



TRANSIZIONE ECOLOGICA



REGIONE SICILIA



COMUNE DI RAMACCA



COMUNE DI CASTEL DI IUDICA

NOME PROGETTO:

Costruzione ed esercizio di un impianto agrovoltaico avente potenza in immissione pari a ~~240,500~~ 205,490MW, con relativo collegamento alla rete elettrica, sito nei comuni di Castel di Iudica e Ramacca (CT) - Impianto "FICURINIA".

ID. PROGETTO DEL MITE: ID_VIP 8434

PROCEDURA:

Valutazione di impatto ambientale ai sensi dell'art. 23 c. 1 del D.Lgs. 152/06 e ss.mm.ii..

PROPONENTE:



INE Ficurinia Srl

A Company of ILOS New Energy Italy

INE FICURINIA S.R.L.
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RESPONSABILE PROGETTO:
Ing. Jury Mancinelli

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Legale rappresentante: Ing. Sergio Chiericoni

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Iscrizione all'Albo n° A 2508
alla Sezione degli Ingegneri (Sez. A)

- Settore civile e ambientale
- Settore industriale
- Settore dell'informazione



ORDINE DEGLI INGEGNERI
DELLA PROVINCIA DI REGGIO CALABRIA



IDENTIFICATORE ELABORATO:

RS06REL069A0_rev.01

CARTELLA:

VIA_16

TITOLO ELABORATO:

Analisi della risorsa solare e stima di produzione energia lotto 3683

SCALA:

-



PROGETTAZIONE E COORDINAMENTO

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N. REV.	DATA	REVISIONE
0	apr-22	Emissione
1	setl-23	Integrazioni con modifica sostanziale del progetto in riscontro a richiesta MASE prot. m_ame:CTVA. RFCISTRO UFFICIAI F.U.0006731.08-06-2023

ELABORATO	VERIFICATO	VALIDATO
Ing. Baldacconi/Ing. D'Elia/Ing. Vizzarro Ing. Baldacconi/Ing. D'Elia	Ing. Bolignano Ing. Bolignano	INE FICURINIA S.R.L. INE FICURINIA S.R.L.

PVsyst - Simulation report

Grid-Connected System

Project: Ficurinia lotto #3683

Variant: New simulation variant

Ground system (tables) on a hill

System power: 25.65 MWp

Cavalera - Italy



PVsyst V7.4.2

VCO, Simulation date:
15/09/23 12:17
with v7.4.2

ARATO SRL (Italy)

Project summary

Geographical Site	Situation	Project settings
Cavalera	Latitude 37.51 °N	Albedo 0.20
Italy	Longitude 14.60 °E	
	Altitude 300 m	
	Time zone UTC+1	
Meteo data		
Cavalera		
PVGIS api TMY		

System summary

Grid-Connected System	Ground system (tables) on a hill		
Simulation for year no 1			
PV Field Orientation	Near Shadings	User's needs	
Fixed plane	Linear shadings : Fast (table)	Unlimited load (grid)	
Tilt/Azimuth 30.7 / 2.1 °			
System information			
PV Array	Inverters		
Nb. of modules 42048 units	Nb. of units 13 units		
Pnom total 25.65 MWp	Pnom total 24.86 MWac		
	Pnom ratio 1.032		

Results summary

Produced Energy 41.54 GWh/year	Specific production 1619 kWh/kWp/year	Perf. Ratio PR 78.62 %
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ARATO SRL (Italy)

General parameters

Grid-Connected System		Ground system (tables) on a hill	
PV Field Orientation		Sheds configuration	
Orientation		Nb. of sheds	1799 units
Fixed plane		Sizes	
Tilt/Azimuth	30.7 / 2.1 °	Sheds spacing	9.56 m
		Collector width	4.60 m
		Ground Cov. Ratio (GCR)	48.1 %
		Shading limit angle	
		Limit profile angle	22.7 °
Horizon		Near Shadings	
Average Height	5.0 °	Linear shadings : Fast (table)	
		Models used	
		Transposition	Perez
		Diffuse	Imported
		Circumsolar	separate
		User's needs	
		Unlimited load (grid)	

PV Array Characteristics

PV module		Inverter	
Manufacturer	JA Solar	Manufacturer	Santerno
Model	JAM78S30-610/MR	Model	Sunway TG 1800 1500V TE - 690
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	610 Wp	Unit Nom. Power	1912 kWac
Number of PV modules	22272 units	Number of inverters	7 units
Nominal (STC)	13.59 MWp	Total power	13384 kWac
Array #1 - Sub-array #1			
Number of PV modules	3168 units	Number of inverters	1 unit
Nominal (STC)	1932 kWp	Total power	1912 kWac
Modules	132 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	1750 kWp	Max. power (=>25°C)	2151 kWac
U mpp	982 V	Pnom ratio (DC:AC)	1.01
I mpp	1781 A	Power sharing within this inverter	
Array #2 - Sub-array #2			
Number of PV modules	3168 units	Number of inverters	1 unit
Nominal (STC)	1932 kWp	Total power	1912 kWac
Modules	132 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	1750 kWp	Max. power (=>25°C)	2151 kWac
U mpp	982 V	Pnom ratio (DC:AC)	1.01
I mpp	1781 A	Power sharing within this inverter	
Array #3 - Sub-array #3			
Number of PV modules	3168 units	Number of inverters	1 unit
Nominal (STC)	1932 kWp	Total power	1912 kWac
Modules	132 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	1750 kWp	Max. power (=>25°C)	2151 kWac
U mpp	982 V	Pnom ratio (DC:AC)	1.01
I mpp	1781 A	Power sharing within this inverter	



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PV Array Characteristics

Array #5 - Sub-array #5

Number of PV modules	3192 units	Number of inverters	1 unit
Nominal (STC)	1947 kWp	Total power	1912 kWac
Modules	133 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	1763 kWp	Max. power (=>25°C)	2151 kWac
U mpp	982 V	Pnom ratio (DC:AC)	1.02
I mpp	1795 A	Power sharing within this inverter	

Array #6 - Sub-array #6

Number of PV modules	3192 units	Number of inverters	1 unit
Nominal (STC)	1947 kWp	Total power	1912 kWac
Modules	133 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	1763 kWp	Max. power (=>25°C)	2151 kWac
U mpp	982 V	Pnom ratio (DC:AC)	1.02
I mpp	1795 A	Power sharing within this inverter	

Array #7 - Sub-array #7

Number of PV modules	3192 units	Number of inverters	1 unit
Nominal (STC)	1947 kWp	Total power	1912 kWac
Modules	133 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	1763 kWp	Max. power (=>25°C)	2151 kWac
U mpp	982 V	Pnom ratio (DC:AC)	1.02
I mpp	1795 A	Power sharing within this inverter	

Array #8 - Sub-array #8

Number of PV modules	3192 units	Number of inverters	1 unit
Nominal (STC)	1947 kWp	Total power	1912 kWac
Modules	133 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	1763 kWp	Max. power (=>25°C)	2151 kWac
U mpp	982 V	Pnom ratio (DC:AC)	1.02
I mpp	1795 A	Power sharing within this inverter	

Array #4 - Sub-array #4

PV module		Inverter	
Manufacturer	JA Solar	Manufacturer	Santerno
Model	JAM78S30-610/MR	Model	SELENWAY STATION TG1800&900-1500V-TE 600 (2489kW)
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	610 Wp	Unit Nom. Power	2489 kWac
Number of PV modules	4080 units	Number of inverters	1 unit
Nominal (STC)	2489 kWp	Total power	2489 kWac
Modules	170 Strings x 24 In series	Operating voltage	860-1200 V
At operating cond. (50°C)		Pnom ratio (DC:AC)	1.00
Pmpp	2254 kWp	Power sharing within this inverter	
U mpp	982 V		
I mpp	2294 A		



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PV Array Characteristics

Array #9 - Sub-array #9**PV module**

Manufacturer JA Solar
Model JAM78S30-610/MR

(Custom parameters definition)

Unit Nom. Power 610 Wp
Number of PV modules 3840 units
Nominal (STC) 2342 kWp
Modules 160 Strings x 24 In series

At operating cond. (50°C)

Pmpp 2121 kWp
U mpp 982 V
I mpp 2159 A

PV module

Manufacturer JA Solar
Model JAM78S30-610/MR

(Custom parameters definition)

Unit Nom. Power 610 Wp
Number of PV modules 11856 units
Nominal (STC) 7232 kWp

Array #10 - Sub-array #10

Number of PV modules 2976 units
Nominal (STC) 1815 kWp
Modules 124 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1644 kWp
U mpp 982 V
I mpp 1673 A

Array #11 - Sub-array #11

Number of PV modules 2976 units
Nominal (STC) 1815 kWp
Modules 124 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1644 kWp
U mpp 982 V
I mpp 1673 A

Array #12 - Sub-array #12

Number of PV modules 2952 units
Nominal (STC) 1801 kWp
Modules 123 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1631 kWp
U mpp 982 V
I mpp 1660 A

Array #13 - Sub-array #13

Number of PV modules 2952 units
Nominal (STC) 1801 kWp
Modules 123 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1631 kWp
U mpp 982 V
I mpp 1660 A

Inverter

Manufacturer Santerno
Model SUNWAY STATION TG1800&900-1500V-TE 600 (2342kW)

(Custom parameters definition)

Unit Nom. Power 2342 kWac
Number of inverters 1 unit
Total power 2342 kWac
Operating voltage 860-1200 V

Max. power (=>25°C) 2430 kWac
Pnom ratio (DC:AC) 1.00

Power sharing within this inverter

Inverter

Manufacturer Santerno
Model Sunway TG 1800 1500V TE - 600

(Custom parameters definition)

Unit Nom. Power 1662 kWac
Number of inverters 4 units
Total power 6648 kWac

Number of inverters 1 unit
Total power 1662 kWac

Operating voltage 860-1200 V
Pnom ratio (DC:AC) 1.09

Power sharing within this inverter

Number of inverters 1 unit
Total power 1662 kWac

Operating voltage 860-1200 V
Pnom ratio (DC:AC) 1.09

Power sharing within this inverter

Number of inverters 1 unit
Total power 1662 kWac

Operating voltage 860-1200 V
Pnom ratio (DC:AC) 1.08

Power sharing within this inverter

Number of inverters 1 unit
Total power 1662 kWac

Operating voltage 860-1200 V
Pnom ratio (DC:AC) 1.08

Power sharing within this inverter



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ARATO SRL (Italy)

PV Array Characteristics

Total PV power		Total inverter power	
Nominal (STC)	25649 kWp	Total power	24863 kWac
Total	42048 modules	Max. power	26624 kWac
Module area	117537 m ²	Number of inverters	13 units
Cell area	108363 m ²	Pnom ratio	1.03

Array losses

Array Soiling Losses		Thermal Loss factor		Serie Diode Loss				
Loss Fraction	3.0 %	Module temperature according to irradiance		Voltage drop	0.7 V			
		Uc (const)	29.0 W/m ² K	Loss Fraction	0.1 % at STC			
		Uv (wind)	0.0 W/m ² K/m/s					
LID - Light Induced Degradation		Module Quality Loss		Module mismatch losses				
Loss Fraction	2.0 %	Loss Fraction	-0.3 %	Loss Fraction	0.8 % at MPP			
Strings Mismatch loss		Module average degradation						
Loss Fraction	0.1 %	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°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	1.000	1.000	1.000	0.985	0.943	0.840	0.000

DC wiring losses

Global wiring resistance	0.69 mΩ		
Loss Fraction	1.5 % at STC		
Array #1 - Sub-array #1		Array #2 - Sub-array #2	
Global array res.	9.1 mΩ	Global array res.	9.1 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #3 - Sub-array #3		Array #4 - Sub-array #4	
Global array res.	9.1 mΩ	Global array res.	7.1 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #5 - Sub-array #5		Array #6 - Sub-array #6	
Global array res.	9.1 mΩ	Global array res.	9.1 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #7 - Sub-array #7		Array #8 - Sub-array #8	
Global array res.	9.1 mΩ	Global array res.	9.1 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #9 - Sub-array #9		Array #10 - Sub-array #10	
Global array res.	7.5 mΩ	Global array res.	9.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #11 - Sub-array #11		Array #12 - Sub-array #12	
Global array res.	9.7 mΩ	Global array res.	9.8 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #13 - Sub-array #13			
Global array res.	9.8 mΩ		
Loss Fraction	1.5 % at STC		



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ARATO SRL (Italy)

System losses

Auxiliaries loss

constant (fans) 10.00 kW
2.2 kW from Power thresh.

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 690 Vac tri
Loss Fraction 2.00 % at STC

Inverters: Sunway TG 1800 1500V TE - 690, SUNWAY STATION TG1800&900-1500V-TE 600 (2489kW), SUNWAY STATION TG1800&900-1500V-TE 600 (2489kW)

Wire section (13 Inv.) Alu 13 x 3 x 1500 mm²
Average wires length 209 m

MV line up to Injection

MV Voltage 20 kV
Average each inverter
Wires Alu 3 x 50 mm²
Length 6534 m
Loss Fraction 2.00 % at STC

AC losses in transformers

MV transfo

Medium voltage 20 kV

One transfo parameters

Nominal power at STC 1.94 MVA
Iron Loss (24/24 Connexion) 1.94 kVA
Iron loss fraction 0.10 % at STC
Copper loss 38.87 kVA
Copper loss fraction 2.00 % at STC
Coils equivalent resistance 3 x 4.90 mΩ

Operating losses at STC (full system)

Nb. identical MV transfos 13
Nominal power at STC 25.26 MVA
Iron loss (24/24 Connexion) 25.26 kVA
Copper loss 505.26 kVA



Horizon definition

Horizon from PVGIS website API, Lat=37°30'25", Long=14°36'10", Alt=300m

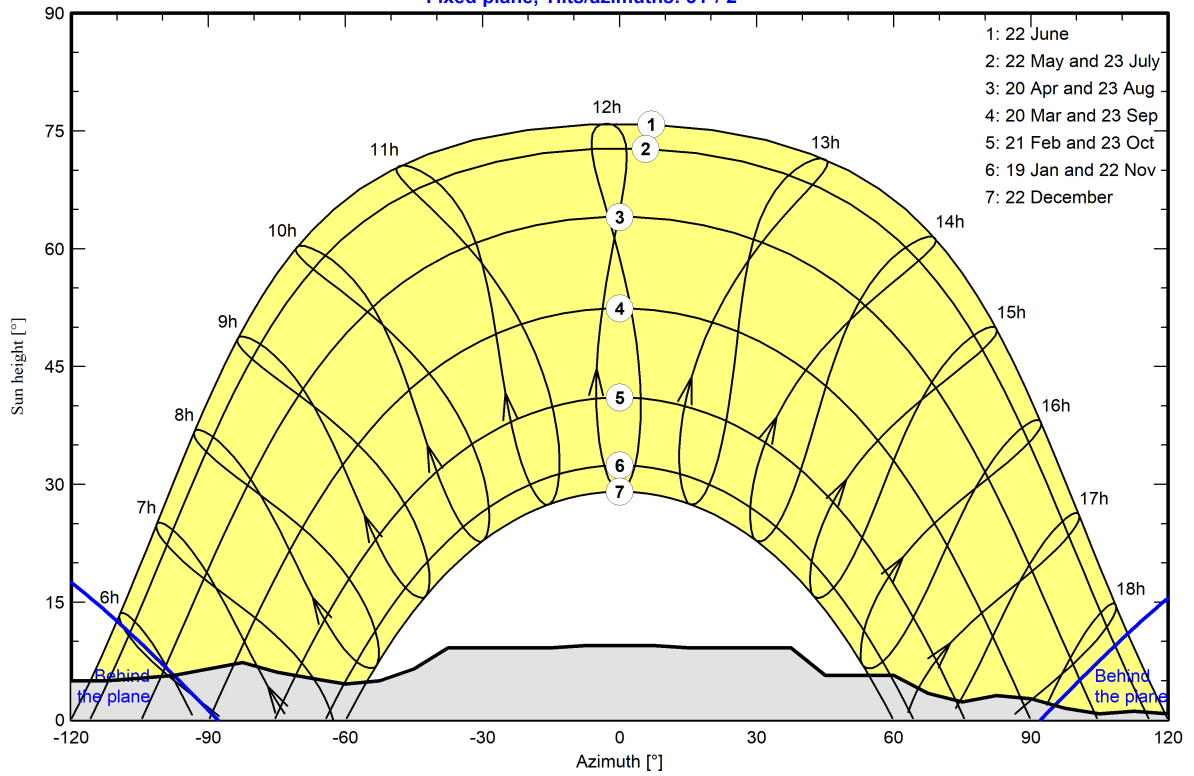
Average Height	5.0 °	Albedo Factor	0.58
Diffuse Factor	0.95	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-143	-135	-128	-120	-113	-105	-98	-90	-83	-75
Height [°]	2.7	3.4	3.1	3.1	4.6	5.3	5.7	5.0	5.0	5.3	5.7	6.5	7.3	6.1
Azimuth [°]	-68	-60	-53	-45	-38	-15	-8	8	15	38	45	60	68	75
Height [°]	5.3	4.6	5.0	6.5	9.2	9.2	9.5	9.5	9.2	9.2	5.7	5.7	3.4	2.3
Azimuth [°]	83	90	98	105	113	120	128	135	143	158	165	173	180	
Height [°]	3.1	2.7	1.5	0.8	1.1	0.8	1.1	1.5	1.1	1.1	1.9	2.3	2.7	

Sun Paths (Height / Azimuth diagram)

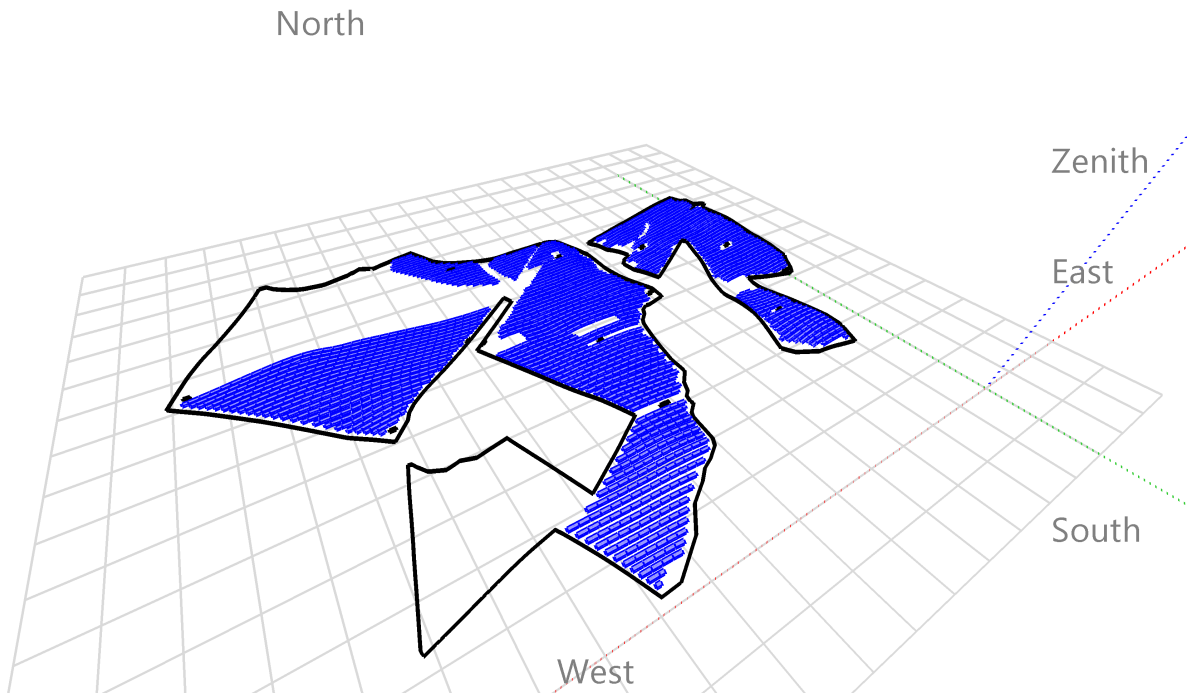
Fixed plane, Tilts/azimuths: 31°/ 2°





Near shadings parameter

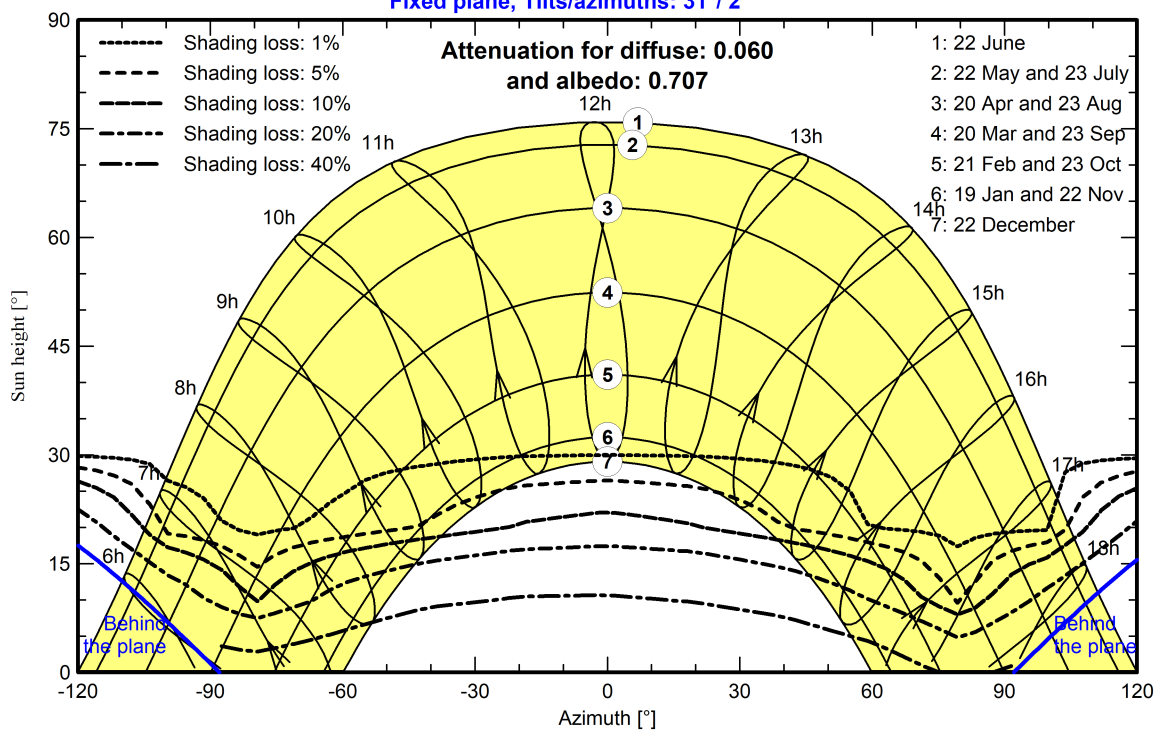
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 31°/ 2°





Main results

System Production

Produced Energy 41.54 GWh/year

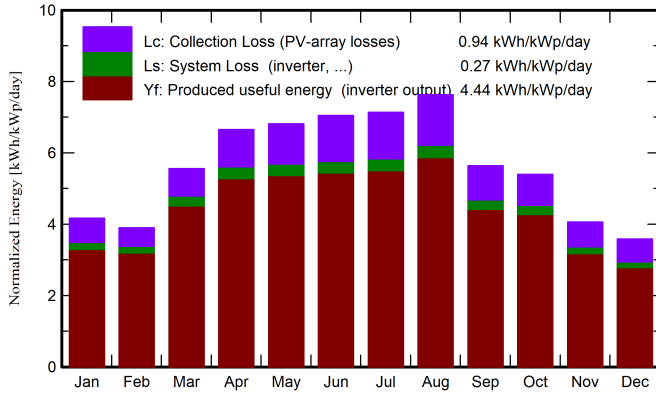
Specific production

1619 kWh/kWp/year

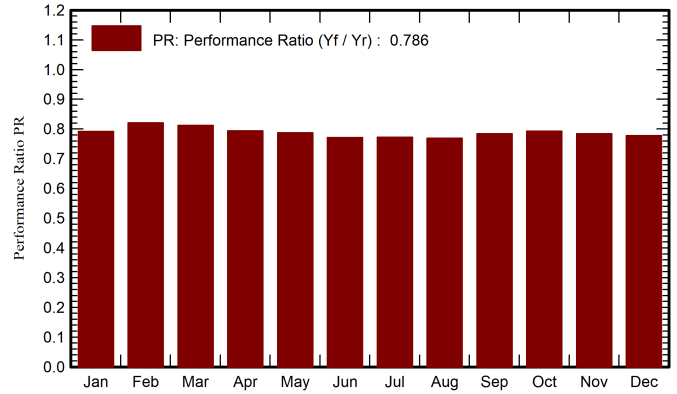
Perf. Ratio PR

78.62 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

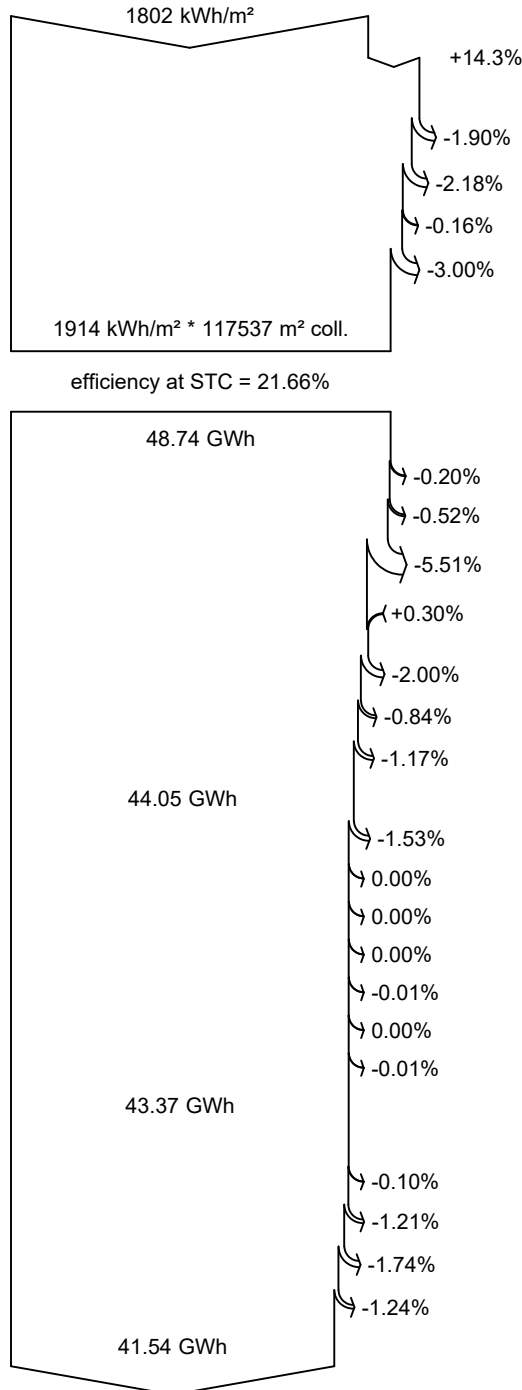
	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray GWh	E_Grid GWh	PR ratio
January	80.2	32.26	8.57	129.2	114.7	2.776	2.623	0.792
February	80.2	39.47	6.34	109.2	99.7	2.435	2.299	0.821
March	140.2	49.96	11.89	172.3	161.8	3.816	3.591	0.812
April	184.9	62.10	17.22	199.4	187.7	4.316	4.060	0.794
May	214.9	68.57	20.23	211.2	198.7	4.529	4.266	0.788
June	226.4	66.87	25.16	211.4	198.6	4.434	4.184	0.772
July	232.3	61.52	26.44	221.1	208.2	4.643	4.379	0.772
August	226.8	55.16	27.51	236.6	223.7	4.949	4.665	0.769
September	146.3	55.78	22.54	169.2	158.8	3.610	3.403	0.784
October	122.7	45.82	19.84	167.4	156.2	3.603	3.402	0.792
November	79.8	33.82	14.66	121.8	109.2	2.593	2.449	0.784
December	67.2	29.64	10.07	111.1	96.7	2.345	2.215	0.778
Year	1802.0	600.99	17.61	2059.9	1914.2	44.049	41.537	0.786

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



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

Auxiliaries (fans, other)

AC ohmic loss

Medium voltage transfo loss

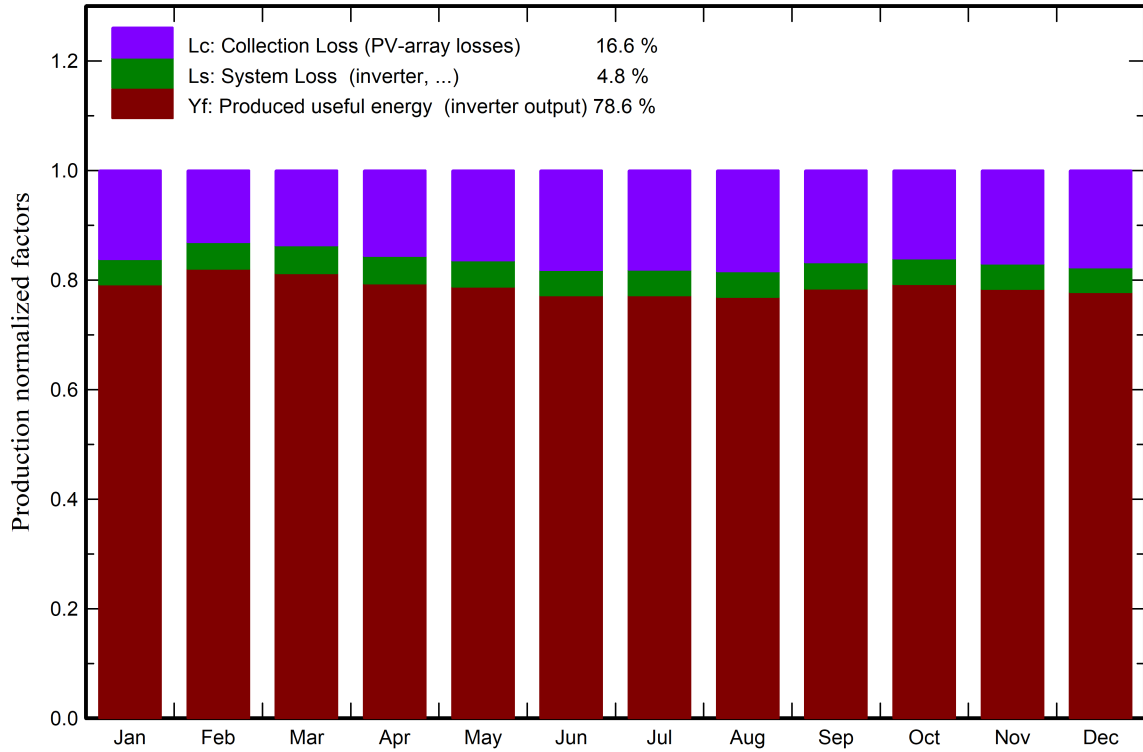
MV line ohmic loss

Energy injected into grid

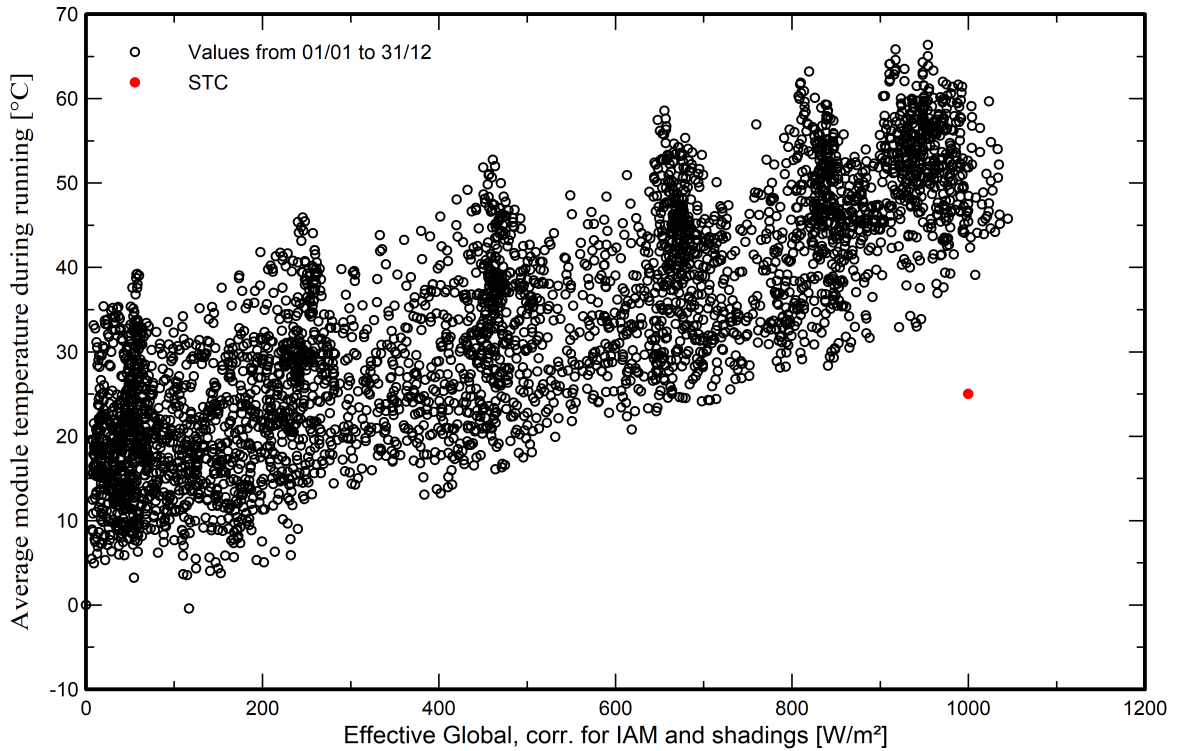


Predef. graphs

Normalized Production and Loss Factors



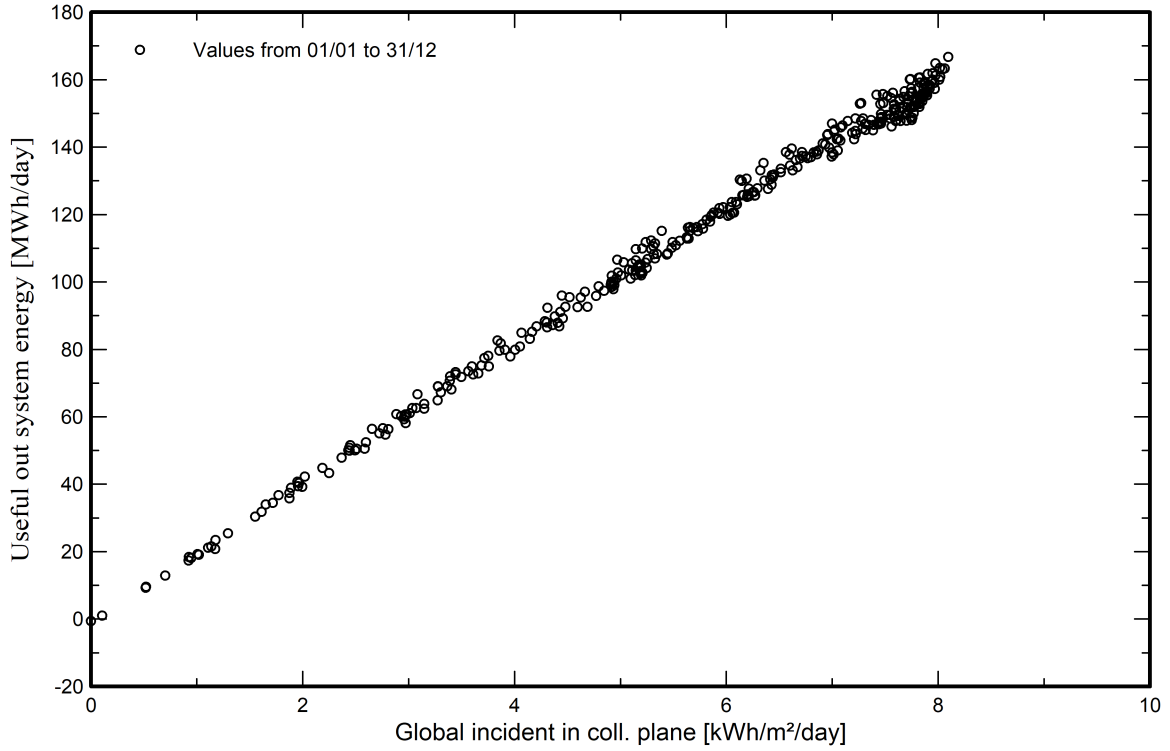
Array Temperature vs. Effective Irradiance



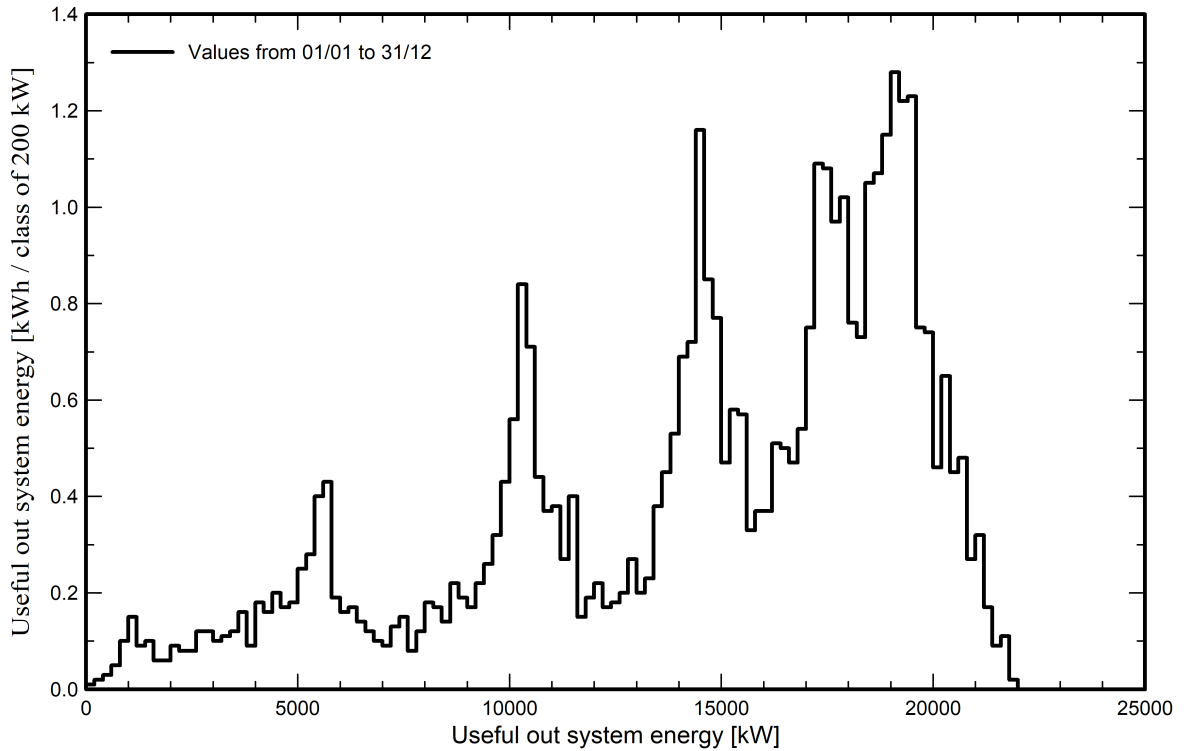


Predef. graphs

Daily Input/Output diagram



System Output Power Distribution

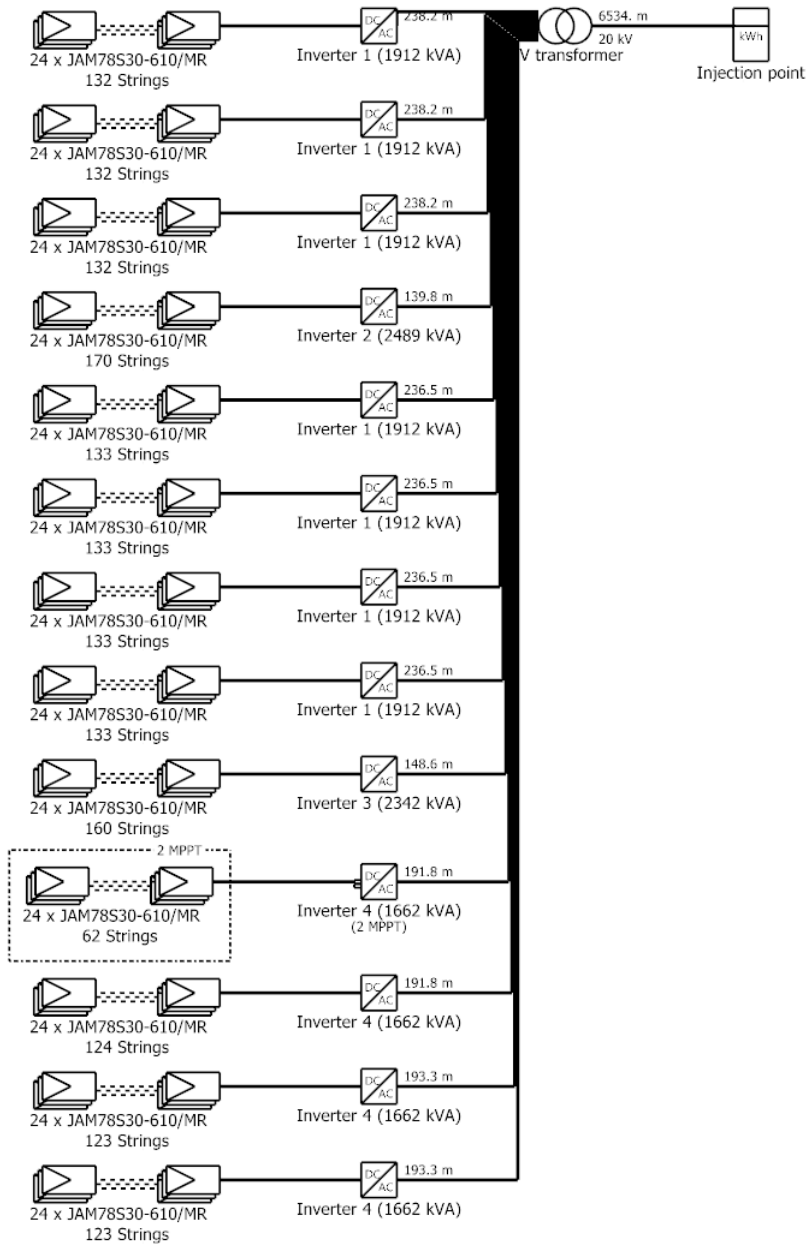




PVsyst V7.4.2

VC0, Simulation date:
15/09/23 12:17
with v7.4.2

Single-line diagram



PV module	JAM78S30-610/MR
Inverter 1	Sunway TG 1800 1500V TE - 690
Inverter 2	SUNWAY STATION TG1800&900-1500V-TE 600 (2489kW)
Inverter 3	SUNWAY STATION TG1800&900-1500V-TE 600 (2342kW)
Inverter 4	Sunway TG 1800 1500V TE - 600
String	24 x JAM78S30-610/MR

Ficurinia lotto #3683

ARATO SRL (Italy)

VC0 : New simulation variant

10/10/23



PVsyst V7.4.2

VC0, Simulation date:
15/09/23 12:17
with v7.4.2

CO₂ Emission Balance

Total: 418873.3 tCO₂

Generated emissions

Total: 38480.84 tCO₂

Source: Detailed calculation from table below

Replaced Emissions

Total: 527108.9 tCO₂

System production: 41537.35 MWh/yr

Grid Lifecycle Emissions: 423 gCO₂/kWh

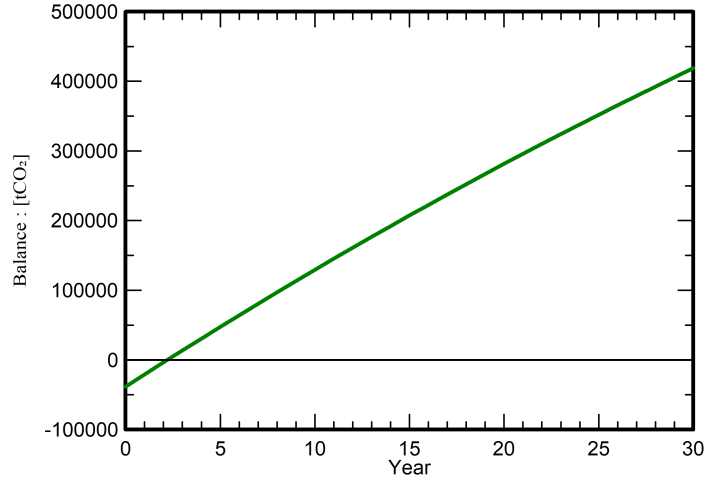
Source: IEA List

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	915 kgCO ₂ /modules	42048 modules	38473920
Supports	2.36 kgCO ₂ /units	1799 units	4246
Inverters	206 kgCO ₂ /units	13.0 units	2674