

PVsyst - Simulation report

Grid-Connected System

Project: REN176 Poirino

Variant: Layout Ottobre 2022 - 46,7 MWp 36 kV SMA 4,6 MVA x 10 RIFERIMENTO AGV

Sheds, single array

System power: 46.72 MWp

Ternavasso - Italy

Author

Renegerica S.p.a. (Italy)



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VCF, Simulation date:
04/11/22 08:56
with v7.2.21

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Project summary

Geographical Site		Situation		Project settings	
Ternavasso		Latitude	44.85 °N	Albedo	0.20
Italy		Longitude	7.86 °E		
		Altitude	282 m		
		Time zone	UTC+1		
Meteo data					
Ternavasso					
PVGIS api TMY					

System summary

Grid-Connected System		Sheds, single array		User's needs	
PV Field Orientation		Near Shadings		Unlimited load (grid)	
Fixed plane		According to strings			
Tilt/Azimuth	35 / 0 °	Electrical effect	100 %		
System information					
PV Array					
Nb. of modules	67228 units	Inverters		10 units	
Pnom total	46.72 MWp	Nb. of units		46.00 MWac	
		Pnom total		60.00 MWac	
		Grid power limit		0.779	
		Grid lim. Pnom ratio			

Results summary

Produced Energy	73.12 GWh/year	Specific production	1565 kWh/kWp/year	Perf. Ratio PR	86.35 %
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General parameters

Grid-Connected System		Sheds, single array			
PV Field Orientation		Sheds configuration		Models used	
Orientation		Nb. of sheds	118 units	Transposition	Perez
Fixed plane		Single array		Diffuse	Imported
Tilt/Azimuth	35 / 0 °	Sizes		Circumsolar	separate
		Sheds spacing	12.0 m		
		Collector width	4.79 m		
		Ground Cov. Ratio (GCR)	39.9 %		
		Top inactive band	0.02 m		
		Bottom inactive band	0.02 m		
		Shading limit angle			
		Limit profile angle	18.8 °		
Horizon		Near Shadings		User's needs	
Average Height	1.1 °	According to strings		Unlimited load (grid)	
		Electrical effect	100 %		
Bifacial system					
Model	2D Calculation				
	unlimited sheds				
Bifacial model geometry		Bifacial model definitions			
Sheds spacing	12.00 m	Ground albedo	0.20		
Sheds width	4.83 m	Bifaciality factor	75 %		
Limit profile angle	18.8 °	Rear shading factor	5.0 %		
GCR	40.2 %	Rear mismatch loss	10.0 %		
Height above ground	1.50 m	Shed transparent fraction	0.0 %		
Grid power limitation					
Active Power	60.00 MWac				
Pnom ratio	0.779				

PV Array Characteristics

PV module		Inverter	
Manufacturer	Jollywood	Manufacturer	SMA
Model	JW-HD132N	Model	Sunny Central 4600 UP
	(Custom parameters definition)		(Original PVsyst database)
Unit Nom. Power	695 Wp	Unit Nom. Power	4600 kWac
Number of PV modules	67228 units	Number of inverters	10 units
Nominal (STC)	46.72 MWp	Total power	46000 kWac
Modules	2401 Strings x 28 In series	Operating voltage	1003-1325 V
At operating cond. (50°C)		Pnom ratio (DC:AC)	1.02
Pmpp	43.60 MWp		
U mpp	1011 V		
I mpp	43142 A		
Total PV power		Total inverter power	
Nominal (STC)	46723 kWp	Total power	46000 kWac
Total	67228 modules	Number of inverters	10 units
Module area	208834 m²	Pnom ratio	1.02
Cell area	195674 m²		



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Array losses

Array Soiling Losses

Loss Fraction 2.0 %

Thermal Loss factor

Module temperature according to irradiance

Uc (const) 20.0 W/m²K

Uv (wind) 0.0 W/m²K/m/s

DC wiring losses

Global array res. 0.38 mΩ

Loss Fraction 1.5 % at STC

LID - Light Induced Degradation

Loss Fraction 0.5 %

Module Quality Loss

Loss Fraction -0.2 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.1 %

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

System losses

Auxiliaries loss

constant (fans) 20.0 kW

20.0 kW from Power thresh.

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 690 Vac tri

Loss Fraction 0.11 % at STC

Inverter: Sunny Central 4600 UP

Wire section (10 Inv.) Copper 10 x 3 x 2500 mm²

Average wires length 15 m

MV line up to Injection

MV Voltage 36 kV

Average each inverter

Wires Copper 3 x 700 mm²

Length 10000 m

Loss Fraction 0.10 % at STC

AC losses in transformers

MV transfo

Grid voltage 36 kV

Operating losses at STC

Nominal power at STC 45939 kVA

Iron loss (night disconnect) 4.59 kW/Inv.

Loss Fraction 0.10 % at STC

Coils equivalent resistance 3 x 1.04 mΩ/inv.

Loss Fraction 1.00 % at STC



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Horizon definition

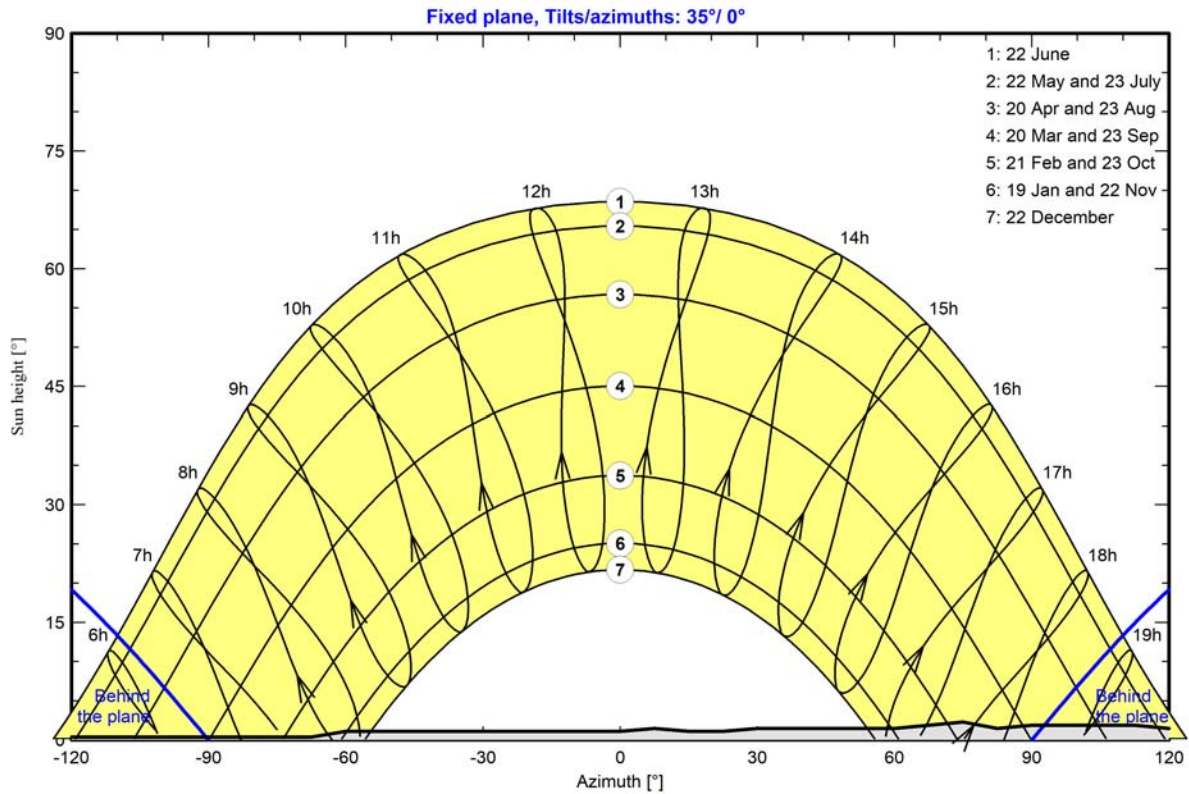
Horizon from PVGIS website API, Lat=44°50'58', Long=7°51'25', Alt=282m

Average Height	1.1 °	Albedo Factor	0.94
Diffuse Factor	1.00	Albedo Fraction	100 %

Horizon profile

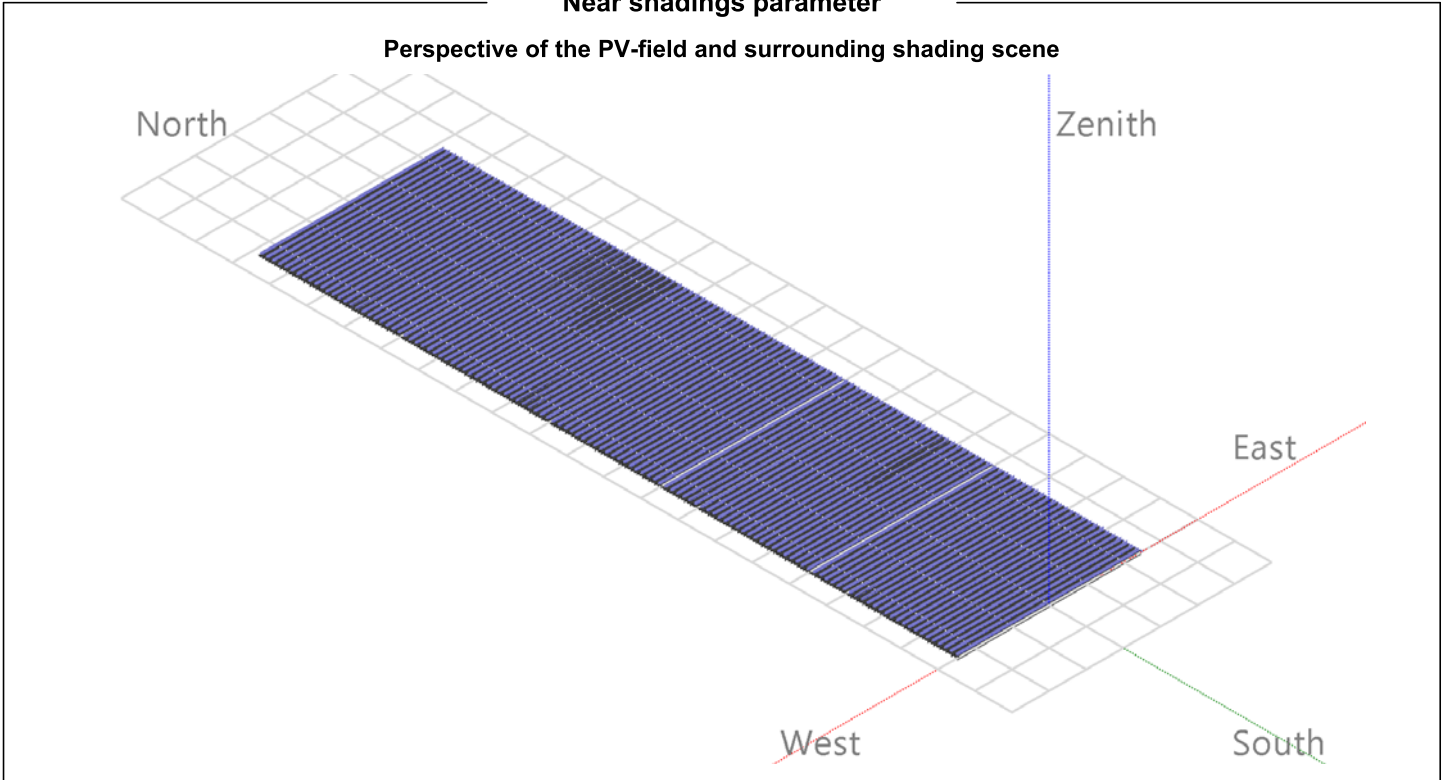
Azimuth [°]	-180	-173	-165	-158	-150	-128	-120	-68	-60	0	8	15	23	30
Height [°]	1.5	0.8	0.4	0.4	0.0	0.0	0.4	0.4	1.1	1.1	1.5	1.1	1.1	1.5
Azimuth [°]	60	68	75	83	90	113	120	128	135	143	165	173	180	
Height [°]	1.5	1.9	2.3	1.5	1.9	1.9	1.5	2.3	1.9	1.5	1.5	1.1	1.5	

Sun Paths (Height / Azimuth diagram)

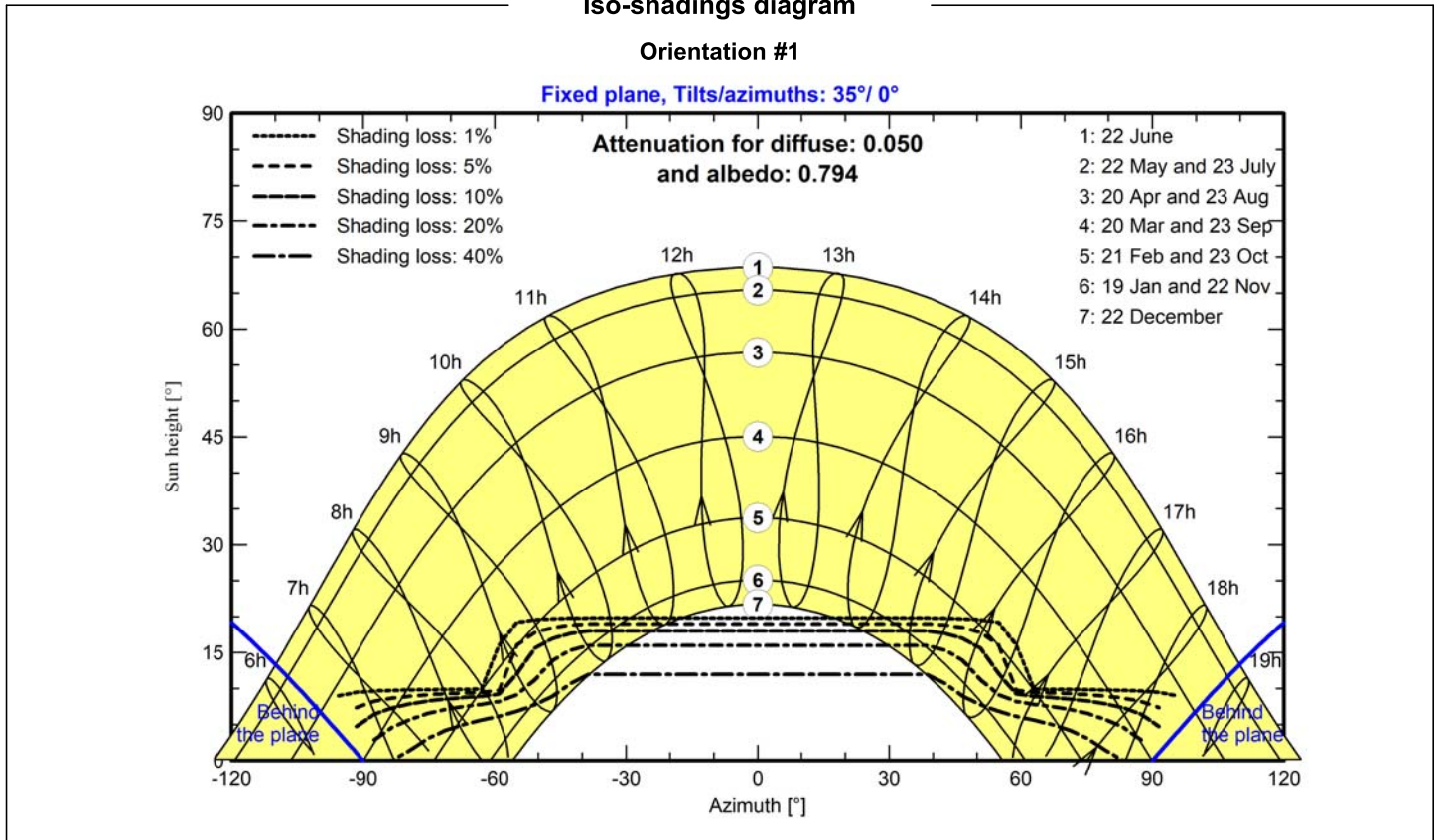




Near shadings parameter



Iso-shadings diagram





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Main results

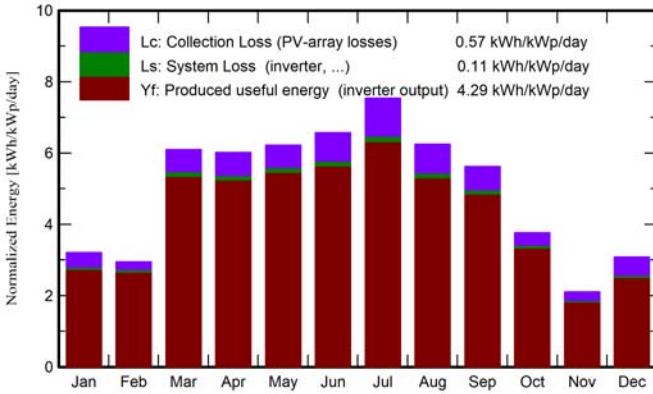
System Production

Produced Energy 73.12 GWh/year

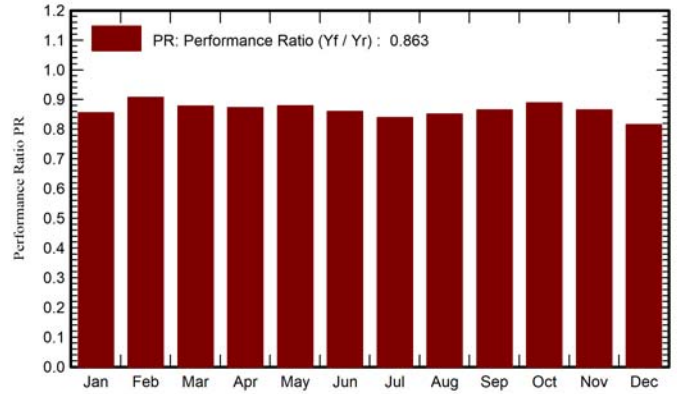
Specific production
Performance Ratio PR

1565 kWh/kWp/year
86.35 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m ²	kWh/m ²	°C	kWh/m ²	kWh/m ²	GWh	GWh	ratio
January	52.8	21.46	4.26	99.3	90.9	4.063	3.966	0.855
February	56.9	31.90	2.35	82.4	76.7	3.584	3.494	0.907
March	138.2	42.24	9.84	188.8	179.1	7.941	7.746	0.878
April	157.9	58.17	12.98	180.4	169.9	7.543	7.357	0.873
May	190.4	76.12	15.64	192.8	181.2	8.119	7.920	0.879
June	203.4	75.43	21.68	197.1	185.4	8.109	7.913	0.859
July	235.6	64.26	23.24	233.8	220.6	9.391	9.167	0.839
August	178.5	68.52	21.95	193.6	182.1	7.889	7.701	0.851
September	135.3	53.08	17.82	168.6	159.1	6.978	6.811	0.865
October	81.0	39.52	14.43	116.7	109.9	4.963	4.844	0.889
November	39.8	21.55	9.02	63.2	58.2	2.627	2.557	0.865
December	46.8	19.05	2.06	95.6	84.4	3.733	3.643	0.816
Year	1516.6	571.30	13.00	1812.3	1697.5	74.941	73.119	0.863

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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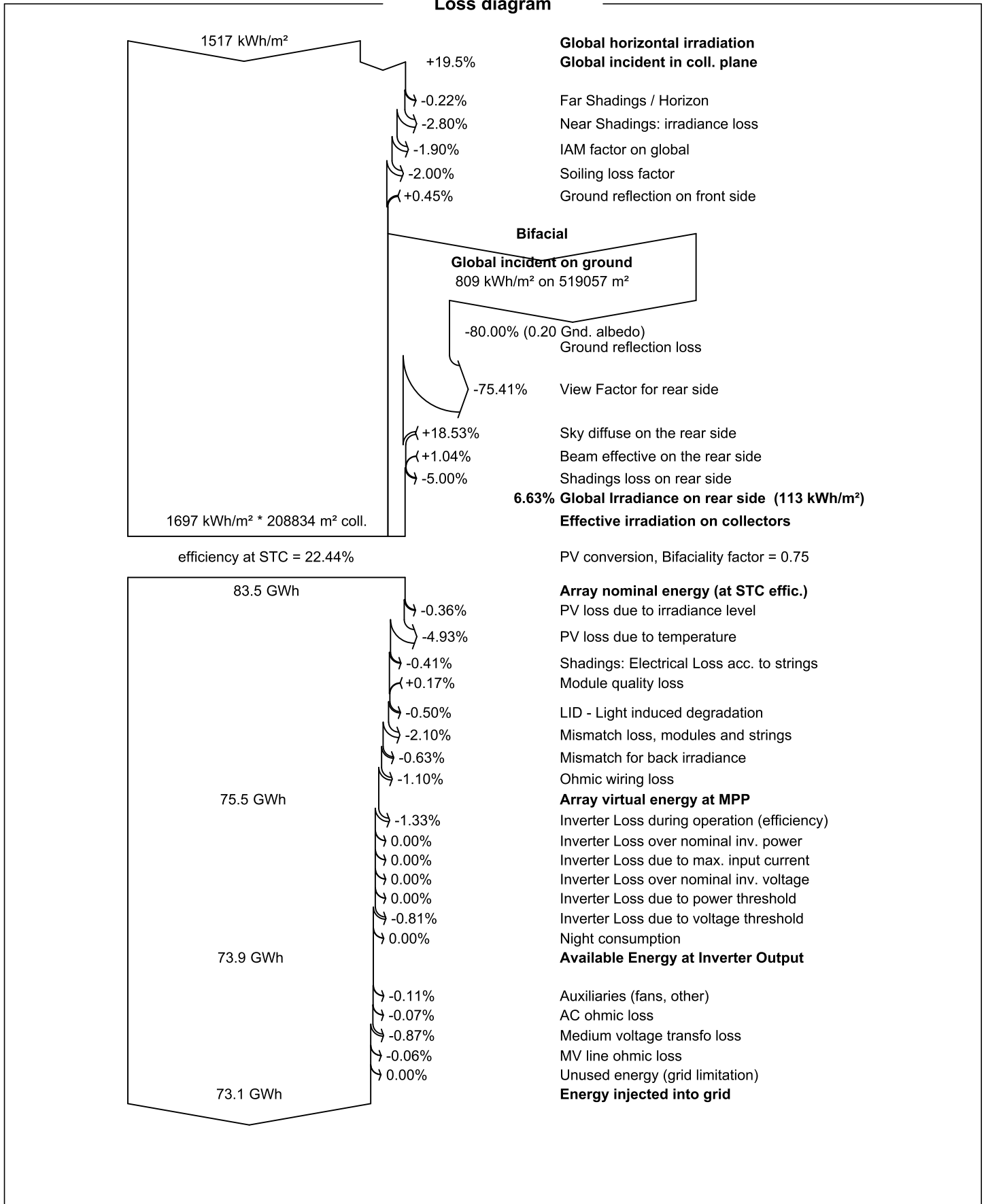
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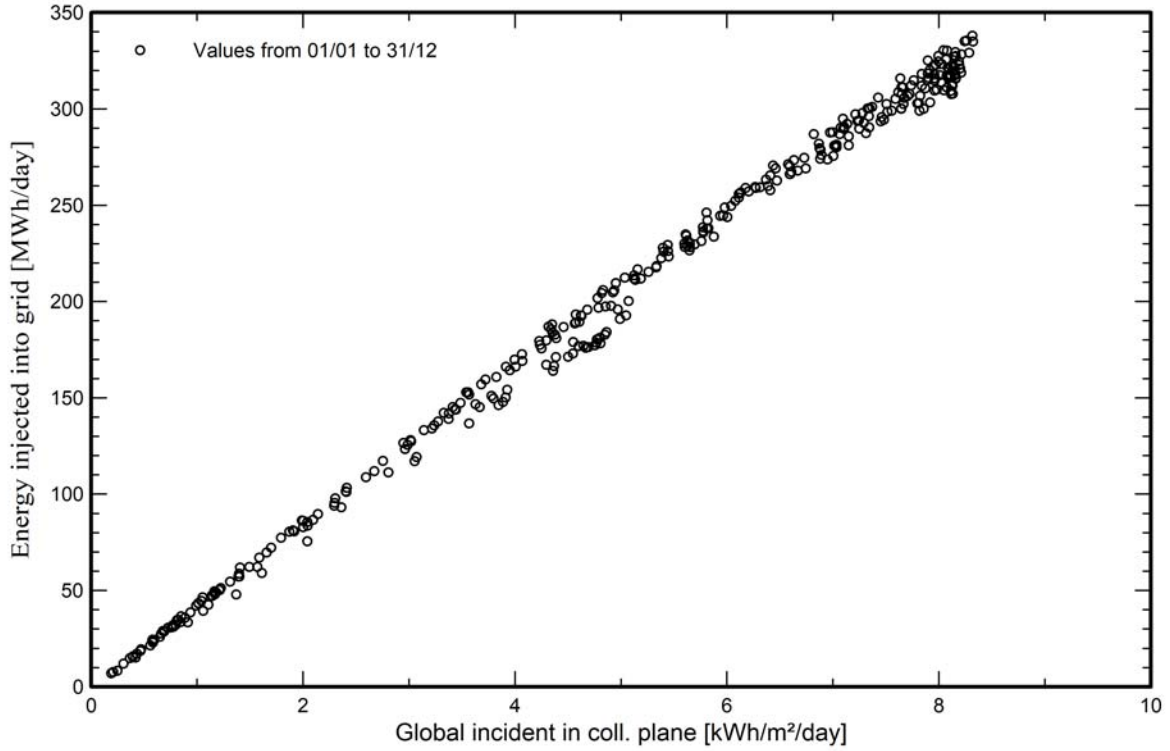
Loss diagram



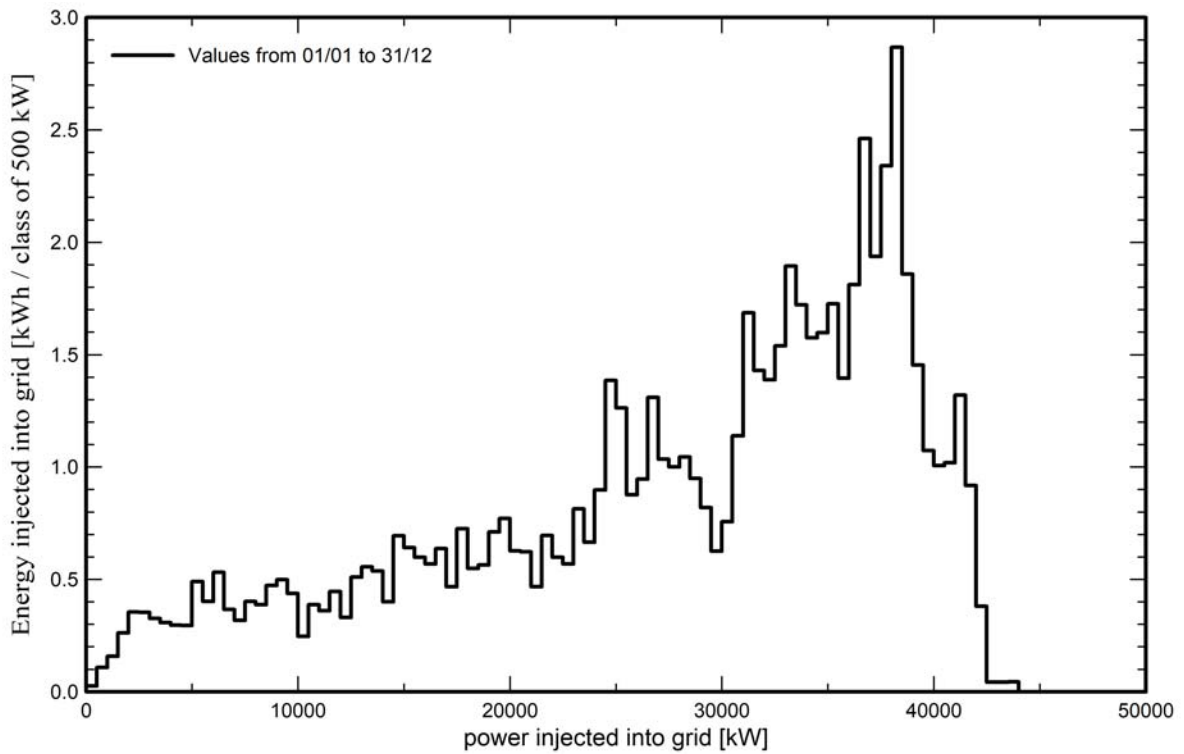


Special graphs

Daily Input/Output diagram



System Output Power Distribution





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CO₂ Emission Balance

Total: 715575.4 tCO₂

Generated emissions

Total: 89510.89 tCO₂

Source: Detailed calculation from table below:

Replaced Emissions

Total: 927876.4 tCO₂

System production: 73118.71 MWh/yr

Grid Lifecycle Emissions: 423 gCO₂/kWh

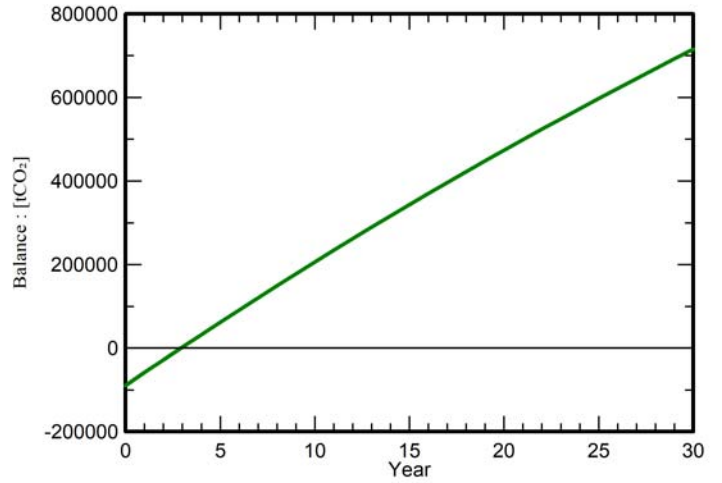
Source: IEA List

Country: Italy

Lifetime: 30 years

Annual degradation: 1.0 %

Saved CO₂ Emission vs. Time



System Lifecycle Emissions Details

Item	LCE	Quantity	Subtotal
			[kgCO ₂]
Modules	1713 kgCO ₂ /kWp	46723 kWp	80024204
Supports	2.82 kgCO ₂ /kg	3361400 kg	9483888
Inverters	280 kgCO ₂ /units	10.00 units	2795