

PVsyst - Simulation report

Grid-Connected System

Project: Proyecto Rotello Prodiel

Variant: Proyecto Rotello 52.7_670Wp_1-30

Tracking system with backtracking

System power: 52.70 MWp

Rotello Prodiel - Italy

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VC2, Simulation date:
 14/03/22 17:25
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Project summary

Geographical Site Rotello Prodiel Italy	Situation Latitude 41.77 °N Longitude 15.06 °E Altitude 171 m Time zone UTC+1	Project settings Albedo 0.20
Meteo data Rotello Prodiel Meteonorm 8.0 (1991-2012), Sat=64% - 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 -0.6 ° Avg axis azim. 0.0 °	Tracking algorithm Astronomic calculation Backtracking activated	Near Shadings Linear shadings
System information PV Array Nb. of modules 78660 units Pnom total 52.70 MWp	Inverters Nb. of units 274 units Pnom total 54.80 MWac Grid power limit 45.14 MWac Grid lim. Pnom ratio 1.168	
User's needs Unlimited load (grid)		

Results summary

Produced Energy	85709 MWh/year	Specific production	1626 kWh/kWp/year	Perf. Ratio PR	87.66 %
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General parameters

Grid-Connected System		Tracking system with backtracking	
PV Field Orientation		Tracking algorithm	
Orientation		Astronomic calculation	
Tracking plane, tilted axis		Backtracking activated	
Avg axis tilt	-0.6 °		
Avg axis azim.	0.0 °		
		Backtracking strategy	
		Nb. of trackers	2622 units
		Sizes	
		Tracker Spacing	5.42 m
		Collector width	2.38 m
		Ground Cov. Ratio (GCR)	44.0 %
		Phi min / max.	-/+ 60.0 °
		Backtracking limit angle	
		Phi limits	+/- 63.8 °
Models used			
Transposition	Perez		
Diffuse	Perez, Meteonorm		
Circumsolar	separate		
Horizon		Near Shadings	
Average Height	1.0 °	Linear shadings	
Bifacial system		User's needs	
Model	2D Calculation unlimited trackers	Unlimited load (grid)	
Bifacial model geometry		Bifacial model definitions	
Tracker Spacing	5.42 m	Ground albedo	0.20
Tracker width	2.38 m	Bifaciality factor	70 %
GCR	44.0 %	Rear shading factor	5.0 %
Axis height above ground	1.60 m	Rear mismatch loss	10.0 %
		Shed transparent fraction	0.0 %
Grid power limitation			
Active Power	45.14 MWac		
Pnom ratio	1.168		

PV Array Characteristics

PV module		Inverter	
Manufacturer	Trina Solar	Manufacturer	Huawei Technologies
Model	TSM-670DEG21C.20	Model	SUN2000-215KTL-H3
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	670 Wp	Unit Nom. Power	200 kWac
Number of PV modules	78660 units	Number of inverters	274 units
Nominal (STC)	52.70 MWp	Total power	54800 kWac
Modules	2622 Strings x 30 In series	Operating voltage	500-1500 V
At operating cond. (50°C)		Max. power (=>33°C)	215 kWac
Pmpp	48.20 MWp	Pnom ratio (DC:AC)	0.96
U mpp	1041 V		
I mpp	46296 A		
Total PV power		Total inverter power	
Nominal (STC)	52702 kWp	Total power	54800 kWac
Total	78660 modules	Nb. of inverters	274 units
Module area	244346 m²	Pnom ratio	0.96
Cell area	228948 m²		



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Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Thermal Loss factor

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

DC wiring losses

Global array res. 0.37 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 1.6 %

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 0.45 %/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°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.999	0.994	0.969	0.929	0.830	0.589	0.000

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 800 Vac tri
 Loss Fraction 1.43 % at STC

Inverter: SUN2000-215KTL-H3

Wire section (274 Inv.) Alu 274 x 3 x 150 mm²
 Average wires length 230 m

MV line up to Injection

MV Voltage 30 kV
 Wires Alu 3 x 1000 mm²
 Length 2600 m
 Loss Fraction 0.47 % at STC

AC losses in transformers

MV transfo

Grid voltage 30 kV

Operating losses at STC

Nominal power at STC 51790 kVA
 Iron loss (24/24 Connexion) 51.79 kW
 Loss Fraction 0.10 % at STC
 Coils equivalent resistance 3 x 0.12 mΩ
 Loss Fraction 1.00 % at STC



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Horizon definition

Horizon from PVGIS website API, Lat=41°46'22', Long=15°3'43', Alt=171m

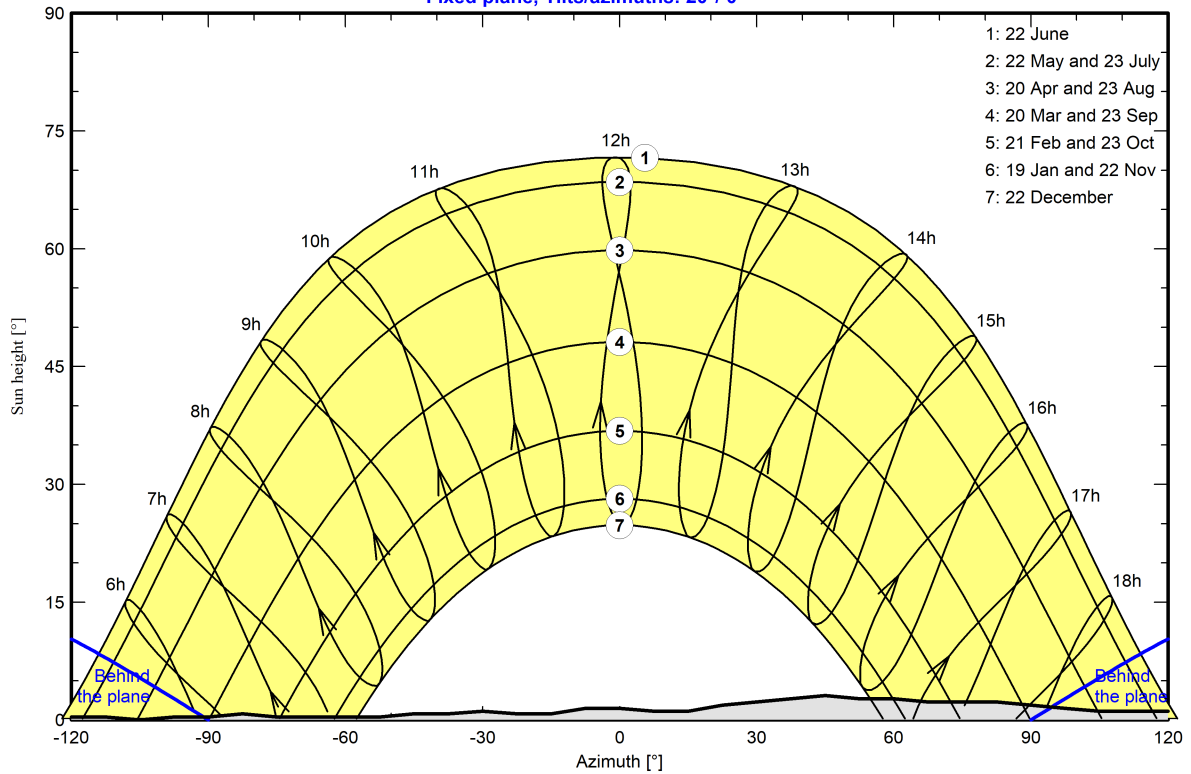
Average Height	1.0 °	Albedo Factor	0.91
Diffuse Factor	0.98	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-158	-150	-113	-105	-98	-90	-83	-75	-53	-45	-38	-30
Height [°]	0.0	0.0	0.4	0.4	0.0	0.4	0.4	0.8	0.4	0.4	0.8	0.8	1.1
Azimuth [°]	-23	-15	-8	0	8	15	23	30	38	45	53	60	68
Height [°]	0.8	0.8	1.5	1.5	1.1	1.1	1.9	2.3	2.7	3.1	2.7	2.7	2.3
Azimuth [°]	83	90	98	105	120	128	143	150	165	173	180		
Height [°]	2.3	1.9	1.5	1.1	1.1	0.8	0.8	0.4	0.4	0.0	0.0		

Sun Paths (Height / Azimuth diagram)

Fixed plane, Tilts/azimuths: 20°/ 0°

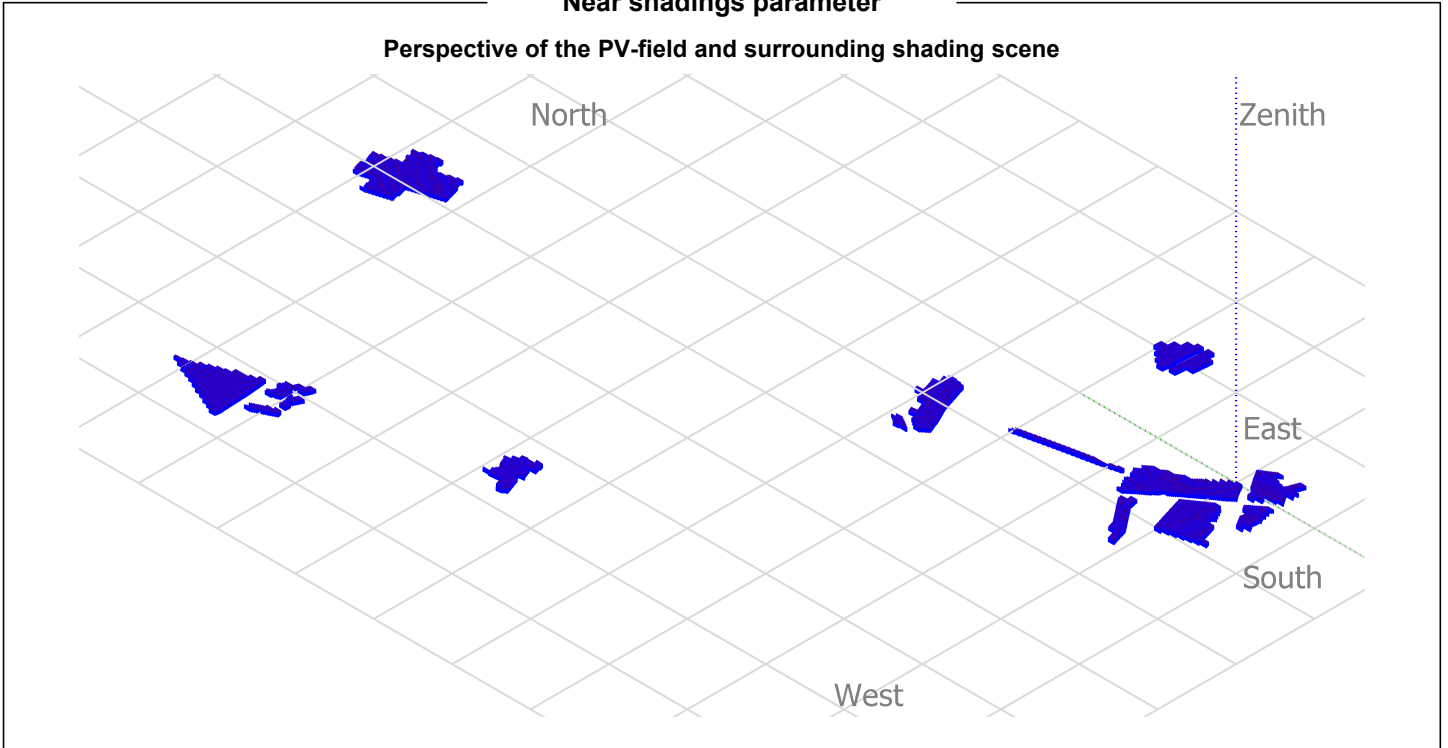




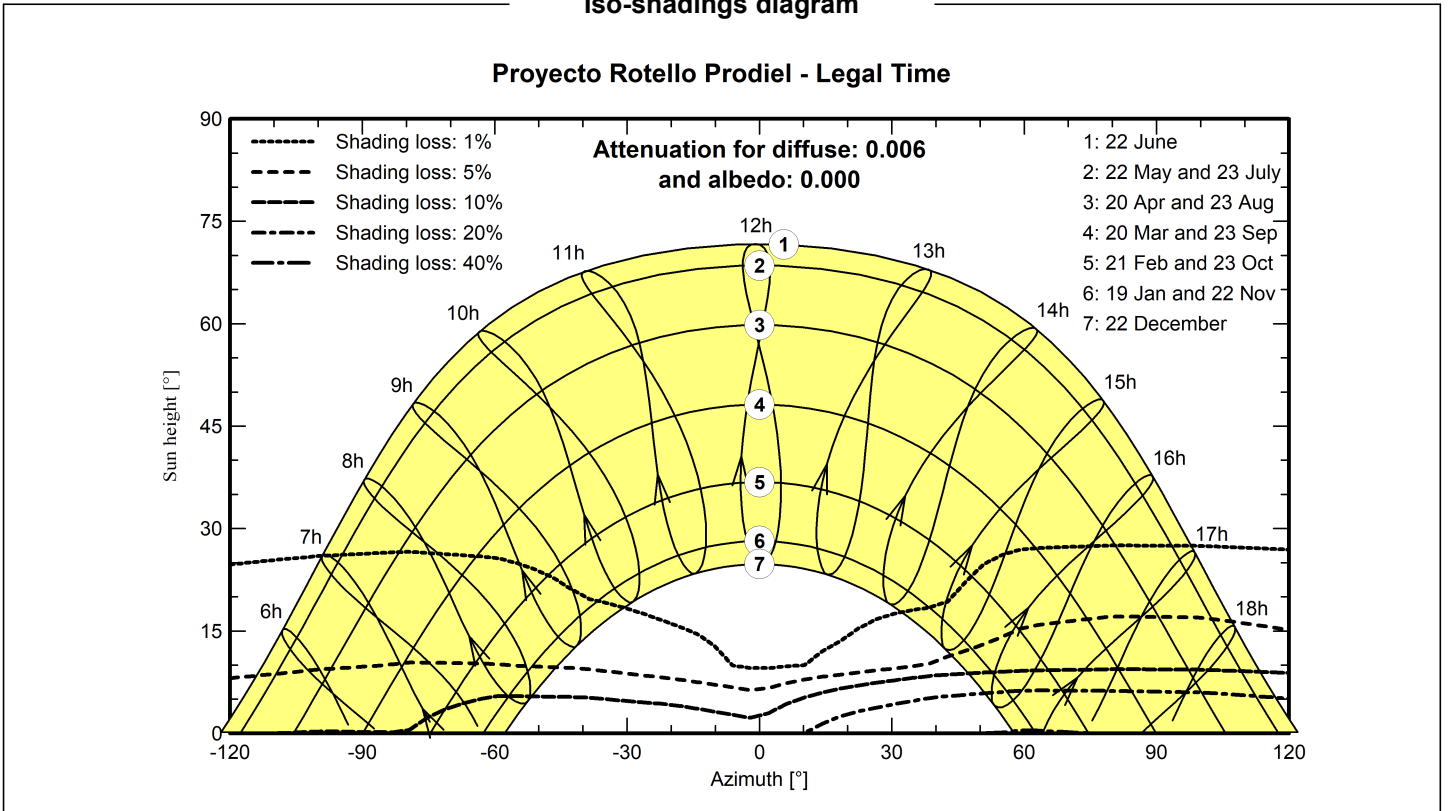
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Near shadings parameter



Iso-shadings diagram





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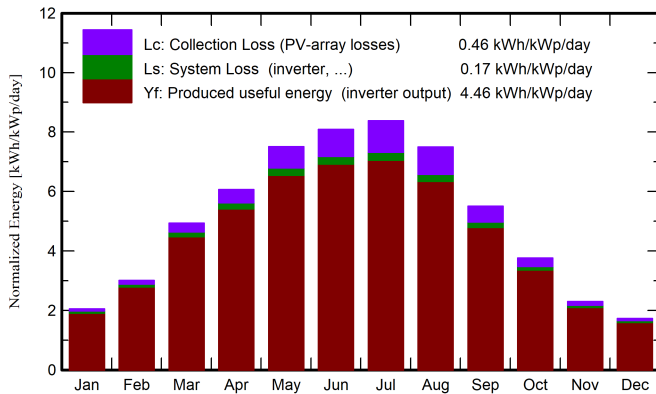
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Main results

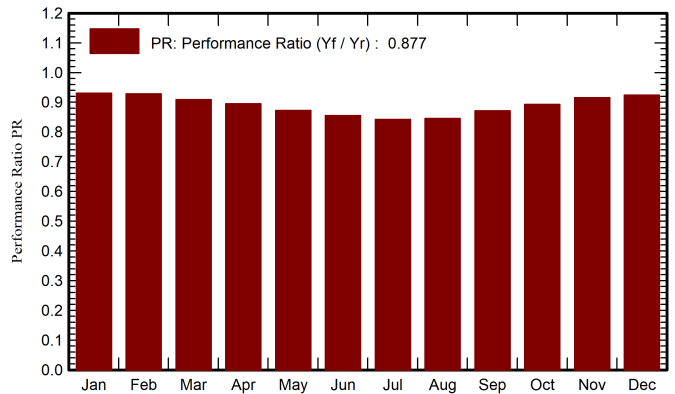
System Production

Produced Energy **85709 MWh/year** Specific production **1626 kWh/kWp/year**
 Performance Ratio PR **87.66 %**

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 MWh	E_Grid MWh	PR ratio
January	50.0	26.88	7.79	63.7	59.6	3238	3122	0.931
February	66.4	33.30	8.29	84.3	79.3	4268	4126	0.929
March	119.9	54.21	11.31	152.9	144.5	7585	7324	0.909
April	145.2	67.86	14.19	181.9	172.6	8892	8575	0.895
May	183.9	82.03	19.51	232.9	221.2	11110	10704	0.872
June	195.3	85.39	24.53	242.8	231.1	11364	10947	0.855
July	202.9	83.61	27.38	259.8	247.2	11967	11525	0.842
August	180.5	74.53	27.08	232.4	220.9	10756	10362	0.846
September	128.4	53.74	21.51	165.2	156.4	7869	7590	0.872
October	91.3	42.47	17.54	116.7	110.1	5688	5493	0.893
November	54.5	30.57	12.52	69.0	64.6	3449	3329	0.915
December	42.7	24.37	8.93	53.6	49.9	2712	2611	0.925
Year	1460.9	658.97	16.77	1855.1	1757.6	88898	85709	0.877

Legends

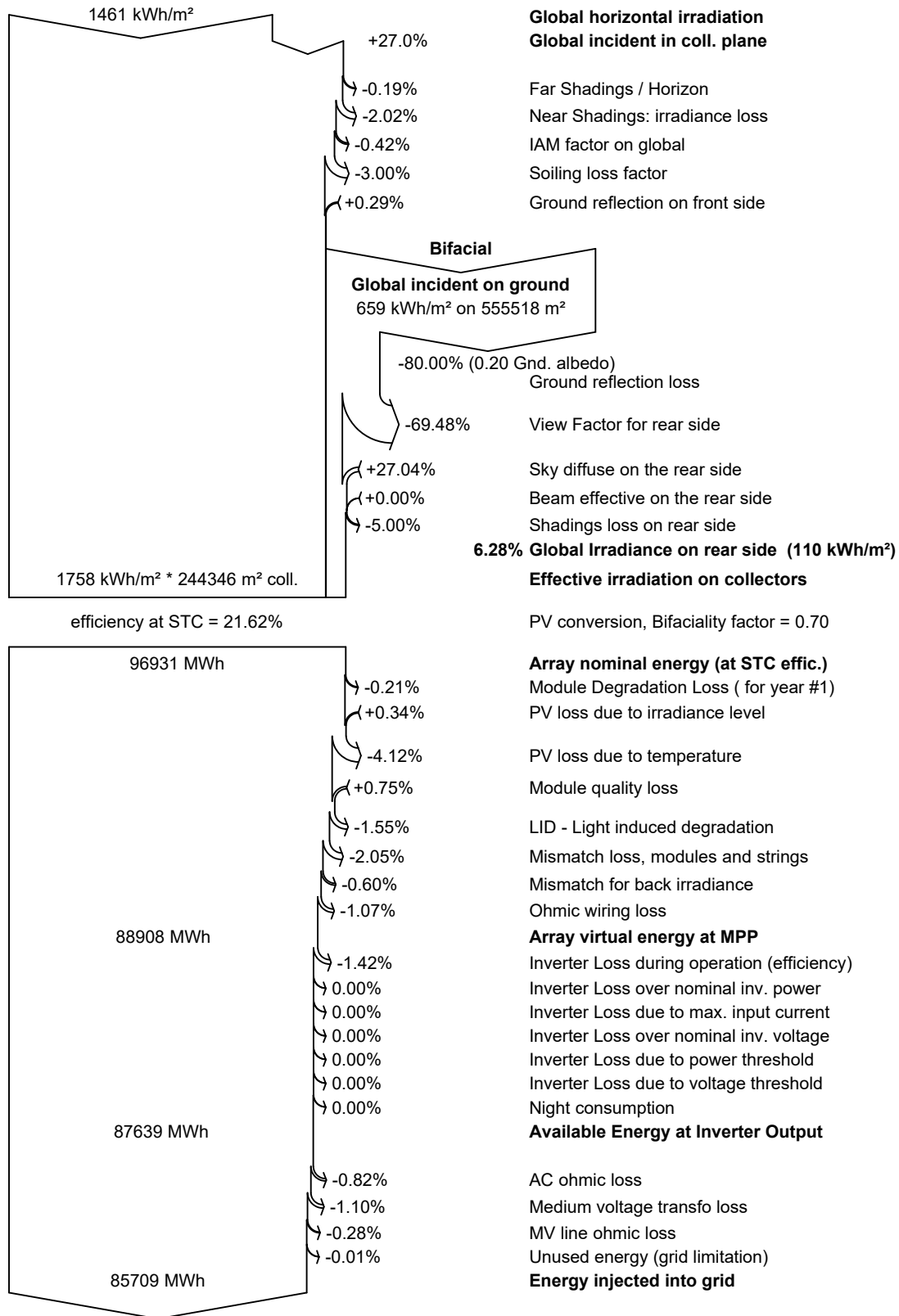
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		



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Loss diagram



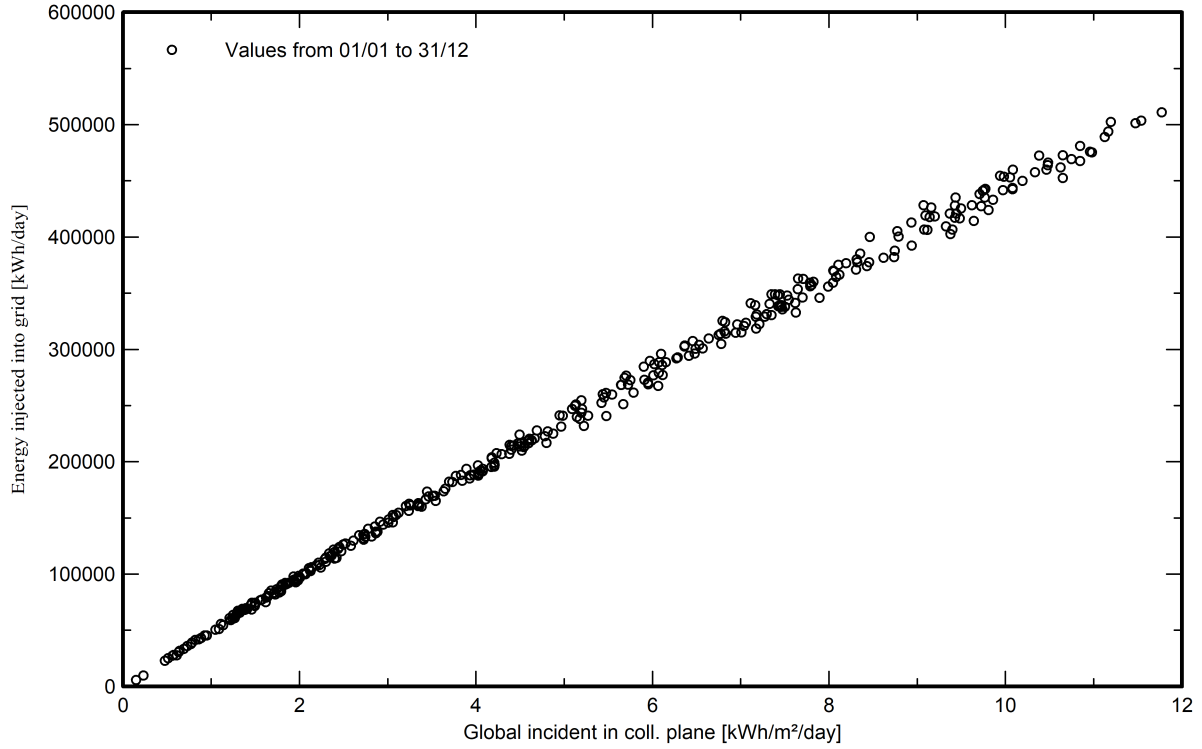


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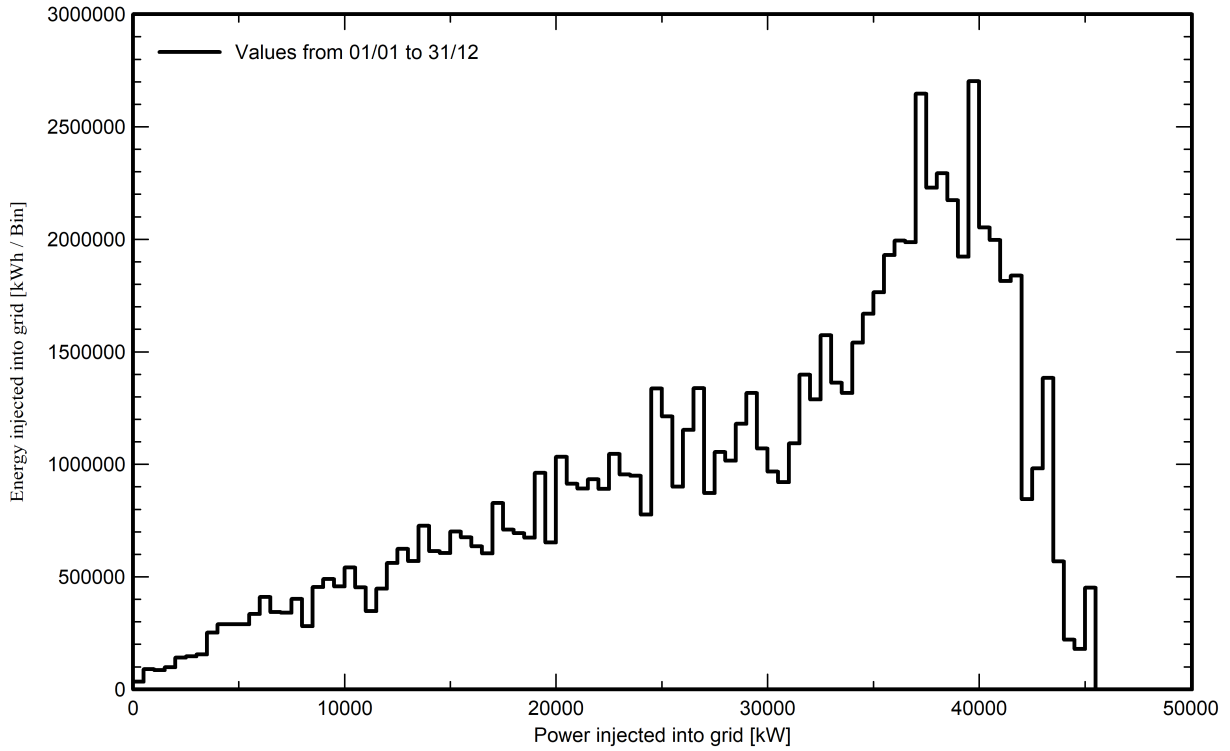
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Special graphs

Diagrama entrada/salida diaria



Distribución de potencia de salida del sistema





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Aging Tool

Aging Parameters

Time span of simulation 30 years

Module average degradation

Loss factor 0.45 %/year

Mismatch due to degradation

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

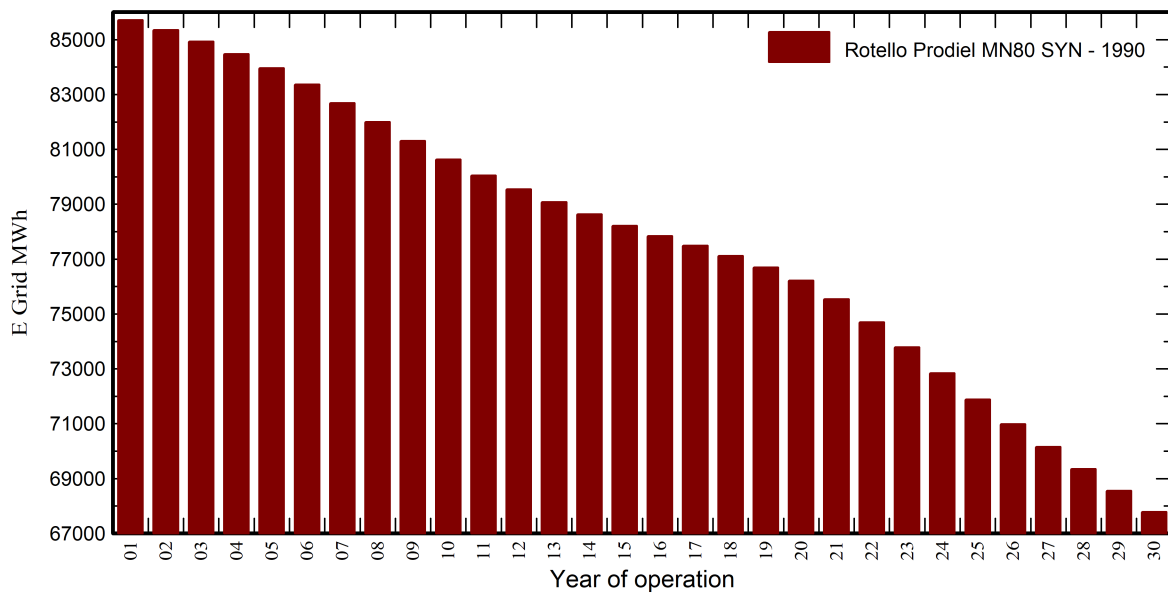
Meteo used in the simulation

#1 Rotello Prodiel MN80 SYN

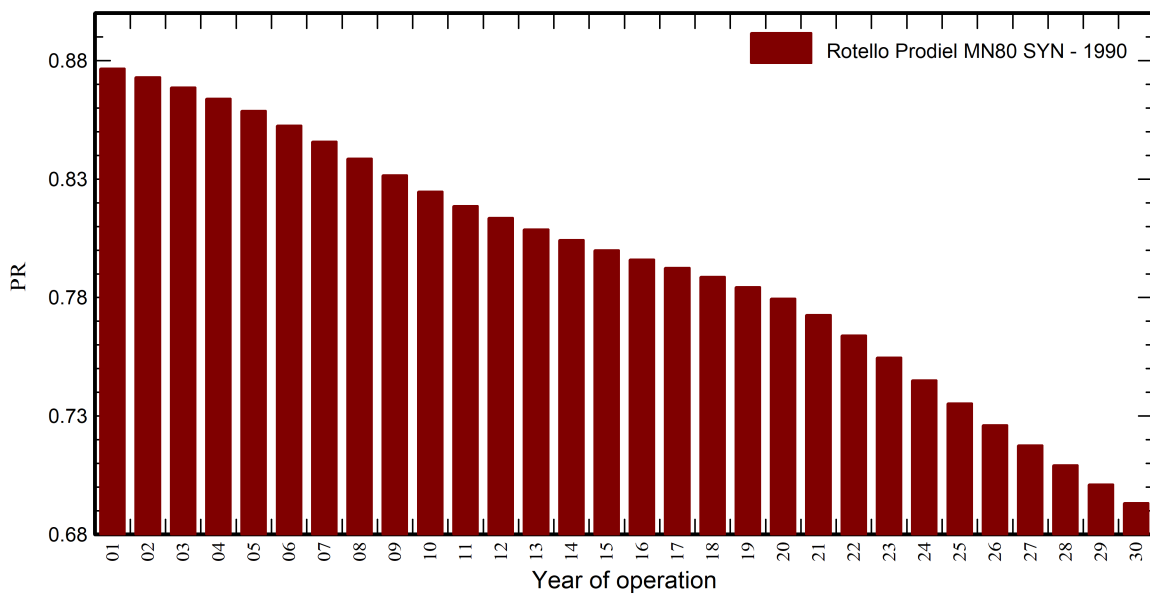
Years 1990 (reference year)

Years simulated 1-30

Energy injected into grid



Performance Ratio





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Aging Tool

Aging Parameters

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Meteo used in the simulation

#1 Rotello Prodiel MN80 SYN

Years 1990 (reference year)

Years simulated 1-30

Rotello Prodiel MN80 SYN

Year	E Grid MWh	PR	PR loss %
1	85709	0.877	0%
2	85345	0.873	-0.4%
3	84932	0.869	-0.9%
4	84469	0.864	-1.4%
5	83957	0.859	-2%
6	83360	0.853	-2.7%
7	82687	0.846	-3.5%
8	81996	0.839	-4.3%
9	81304	0.832	-5.1%
10	80629	0.825	-5.9%
11	80040	0.819	-6.6%
12	79540	0.814	-7.2%
13	79073	0.809	-7.7%
14	78632	0.804	-8.3%
15	78209	0.8	-8.8%
16	77832	0.796	-9.2%
17	77485	0.793	-9.6%
18	77113	0.789	-10%
19	76695	0.784	-10.5%
20	76208	0.779	-11.1%
21	75540	0.773	-11.9%
22	74693	0.764	-12.9%
23	73786	0.755	-13.9%
24	72842	0.745	-15%
25	71885	0.735	-16.1%
26	70985	0.726	-17.2%
27	70152	0.718	-18.2%
28	69340	0.709	-19.1%
29	68547	0.701	-20%
30	67775	0.693	-20.9%



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P50 - P90 evaluation

Meteo data

Source Meteororm 8.0 (1991-2012), Sat=64%
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 3.00 GWh
P50 85.71 GWh
P90 81.86 GWh
P95 80.78 GWh

Probability distribution

