

PVsyst - Simulation report

Grid-Connected System

Project: Rotello

Variant: Variante 625 W

Tracking system with backtracking

System power: 27.05 MWp

Rotello - Italia



Project: Rotello

Variante: Variante 625 W

Tiemes srl (Italy)

PVsyst V7.4.5

VC2, Simulation date:
18/03/24 16:59
with v7.4.5

Project summary

Geographical Site	Situation	Project settings
Rotello	Latitude 41.73 °N	Albedo 0.20
Italia	Longitude 15.06 °E	
	Altitude 206 m	
	Time zone UTC+1	
Meteo data		
Rotello		
PVGIS api TMY		

System summary

Grid-Connected System	Tracking system with backtracking	
Simulation for year no 1		
PV Field Orientation	Tracking algorithm	Near Shadings
Orientation	Astronomic calculation	Linear shadings : Fast (table)
Tracking plane, horizontal N-S axis	Backtracking activated	Diffuse shading Automatic
Axis azimuth 0 °		
System information		
PV Array	Inverters	
Nb. of modules 43272 units	Nb. of units 7 units	
Pnom total 27.05 MWp	Pnom total 25.53 MWac	
	Grid power limit 23.10 MWac	
	Grid lim. Pnom ratio 1.171	
User's needs		
Unlimited load (grid)		

Results summary

Produced Energy 47823055 kWh/year	Specific production 1768 kWh/kWp/year	Perf. Ratio PR 85.97 %
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General parameters

Grid-Connected System		Tracking system with backtracking	
PV Field Orientation		Tracking algorithm	Backtracking array
Orientation		Astronomic calculation	Nb. of trackers 941 units
Tracking plane, horizontal N-S axis		Backtracking activated	Sizes
Axis azimuth	0 °		Tracker Spacing 9.10 m
			Collector width 4.95 m
			Ground Cov. Ratio (GCR) 54.4 %
			Phi min / max. -/+ 55.0 °
			Backtracking strategy
			Phi limits for BT -/+ 57.0 °
			Backtracking pitch 9.10 m
			Backtracking width 4.95 m
			Mode Automatic
Models used		Near Shadings	User's needs
Transposition	Perez	Linear shadings : Fast (table)	Unlimited load (grid)
Diffuse	Imported	Diffuse shading Automatic	
Circumsolar	separate		
Horizon			
Average Height	1.7 °		
Bifacial system			
Model	2D Calculation unlimited trackers		
Bifacial model geometry		Bifacial model definitions	
Tracker Spacing	9.10 m	Ground albedo	0.20
Tracker width	4.95 m	Bifaciality factor	80 %
GCR	54.4 %	Rear shading factor	5.0 %
Axis height above ground	2.10 m	Rear mismatch loss	10.0 %
		Shed transparent fraction	0.0 %
Grid power limitation			
Active power	23.10 MWac		
Pnom ratio	1.171		

PV Array Characteristics

PV module		Inverter	
Manufacturer	Jinkosolar	Manufacturer	SMA
Model	JKM625N-78HL4-BDV	Model	Sunny Central 2660 UP
(Custom parameters definition)		(Original PVsyst database)	
Unit Nom. Power	625 Wp	Unit Nom. Power	2667 kWac
Number of PV modules	8688 units	Number of inverters	2 units
Nominal (STC)	5430 kWp	Total power	5334 kWac
Array #1 - Sottocampo #1			
Number of PV modules	4344 units	Number of inverters	1 unit
Nominal (STC)	2715 kWp	Total power	2667 kWac
Modules	181 string x 24 In series		
At operating cond. (50°C)		Operating voltage	880-1325 V
Pmpp	2511 kWp	Pnom ratio (DC:AC)	1.02
U mpp	1016 V		
I mpp	2470 A		



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PV Array Characteristics

Array #2 - Sottocampo #2

Number of PV modules 4344 units
Nominal (STC) 2715 kWp
Modules 181 string x 24 In series

At operating cond. (50°C)

Pmpp 2511 kWp
U mpp 1016 V
I mpp 2470 A

PV module

Manufacturer Jinkosolar
Model JKM625N-78HL4-BDV
(Custom parameters definition)

Unit Nom. Power 625 Wp
Number of PV modules 15600 units
Nominal (STC) 9750 kWp

Array #3 - Sottocampo #3

Number of PV modules 7800 units
Nominal (STC) 4875 kWp
Modules 325 string x 24 In series

At operating cond. (50°C)

Pmpp 4509 kWp
U mpp 1016 V
I mpp 4436 A

Array #4 - Sottocampo #4

Number of PV modules 7800 units
Nominal (STC) 4875 kWp
Modules 325 string x 24 In series

At operating cond. (50°C)

Pmpp 4509 kWp
U mpp 1016 V
I mpp 4436 A

Array #5 - Sottocampo #5

PV module
Manufacturer Jinkosolar
Model JKM625N-78HL4-BDV
(Custom parameters definition)

Unit Nom. Power 625 Wp
Number of PV modules 5160 units
Nominal (STC) 3225 kWp
Modules 215 string x 24 In series

At operating cond. (50°C)

Pmpp 2983 kWp
U mpp 1016 V
I mpp 2935 A

PV module

Manufacturer Jinkosolar
Model JKM625N-78HL4-BDV
(Custom parameters definition)

Unit Nom. Power 625 Wp
Number of PV modules 13824 units
Nominal (STC) 8640 kWp

Number of inverters 1 unit
Total power 2667 kWac

Operating voltage 880-1325 V
Pnom ratio (DC:AC) 1.02

Inverter

Manufacturer SMA
Model Sunny Central 4600 UP
(Original PVsyst database)

Unit Nom. Power 4600 kWac
Number of inverters 2 units
Total power 9200 kWac

Number of inverters 1 unit
Total power 4600 kWac

Operating voltage 1003-1325 V
Pnom ratio (DC:AC) 1.06

Number of inverters 1 unit
Total power 4600 kWac

Operating voltage 1003-1325 V
Pnom ratio (DC:AC) 1.06

Inverter
Manufacturer SMA
Model Sunny Central 3000-EV
(Original PVsyst database)

Unit Nom. Power 3000 kWac
Number of inverters 1 unit
Total power 3000 kWac
Operating voltage 956-1425 V
Pnom ratio (DC:AC) 1.08

Inverter

Manufacturer SMA
Model Sunny Central 4000 UP
(Original PVsyst database)

Unit Nom. Power 4000 kWac
Number of inverters 2 units
Total power 8000 kWac



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PV Array Characteristics

Array #6 - Sottocampo #6

Number of PV modules	6744 units	Number of inverters	1 unit
Nominal (STC)	4215 kWp	Total power	4000 kWac
Modules	281 string x 24 In series		
At operating cond. (50°C)		Operating voltage	880-1325 V
Pmpp	3899 kWp	Pnom ratio (DC:AC)	1.05
U mpp	1016 V		
I mpp	3835 A		

Array #7 - Sottocampo #7

Number of PV modules	7080 units	Number of inverters	1 unit
Nominal (STC)	4425 kWp	Total power	4000 kWac
Modules	295 string x 24 In series		
At operating cond. (50°C)		Operating voltage	880-1325 V
Pmpp	4093 kWp	Pnom ratio (DC:AC)	1.11
U mpp	1016 V		
I mpp	4026 A		

Total PV power

Nominal (STC)	27045 kWp
Total	43272 modules
Module area	120959 m ²
Cell area	111450 m ²

Total inverter power

Total power	25534 kWac
Number of inverters	7 units
Pnom ratio	1.06

Array losses

Array Soiling Losses

Loss Fraction 2.0 %

Thermal Loss factor

Module temperature according to irradiance
 Uc (const) 29.0 W/m²K
 Uv (wind) 0.0 W/m²K/m/s

LID - Light Induced Degradation

Loss Fraction 0.4 %

Module Quality Loss

Loss Fraction -0.4 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.2 %

Module average degradation

Year no 1
 Loss factor 0.4 %/year

Mismatch due to degradation

Imp RMS dispersion 0 %/year
 Vmp RMS dispersion 0 %/year

IAM loss factor

Incidence effect (IAM): Fresnel, AR coating, n(glass)=1.526, n(AR)=1.290

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

DC wiring losses

Global wiring resistance 0.67 mΩ
 Loss Fraction 1.5 % at STC



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DC wiring losses

Array #1 - Sottocampo #1		Array #2 - Sottocampo #2	
Global array res.	6.7 mΩ	Global array res.	6.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #3 - Sottocampo #3		Array #4 - Sottocampo #4	
Global array res.	3.7 mΩ	Global array res.	3.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #5 - Sottocampo #5		Array #6 - Sottocampo #6	
Global array res.	5.6 mΩ	Global array res.	4.3 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #7 - Sottocampo #7			
Global array res.	4.1 mΩ		
Loss Fraction	1.5 % at STC		

System losses

Auxiliaries loss	
Proportionnal to Power	4.0 W/kW
0.0 kW from Power thresh.	

AC wiring losses

Inv. output line up to MV transfo			
Inverter voltage	600 Vac tri		
Loss Fraction	0.02 % at STC		
Inverter: Sunny Central 2660 UP		Inverters: Sunny Central 2660 UP, Sunny Central 3000-EV	
Wire section (1 Inv.)	Copper 1 x 3 x 2500 mm ²	Wire section (2 Inv.)	Copper 2 x 3 x 2000 mm ²
Wires length	3 m	Average wires length	3 m
Inverters: Sunny Central 4600 UP, Sunny Central 4000 UP			
Wire section (4 Inv.)	Copper 4 x 3 x 3000 mm ²		
Average wires length	3 m		
MV line up to HV Transfo		HV line up to Injection	
MV Voltage	30 kV	HV line voltage	150 kV
Average each inverter		Wires	Alu 3 x 500 mm ²
Wires	Alu 3 x 500 mm ²	Length	1000 m
Length	3500 m	Loss Fraction	0.01 % at STC
Loss Fraction	0.09 % at STC		

AC losses in transformers

MV transfo	
Medium voltage	30 kV
One transfo in each sub-array	
Array #1 - Sottocampo #1	
Transformer parameters	
Nominal power at STC	2.66 MVA
Iron Loss (24/24 Connexion)	2.67 kVA
Iron loss fraction	0.10 % at STC
Copper loss	26.61 kVA
Copper loss fraction	1.00 % at STC
Coils equivalent resistance	3 x 1.35 mΩ



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AC losses in transformers

MV transfo

Medium voltage 30 kV

One transfo in each sub-array

Array #2 - Sottocampo #2

Transformer parameters

Nominal power at STC 2.66 MVA
Iron Loss (24/24 Connexion) 2.67 kVA
Iron loss fraction 0.10 % at STC
Copper loss 26.61 kVA
Copper loss fraction 1.00 % at STC
Coils equivalent resistance 3 x 1.35 mΩ

Array #3 - Sottocampo #3

Transformer parameters

Nominal power at STC 4.79 MVA
Iron Loss (24/24 Connexion) 4.60 kVA
Iron loss fraction 0.10 % at STC
Copper loss 49.92 kVA
Copper loss fraction 1.04 % at STC
Coils equivalent resistance 3 x 1.04 mΩ

Array #4 - Sottocampo #4

Transformer parameters

Nominal power at STC 4.79 MVA
Iron Loss (24/24 Connexion) 4.60 kVA
Iron loss fraction 0.10 % at STC
Copper loss 49.92 kVA
Copper loss fraction 1.04 % at STC
Coils equivalent resistance 3 x 1.04 mΩ

Array #5 - Sottocampo #5

Transformer parameters

Nominal power at STC 3.17 MVA
Iron Loss (24/24 Connexion) 3.00 kVA
Iron loss fraction 0.09 % at STC
Copper loss 33.50 kVA
Copper loss fraction 1.06 % at STC
Coils equivalent resistance 3 x 1.43 mΩ

Array #6 - Sottocampo #6

Transformer parameters

Nominal power at STC 4.13 MVA
Iron Loss (24/24 Connexion) 4.00 kVA
Iron loss fraction 0.10 % at STC
Copper loss 42.73 kVA
Copper loss fraction 1.03 % at STC
Coils equivalent resistance 3 x 0.90 mΩ

Array #7 - Sottocampo #7

Transformer parameters

Nominal power at STC 4.34 MVA
Iron Loss (24/24 Connexion) 4.00 kVA
Iron loss fraction 0.09 % at STC
Copper loss 47.06 kVA
Copper loss fraction 1.08 % at STC
Coils equivalent resistance 3 x 0.90 mΩ



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AC losses in transformers

HV transfo

Grid voltage 150 kV

Transformer from Datasheets

Nominal power 35000 kVA

Iron Loss (24/24 Connexion) 35.00 kVA

Iron loss fraction 0.10 % of PNom

Copper loss 328.40 kVA

Copper loss fraction 0.94 % at PNom

Coils equivalent resistance 3 x 241.27 mΩ



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Horizon definition

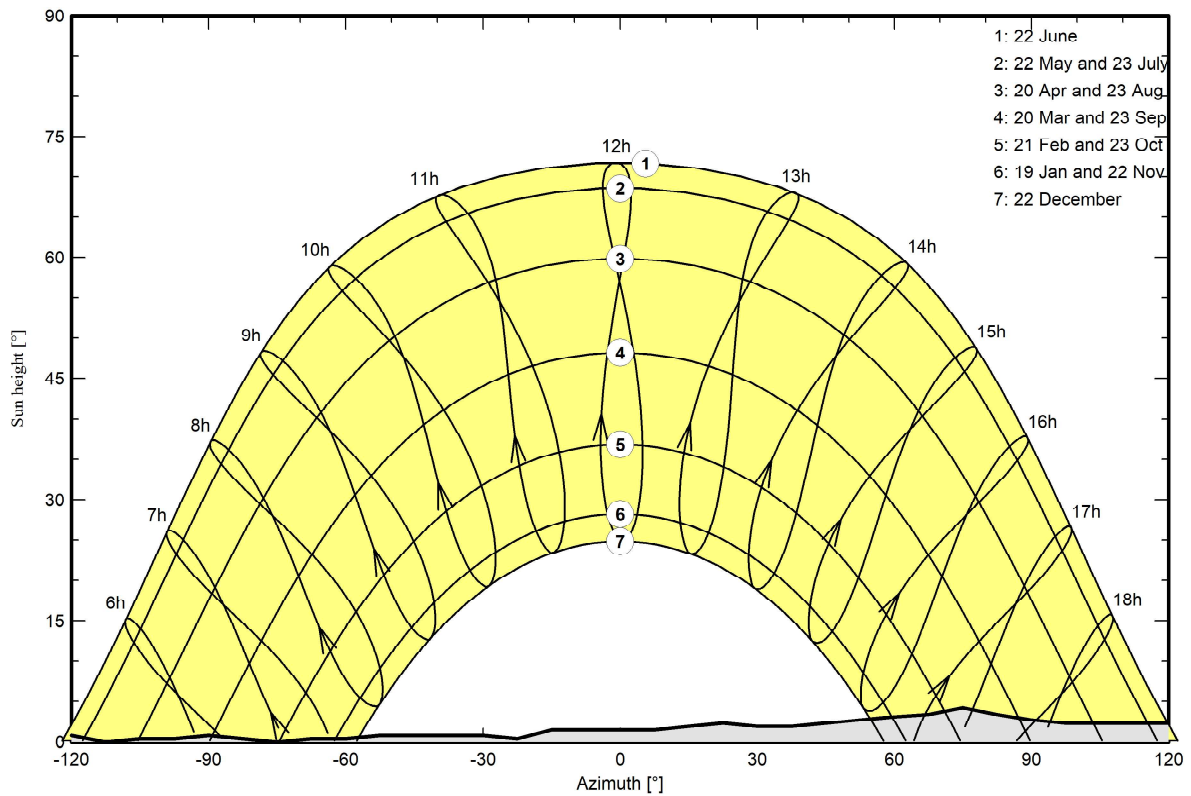
Horizon from PVGIS website API, Lat=41°43'41', Long=15°3'41', Alt=206m

Average Height	1.7 °	Albedo Factor	0.86
Diffuse Factor	0.96	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-150	-143	-135	-128	-120	-113	-105	-98	-90	-83	-75	-68
Height [°]	1.9	1.9	0.8	0.8	1.1	0.8	0.0	0.4	0.4	0.8	0.4	0.0	0.4
Azimuth [°]	-60	-53	-30	-23	-15	8	15	23	30	38	45	53	60
Height [°]	0.4	0.8	0.8	0.4	1.5	1.5	1.9	2.3	1.9	1.9	2.3	2.7	3.1
Azimuth [°]	68	75	83	90	98	120	128	135	143	150	180		
Height [°]	3.4	4.2	3.4	2.7	2.3	2.3	3.1	2.7	2.3	1.9	1.9		

Sun Paths (Height / Azimuth diagram)



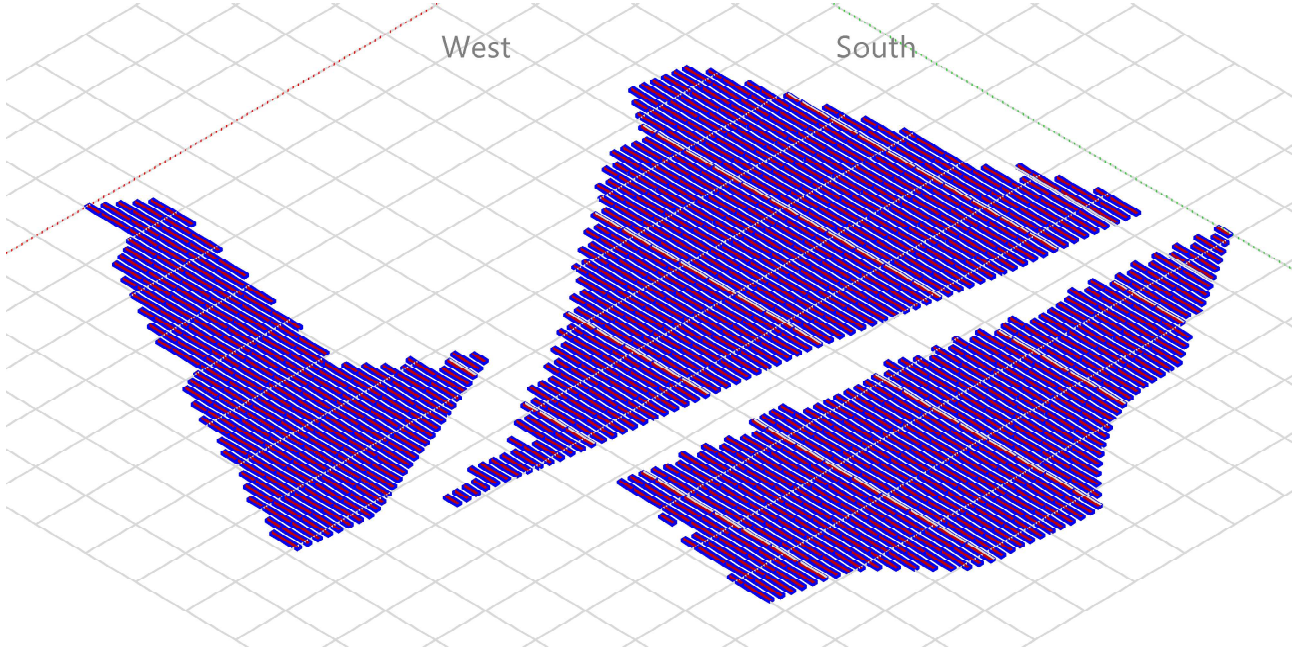


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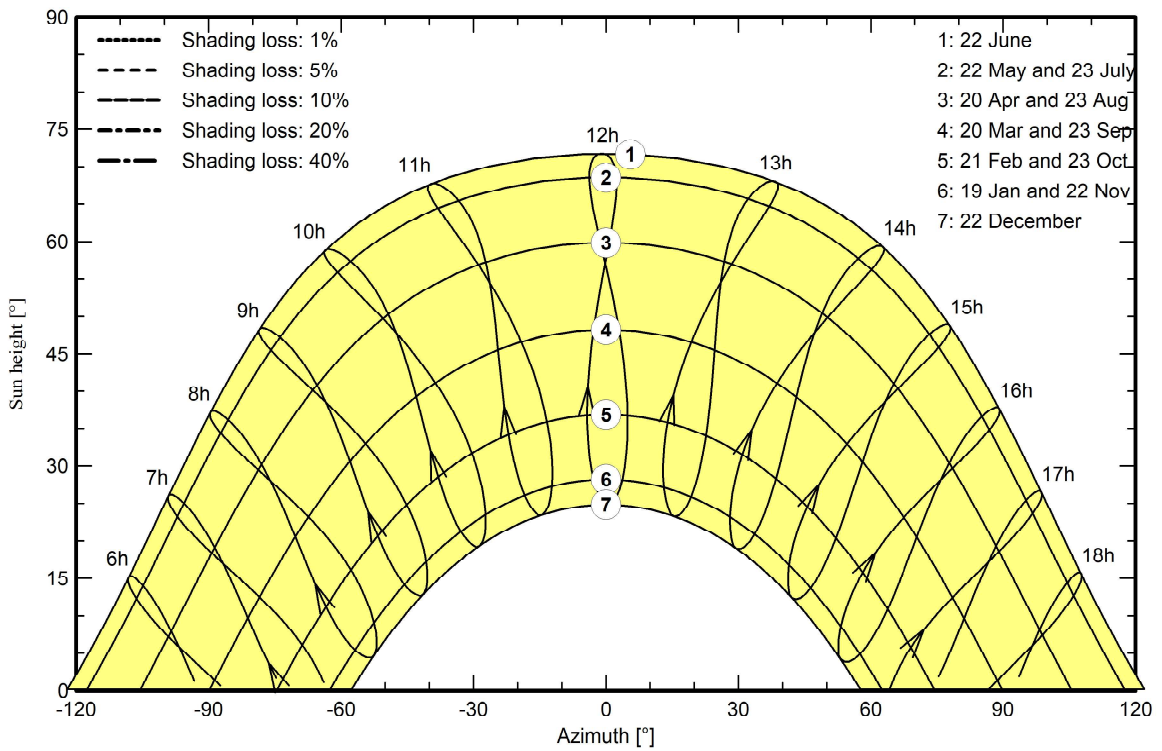
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1





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Main results

System Production

Produced Energy 47823055 kWh/year

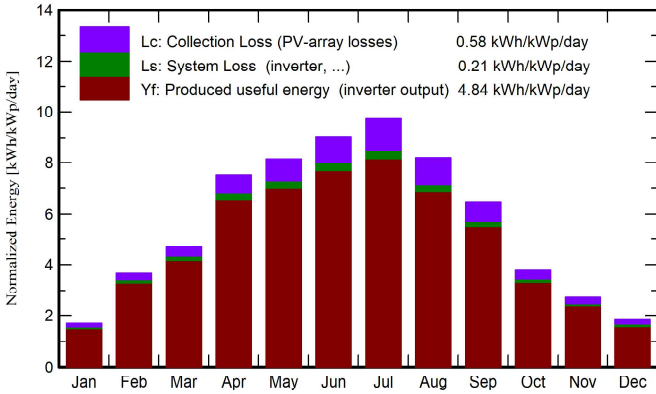
Specific production

1768 kWh/kWp/year

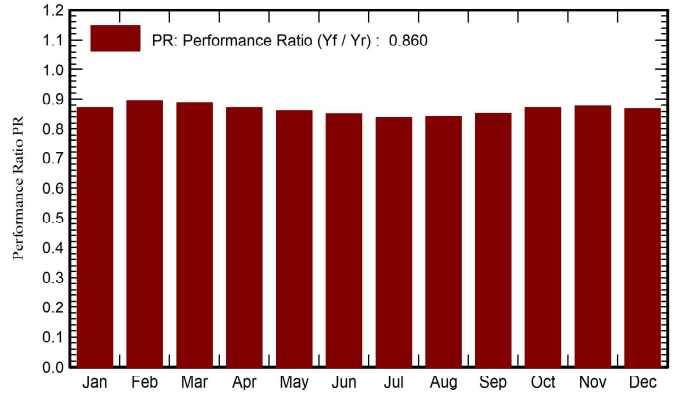
Perf. Ratio PR

85.97 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_Grid kWh	PR ratio
January	44.4	26.13	7.74	52.8	47.7	1324300	1243672	0.871
February	82.1	32.89	6.85	102.9	96.1	2608777	2493387	0.896
March	117.0	48.48	9.16	145.5	136.5	3655579	3498214	0.889
April	178.5	59.44	14.42	225.8	214.8	5548252	5322925	0.872
May	202.9	77.56	18.17	252.1	239.7	6122745	5877739	0.862
June	217.8	72.52	21.94	271.3	258.7	6506631	6247526	0.852
July	236.8	60.87	25.58	302.1	289.1	7118937	6837805	0.837
August	199.3	62.36	25.37	253.7	241.9	6011666	5774623	0.841
September	152.8	51.14	22.86	193.8	183.8	4654944	4470106	0.853
October	95.1	40.80	15.15	118.2	110.4	2915013	2786307	0.872
November	63.9	27.14	9.16	81.6	75.0	2033278	1933964	0.877
December	46.1	22.28	8.21	56.9	51.6	1419823	1336786	0.869
Year	1636.6	581.62	15.44	2056.8	1945.3	49919944	47823055	0.860

Legends

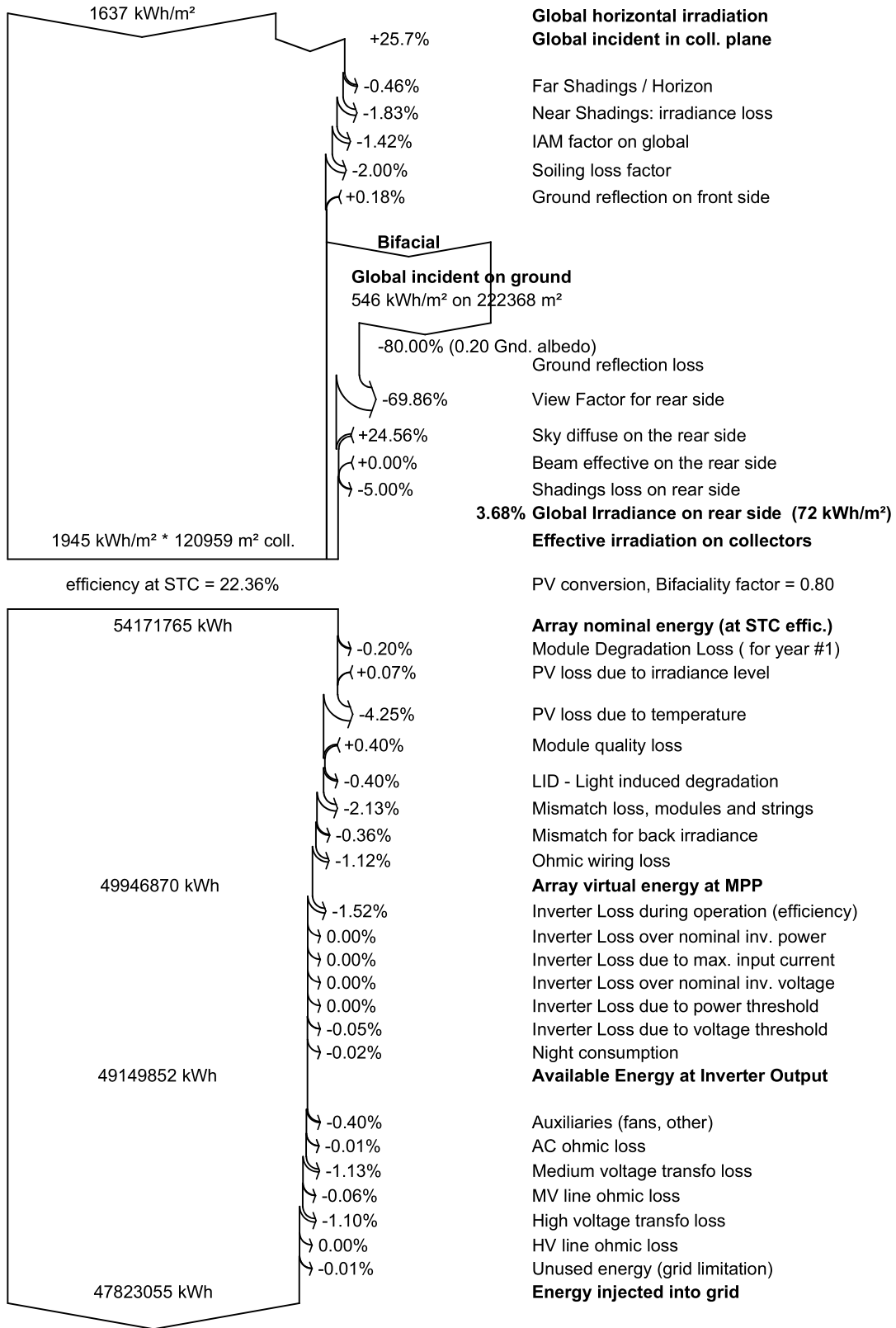
- GlobHor Global horizontal irradiation
- DiffHor Horizontal diffuse irradiation
- T_Amb Ambient Temperature
- GlobInc Global incident in coll. plane
- GlobEff Effective Global, corr. for IAM and shadings
- EArray Effective energy at the output of the array
- E_Grid Energy injected into grid
- PR Performance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



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Loss diagram



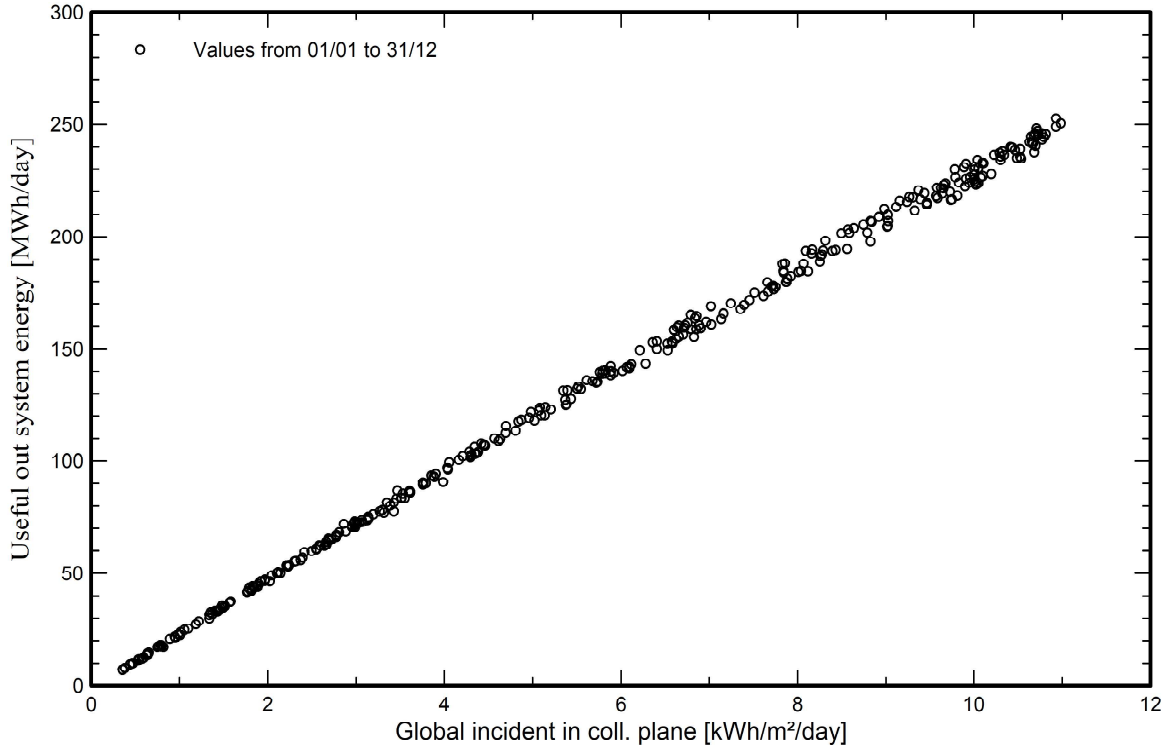


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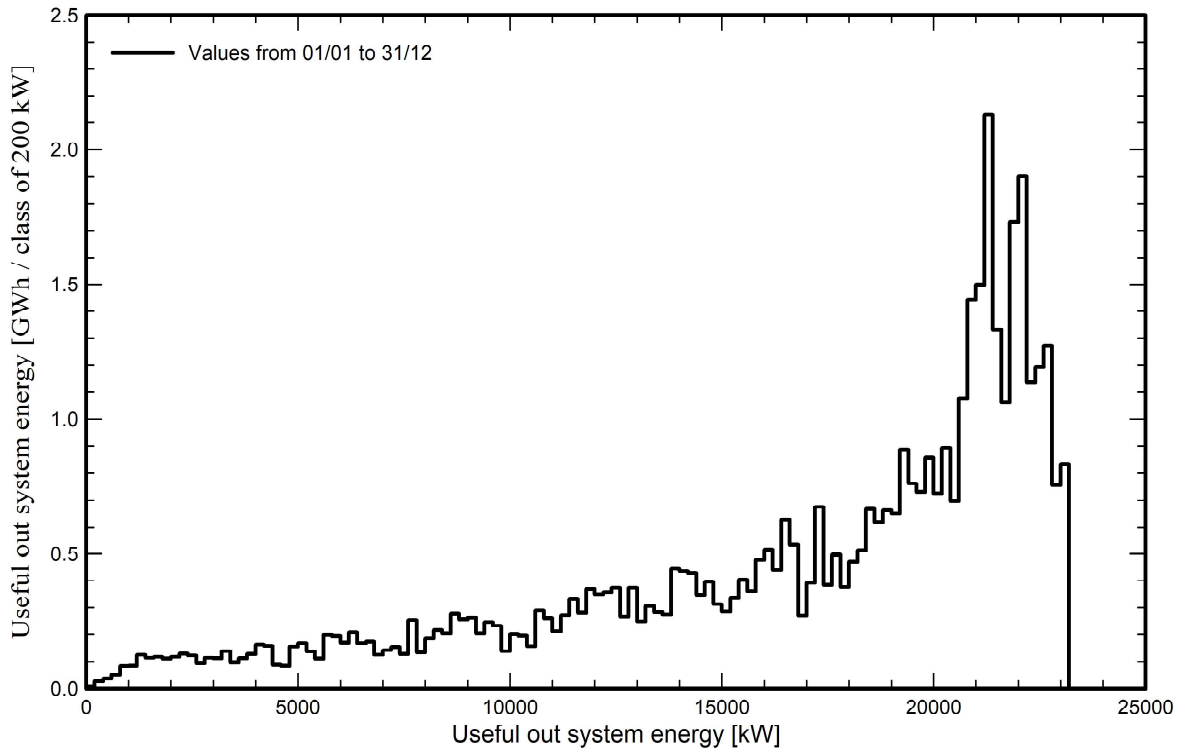
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Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema

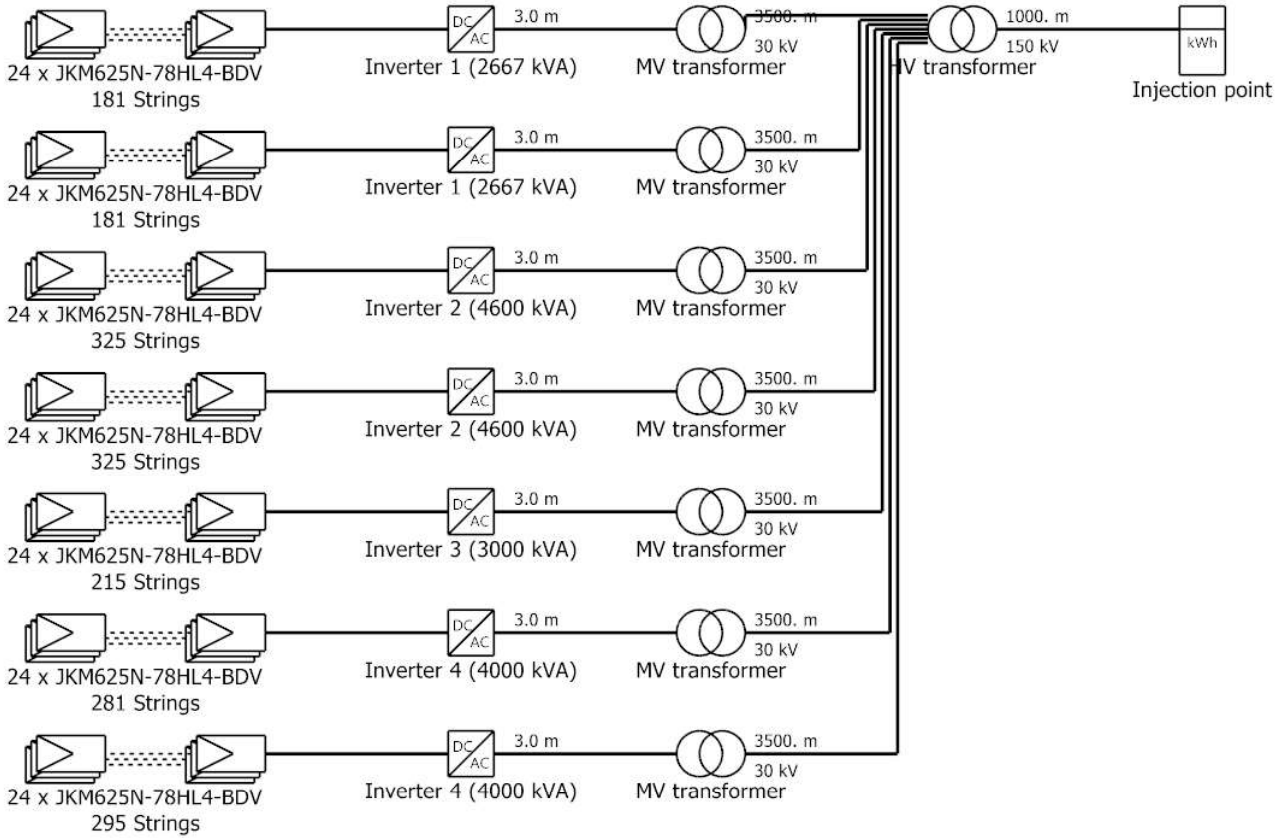




Single-line diagram

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PV module	JKM625N-78HL4-BDV
Inverter 1	Sunny Central 2660 UP
Inverter 2	Sunny Central 4600 UP
Inverter 3	Sunny Central 3000-EV
Inverter 4	Sunny Central 4000 UP
String	24 x JKM625N-78HL4-BDV

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VC2 : Variante 625 W

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