

REGIONE: MOLISE
PROVINCIA: CAMPOBASSO
COMUNE: MONTORIO NEI FRENTANI,
LARINO

ridium

~~Impianto per la produzione di energia elettrica da fonte solare in Montorio
nei Frentani (CB) denominato agrivoltaico~~ "Montorio nei Frentani 21.7"

SIMULAZIONE ENERGETICA (PVSyst)

PROGETTISTI		IL PROPONENTE
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		MAGGIO 20222023

PVsyst - Simulation report

Grid-Connected System

Project: Proyecto Montorio Nei Frentani

Variant: Proyecto Montorio Nei Frentani_2V8-16 Fixed_600Wp_1-30

Ground system (tables) on a hill

System power: 21.72 MWp

Montorio Nei Frentani - Italy



Project: Proyecto Montorio Nei Frentani

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PVsyst V7.2.8

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27/12/21 15:07
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Project summary

Geographical Site

Montorio Nei Frentani

Italy

Situation

Latitude 41.78 °N

Longitude 14.98 °E

Altitude 265 m

Time zone UTC+1

Project settings

Albedo 0.20

Meteo data

Montorio Nei Frentani

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 26 / -1 °

Near Shadings

Linear shadings

User's needs

Unlimited load (grid)

System information

PV Array

Nb. of modules 36192 units

Pnom total 21.72 MWp

Inverters

Nb. of units 102 units

Pnom total 20.81 MWac

Grid power limit 16.65 MWac

Grid lim. Pnom ratio 1.304

Results summary

Produced Energy 30121 MWh/year Specific production 1387 kWh/kWp/year Perf. Ratio PR 83.38 %

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General parameters

Grid-Connected System

PV Field Orientation

Orientation

Fixed plane
Tilt/Azimuth 26 / -1 °

Horizon

Average Height 3.9 °

Grid power limitation

Active Power 16.65 MWac
Pnom ratio 1.304

Ground system (tables) on a hill

Sheds configuration

Nb. of sheds 1152 units
Sizes
Sheds spacing 7.20 m
Collector width 4.36 m
Ground Cov. Ratio (GCR) 60.6 %
Shading limit angle
Limit profile angle 30.2 °

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-600DE20
(Custom parameters definition)

Unit Nom. Power 600 Wp
Number of PV modules 36192 units
Nominal (STC) 21.72 MWp
Modules 1131 Strings x 32 In series

At operating cond. (51°C)

Pmpp 19.80 MWp
U mpp 991 V
I mpp 19976 A

Total PV power

Nominal (STC) 21715 kWp
Total 36192 modules
Module area 102428 m²
Cell area 95764 m²

Inverter

Manufacturer Huawei Technologies
Model SUN2000-215KTL-H0
(Custom parameters definition)

Unit Nom. Power 204 kWac
Number of inverters 102 units
Total power 20808 kWac
Operating voltage 500-1500 V
Max. power (=>33°C) 215 kWac
Pnom ratio (DC:AC) 1.04

Total inverter power

Total power 20808 kWac
Nb. of inverters 102 units
Pnom ratio 1.04

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. 0.82 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss

Loss Fraction -0.8 %

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



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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 1.03 % at STC

Inverter: SUN2000-215KTL-H0

Wire section (102 Inv.) Alu 102 x 3 x 150 mm²
Average wires length 150 m

MV line up to Injection

MV Voltage 30 kV
Wires Alu 3 x 500 mm²
Length 2200 m
Loss Fraction 0.33 % at STC

AC losses in transformers

MV transfo

Grid voltage 30 kV

Operating losses at STC

Nominal power at STC 21323 kVA
Iron loss (24/24 Connexion) 21.32 kW
Loss Fraction 0.10 % at STC
Coils equivalent resistance 3 x 0.30 mΩ
Loss Fraction 1.00 % at STC



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Horizon definition

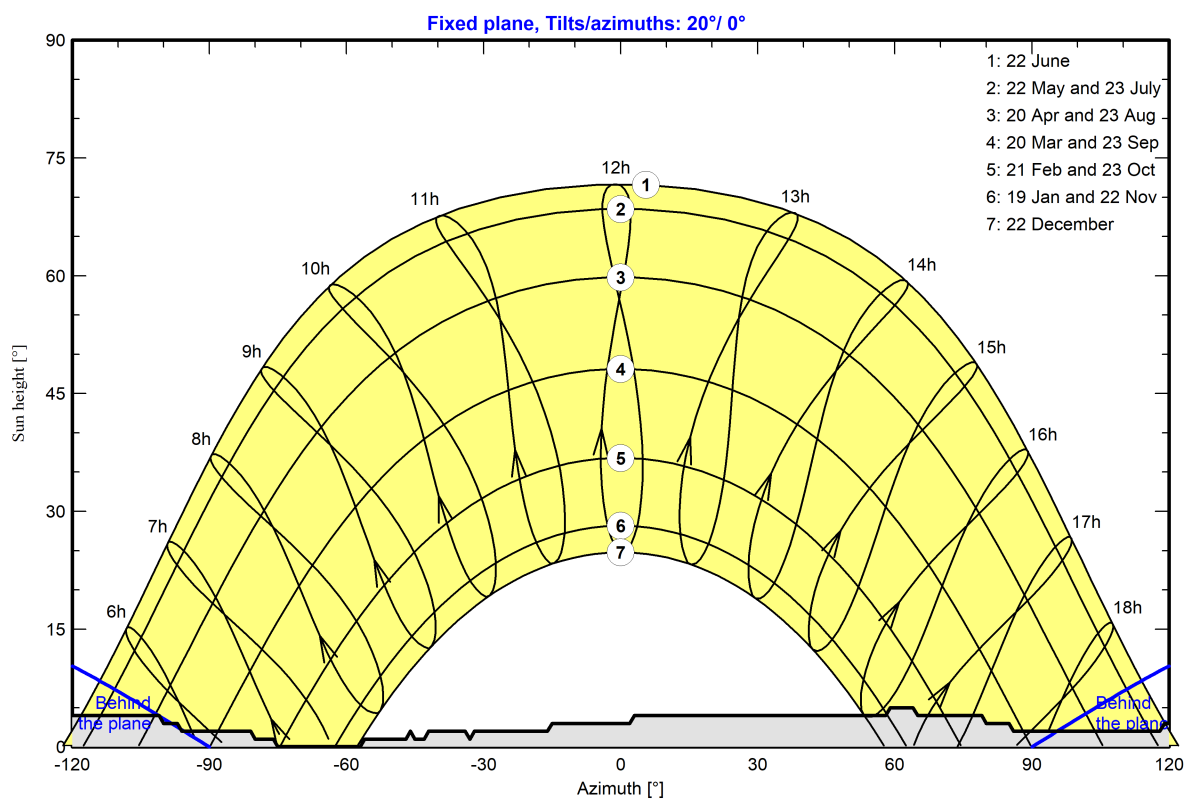
Horizonte del servicio web de Meteonorm, lat=41,7797, lon=14,9829

Average Height 3.9 ° Albedo Factor 0.85
Diffuse Factor 0.99 Albedo Fraction 100 %

Horizon profile

Azimuth [°]	-180	-154	-153	-151	-150	-149	-147	-131	-130	-101	-100	-97	-96
Height [°]	9.0	9.0	8.0	8.0	7.0	7.0	5.0	5.0	4.0	4.0	3.0	3.0	2.0
Azimuth [°]	-81	-80	-76	-75	-57	-56	-47	-46	-45	-43	-42	-34	-33
Height [°]	2.0	1.0	1.0	0.0	0.0	1.0	1.0	2.0	1.0	1.0	2.0	2.0	1.0
Azimuth [°]	-32	-16	-15	2	3	58	59	64	65	79	80	85	86
Height [°]	2.0	2.0	3.0	3.0	4.0	4.0	5.0	5.0	4.0	4.0	3.0	3.0	2.0
Azimuth [°]	118	119	145	146	147	149	150	151	152	153	154	155	179
Height [°]	2.0	3.0	3.0	4.0	4.0	6.0	6.0	7.0	7.0	8.0	8.0	9.0	9.0

Sun Paths (Height / Azimuth diagram)



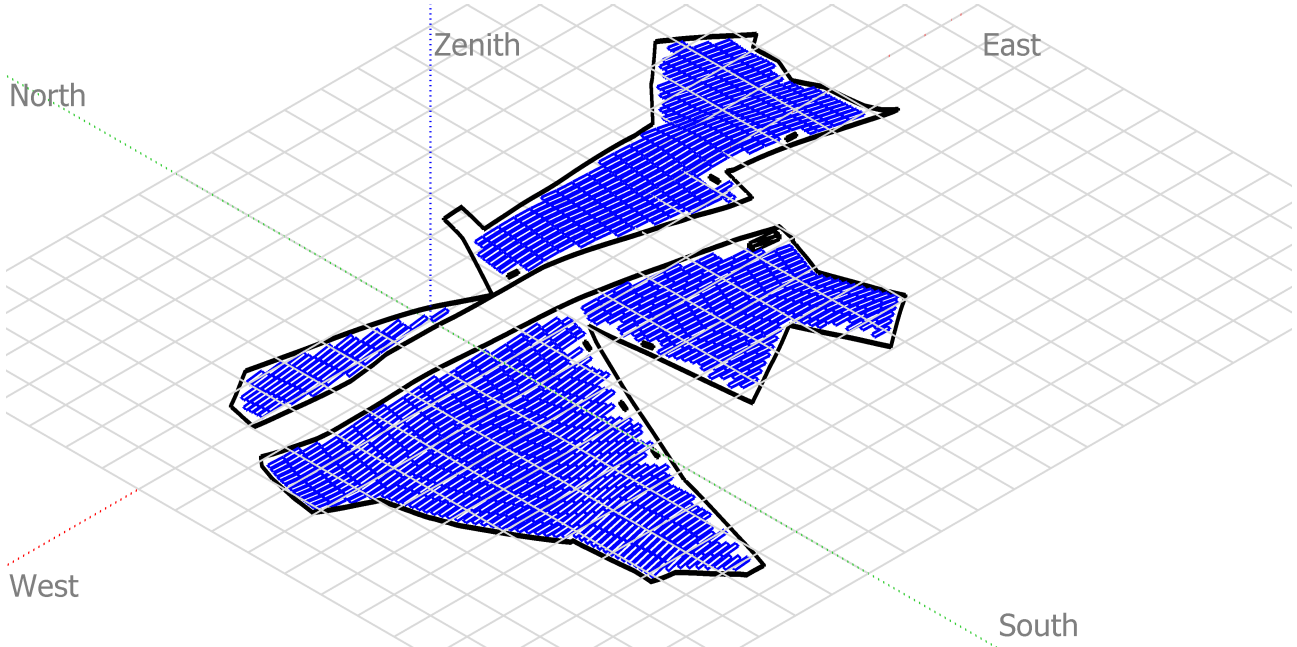


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Near shadings parameter

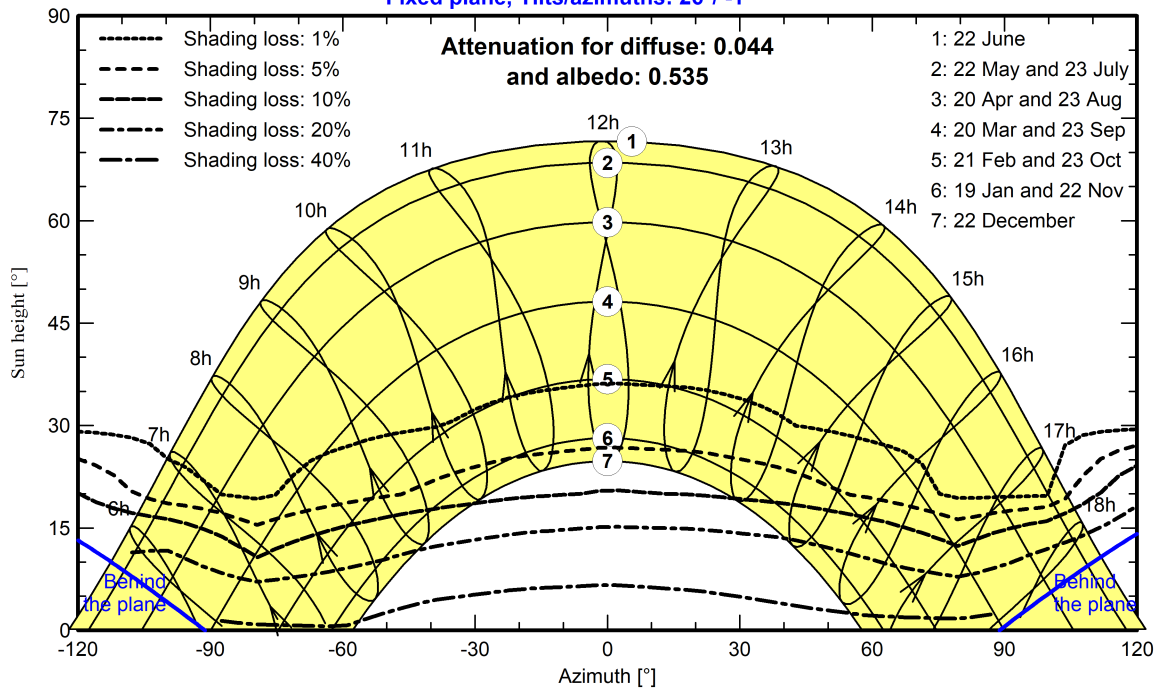
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Projecto Montorio Nei Frentani - Legal Time

Fixed plane, Tilts/azimuths: 26°/-1°





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Main results

System Production

Produced Energy

30121 MWh/year

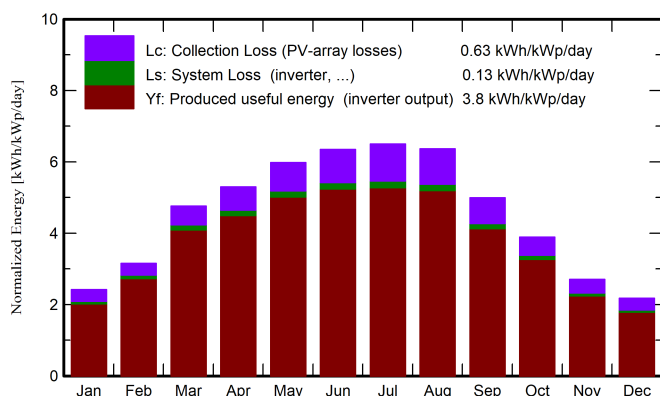
Specific production

1387 kWh/kWp/year

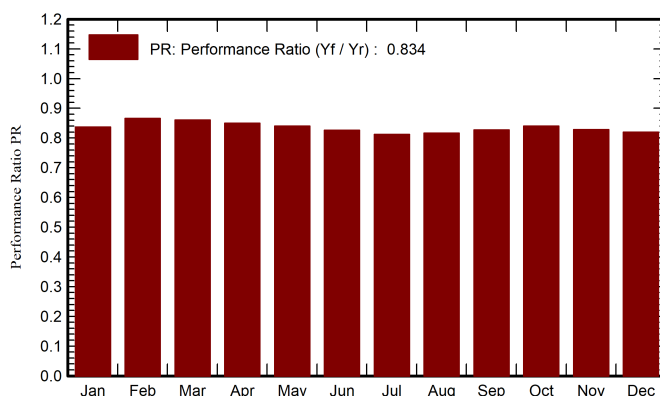
Performance Ratio PR

83.38 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	MWh	MWh	ratio
January	50.0	26.82	7.51	74.8	66.5	1411	1361	0.837
February	65.4	35.40	8.11	88.3	81.4	1720	1662	0.867
March	120.1	52.15	11.13	147.6	139.2	2854	2759	0.861
April	145.9	68.50	14.01	158.9	150.0	3032	2932	0.850
May	183.6	90.32	19.37	185.2	174.8	3493	3380	0.840
June	194.4	90.53	24.44	190.4	180.0	3531	3416	0.826
July	204.1	76.45	27.54	201.5	191.0	3679	3556	0.813
August	183.4	74.17	27.22	197.4	187.0	3620	3498	0.816
September	128.6	55.18	21.50	149.8	141.4	2784	2689	0.827
October	92.8	46.92	17.36	120.7	112.1	2279	2203	0.841
November	54.4	25.52	12.24	81.3	73.1	1515	1461	0.828
December	42.5	22.38	8.64	67.6	58.9	1249	1203	0.820
Year	1465.3	664.32	16.64	1663.5	1555.4	31166	30121	0.834

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

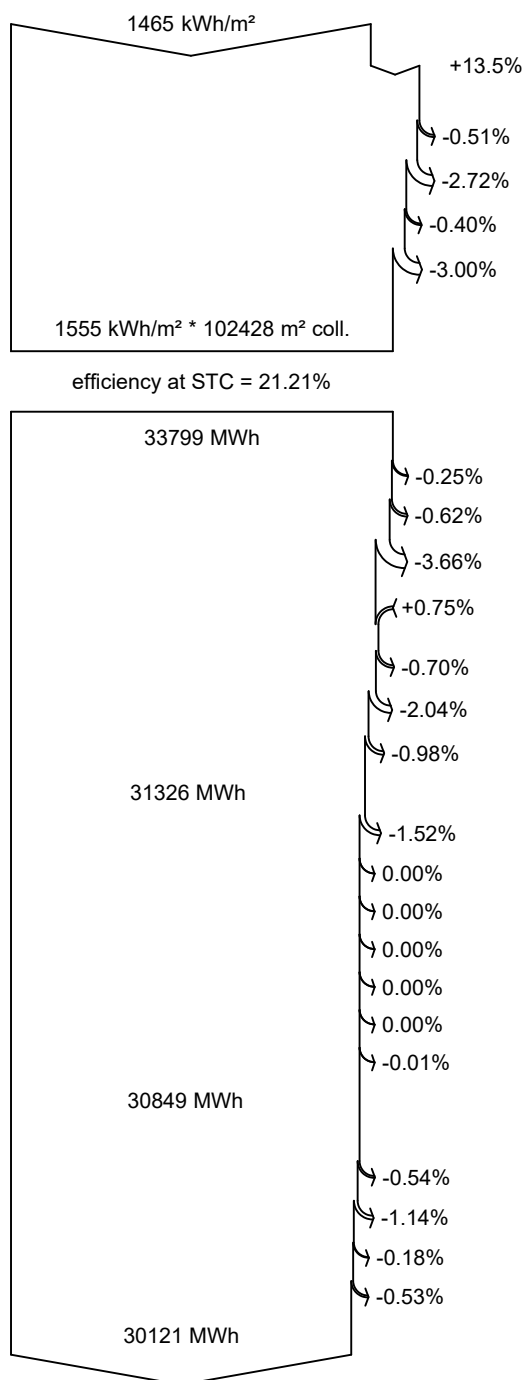
PR Performance Ratio



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Loss diagram



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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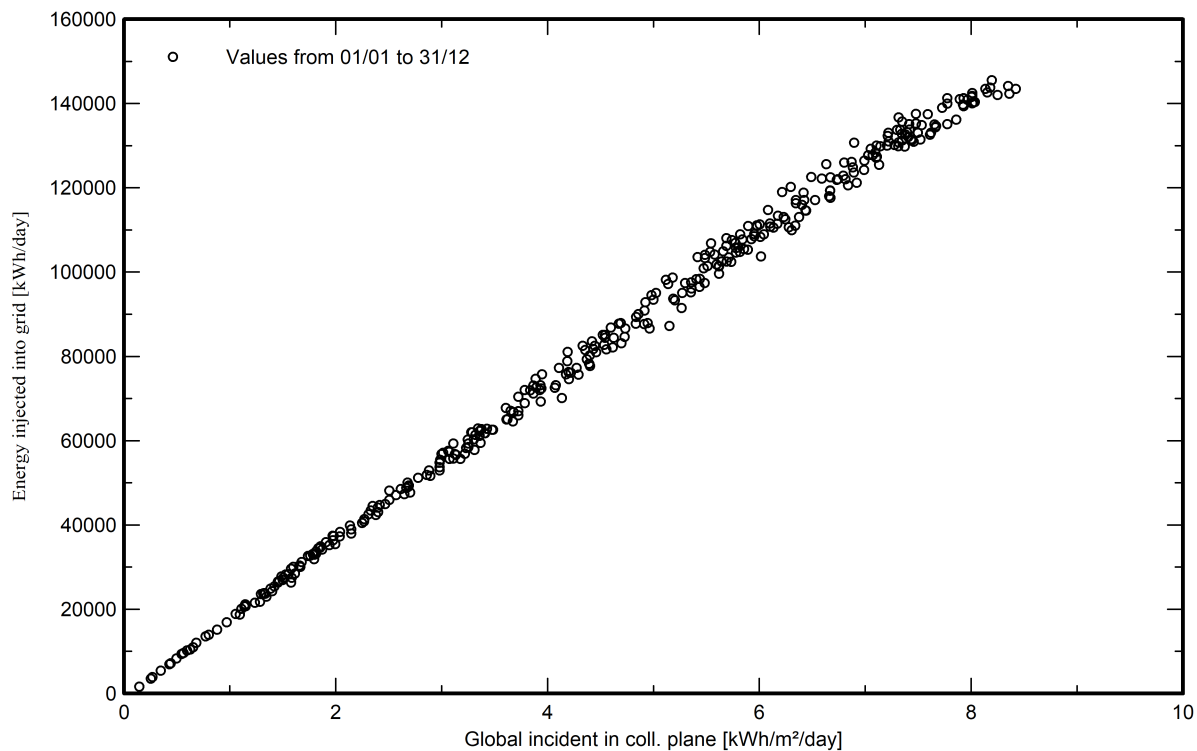
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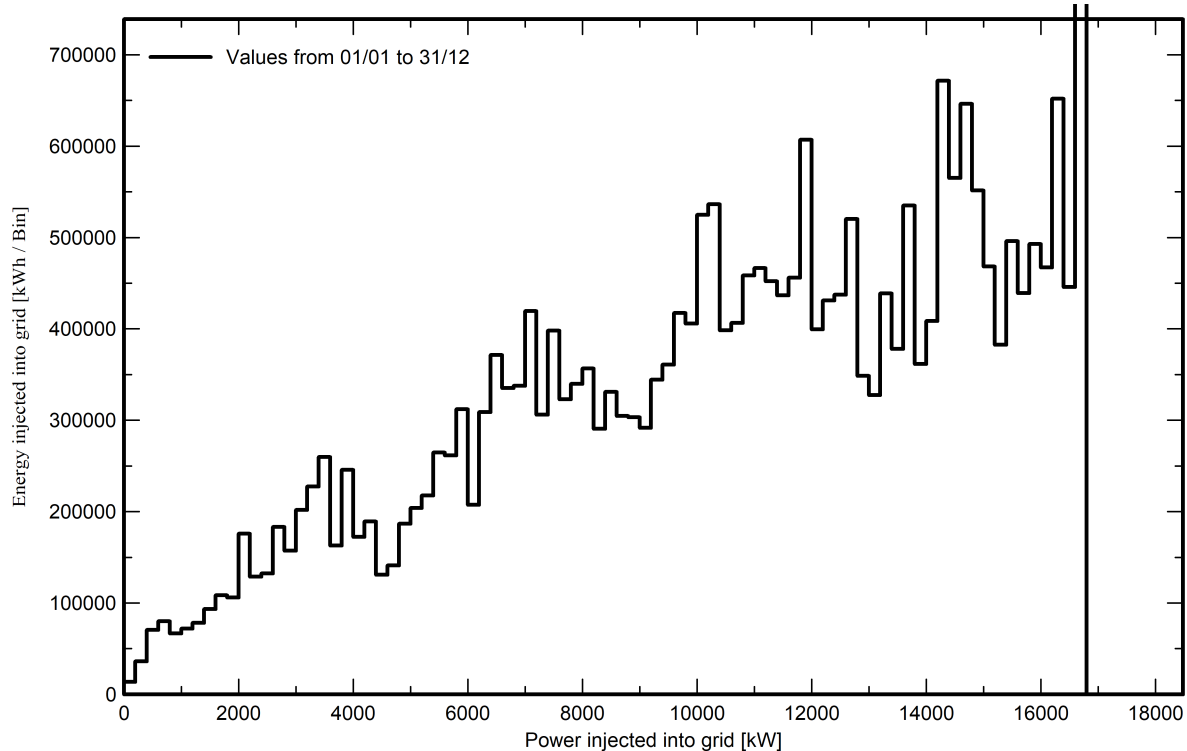
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Special graphs

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

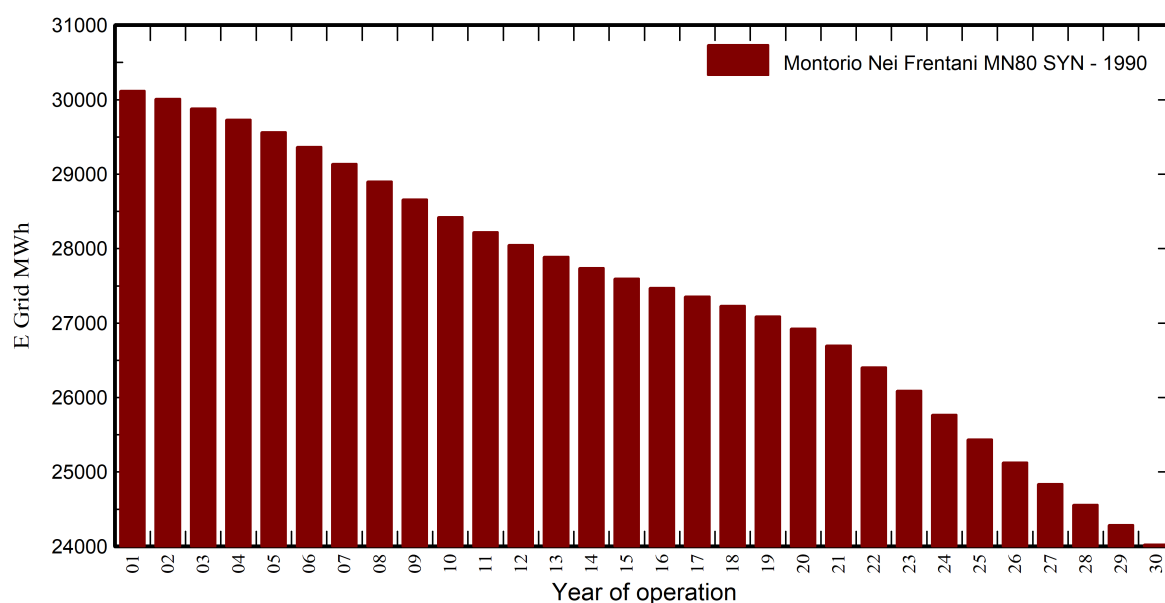
Meteo used in the simulation

#1 Montorio Nei Frentani MN80 SYN

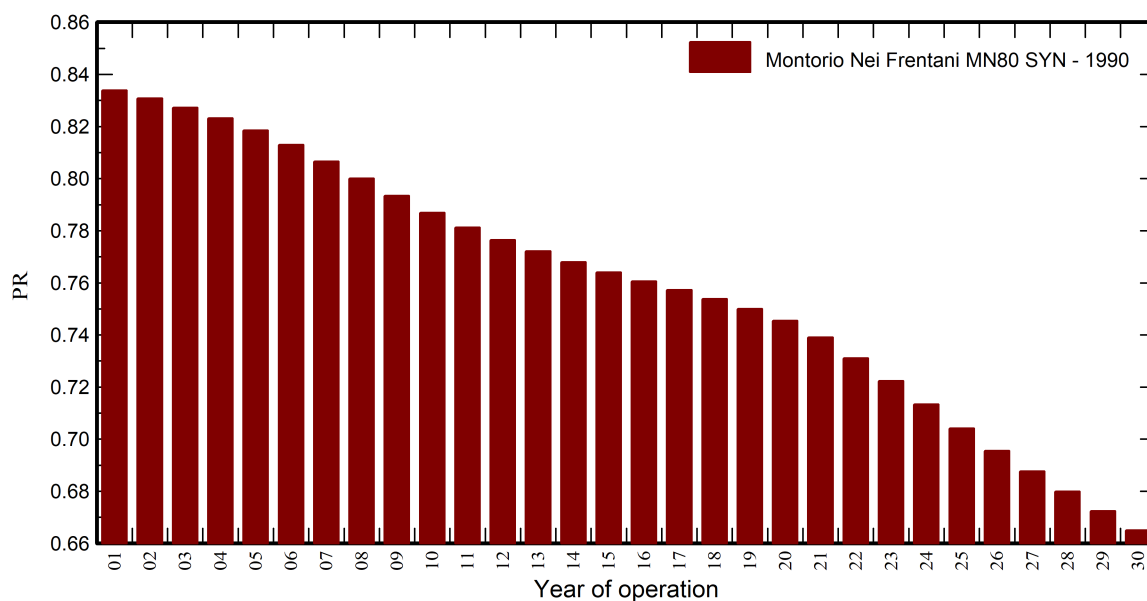
Years 1990 (reference year)

Years simulated 1-30

Energy injected into grid



Performance Ratio





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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 Montorio Nei Frentani MN80 SYN

Years 1990 (reference year)

Years simulated 1-30

Montorio Nei Frentani MN80 SYN

Year	E Grid	PR	PR loss
	MWh		%
1	30121	0.834	0%
2	30010	0.831	-0.4%
3	29881	0.827	-0.8%
4	29733	0.823	-1.3%
5	29566	0.818	-1.8%
6	29366	0.813	-2.5%
7	29137	0.807	-3.3%
8	28900	0.8	-4.1%
9	28660	0.793	-4.9%
10	28424	0.787	-5.6%
11	28220	0.781	-6.3%
12	28049	0.776	-6.9%
13	27890	0.772	-7.4%
14	27741	0.768	-7.9%
15	27598	0.764	-8.4%
16	27472	0.761	-8.8%
17	27356	0.757	-9.2%
18	27231	0.754	-9.6%
19	27090	0.75	-10.1%
20	26926	0.745	-10.6%
21	26698	0.739	-11.4%
22	26406	0.731	-12.3%
23	26092	0.722	-13.4%
24	25766	0.713	-14.5%
25	25435	0.704	-15.6%
26	25125	0.696	-16.6%
27	24839	0.688	-17.5%
28	24560	0.68	-18.5%
29	24289	0.672	-19.4%
30	24025	0.665	-20.2%



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P50 - P90 evaluation

Meteo data

Source Meteoronorm 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 1.05 GWh
P50 30.12 GWh
P90 28.77 GWh
P95 28.39 GWh

Probability distribution

