

PVsyst - Simulation report

Grid-Connected System

Project: Proyecto Rotello 52

Variant: Proyecto Rotello 52 Fixed_52.43MWp_1-30

Ground system (tables) on a hill

System power: 52.43 MWp

Rotello 55 - Italy

RENERGEIA S.A



**PVsyst V7.2.8**

VC3, Simulation date:
02/02/22 10:24
with v7.2.8

Project summary**Geographical Site****Rotello 55**

Italy

Situation

Latitude 41.75 °N
Longitude 15.05 °E
Altitude 238 m
Time zone UTC+1

Project settings

Albedo 0.20

Meteo data

Rotello 55

Meteonorm 8.0 (1991-2012), Sat=90% - Sintético

System summary**Grid-Connected System**

Simulation for year no 1

Ground system (tables) on a hill**PV Field Orientation**

Fixed plane

Tilt/Azimuth 25 / 0 °

Near Shadings

Linear shadings

User's needs

Unlimited load (grid)

System information**PV Array**

Nb. of modules 79440 units
Pnom total 52.43 MWp

Inverters

Nb. of units 260 units
Pnom total 53.04 MWac
Grid power limit 42.92 MWac
Grid lim. Pnom ratio 1.222

Results summary

Produced Energy 70023 MWh/year Specific production 1336 kWh/kWp/year Perf. Ratio PR 80.11 %

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General parameters

Grid-Connected System

PV Field Orientation

Orientation

Fixed plane
Tilt/Azimuth 25 / 0 °

Horizon

Average Height 4.2 °

Grid power limitation

Active Power 42.92 MWac
Pnom ratio 1.222

Ground system (tables) on a hill

Sheds configuration

Nb. of sheds 743 units

Sizes

Sheds spacing 7.50 m
Collector width 4.79 m
Ground Cov. Ratio (GCR) 63.8 %

Shading limit angle

Limit profile angle 32.9 °

Near Shadings

Linear shadings

Models used

Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

User's needs

Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer Trina Solar
Model TSM-660DE21

(Custom parameters definition)

Unit Nom. Power 660 Wp
Number of PV modules 79440 units
Nominal (STC) 52.43 MWp
Modules 2648 Strings x 30 In series

At operating cond. (51°C)

Pmpp 47.83 MWp
U mpp 1022 V
I mpp 46792 A

Total PV power

Nominal (STC) 52430 kWp
Total 79440 modules
Module area 246769 m²
Cell area 231218 m²

Inverter

Manufacturer Huawei Technologies
Model SUN2000-215KTL-H0

(Custom parameters definition)

Unit Nom. Power 204 kWac
Number of inverters 260 units
Total power 53040 kWac
Operating voltage 500-1500 V
Max. power (=>33°C) 215 kWac
Pnom ratio (DC:AC) 0.99

Total inverter power

Total power 53040 kWac
Nb. of inverters 260 units
Pnom ratio 0.99

Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Serie Diode Loss

Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

Module mismatch losses

Loss Fraction 2.0 % at MPP

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 0.7 %

Strings Mismatch loss

Loss Fraction 0.1 %

DC wiring losses

Global array res. 0.36 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss

Loss Fraction -0.8 %

Module average degradation

Year no 1
Loss factor 0.55 %/year

Mismatch due to degradation

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



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Array losses

IAM loss factor

Incidence effect (IAM): User defined profile

0°	40°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.998	0.992	0.983	0.961	0.933	0.853	0.000



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AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 800 Vac tri
Loss Fraction 1.30 % at STC

Inverter: SUN2000-215KTL-H0

Wire section (260 Inv.) Alu 260 x 3 x 150 mm²
Average wires length 200 m

MV line up to Injection

MV Voltage 30 kV
Wires Alu 3 x 1000 mm²
Length 2500 m
Loss Fraction 0.45 % at STC

AC losses in transformers

MV transfo

Grid voltage 30 kV

Operating losses at STC

Nominal power at STC 51498 kVA
Iron loss (24/24 Connexion) 51.50 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

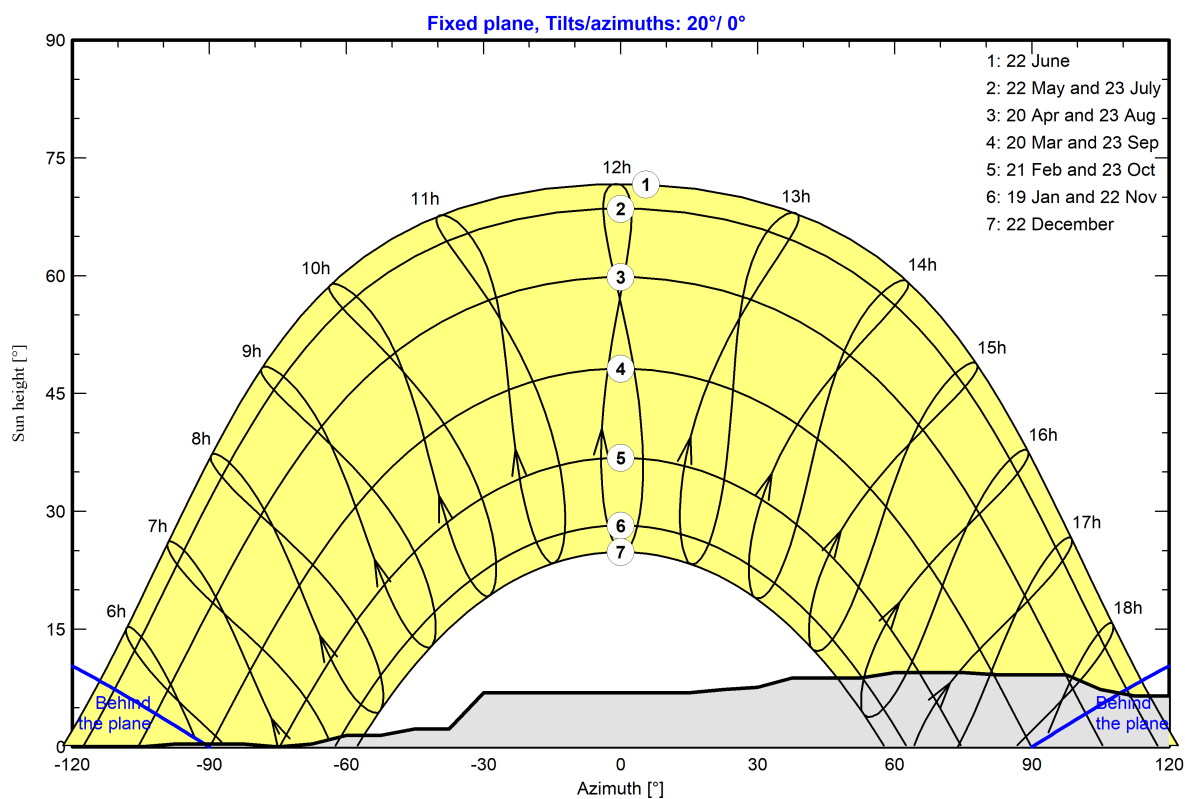
Horizon from PVGIS website API, Lat=41°44'45', Long=15°2'43', Alt=238m

Average Height	4.2 °	Albedo Factor	0.70
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-105	-98	-83	-75	-68	-60	-53	-45	-38	-30	15	23	30
Height [°]	0.0	0.0	0.4	0.4	0.0	0.4	1.5	1.5	2.3	2.3	6.9	6.9	7.3	7.6
Azimuth [°]	38	53	60	75	83	98	105	113	143	150	158	165	180	
Height [°]	8.8	8.8	9.5	9.5	9.2	9.2	7.3	6.5	6.5	3.1	3.1	0.0	0.0	

Sun Paths (Height / Azimuth diagram)



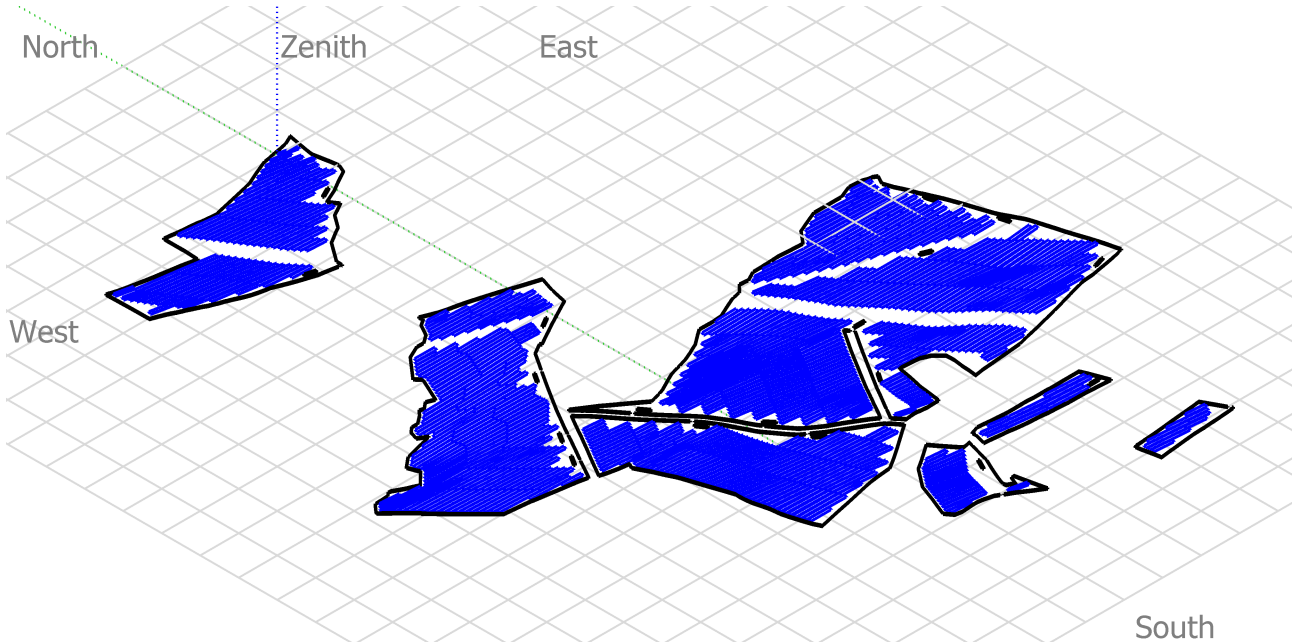


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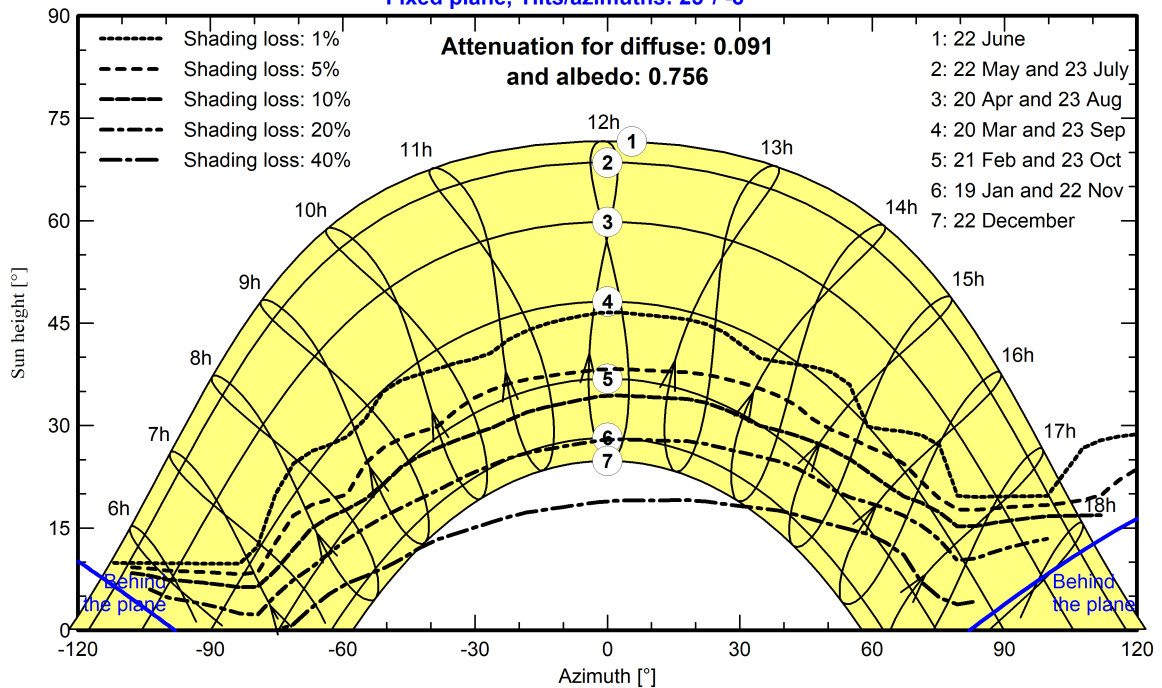
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Proyecto Rotello 52 - Legal Time
Fixed plane, Tilts/azimuths: 25°/ -8°





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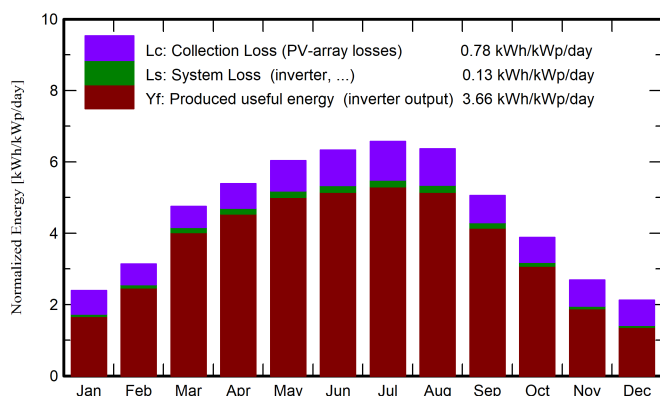
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Main results

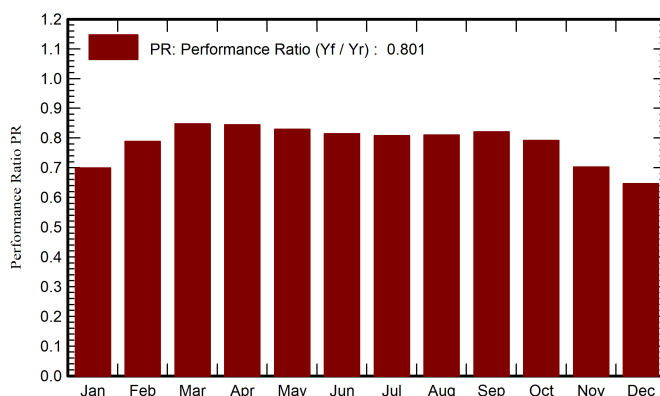
System Production

Produced Energy (P50)	70023 MWh/year	Specific production (P50)	1336 kWh/kWp/year	Performance Ratio PR	80.11 %
Produced Energy (P90)	66.9 GWh/year	Specific production (P90)	1276 kWh/kWp/year		
Produced Energy (P95)	66.0 GWh/year	Specific production (P95)	1259 kWh/kWp/year		

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	MWh	MWh	ratio
January	50.0	26.87	7.68	74.2	55.0	2826	2721	0.699
February	66.0	35.40	8.28	87.8	73.7	3760	3628	0.789
March	121.0	55.73	11.22	147.3	135.2	6778	6544	0.847
April	146.0	69.80	14.12	161.5	150.1	7406	7150	0.844
May	185.0	85.58	19.53	187.1	174.0	8431	8141	0.830
June	194.8	81.81	24.41	189.8	176.8	8397	8105	0.815
July	204.7	81.48	27.35	203.6	190.4	8936	8622	0.808
August	183.6	72.00	27.05	197.4	185.1	8693	8384	0.810
September	129.4	57.16	21.52	151.8	140.4	6768	6532	0.821
October	92.7	41.93	17.56	120.4	105.7	5185	5002	0.792
November	55.2	28.84	12.44	80.6	61.1	3078	2967	0.702
December	42.5	23.58	8.83	65.7	45.3	2318	2228	0.647
Year	1470.9	660.18	16.72	1667.2	1492.8	72576	70023	0.801

Legends

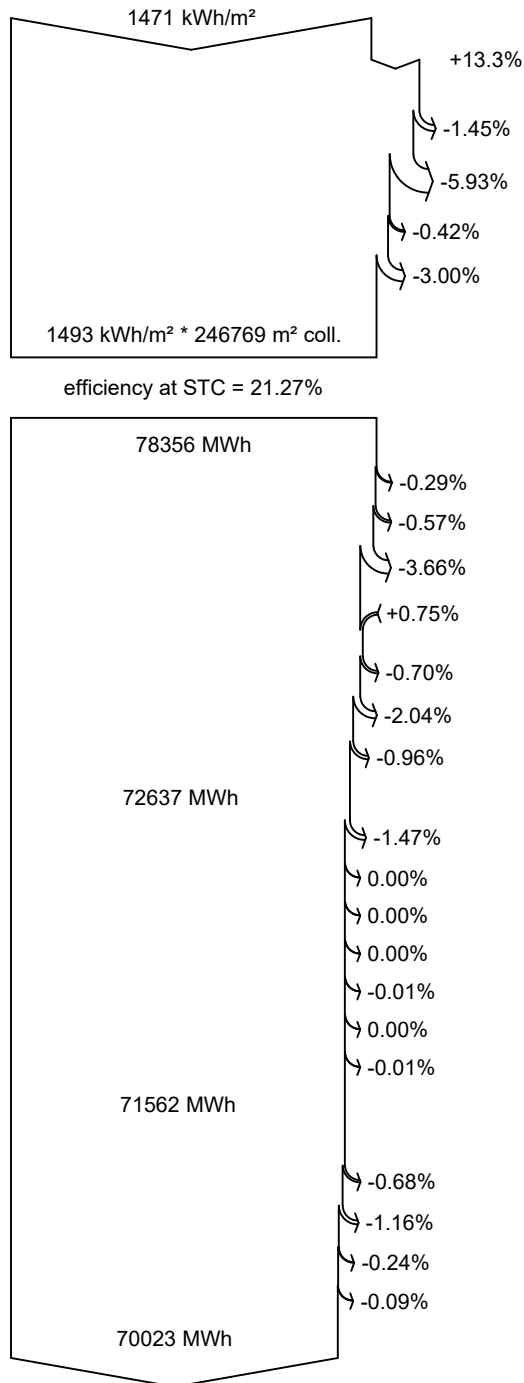
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		



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Loss diagram



Global horizontal irradiation

Global incident in coll. plane

Far Shadings / Horizon

Near Shadings: irradiance loss

IAM factor on global

Soiling loss factor

Effective irradiation on collectors

PV conversion

Array nominal energy (at STC effic.)

Module Degradation Loss (for year #1)

PV loss due to irradiance level

PV loss due to temperature

Module quality loss

LID - Light induced degradation

Mismatch loss, modules and strings

Ohmic wiring loss

Array virtual energy at MPP

Inverter Loss during operation (efficiency)

Inverter Loss over nominal inv. power

Inverter Loss due to max. input current

Inverter Loss over nominal inv. voltage

Inverter Loss due to power threshold

Inverter Loss due to voltage threshold

Night consumption

Available Energy at Inverter Output

AC ohmic loss

Medium voltage transfo loss

MV line ohmic loss

Unused energy (grid limitation)

Energy injected into grid

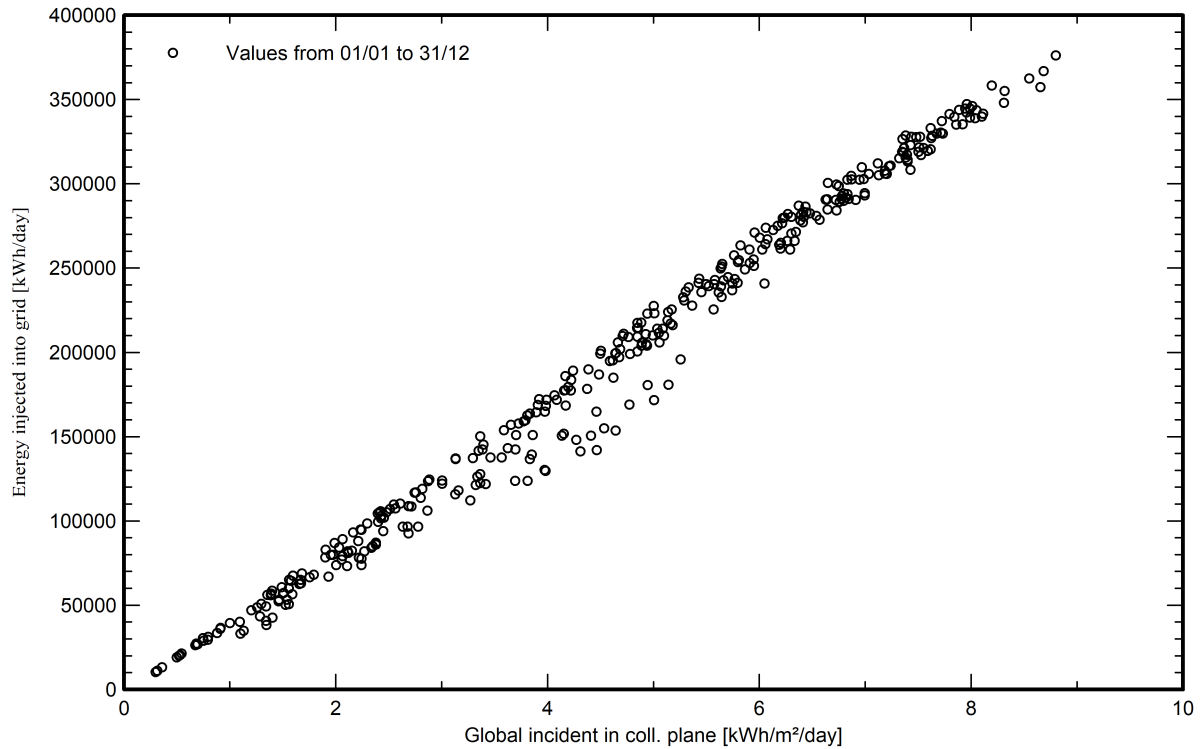


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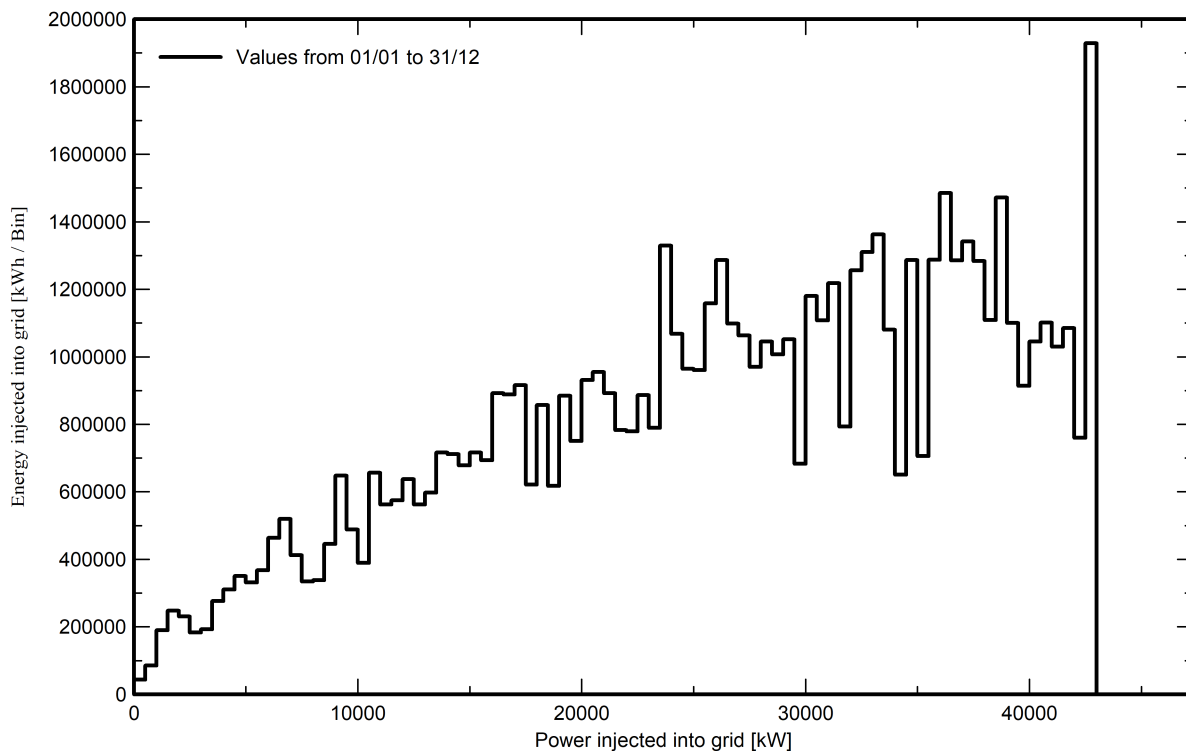
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Special graphs

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 0.55 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

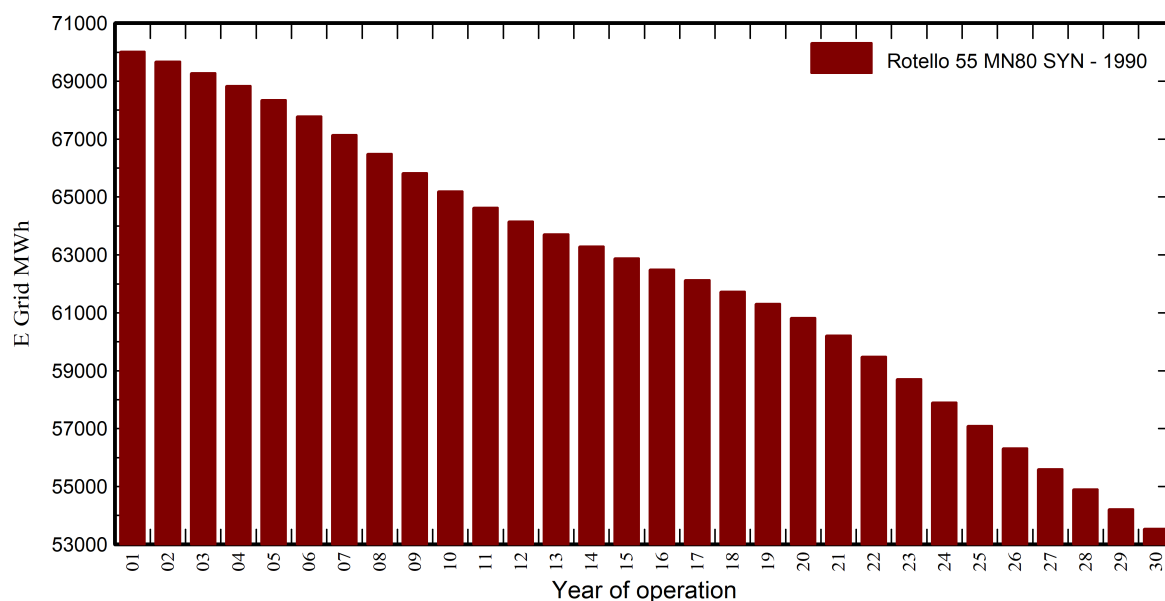
Meteo used in the simulation

#1 Rotello 55 MN80 SYN

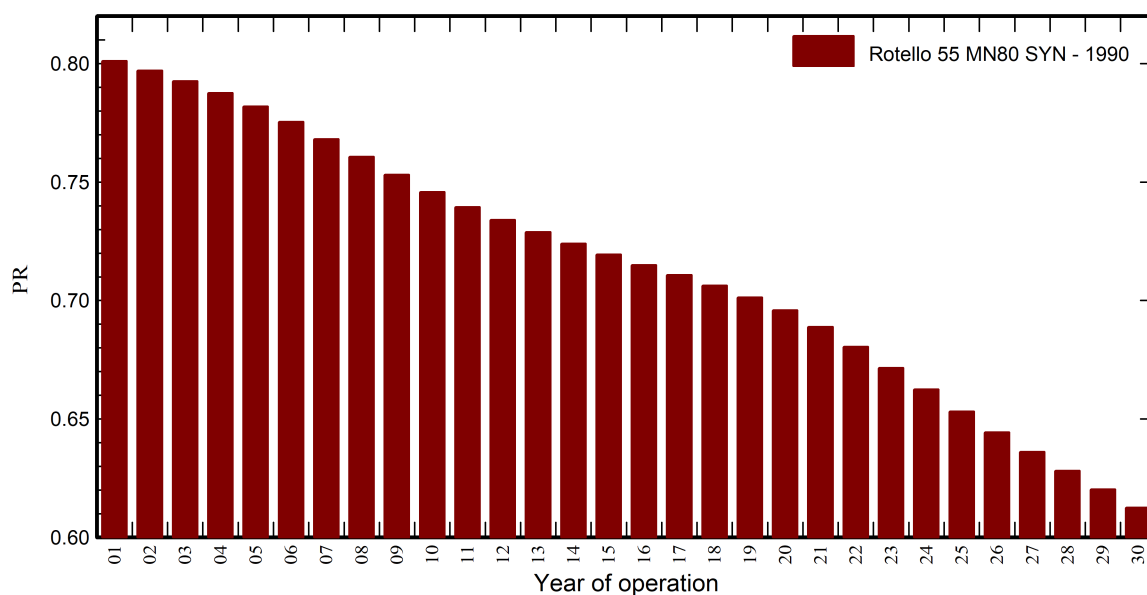
Years 1990 (reference year)

Years simulated 1-30

Energy injected into grid



Performance Ratio



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Time span of simulation 30 years

Module average degradation

Loss factor 0.55 %/year

Mismatch due to degradation

Imp RMS dispersion 0.4 %/year

Vmp RMS dispersion 0.4 %/year

Meteo used in the simulation**#1 Rotello 55 MN80 SYN**

Years 1990 (reference year)

Years simulated 1-30

Rotello 55 MN80 SYN

Year	E Grid	PR	PR loss
	MWh		%
1	70023	0.801	0%
2	69674	0.797	-0.5%
3	69279	0.793	-1.1%
4	68837	0.788	-1.7%
5	68350	0.782	-2.4%
6	67782	0.775	-3.2%
7	67144	0.768	-4.1%
8	66486	0.761	-5.1%
9	65829	0.753	-6%
10	65188	0.746	-6.9%
11	64629	0.739	-7.7%
12	64156	0.734	-8.4%
13	63712	0.729	-9%
14	63289	0.724	-9.6%
15	62880	0.719	-10.2%
16	62496	0.715	-10.7%
17	62124	0.711	-11.3%
18	61731	0.706	-11.8%
19	61304	0.701	-12.5%
20	60826	0.696	-13.1%
21	60217	0.689	-14%
22	59482	0.68	-15.1%
23	58704	0.672	-16.2%
24	57901	0.662	-17.3%
25	57090	0.653	-18.5%
26	56321	0.644	-19.6%
27	55602	0.636	-20.6%
28	54899	0.628	-21.6%
29	54212	0.62	-22.6%
30	53539	0.613	-23.5%



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P50 - P90 evaluation

Meteo data

Source Meteonorm 8.0 (1991-2012), Sat=90%
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 2.45 GWh
P50 70.02 GWh
P90 66.88 GWh
P95 66.00 GWh

Probability distribution

