Comune di Manciano,
Provincia di Grosseto, Regione Toscana

ARNG SOLAR VI S.R.L.

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Impianto Agrivoltaico "MANCIANO 24.48"

PD01_21 – SIMULAZIONE ENERGETICA (PVSYST)

PROGETTISTI	IL PROPONENTE
Coordinamento tecnico di progetto	
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	GIUGNO 2023

Version 7.3.1

PVsyst - Simulation report

Grid-Connected System

Project: ITS2MA - Manciano

Variant: Manciano_Tracker.1P(14-28)_690Wp.Bif_Pitch=4.5m

Tracking system with backtracking

System power: 27.55 MWp

Manciano - Italy

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Project summary

Geographical Site
Manciano
Italy

Situation

Latitude	42.47 °N
Longitude	11.59 °E
Altitude	112 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Manciano
Meteonorm 8.0 (1991-2014), Sat=100% - Sintético

System summary

Grid-Connected System
Simulation for year no 1

Tracking system with backtracking

PV Field Orientation

Orientation	
Tracking plane, tilted axis	
Avg axis tilt	1.7 °
Avg axis azim.	0 °

Tracking algorithm
Irradiance optimization
Backtracking activated

Near Shadings
According to strings
Electrical effect 100 %

System information

PV Array

Nb. of modules	39928 units
Pnom total	27.55 MWp

Inverters

Nb. of units	95 units
Pnom total	31.35 MWac
Grid power limit	24.48 MWac
Grid lim. Pnom ratio	1.125

User's needs
Unlimited load (grid)

Results summary

Produced Energy	43899 MWh/year	Specific production	1593 kWh/kWp/year	Perf. Ratio PR	82.97 %

Table of contents

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General parameters

Grid-Connected System

Tracking system with backtracking

PV Field Orientation

Orientation

Tracking plane, tilted axis	
Avg axis tilt	1.7 °
Avg axis azim.	0 °

Tracking algorithm

Irradiance optimization	
Backtracking activated	

Backtracking array

Nb. of trackers	1592 units

Sizes

Tracker Spacing	4.50 m
Collector width	2.38 m
Ground Cov. Ratio (GCR)	53.0 %
Phi min / max.	-/+ 60.0 °

Backtracking strategy

Phi limits for BT	-/+ 79.9 °
Backtracking pitch	4.47 m
Backtracking width	2.38 m

Models used

Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon

Average Height	3.9 °

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	4.50 m
Tracker width	2.38 m
GCR	53.0 %
Axis height above ground	2.64 m

Bifacial model definitions

Ground albedo	0.20
Bifaciality factor	85 %
Rear shading factor	5.0 %
Rear mismatch loss	10.0 %
Shed transparent fraction	0.0 %

Grid power limitation

Active Power	24.48 MWac
Pnom ratio	1.125

PV Array Characteristics

PV module

Manufacturer	Risen Energy Co., Ltd
Model	RSM132-8-690BHDG
(Custom parameters definition)	
Unit Nom. Power	690 Wp
Number of PV modules	39928 units
Nominal (STC)	27.55 MWp
Modules	1426 Strings x 28 In series
At operating cond. (50°C)	
Pmpp	25.98 MWp
U mpp	1076 V
I mpp	24139 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H1-Preliminary V0.1
(Custom parameters definition)	
Unit Nom. Power	330 kWac
Number of inverters	95 units
Total power	31350 kWac
Operating voltage	500-1500 V
Pnom ratio (DC:AC)	0.88
Power sharing within this inverter	

Total PV power

Nominal (STC)	27550 kWp
Total	39928 modules
Module area	124030 m²
Cell area	116214 m²

Total inverter power

Total power	31350 kWac
Number of inverters	95 units
Pnom ratio	0.88

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Array losses

Array Soiling Losses
Loss Fraction 2.5 %

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

DC wiring losses
Global array res. 0.72 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 0.5 %

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

IAM loss factor
Incidence effect (IAM): User defined profile

0°	20°	40°	60°	70°	75°	80°	85°	90°
1.000	1.000	1.000	1.000	0.992	0.977	0.945	0.852	0.000

System losses

Auxiliaries loss
constant (fans) 10.00 kW
0.0 kW from Power thresh.
Night aux. cons. 7.00 kW

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 800 Vac tri
Loss Fraction 1.29 % at STC
Inverter: SUN2000-330KTL-H1-Preliminary V0.1
Wire section (95 Inv.) Alu 95 x 3 x 240 mm²
Average wires length 220 m

MV line up to Injection
MV Voltage 36 kV
Wires Alu 3 x 700 mm²
Length 2930 m
Loss Fraction 0.28 % at STC

AC losses in transformers

MV transfo
Medium voltage 36 kV
Transformer parameters
Nominal power at STC 27.08 MVA
Iron Loss (24/24 Connexion) 31.41 kVA
Iron loss fraction 0.12 % at STC
Copper loss 233.97 kVA
Copper loss fraction 0.86 % at STC
Coils equivalent resistance 3 x 0.20 mΩ

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Horizon definition

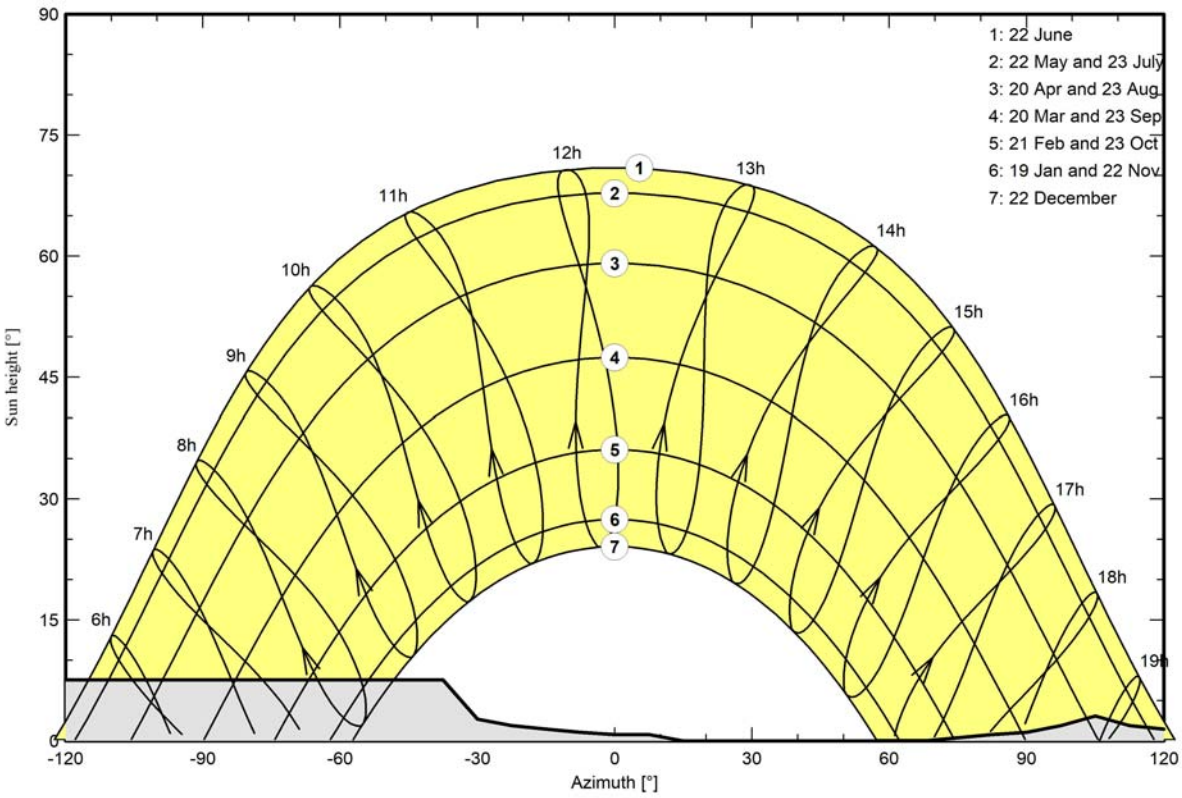
Horizon from PVGIS website API, Lat=42°27''58', Long=11°35''32', Alt=112m

Average Height	3.9 °	Albedo Factor	0.95
Diffuse Factor	0.99	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-38	-30	-23	-15
Height [°]	5.3	6.1	6.5	6.5	6.9	7.6	7.6	2.7	1.9	1.5
Azimuth [°]	-8	0	8	15	68	75	83	90	98	105
Height [°]	1.1	0.8	0.8	0.0	0.0	0.4	0.8	1.1	1.9	3.1
Azimuth [°]	113	120	128	135	143	150	158	165	173	180
Height [°]	1.9	1.5	1.1	1.5	1.9	2.7	4.2	5.0	5.7	5.3

Sun Paths (Height / Azimuth diagram)



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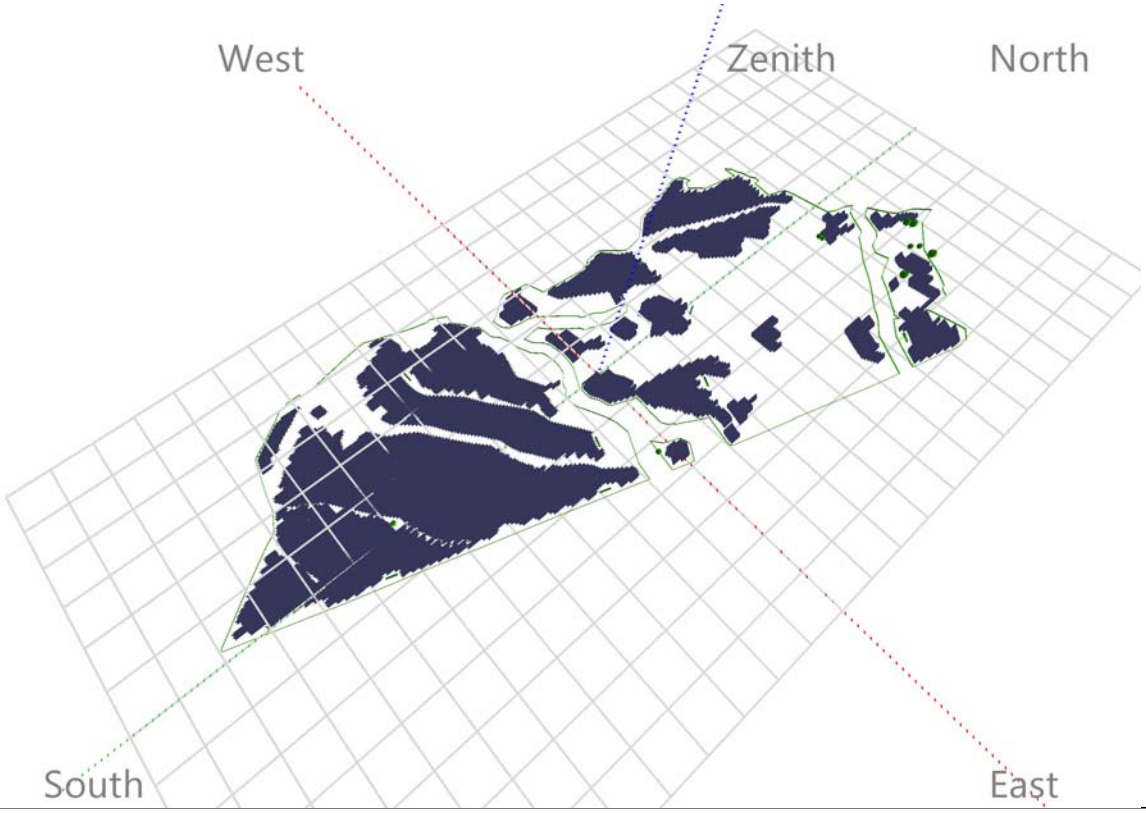
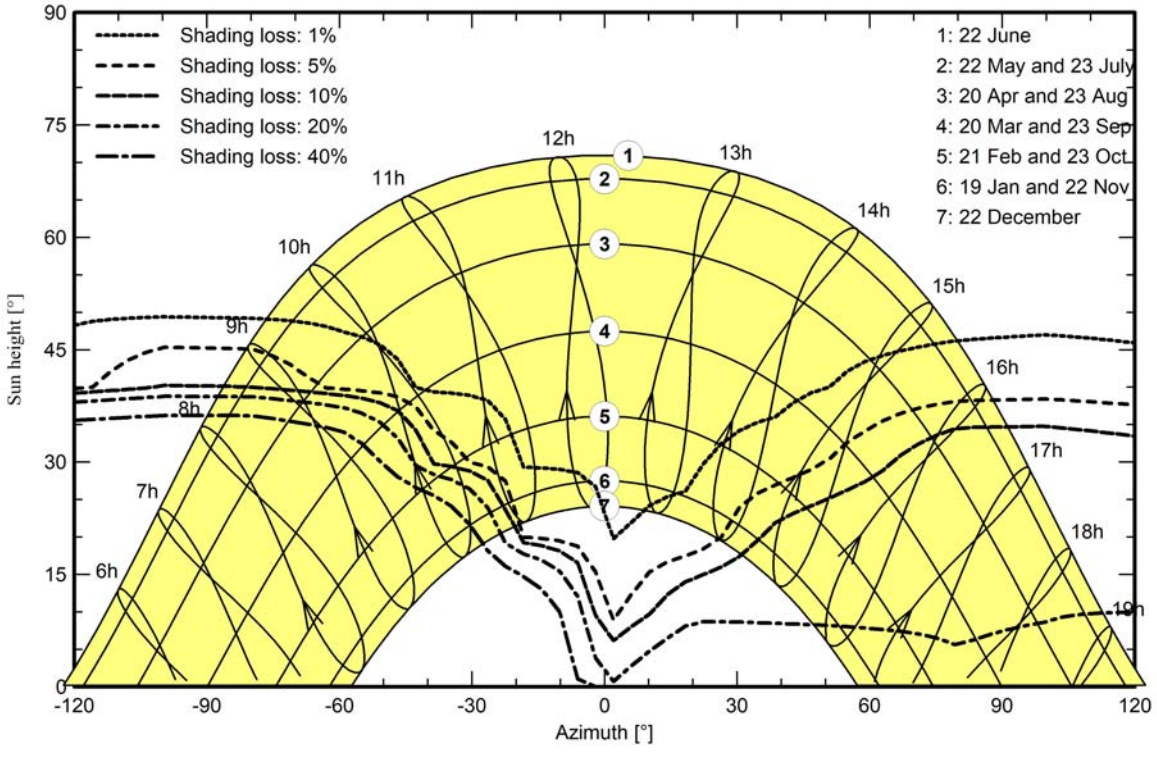
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

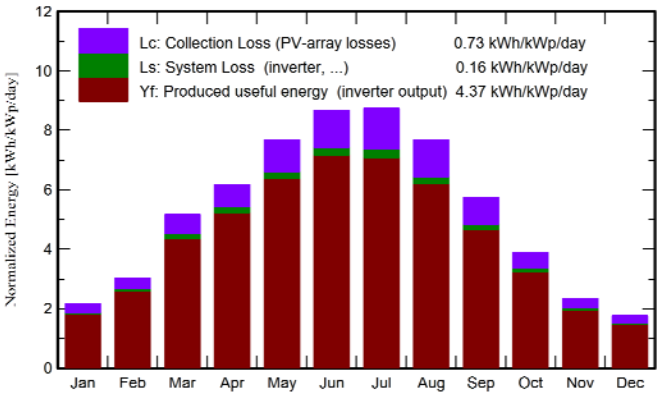


Main results

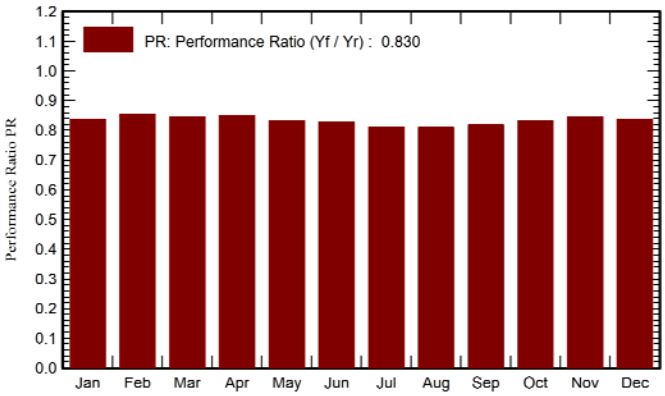
System Production

Produced Energy	43899 MWh/year	Specific production	1593 kWh/kWp/year
		Performance Ratio PR	82.97 %

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	51.3	25.64	6.70	66.7	61.1	1600	1536	0.837
February	66.3	31.69	7.71	84.9	79.3	2075	2000	0.855
March	123.3	48.05	11.02	159.9	149.8	3863	3729	0.846
April	149.5	69.92	14.31	185.1	173.8	4494	4338	0.851
May	189.9	76.86	18.75	238.0	223.8	5659	5456	0.832
June July	208.0	85.71	23.30	259.7	244.0	6157	5937	0.830
August	214.7	75.75	26.19	270.9	254.9	6295	6064	0.813
September	187.7	72.94	25.97	238.6	223.8	5511	5316	0.809
October	133.5	52.06	20.90	172.0	160.9	4019	3876	0.818
November	93.7	44.92	17.04	120.8	112.3	2876	2776	0.834
December	53.2	27.35	11.87	69.8	64.9	1689	1623	0.844
	41.5	21.58	8.04	54.1	49.4	1304	1247	0.837
Year	1512.6	632.49	16.03	1920.5	1798.0	45542	43899	0.830

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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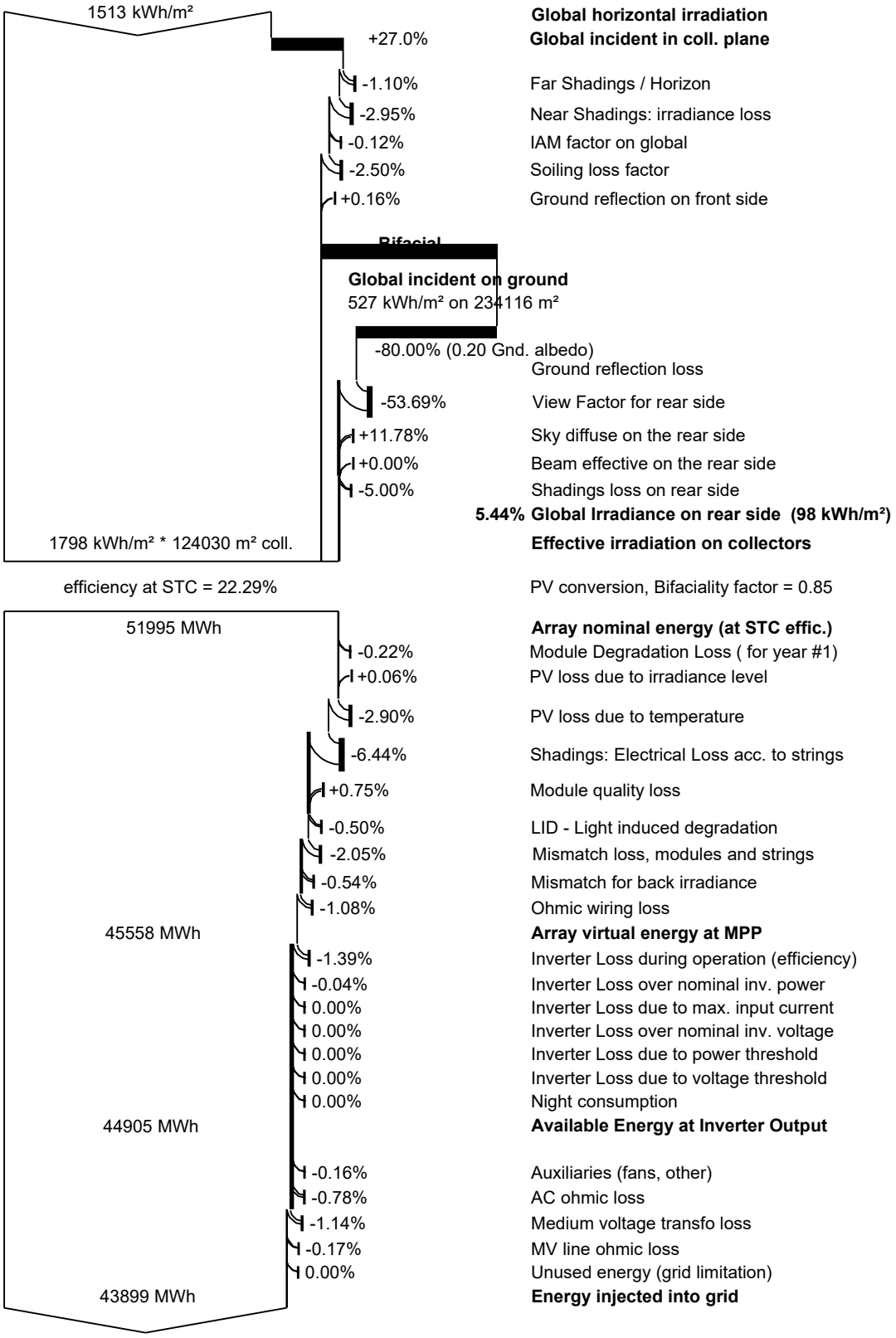
Loss diagram



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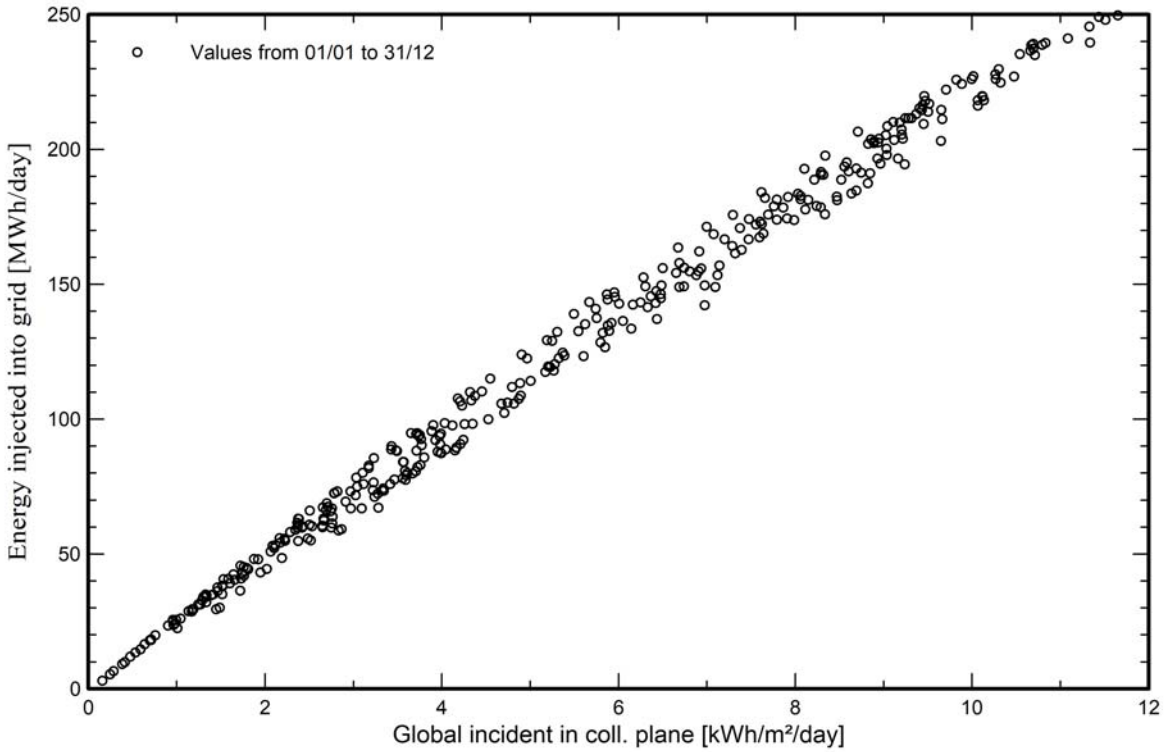
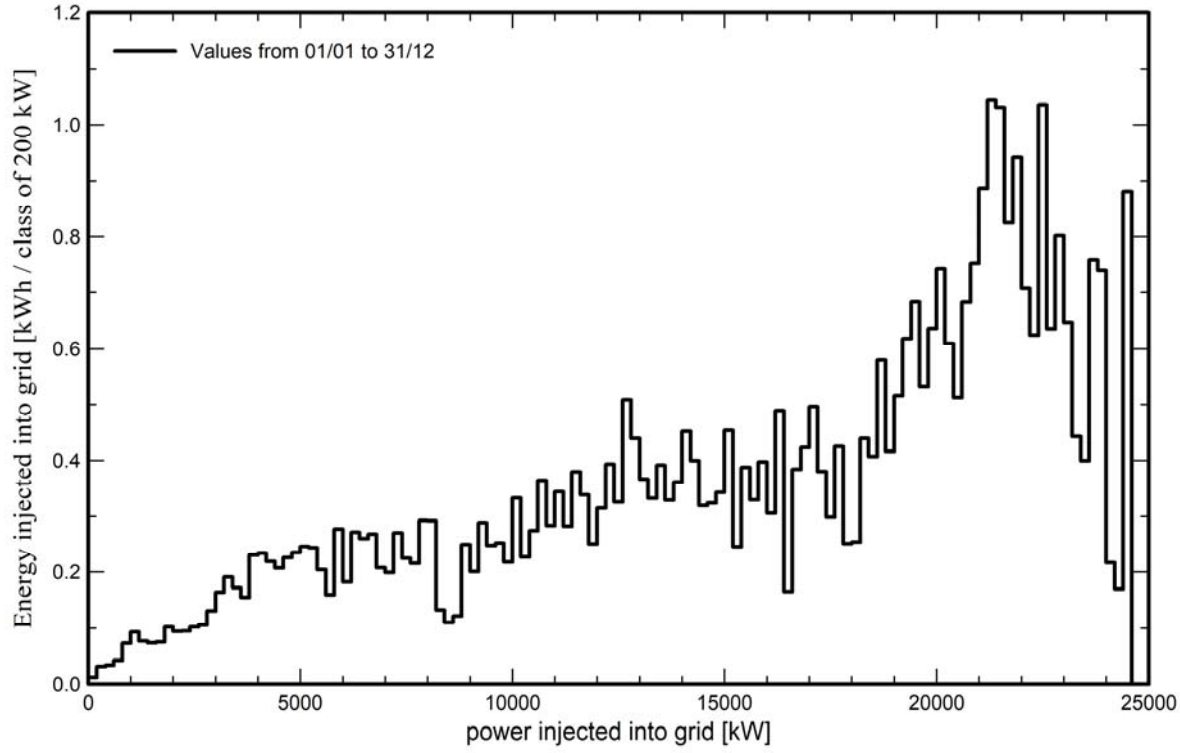
Predef. graphs

Diagrama entrada/salida diaria



Distribución de potencia de salida del sistema



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

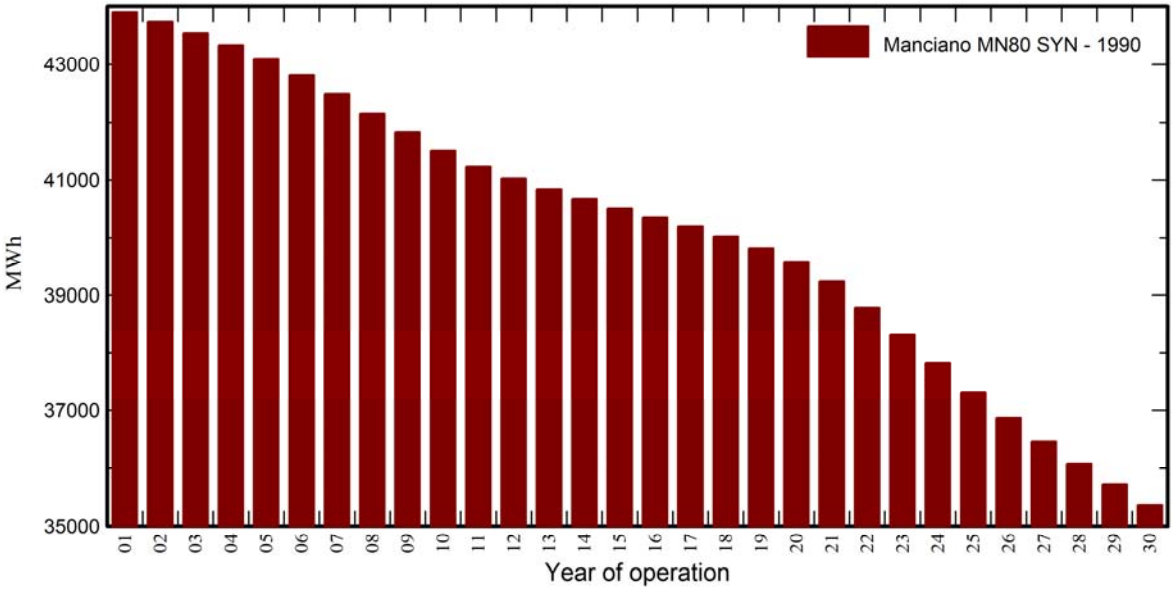
Meteo used in the simulation

#1 Manciano MN80 SYN

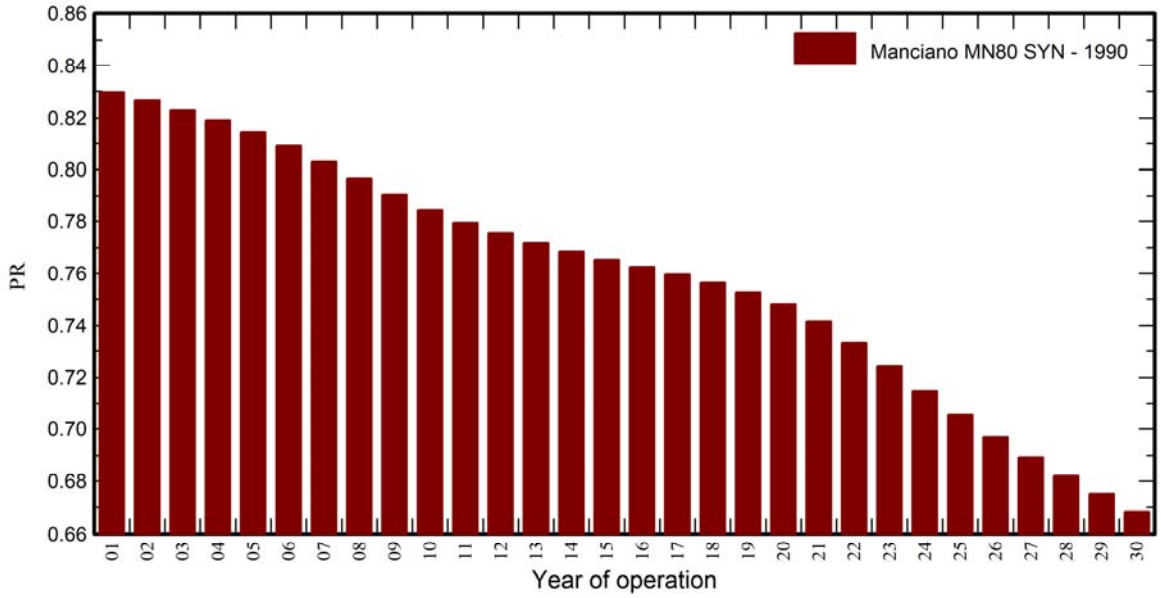
Years 1990 (reference year)

Years simulated 1-30

System output 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

#1 Manciano MN80 SYN

Years 1990 (reference year)
Years simulated 1-30

Manciano MN80 SYN

Year	System output	PR	PR loss
	MWh		%
1	43899	0.83	0%
2	43735	0.827	-0.4%
3	43548	0.823	-0.8%
4	43336	0.819	-1.3%
5	43099	0.815	-1.8%
6	42814	0.809	-2.5%
7	42487	0.803	-3.2%
8	42152	0.797	-4%
9	41820	0.79	-4.7%
10	41500	0.784	-5.5%
11	41236	0.779	-6.1%
12	41030	0.775	-6.5%
13	40842	0.772	-7%
14	40667	0.769	-7.4%
15	40499	0.765	-7.7%
16	40343	0.762	-8.1%
17	40191	0.76	-8.4%
18	40021	0.756	-8.8%
19	39821	0.753	-9.3%
20	39581	0.748	-9.8%
21	39237	0.742	-10.6%
22	38791	0.733	-11.6%
23	38314	0.724	-12.7%
24	37820	0.715	-13.8%
25	37325	0.705	-15%
26	36872	0.697	-16%
27	36468	0.689	-16.9%
28	36084	0.682	-17.8%
29	35718	0.675	-18.6%
30	35372	0.669	-19.4%

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P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.0 (1991-2014), Sat=100%
Kind	Monthly averages
Sintético - Multi-year average	
Year-to-year variability(Variance)	3.0 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	3.5 %

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	1.54 GWh
P50	43.90 GWh
P90	41.93 GWh
P95	41.37 GWh

Probability distribution