





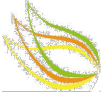







REGIONE PUGLIA

PROVINCIA di FOGGIA

COMUNE di
SERRACAPRIOLA

COMUNE di
SAN PAOLO DI CIVITATE

COMUNE di
TORREMAGGIORE

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<p>Opera</p>	<p>Progetto definitivo per la realizzazione di un impianto Agri-Fotovoltaico denominato " TOVAGLIA" da realizzarsi in cave dismesse o da dismettere e recuperare, site in località "Masseria Tovaglia" nel territorio comunale di Serracapriola (FG) per una potenza complessiva di 26,557MWp nonchè delle opere connesse ed infrastrutture indispensabili alla costruzione e all'esercizio dell'impianto</p>				
<p>AUTORITA' PROCEDENTE V.I.A. :</p>	 <p>Ministero dell'Ambiente e della Sicurezza Energetica</p>	<p>AUTORITA' PROCEDENTE A.U. :</p>	 <p>REGIONE PUGLIA</p>		
<p>Oggetto</p>	<p>Nome Elaborato: 96WX1A8_RelazioneProducibilità.pdf Descrizione Elaborato: Relazione Producibilità - Report Pvsyst e PVGIS</p>				
<p>00</p>	<p>28/10/2022</p>	<p>Progetto definitivo</p>	<p>Ing. A. Mezzina</p>	<p>Pacifico Acquamarina 2 S.r.l.</p>	
<p>Rev.</p>	<p>Data</p>	<p>Oggetto della revisione</p>	<p>Elaborazione</p>	<p>Verifica</p>	<p>Approvazione</p>
<p>Scala:</p>	<p>Codice Pratica 96WX1A8</p>				
<p>Formato:</p>	<p>Codice Pratica 96WX1A8</p>				

PVsyst - Simulation report

Grid-Connected System

Project: Acquamarina 2

Variant: Nuova variante di simulazione

Unlimited Trackers with backtracking

System power: 26.56 MWp

Serracapriola - Italia



Project: Acquamarina 2
Variant: Nuova variante di simulazione

PVsyst V7.3.2

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Project summary

Geographical Site Serracapriola Italia	Situation Latitude 41.81 °N Longitude 15.16 °E Altitude 264 m Time zone UTC+1	Project settings Albedo 0.20
Meteo data Serracapriola PVGIS api TMY		

System summary

Grid-Connected System Simulation for year no 1	Unlimited Trackers with backtracking		
PV Field Orientation Orientation Tracking horizontal axis	Tracking algorithm Astronomic calculation Backtracking activated	Near Shadings No Shadings	
System information PV Array		Inverters	
Nb. of modules	45396 units	Nb. of units	6 units
Pnom total	26.56 MWp	Pnom total	24.00 MWac
		Pnom ratio	1.107
User's needs Unlimited load (grid)			

Results summary

Produced Energy	44659311 kWh/year	Specific production	1682 kWh/kWp/year	Perf. Ratio PR	88.77 %
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Table of contents

Project and results summary	2
General parameters, PV Array Characteristics, System losses	3
Main results	7
Loss diagram	8
Predef. graphs	9
Single-line diagram	10



Project: Acquamarina 2

Variant: Nuova variante di simulazione

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General parameters

Grid-Connected System		Unlimited Trackers with backtracking	
PV Field Orientation		Tracking algorithm	
Orientation		Astronomic calculation	
Tracking horizontal axis		Backtracking activated	
		Backtracking array	
		Nb. of trackers	10 units
		Unlimited trackers	
		Sizes	
		Tracker Spacing	9.00 m
		Collector width	3.00 m
		Ground Cov. Ratio (GCR)	33.3 %
		Left inactive band	0.02 m
		Right inactive band	0.02 m
		Phi min / max.	-60.0 / 0.0 °
		Backtracking strategy	
		Phi limits for BT	-/+ 70.2 °
		Backtracking pitch	9.00 m
		Backtracking width	3.00 m
Models used			
Transposition	Perez		
Diffuse	Imported		
Circumsolar	separate		
Horizon		Near Shadings	
Free Horizon		No Shadings	
		User's needs	
		Unlimited load (grid)	
Bifacial system			
Model	2D Calculation unlimited trackers		
Bifacial model geometry		Bifacial model definitions	
Tracker Spacing	9.00 m	Ground albedo	0.30
Tracker width	3.04 m	Bifaciality factor	80 %
GCR	33.8 %	Rear shading factor	5.0 %
Axis height above ground	2.10 m	Rear mismatch loss	10.0 %
		Shed transparent fraction	0.0 %

PV Array Characteristics

PV module		Inverter	
Manufacturer	Jinkosolar	Manufacturer	SMA
Model	JKM585M-7RL4-V	Model	Sunny Central 4000 UP
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	585 Wp	Unit Nom. Power	4000 kWac
Number of PV modules	45396 units	Number of inverters	6 units
Nominal (STC)	26.56 MWp	Total power	24000 kWac
Array #1 - Subcampo S1.1			
Number of PV modules	6448 units	Number of inverters	1 unit
Nominal (STC)	3772 kWp	Total power	4000 kWac
Modules	248 Strings x 26 In series		
At operating cond. (50°C)		Operating voltage	
Pmpp	3441 kWp	880-1325 V	
U mpp	1047 V	Pnom ratio (DC:AC)	
I mpp	3286 A	0.94	



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PV Array Characteristics

Array #2 - Subcampo S2.1			
Number of PV modules	7540 units	Number of inverters	1 unit
Nominal (STC)	4411 kWp	Total power	4000 kWac
Modules	290 Strings x 26 In series		
At operating cond. (50°C)			
Pmpp	4024 kWp	Operating voltage	880-1325 V
U mpp	1047 V	Pnom ratio (DC:AC)	1.10
I mpp	3843 A		
Array #3 - Subcampo S2.2			
Number of PV modules	7566 units	Number of inverters	1 unit
Nominal (STC)	4426 kWp	Total power	4000 kWac
Modules	291 Strings x 26 In series		
At operating cond. (50°C)			
Pmpp	4038 kWp	Operating voltage	880-1325 V
U mpp	1047 V	Pnom ratio (DC:AC)	1.11
I mpp	3856 A		
Array #4 - Subcampo S3.1			
Number of PV modules	7956 units	Number of inverters	1 unit
Nominal (STC)	4654 kWp	Total power	4000 kWac
Modules	306 Strings x 26 In series		
At operating cond. (50°C)			
Pmpp	4246 kWp	Operating voltage	880-1325 V
U mpp	1047 V	Pnom ratio (DC:AC)	1.16
I mpp	4055 A		
Array #5 - Subcampo S3.2			
Number of PV modules	7930 units	Number of inverters	1 unit
Nominal (STC)	4639 kWp	Total power	4000 kWac
Modules	305 Strings x 26 In series		
At operating cond. (50°C)			
Pmpp	4232 kWp	Operating voltage	880-1325 V
U mpp	1047 V	Pnom ratio (DC:AC)	1.16
I mpp	4042 A		
Array #6 - Subcampo S3.3			
Number of PV modules	7956 units	Number of inverters	1 unit
Nominal (STC)	4654 kWp	Total power	4000 kWac
Modules	306 Strings x 26 In series		
At operating cond. (50°C)			
Pmpp	4246 kWp	Operating voltage	880-1325 V
U mpp	1047 V	Pnom ratio (DC:AC)	1.16
I mpp	4055 A		
Total PV power		Total inverter power	
Nominal (STC)	26557 kWp	Total power	24000 kWac
Total	45396 modules	Number of inverters	6 units
Module area	124116 m ²	Pnom ratio	1.11



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Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Thermal Loss factor

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

Serie Diode Loss

Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation

Loss Fraction 2.0 %

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 0.4 %/year

Mismatch due to degradation

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

IAM loss factor

Incidence effect (IAM): Fresnel, AR coating, n(glass)=1.526, n(AR)=1.290

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

Spectral correction

FirstSolar model

Coefficient Set	C0	C1	C2	C3	C4	C5
Monocrystalline Si	0,85914	-0,02088	-0,0058853	0,12029	0,026814	-0,001781

DC wiring losses

Global wiring resistance 0.25 mΩ
Loss Fraction 0.5 % at STC

Array #1 - Subcampo S1.1

Global array res. 0.34 mΩ
Loss Fraction 0.1 % at STC

Array #2 - Subcampo S2.1

Global array res. 4.5 mΩ
Loss Fraction 1.5 % at STC

Array #3 - Subcampo S2.2

Global array res. 4.5 mΩ
Loss Fraction 1.5 % at STC

Array #4 - Subcampo S3.1

Global array res. 4.3 mΩ
Loss Fraction 1.5 % at STC

Array #5 - Subcampo S3.2

Global array res. 4.3 mΩ
Loss Fraction 1.5 % at STC

Array #6 - Subcampo S3.3

Global array res. 4.3 mΩ
Loss Fraction 1.5 % at STC

System losses

Unavailability of the system

Time fraction 2.0 %
7.3 days,
3 periods

Auxiliaries loss

constant (fans) 32.0 kW
2.0 kW from Power thresh.



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AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 600 Vac tri
Loss Fraction 0.03 % at STC

Global System

Wire section Copper 3 x 50000 mm²
Wires length 10 m

MV line up to Injection

MV Voltage 30 kV
Average each inverter
Wires Alu 3 x 240 mm²
Length 12500 m
Loss Fraction 0.28 % at STC

AC losses in transformers

MV transfo

Medium voltage 30 kV

One transfo parameters

Nominal power at STC 1.53 MVA
Iron Loss (24/24 Connexion) 1.53 kVA
Iron loss fraction 0.10 % at STC
Copper loss 15.32 kVA
Copper loss fraction 1.00 % at STC
Coils equivalent resistance 3 x 2.35 mΩ

Operating losses at STC (full system)

Nb. identical MV transfos 17
Nominal power at STC 26.04 MVA
Iron loss (24/24 Connexion) 26.04 kVA
Copper loss 260.39 kVA



Project: Acquamarina 2
 Variant: Nuova variante di simulazione

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Main results

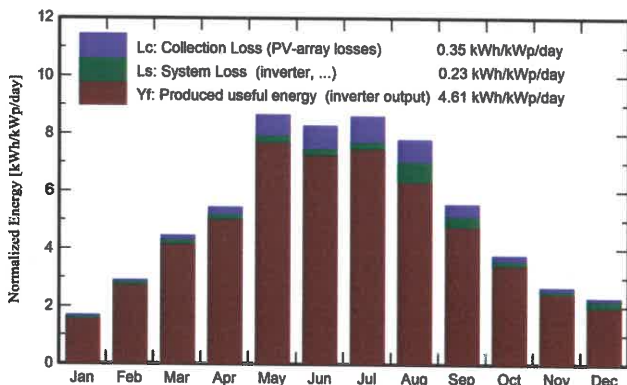
System Production

Produced Energy **44659311 kWh/year**

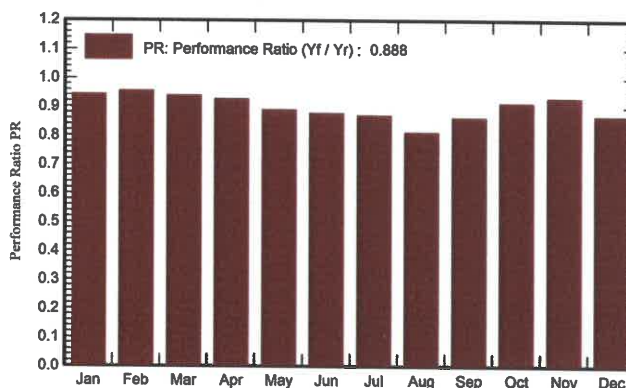
Specific production
 Performance Ratio PR

1682 kWh/kWp/year
88.77 %

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 kWh	E_Grid kWh	PR ratio
January	45.2	26.07	7.66	51.9	47.3	1359582	1301381	0.944
February	70.4	32.91	5.41	80.9	75.1	2127970	2052671	0.955
March	117.8	48.46	9.06	138.1	129.9	3561829	3444153	0.939
April	145.6	65.72	13.45	163.2	154.2	4155131	4021636	0.928
May	230.4	67.57	19.58	268.6	255.7	6559347	6354670	0.891
June	215.7	71.84	23.11	248.6	236.6	5987773	5800976	0.879
July	229.3	67.49	25.81	266.7	253.9	6367588	6171106	0.871
August	206.5	61.11	25.11	241.7	229.9	5813541	5224415	0.814
September	142.2	55.74	21.25	166.6	157.3	4110286	3822985	0.864
October	98.9	41.08	15.06	116.9	109.3	2966979	2840342	0.915
November	66.6	27.47	12.09	80.0	73.4	2053204	1981250	0.932
December	60.1	24.88	8.19	71.2	64.1	1836444	1643726	0.870
Year	1628.6	590.34	15.54	1894.4	1786.6	46899673	44659311	0.888

Legends

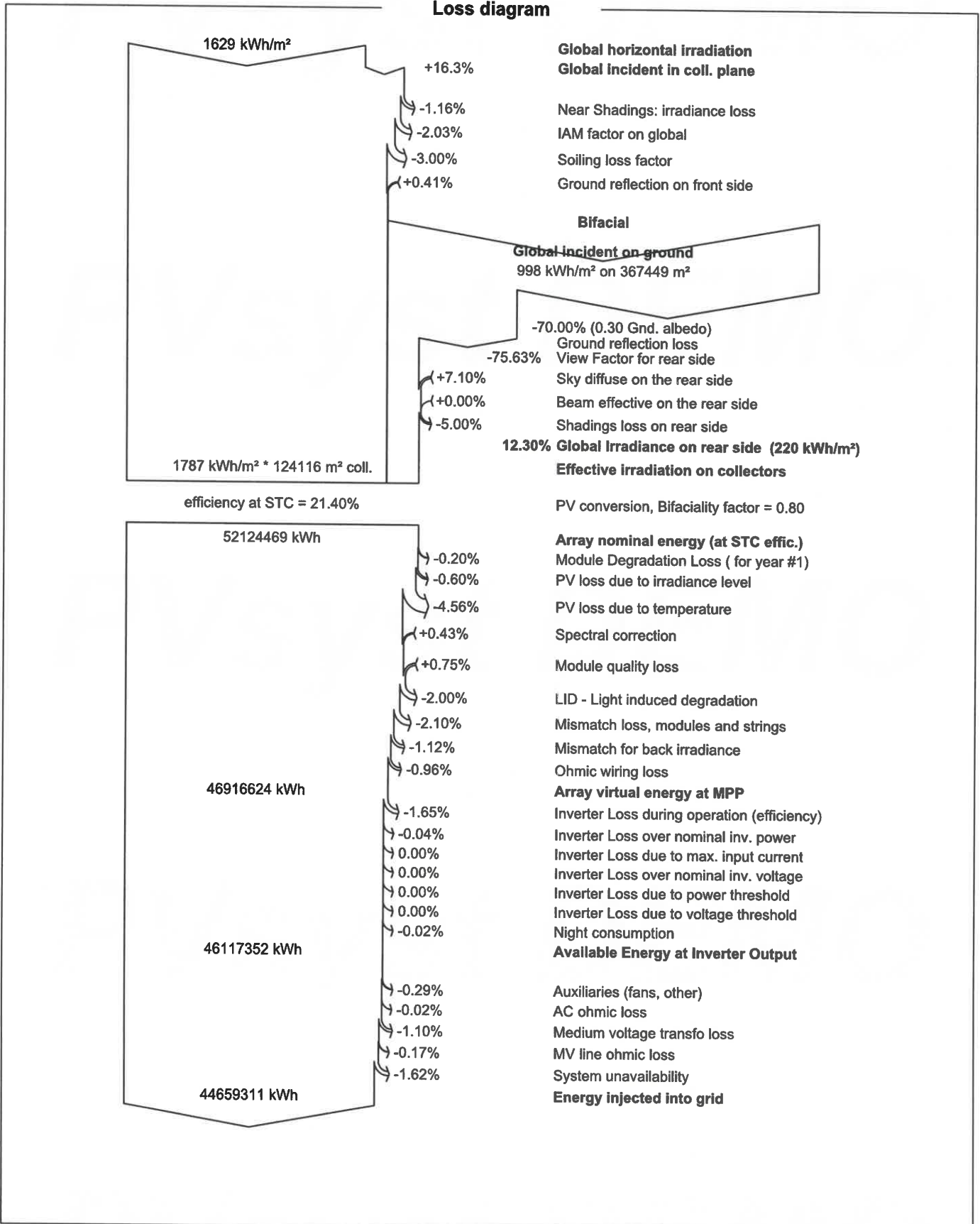
- | | | | |
|---------|--|--------|---|
| GlobHor | Global horizontal irradiation | EArray | Effective energy at the output of the array |
| DiffHor | Horizontal diffuse irradiation | E_Grid | Energy injected into grid |
| T_Amb | Ambient Temperature | PR | Performance Ratio |
| GlobInc | Global incident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



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Loss diagram



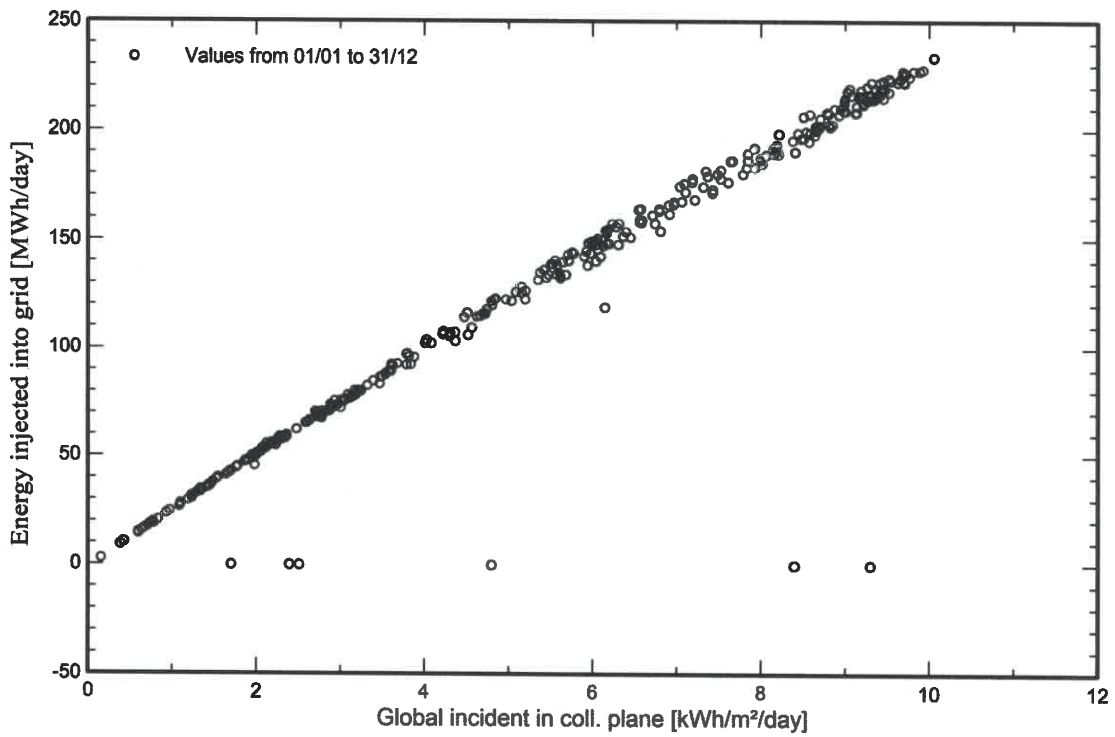


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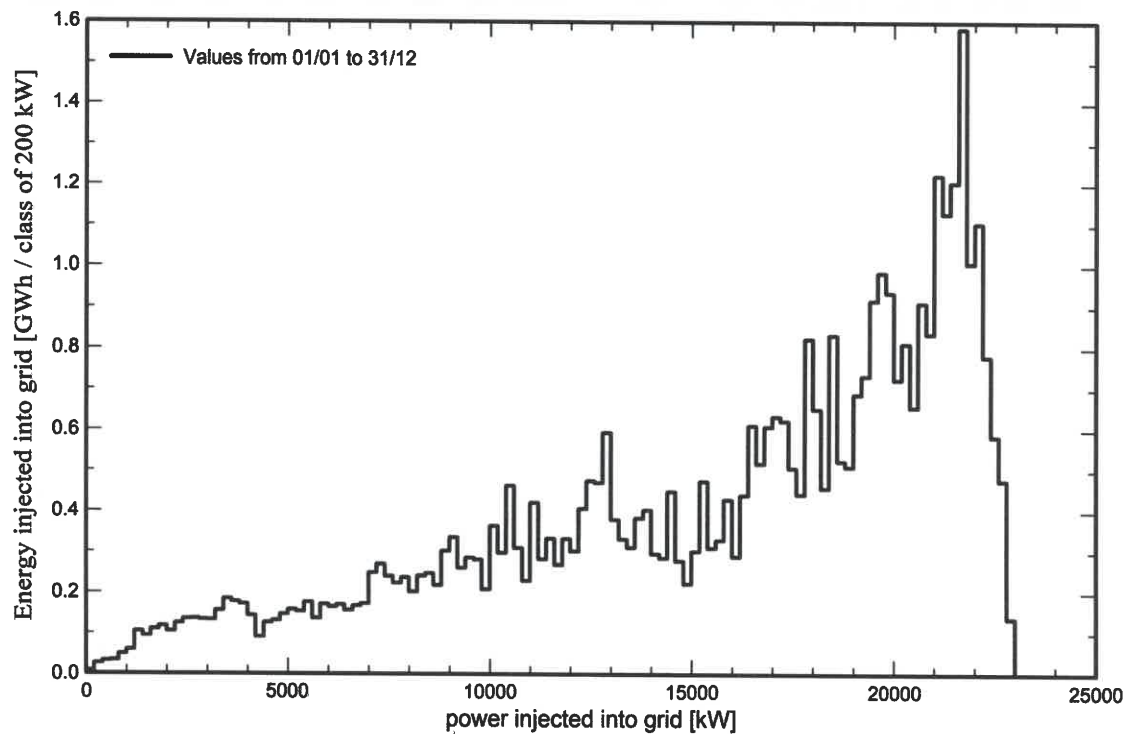
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Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema

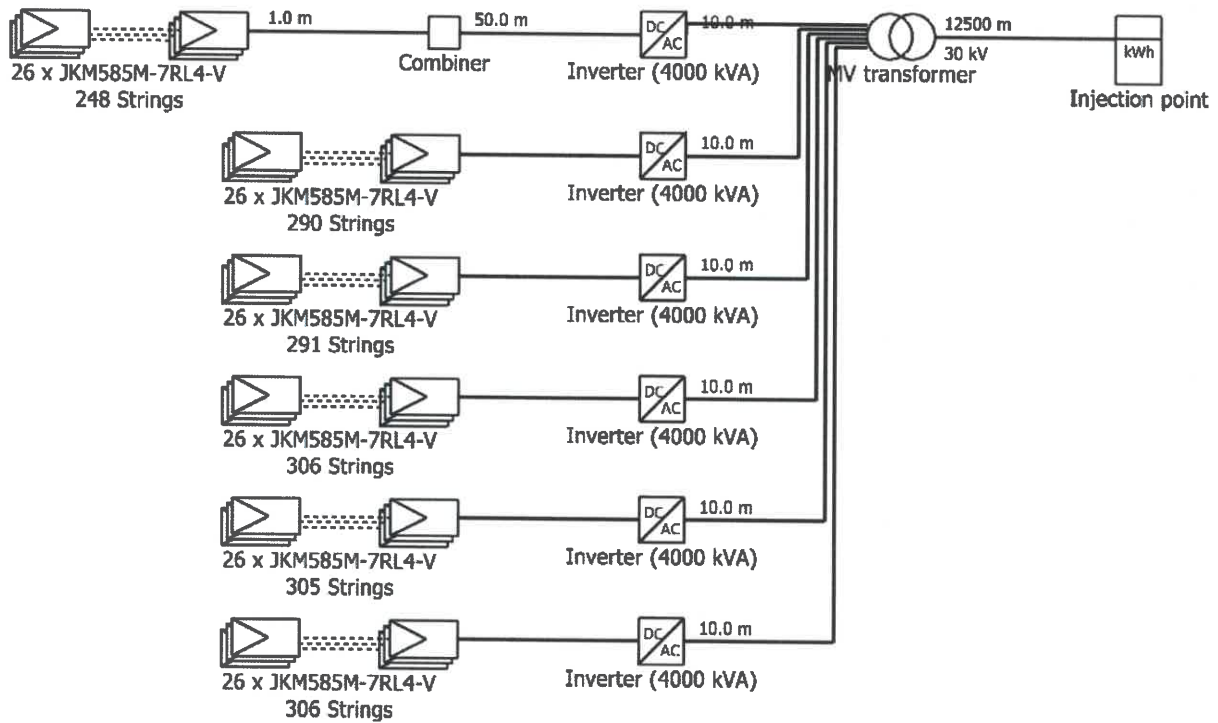




Single-line diagram

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PV module	JKM585M-7RL4-V
Inverter	Sunny Central 4000 UP
String	26 x JKM585M-7RL4-V

Acquamarina 2

VCO : Nuova variante di simulazione

24/03/23

Performance of grid-connected PV

PVGIS-5 estimates of solar electricity generation:

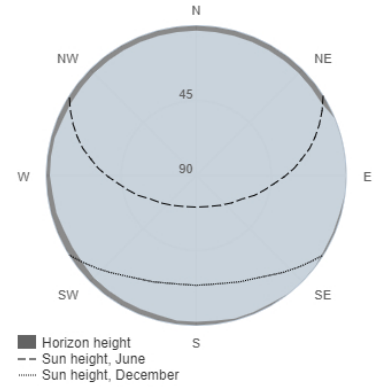
Provided inputs:

Latitude/Longitude: 41.890,15.230
 Horizon: Calculated
 Database used: PVGIS-SARAH2
 PV technology: Crystalline silicon
 PV installed: 26557 kWp
 System loss: 14 %

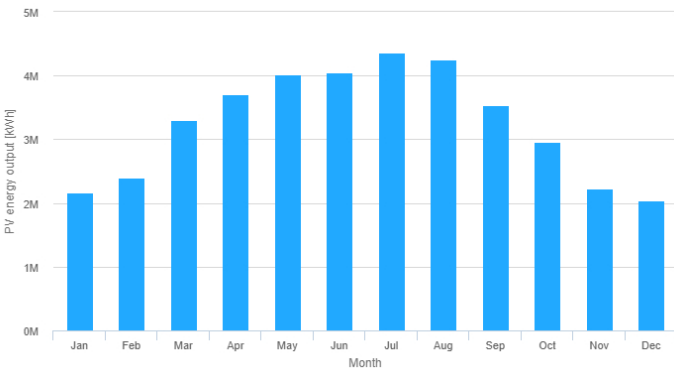
Simulation outputs

Slope angle: 35 °
 Azimuth angle: 0 °
 Yearly PV energy production: 39001678.94 kWh
 Yearly in-plane irradiation: 1885.56 kWh/m²
 Year-to-year variability: 1200362.39 kWh
 Changes in output due to:
 Angle of incidence: -2.66 %
 Spectral effects: 0.91 %
 Temperature and low irradiance: -7.8 %
 Total loss: -22.11 %

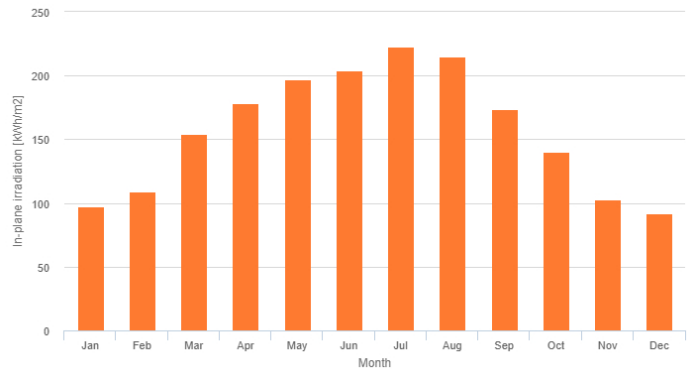
Outline of horizon at chosen location:



Monthly energy output from fix-angle PV system:



Monthly in-plane irradiation for fixed-angle:



Monthly PV energy and solar irradiation

Month	E_m	H(i)_m	SD_m
January	21684597.6	471091.8	37.6
February	239675768.9	395632.2	68.9
March	330307164.1	425719.6	164.1
April	369957308.1	297835.5	308.1
May	402151097.2	295027.2	1097.2
June	405521094.0	174011.2	1094.0
July	436037632.5	196817.9	632.5
August	424688265.0	247701.5	265.0
September	353986983.9	211507.9	183.9
October	295240640.1	387515.1	140.1
November	222306202.6	249650.2	202.6
December	203449312.5	295006.5	312.5

E_m: Average monthly electricity production from the defined system [kWh].
 H(i)_m: Average monthly sum of global irradiation per square meter received by the modules of the given system [kWh/m²].
 SD_m: Standard deviation of the monthly electricity production due to year-to-year variation [kWh].