



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 MW, con relativo collegamento alla rete elettrica, sito nei comuni di Castel di Iudica e Ramacca (CT) - Impianto "FICURINIA".

ID. PROGETTO DEL MITE:

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

INE FICURINIA S.R.L.

a company of ILOS New Energy Italy

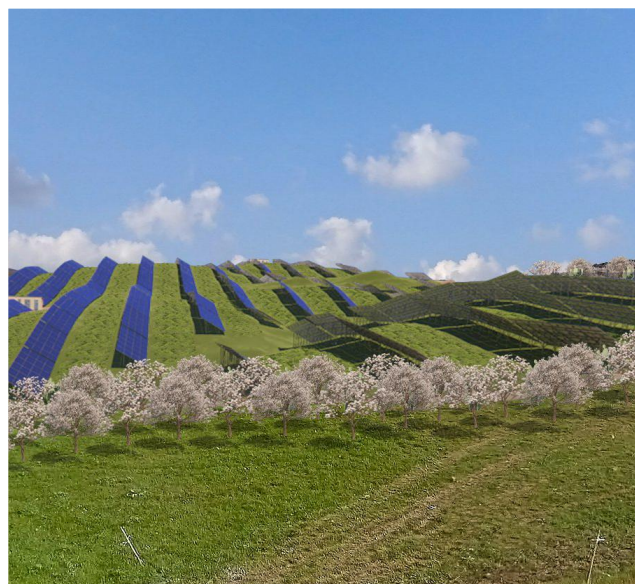
P.IVA e C.F.: IT 11311551002

Sege legale: Piazza di Sant Anastasia 7, 00186 Roma

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Sergio Chiericoni
Firmato Digitalmente

Legale rappresentante: Ing. Sergio Chiericoni



IDENTIFICATORE ELABORATO:

RS06REL069A0

CARTELLA:

VIA_2

ELABORATO REDATTO DA:

Dott. Ing. Giada Stella BOLIGNANO

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

TITOLO ELABORATO:

Analisi della risorsa solare e stima di produzione energia lotto 3683

SCALA:

-



PROGETTAZIONE E COORDINAMENTO

Arato SRL

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OPERE ELETTRICHE



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IDRAULICA

13 Ingegneria S.r.l.

13 Ingegneria S.r.l.

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STUDIO PEDO-AGRONOMICO

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N. REV.
0

DATA
apr-22

REVISIONE
Emissione

ELABORATO

Ing. Baldaconi

VERIFICATO

Ing. Bolignano

VALIDATO

INE Ficurinia S.r.l.

PVsyst - Simulation report

Grid-Connected System

Project: Ficurinia #3683

Variant: New simulation variant

Ground system (tables) on a hill

System power: 38.34 MWp

Cavalera - Italy



PVsyst V7.2.12

VCO, Simulation date:
 17/03/22 14:50
 with v7.2.12

ARATO SRL (Italy)

Project summary

Geographical Site		Situation		Project settings	
Cavalera		Latitude	37.51 °N	Albedo	0.20
Italy		Longitude	14.60 °E		
		Altitude	289 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		According to strings		Unlimited load (grid)	
Tilt/Azimuth	31 / 1 °	Electrical effect	90 %		
System information					
PV Array					
Nb. of modules		62856 units	Inverters	Nb. of units	18 units
Pnom total		38.34 MWp		Pnom total	34.22 MWac
				Pnom ratio	1.120

Results summary

Produced Energy	64 GWh/year	Specific production	1672 kWh/kWp/year	Perf. Ratio PR	82.79 %
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Near shading definition - Iso-shadings diagram	10
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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	2686 units
Fixed plane		Sizes	
Tilt/Azimuth	31 / 1 °	Sheds spacing	10.5 m
		Collector width	4.60 m
		Ground Cov. Ratio (GCR)	43.9 %
Horizon		Near Shadings	
Average Height	4.3 °	According to strings	
		Electrical effect	90 %
		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	WINWAY STATION TG1800&900-1500V-TE 600 (2493kW)
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	610 Wp	Unit Nom. Power	2493 kWac
Number of PV modules	13896 units	Number of inverters	3 units
Nominal (STC)	8477 kWp	Total power	7479 kWac
Array #1 - Area 1a			
Number of PV modules	4896 units	Number of inverters	1 unit
Nominal (STC)	2987 kWp	Total power	2493 kWac
Modules	204 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	860-1200 V
Pmpp	2704 kWp	Max. power (=>25°C)	2493 kWac
U mpp	983 V	Pnom ratio (DC:AC)	1.20
I mpp	2752 A		
Array #2 - Area 1b			
Number of PV modules	4896 units	Number of inverters	1 unit
Nominal (STC)	2987 kWp	Total power	2493 kWac
Modules	204 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	860-1200 V
Pmpp	2704 kWp	Max. power (=>25°C)	2493 kWac
U mpp	983 V	Pnom ratio (DC:AC)	1.20
I mpp	2752 A		
Array #7 - Area 3			
Number of PV modules	4104 units	Number of inverters	1 unit
Nominal (STC)	2503 kWp	Total power	2493 kWac
Modules	171 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	860-1200 V
Pmpp	2267 kWp	Max. power (=>25°C)	2493 kWac
U mpp	983 V	Pnom ratio (DC:AC)	1.00
I mpp	2307 A		



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ARATO SRL (Italy)

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	30096 units	Number of inverters	8 units
Nominal (STC)	18.36 MWp	Total power	15296 kWac
Array #3 - Area 2a			
Number of PV modules	3744 units	Number of inverters	1 unit
Nominal (STC)	2284 kWp	Total power	1912 kWac
Modules	156 Strings x 24 In series		
At operating cond. (50°C)			
Pmpp	2068 kWp	Operating voltage	690-1200 V
U mpp	983 V	Max. power (=>25°C)	2151 kWac
I mpp	2105 A	Pnom ratio (DC:AC)	1.19
Array #4 - Area 2b			
Number of PV modules	3744 units	Number of inverters	1 unit
Nominal (STC)	2284 kWp	Total power	1912 kWac
Modules	156 Strings x 24 In series		
At operating cond. (50°C)			
Pmpp	2068 kWp	Operating voltage	690-1200 V
U mpp	983 V	Max. power (=>25°C)	2151 kWac
I mpp	2105 A	Pnom ratio (DC:AC)	1.19
Array #5 - Area 2c			
Number of PV modules	3744 units	Number of inverters	1 unit
Nominal (STC)	2284 kWp	Total power	1912 kWac
Modules	156 Strings x 24 In series		
At operating cond. (50°C)			
Pmpp	2068 kWp	Operating voltage	690-1200 V
U mpp	983 V	Max. power (=>25°C)	2151 kWac
I mpp	2105 A	Pnom ratio (DC:AC)	1.19
Array #6 - Area 2d			
Number of PV modules	3744 units	Number of inverters	1 unit
Nominal (STC)	2284 kWp	Total power	1912 kWac
Modules	156 Strings x 24 In series		
At operating cond. (50°C)			
Pmpp	2068 kWp	Operating voltage	690-1200 V
U mpp	983 V	Max. power (=>25°C)	2151 kWac
I mpp	2105 A	Pnom ratio (DC:AC)	1.19
Array #8 - Area 4a			
Number of PV modules	3768 units	Number of inverters	1 unit
Nominal (STC)	2298 kWp	Total power	1912 kWac
Modules	157 Strings x 24 In series		
At operating cond. (50°C)			
Pmpp	2081 kWp	Operating voltage	690-1200 V
U mpp	983 V	Max. power (=>25°C)	2151 kWac
I mpp	2118 A	Pnom ratio (DC:AC)	1.20



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ARATO SRL (Italy)

PV Array Characteristics

Array #9 - Area 4b

Number of PV modules	3792 units	Number of inverters	1 unit
Nominal (STC)	2313 kWp	Total power	1912 kWac
Modules	158 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	2095 kWp	Max. power (=>25°C)	2151 kWac
U mpp	983 V	Pnom ratio (DC:AC)	1.21
I mpp	2132 A		

Array #10 - Area 4c

Number of PV modules	3792 units	Number of inverters	1 unit
Nominal (STC)	2313 kWp	Total power	1912 kWac
Modules	158 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	2095 kWp	Max. power (=>25°C)	2151 kWac
U mpp	983 V	Pnom ratio (DC:AC)	1.21
I mpp	2132 A		

Array #11 - Area 4d

Number of PV modules	3768 units	Number of inverters	1 unit
Nominal (STC)	2298 kWp	Total power	1912 kWac
Modules	157 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	690-1200 V
Pmpp	2081 kWp	Max. power (=>25°C)	2151 kWac
U mpp	983 V	Pnom ratio (DC:AC)	1.20
I mpp	2118 A		

PV module

Manufacturer	JA Solar
Model	JAM78S30-610/MR
(Custom parameters definition)	
Unit Nom. Power	610 Wp
Number of PV modules	7632 units
Nominal (STC)	4656 kWp

Inverter

Manufacturer	Santerno
Model	Sunway TG 1800 1500V TE - 600 (1600W)
(Custom parameters definition)	
Unit Nom. Power	1600 kWac
Number of inverters	3 units
Total power	4800 kWac

Array #12 - Area 5a

Number of PV modules	2544 units	Number of inverters	1 unit
Nominal (STC)	1552 kWp	Total power	1600 kWac
Modules	106 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	860-1200 V
Pmpp	1405 kWp	Max. power (=>25°C)	1871 kWac
U mpp	983 V	Pnom ratio (DC:AC)	0.97
I mpp	1430 A		

Array #13 - Area 5b

Number of PV modules	2544 units	Number of inverters	1 unit
Nominal (STC)	1552 kWp	Total power	1600 kWac
Modules	106 Strings x 24 In series		
At operating cond. (50°C)		Operating voltage	860-1200 V
Pmpp	1405 kWp	Max. power (=>25°C)	1871 kWac
U mpp	983 V	Pnom ratio (DC:AC)	0.97
I mpp	1430 A		



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ARATO SRL (Italy)

PV Array Characteristics

Array #14 - Area 5c

Number of PV modules 2544 units
 Nominal (STC) 1552 kWp
 Modules 106 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1405 kWp
 U mpp 983 V
 I mpp 1430 A

Number of inverters 1 unit
 Total power 1600 kWac

Operating voltage 860-1200 V
 Max. power (=>25°C) 1871 kWac
 Pnom ratio (DC:AC) 0.97

PV module

Manufacturer JA Solar
 Model JAM78S30-610/MR
 (Custom parameters definition)

Unit Nom. Power 610 Wp
 Number of PV modules 11232 units
 Nominal (STC) 6852 kWp

Array #15 - Area 6a

Number of PV modules 2808 units
 Nominal (STC) 1713 kWp
 Modules 117 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1551 kWp
 U mpp 983 V
 I mpp 1579 A

Inverter

Manufacturer Santerno
 Model Sunway TG 1800 1500V TE - 600 (1662W)
 (Custom parameters definition)

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

Array #16 - Area 6b

Number of PV modules 2808 units
 Nominal (STC) 1713 kWp
 Modules 117 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1551 kWp
 U mpp 983 V
 I mpp 1579 A

Number of inverters 1 unit
 Total power 1662 kWac

Operating voltage 860-1200 V
 Max. power (=>25°C) 1662 kWac
 Pnom ratio (DC:AC) 1.03

Number of inverters 1 unit
 Total power 1662 kWac

Operating voltage 860-1200 V
 Max. power (=>25°C) 1662 kWac
 Pnom ratio (DC:AC) 1.03

Array #17 - Area 6c

Number of PV modules 2808 units
 Nominal (STC) 1713 kWp
 Modules 117 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1551 kWp
 U mpp 983 V
 I mpp 1579 A

Number of inverters 1 unit
 Total power 1662 kWac

Operating voltage 860-1200 V
 Max. power (=>25°C) 1662 kWac
 Pnom ratio (DC:AC) 1.03

Array #18 - Area 6d

Number of PV modules 2808 units
 Nominal (STC) 1713 kWp
 Modules 117 Strings x 24 In series

At operating cond. (50°C)

Pmpp 1551 kWp
 U mpp 983 V
 I mpp 1579 A

Number of inverters 1 unit
 Total power 1662 kWac

Operating voltage 860-1200 V
 Max. power (=>25°C) 1662 kWac
 Pnom ratio (DC:AC) 1.03



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ARATO SRL (Italy)

PV Array Characteristics

Total PV power		Total inverter power	
Nominal (STC)	38342 kWp	Total power	34223 kWac
Total	62856 modules	Number of inverters	18 units
Module area	175702 m ²	Pnom ratio	1.12
Cell area	161987 m ²		

Array losses

Array Soiling Losses		Thermal Loss factor		Serie Diode Loss				
Loss Fraction	2.0 %	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	1.0 %	Loss Fraction	-0.5 %	Loss Fraction	0.5 % 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	0.46 mΩ		
Loss Fraction	1.5 % at STC		
Array #1 - Area 1a		Array #2 - Area 1b	
Global array res.	5.9 mΩ	Global array res.	5.9 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #3 - Area 2a		Array #4 - Area 2b	
Global array res.	7.7 mΩ	Global array res.	7.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #5 - Area 2c		Array #6 - Area 2d	
Global array res.	7.7 mΩ	Global array res.	7.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #7 - Area 3		Array #8 - Area 4a	
Global array res.	7.1 mΩ	Global array res.	7.7 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #9 - Area 4b		Array #10 - Area 4c	
Global array res.	7.6 mΩ	Global array res.	7.6 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #11 - Area 4d		Array #12 - Area 5a	
Global array res.	7.7 mΩ	Global array res.	11 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #13 - Area 5b		Array #14 - Area 5c	
Global array res.	11 mΩ	Global array res.	11 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC



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DC wiring losses

Array #15 - Area 6a		Array #16 - Area 6b	
Global array res.	10 mΩ	Global array res.	10 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #17 - Area 6c		Array #18 - Area 6d	
Global array res.	10 mΩ	Global array res.	10 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC

System losses

Auxiliaries loss	
constant (fans)	10.00 kW
0.0 kW from Power thresh.	

AC wiring losses

Inv. output line up to MV transfo	
Inverter voltage	600 Vac tri
Loss Fraction	0.65 % at STC
Inverters: SUNWAY STATION TG1800&900-1500V-TE 600 (2493kW), Sunway TG 1800 1500V TE - 690, Sunway TG 1800 1500V TE - 600 (1600W), S	
Wire section (18 Inv.)	Copper 18 x 3 x 10000 mm ²
Average wires length	651 m
MV line up to Injection	
MV Voltage	20 kV
Average each inverter	
Wires	Copper 3 x 50 mm ²
Length	500 m
Loss Fraction	0.10 % at STC

AC losses in transformers

MV transfo	
Grid voltage	20 kV
Operating losses at STC	
Nominal power at STC	37756 kVA
Iron loss (night disconnect)	2.10 kW/Inv.
Loss Fraction	0.10 % at STC
Coils equivalent resistance	3 x 1.72 mΩ/inv.
Loss Fraction	1.00 % at STC



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ARATO SRL (Italy)

Horizon definition

Horizon from PVGIS website API, Lat=37°30'28', Long=14°36'45', Alt=383m

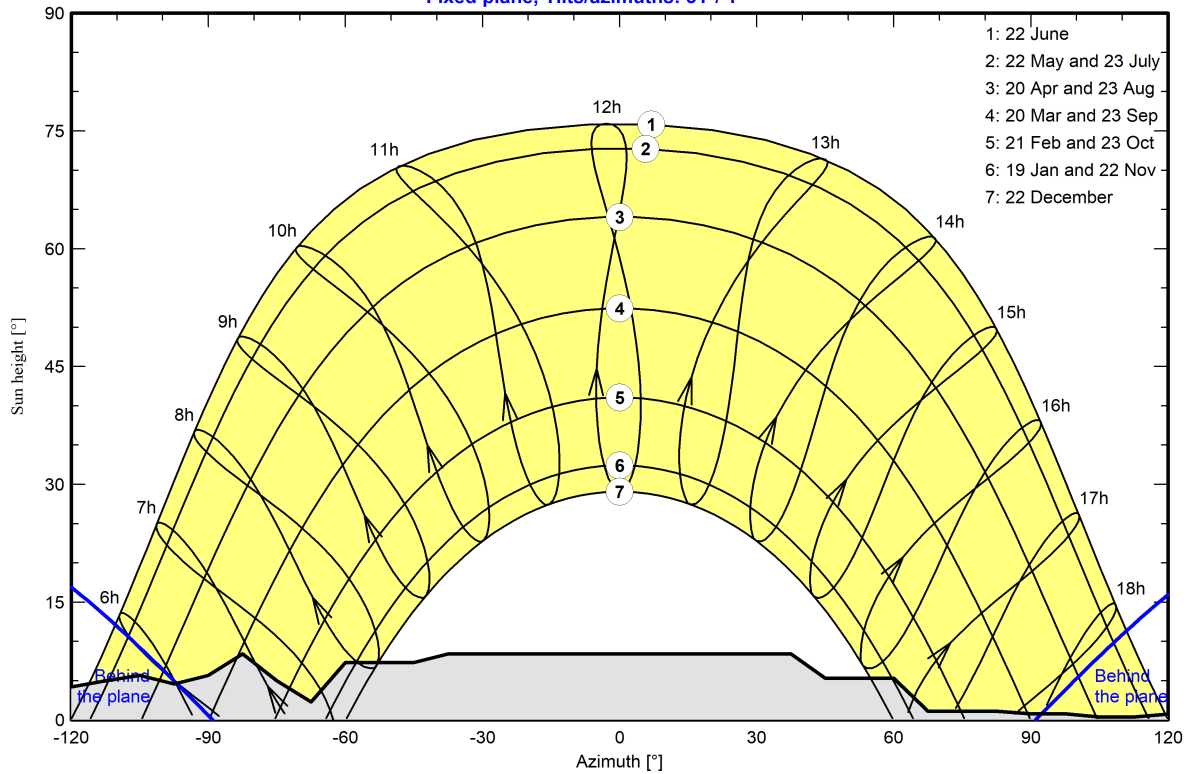
Average Height	4.3 °	Albedo Factor	0.61
Diffuse Factor	0.95	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-135	-128	-120	-113	-105	-98
Height [°]	1.5	2.7	3.1	2.7	1.5	3.1	4.2	3.8	4.2	5.0	5.7	4.6
Azimuth [°]	-90	-83	-75	-68	-60	-45	-38	38	45	60	68	83
Height [°]	5.7	8.4	5.0	2.3	7.3	7.3	8.4	8.4	5.3	5.3	1.1	1.1
Azimuth [°]	90	98	105	113	128	135	143	150	158	165	173	180
Height [°]	0.8	0.8	0.4	0.4	1.1	1.1	0.8	1.5	1.1	1.1	1.5	1.5

Sun Paths (Height / Azimuth diagram)

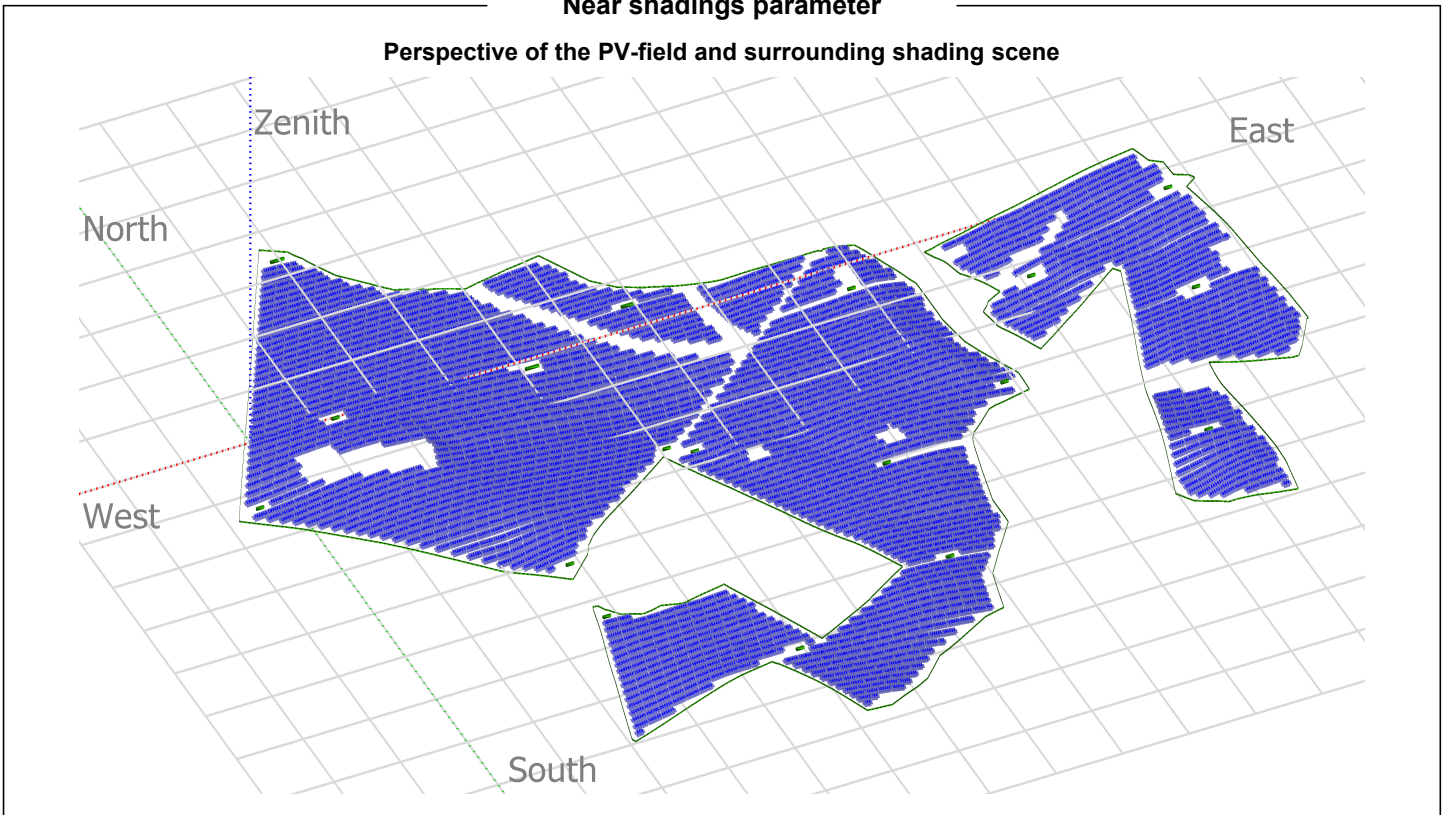
Fixed plane, Tilts/azimuths: 31°/ 1°





Near shadings parameter

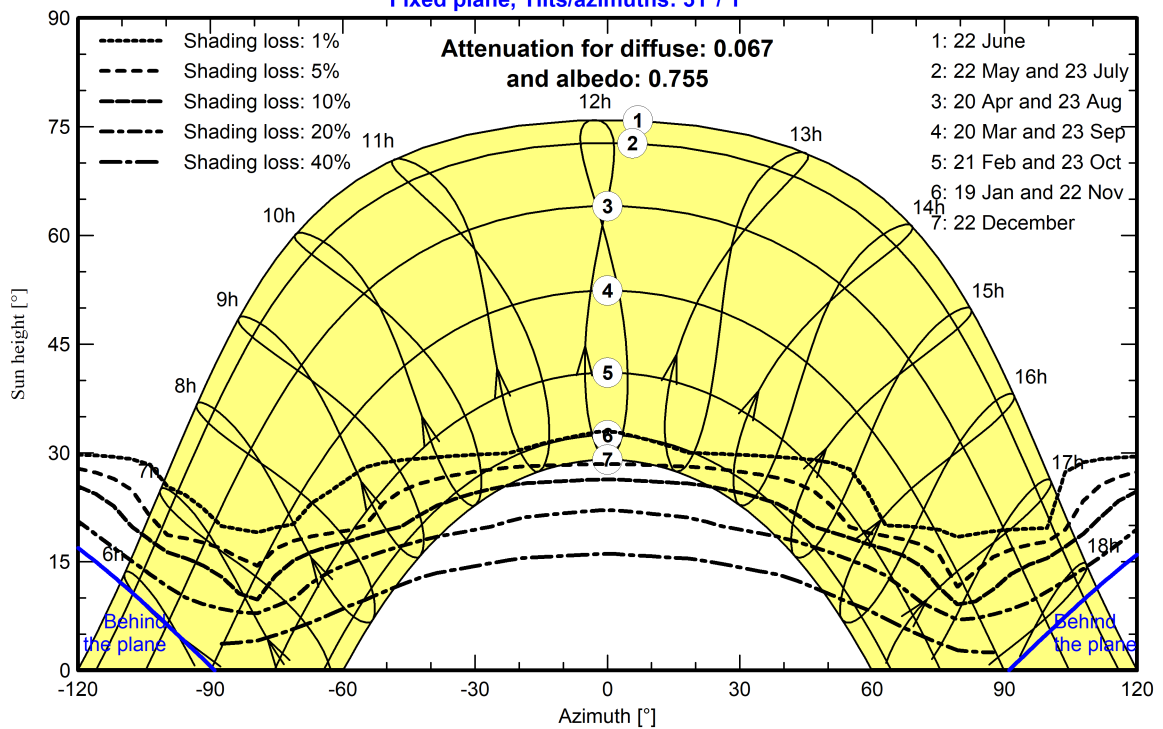
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 31°/ 1°





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ARATO SRL (Italy)

Main results

System Production

Produced Energy

64 GWh/year

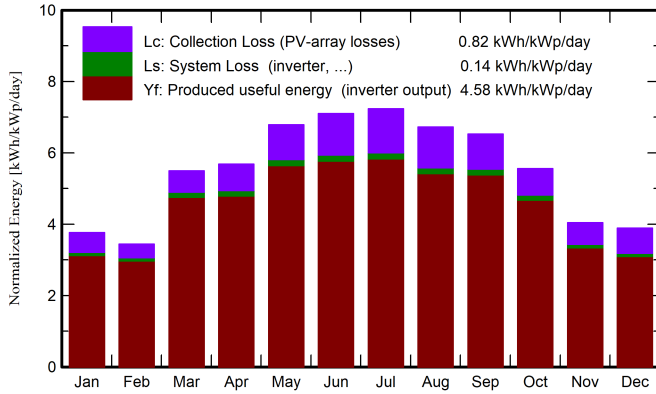
Specific production

1672 kWh/kWp/year

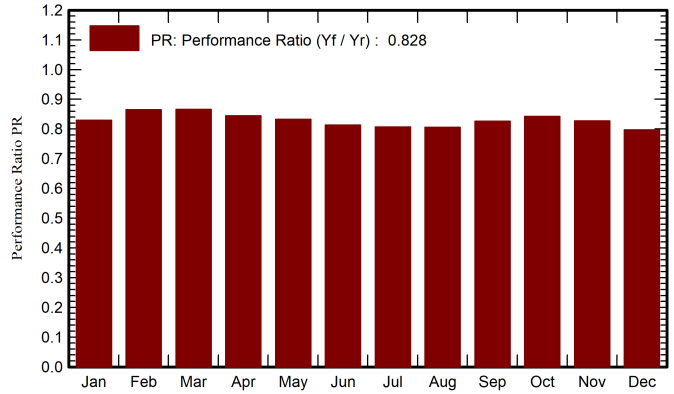
Performance Ratio PR

82.79 %

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	74.2	31.84	5.85	116.8	105.4	3.822	3.713	0.829
February	72.8	40.94	4.54	96.2	88.9	3.289	3.193	0.866
March	140.7	58.51	7.87	170.5	161.3	5.825	5.657	0.866
April	159.7	67.25	13.05	170.4	161.0	5.688	5.517	0.844
May	214.3	78.44	17.43	210.3	199.4	6.916	6.716	0.833
June	227.6	70.77	23.09	212.9	202.1	6.840	6.640	0.813
July	234.9	65.96	25.31	224.3	213.3	7.141	6.936	0.806
August	200.6	62.39	25.33	208.5	198.4	6.638	6.446	0.806
September	165.7	55.83	20.81	195.7	186.5	6.386	6.201	0.826
October	126.5	43.45	15.54	172.2	163.4	5.728	5.564	0.843
November	79.0	32.23	9.08	121.2	110.4	3.957	3.842	0.827
December	72.3	30.73	5.63	120.6	105.4	3.791	3.686	0.797
Year	1768.4	638.34	14.52	2019.7	1895.5	66.020	64.111	0.828

Legends

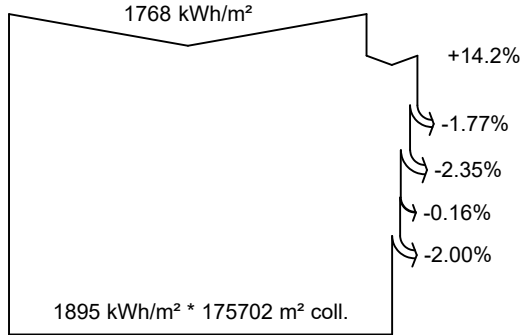
- GlobHor Global horizontal irradiation
- DiffHor Horizontal diffuse irradiation
- T_Amb Ambient Temperature
- GlobInc Global incident in coll. plane
- GlobEff Effective Global, corr. for IAM and shadings
- EArray Effective energy at the output of the array
- E_Grid Energy injected into grid
- PR Performance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



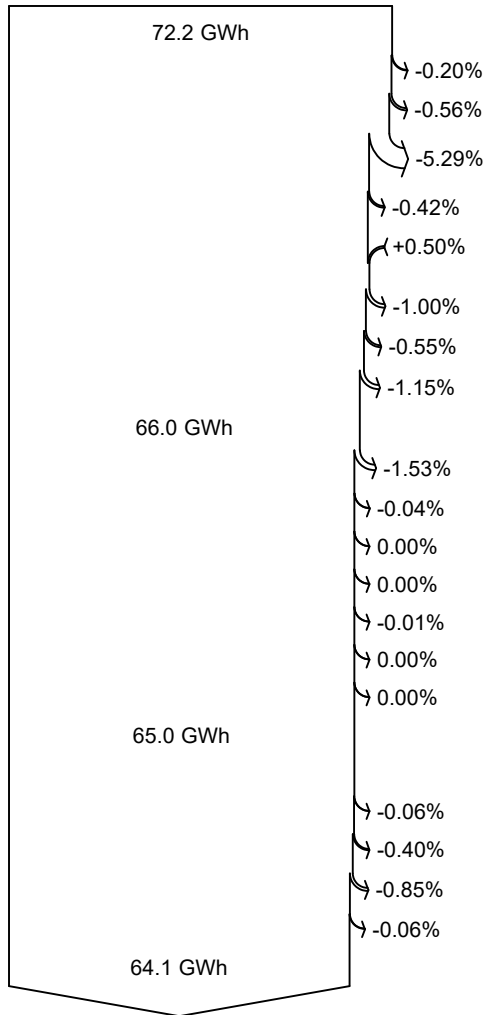
PVsyst V7.2.12

VC0, Simulation date:
 17/03/22 14:50
 with v7.2.12

Loss diagram



efficiency at STC = 21.66%



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
- Shadings: Electrical Loss acc. to strings
- 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

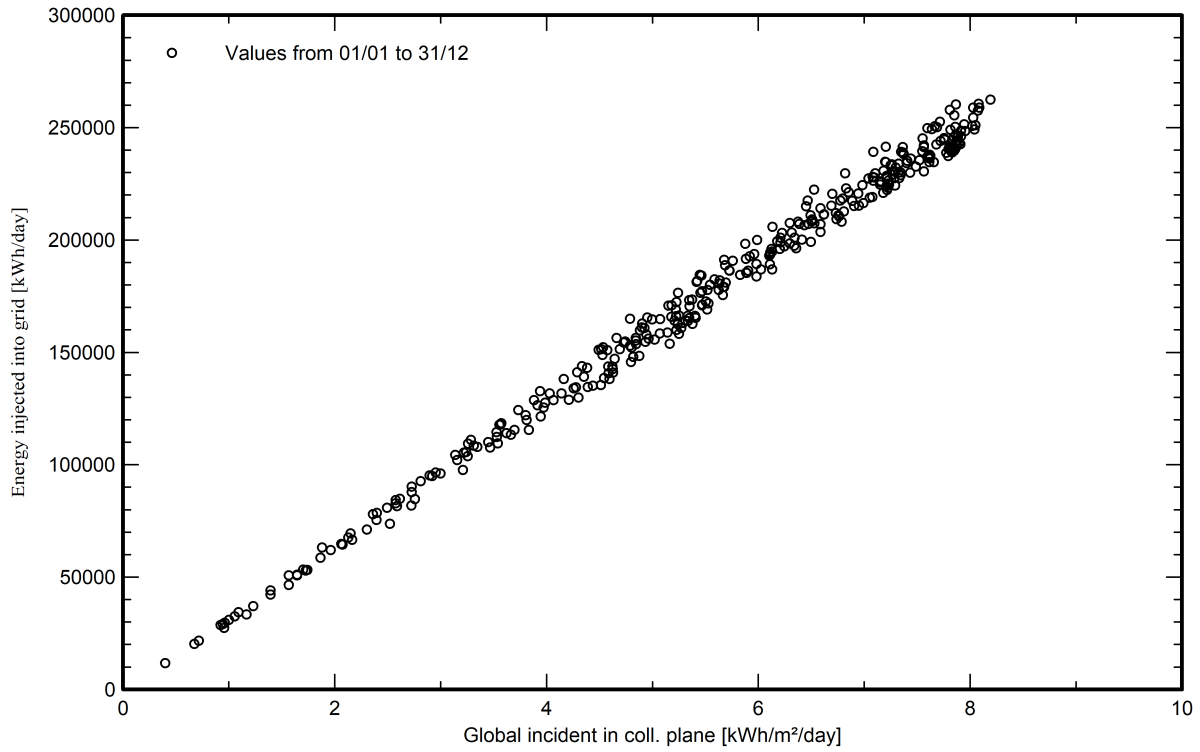
- Auxiliaries (fans, other)
- AC ohmic loss
- Medium voltage transfo loss
- MV line ohmic loss

Energy injected into grid



Special graphs

Daily Input/Output diagram



System Output Power Distribution

