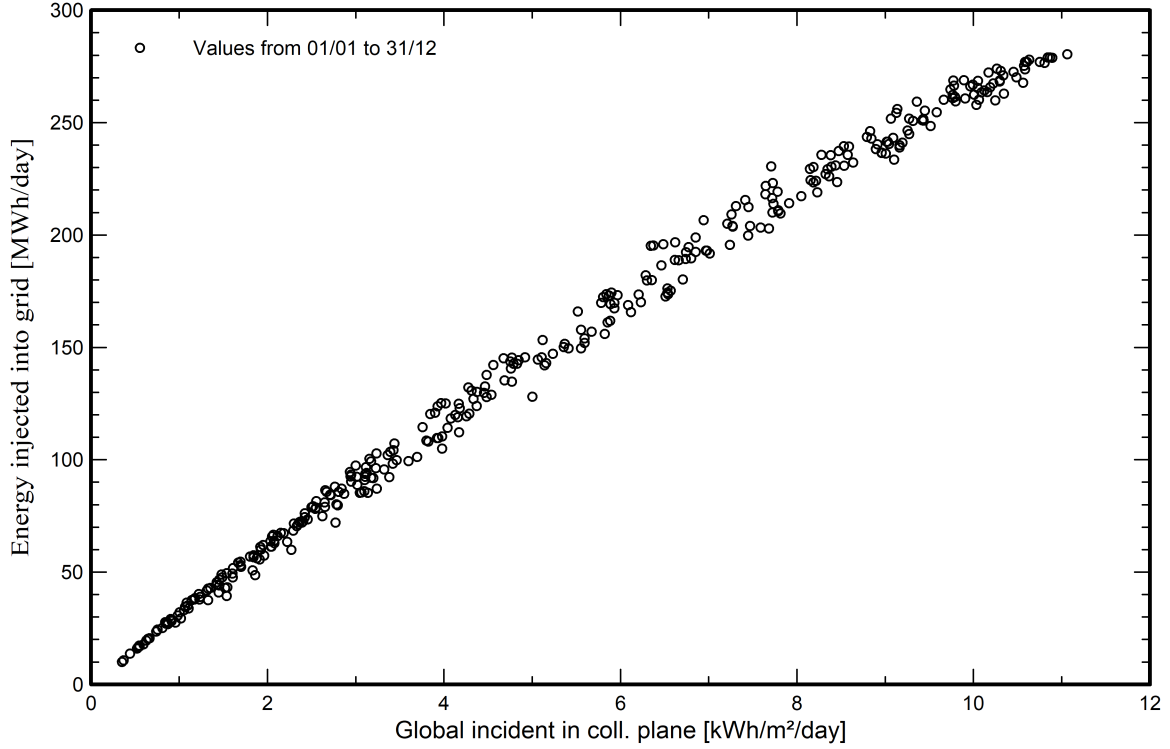


**PVsyst V7.4.0**

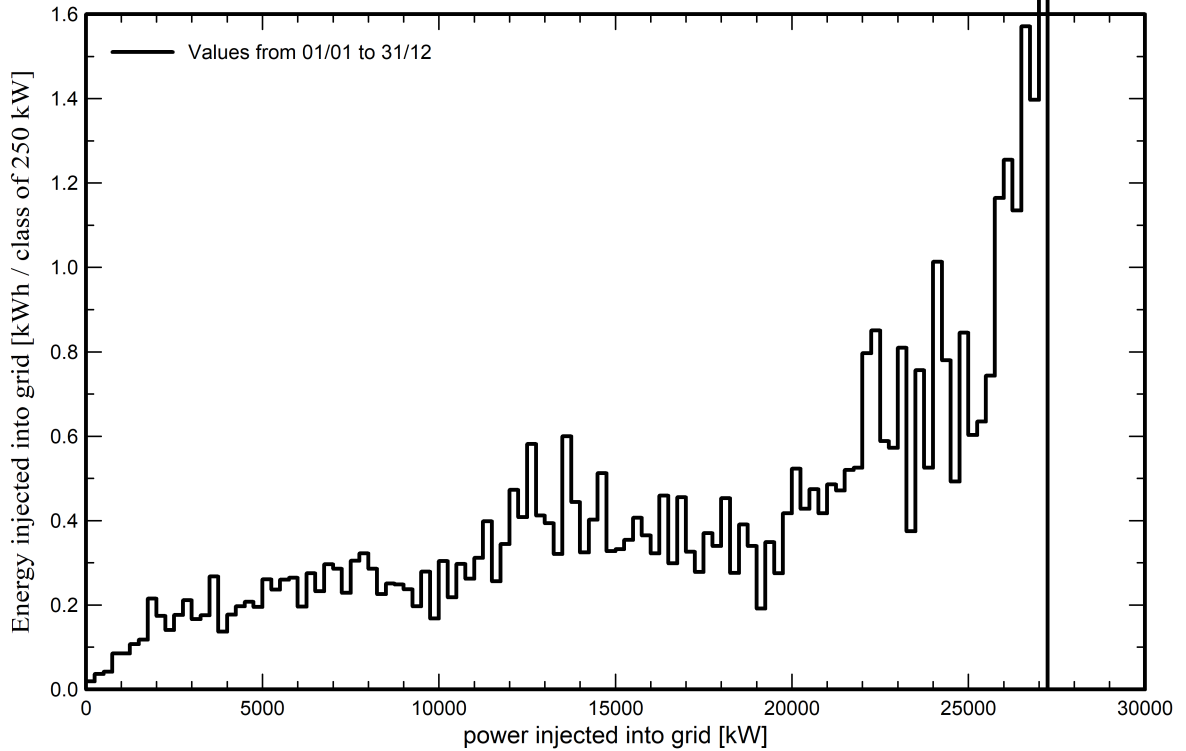
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**Predef. graphs**

**Diagramma giornaliero entrata/uscita**



**Distribuzione potenza in uscita sistema**





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**Aging Tool**

**Aging Parameters**

Time span of simulation 30 years

**Module average degradation**

Loss factor 0.4 %/year

**Mismatch due to degradation**

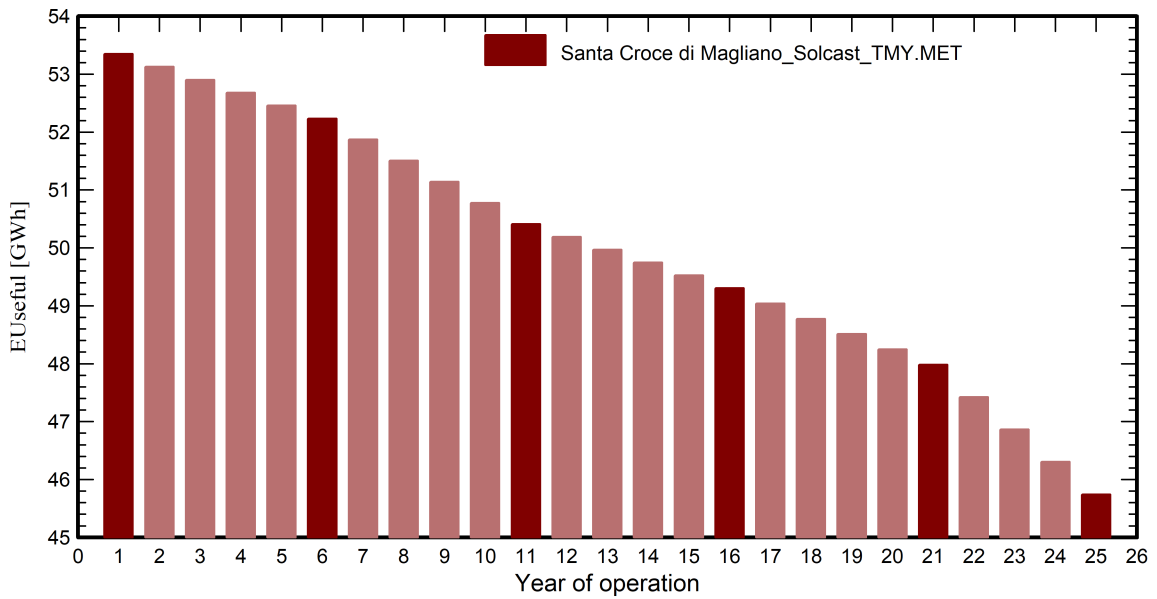
Imp RMS dispersion 0.4 %/year  
Vmp RMS dispersion 0.4 %/year

**Meteo used in the simulation**

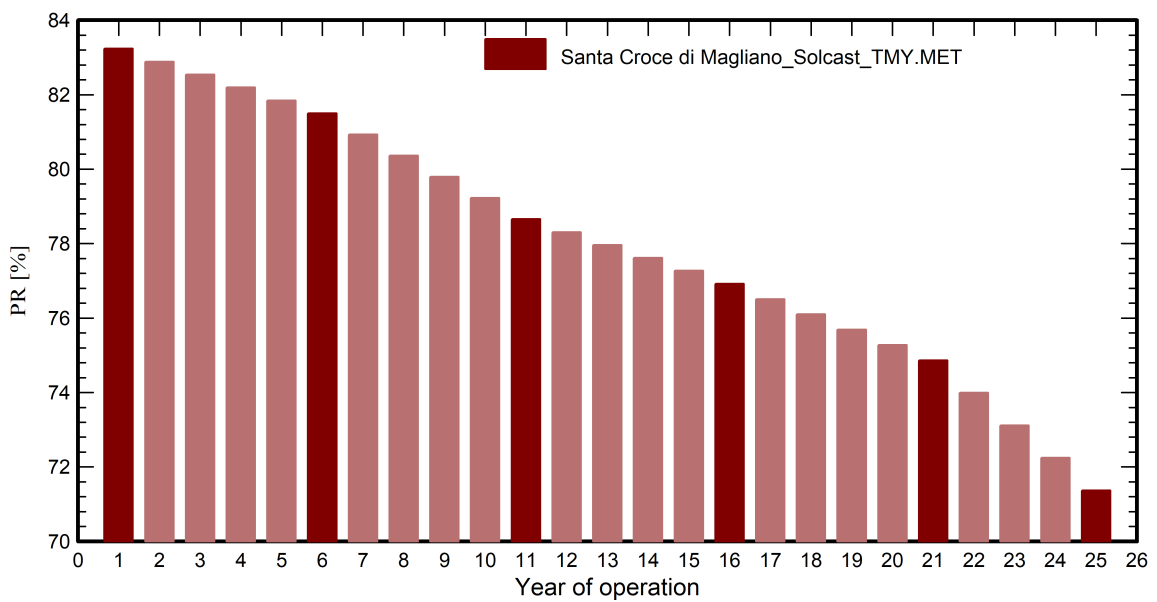
**Santa Croce di Magliano Solcast TMY**

Years reference year

**Useful out system energy**



**Performance Ratio**





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**Aging Tool**

**Aging Parameters**

Time span of simulation 30 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**

**Santa Croce di Magliano Solcast TMY**

Years reference year

	<b>EUseful</b>	<b>PR</b>	<b>PR loss</b>
<b>Year</b>	<b>GWh</b>	<b>%</b>	<b>%</b>
1	53.35	83.24	-0.21
2	53.13	82.89	-0.63
3	52.90	82.54	-1.04
4	52.68	82.19	-1.46
5	52.46	81.84	-1.88
6	52.23	81.49	-2.30
7	51.87	80.93	-2.98
8	51.50	80.36	-3.66
9	51.14	79.79	-4.34
10	50.78	79.22	-5.02
11	50.41	78.65	-5.70
12	50.19	78.31	-6.12
13	49.97	77.96	-6.53
14	49.75	77.61	-6.95
15	49.52	77.27	-7.36
16	49.30	76.92	-7.78
17	49.04	76.51	-8.27
18	48.77	76.10	-8.77
19	48.51	75.69	-9.26
20	48.25	75.27	-9.75
21	47.98	74.86	-10.25
22	47.42	73.99	-11.30
23	46.86	73.11	-12.34
24	46.30	72.24	-13.39
25	45.74	71.37	-14.44



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**P50 - P90 evaluation**

**Meteo data**

Source	Solcast TMY
Kind	Monthly averages
TMY - Multi-year average	
Year-to-year variability(Variance)	3.0 %

**Specified Deviation**

Climate change	0.0 %
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**Global variability (meteo + system)**

Variability (Quadratic sum)	3.5 %
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**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	1.87 GWh
P50	53.35 GWh
P90	50.96 GWh
P95	50.28 GWh

**Probability distribution**

