MONREALE SOLAR S.R.L.

IMPIANTO FOTOVOLTAICO DI POTENZA NOMINALE DI CIRCA 93,51 MWP DA REALIZZARSI NEL COMUNE DI MONREALE (PA)

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Azienda con Sistema di Gestione Certificato
UNI EN ISO 9001:2015
UNI EN ISO 14001:2015
UNI ISO 45001:2018

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ELABORATO	TITOLO	COMMESSA	TIPOLOGIA
C06	**VALUTAZIONE DELLA PRODUCIBILITA'**	**23006**	**D**
		CODICE ELABORATO	
		DC23006D-C06	
REVISIONE		SOSTITUISCE	SOSTITUITO DA
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		NOME FILE	PAGINE
		DC23006D-C06.doc	**6+copertina**

REV	DATA	MODIFICA	Elaborato	Controllato	Approvato
00	25/07/23	Emissione	D'Arcangelo	Miglionico	Pomponio
01					
02					
03					
04					
05					
06					

INDICE

1. PREMESSA

La presente relazione è relativa al progetto di un impianto fotovoltaico per la produzione di energia elettrica della potenza nominale DC di 93,51 MWp e potenza AC ai fini della connessione (a cosφ=1) pari a 86,52 MWp, da realizzarsi nel comune di Monreale (PA) e delle relative opere connesse da realizzarsi nello stesso comune.

La soluzione di connessione prevede che l'impianto venga collegato in antenna a 220 kV con una nuova stazione elettrica di smistamento (SE) a 220 kV della RTN, da inserire in entra – esce sulla linea RTN a 220 kV "Partinico - Partanna".

Si fa presente che la nuova stazione elettrica di smistamento (SE) a 220 kV della RTN, da inserire in entra – esce sulla linea RTN a 220 kV "Partinico - Partanna", alla quale l'impianto fotovoltaico si collegherà **non fa parte del progetto**.

Il progetto consta de:

- la realizzazione di un impianto fotovoltaico;
- la realizzazione del cavidotto di connessione;
- la realizzazione della sottostazione elettrica di trasformazione utente 220/30 kV;
- la realizzazione del cavidotto AT di collegamento tra la sottostazione elettrica di trasformazione e la nuova stazione elettrica di smistamento (SE) a 220 kV della RTN.

Oggetto della presente relazione è l'analisi delle soluzioni per il superamento delle interferenze presenti lungo il tracciato del cavidotto di connessione che si estenderà tra l'impianto fotovoltaico e la sottostazione elettrica di trasformazione utente.

Le diverse interferenze e le loro soluzioni, nei diversi tratti, sono visibili nell'elaborato "DW23006D-P04 Percorso cavidotto con indicazione delle interferenze e tipologico attraversamenti".

1.1 *Inquadramento dell'impianto fotovoltaico*

Il suolo sul quale sarà realizzato l'impianto fotovoltaico ricopre una superficie di circa 145 ettari. Esso ricade nel foglio 1:25.000 delle cartografie dell'Istituto Geografico Militare (IGM Vecchia Ed.) n. 258 IV-SO "Monte Petroso" e n. 258 III-NO "Gibellina", ed è catastalmente individuato ai fogli di mappa nn. 181-184 del comune di Monreale (PA).

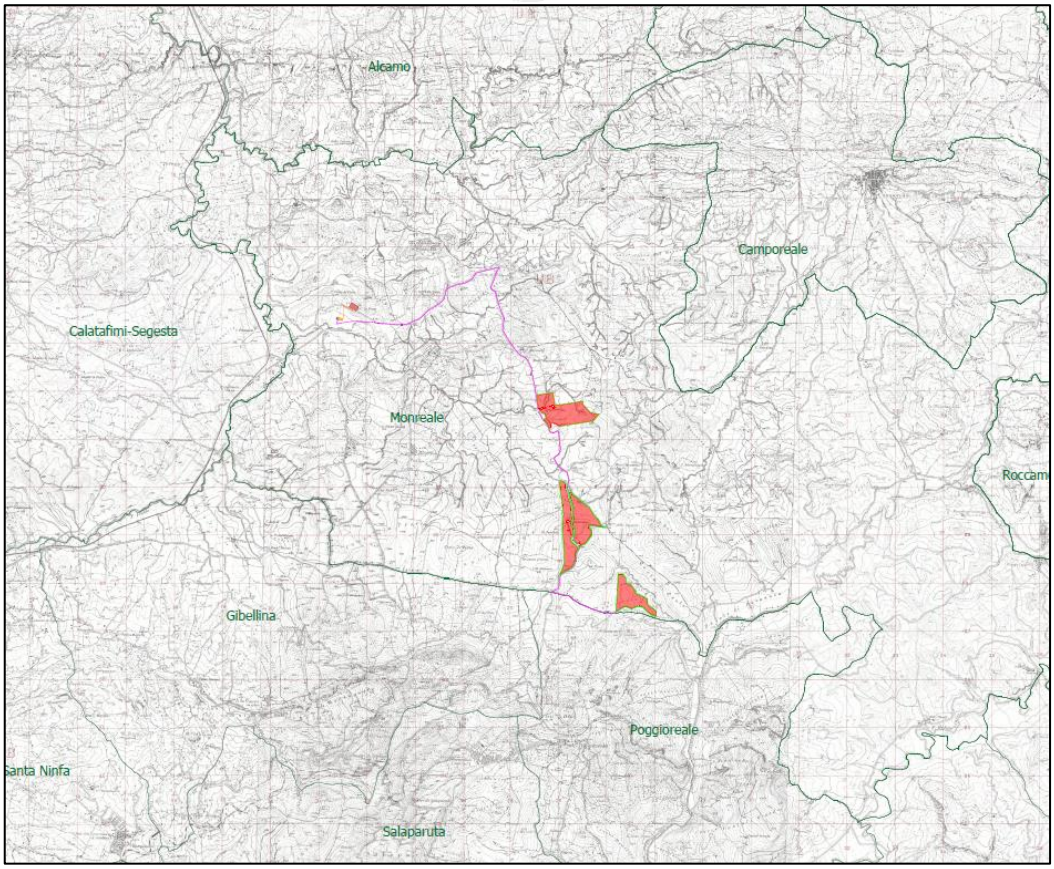

Figura 1: Inquadramento su IGM dell'impianto fotovoltaico

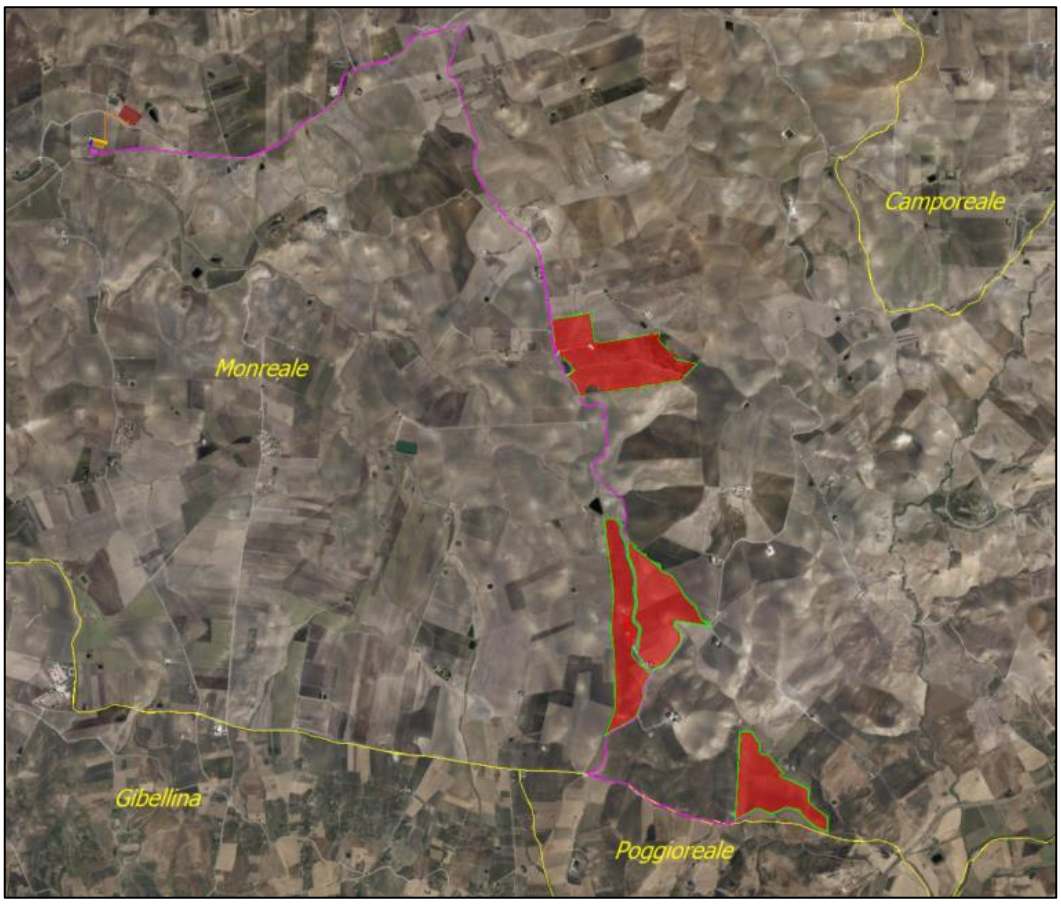

Figura 2: Inquadramento su ortofoto dell'impianto fotovoltaico

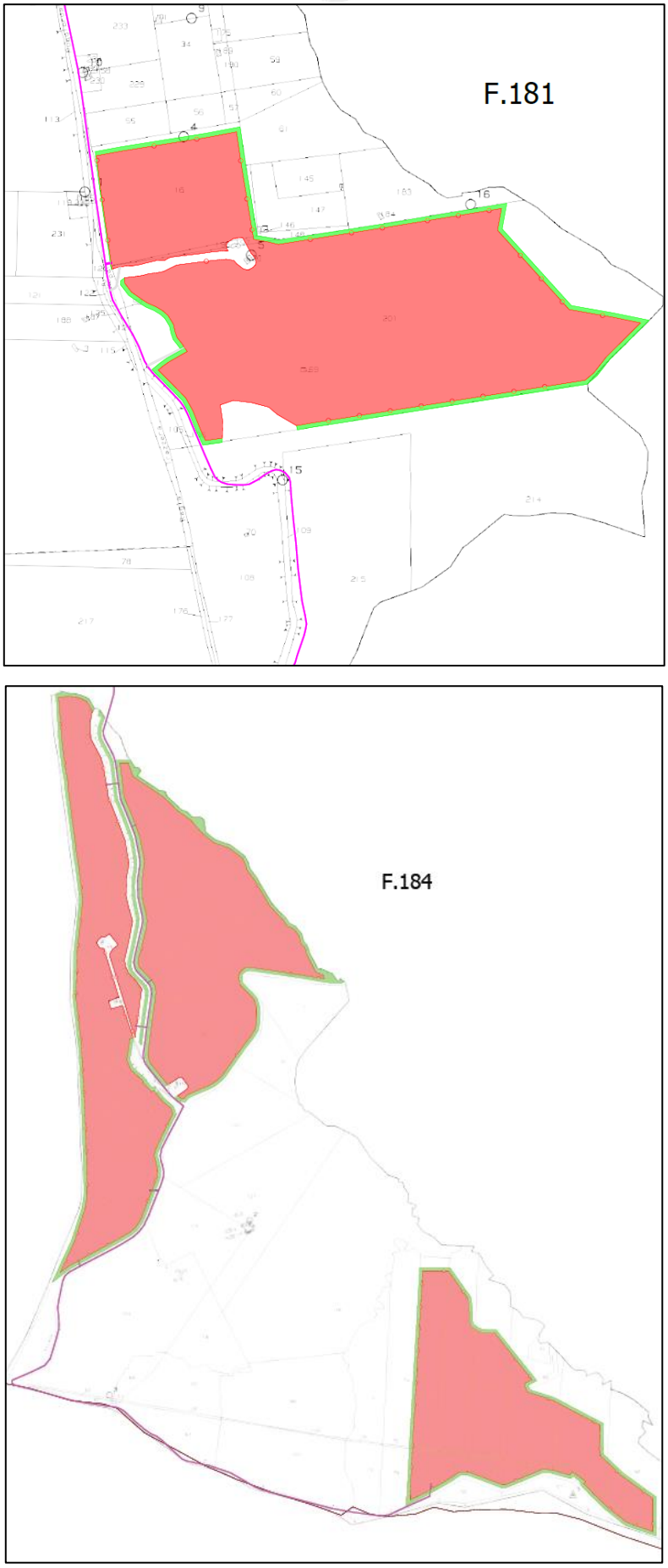

Figura 3: Inquadramento su stralcio catastale dell'impianto fotovoltaico

2. PRODUCIBILITA'

In base ai dati storici riportati dal software Meteonorm, l'irraggiamento globale incidente sul piano dei collettori sono quelli riportati nelle seguenti tabelle, rispettivamente per il sistema fisso inclinato a 25° e per il sistema tracker.

Gen	Feb	Mar	Apr	Mag	Giu	Lug	Ago	Set	Ott	Nov	Dic
86.9	106.0	154.9	173.4	205.0	204.5	219.9	211.3	170.3	140.1	99.9	81.9

Tabella 1: Dati di radiazione per la città Monreale (località Sirignano) su superficie incidente (elaborazione su Meteonorm 8.1). Radiazione globale annua sulla superficie incidente piano collettori strutture fisse inclinate a 25°: 1854.1 kWh/m2.

Gen	Feb	Mar	Apr	Mag	Giu	Lug	Ago	Set	Ott	Nov	Dic
74.4	99.0	160.1	198.6	259.7	270.4	285.6	255.4	187.0	134.6	86.6	67.1

Tabella 2: Dati di radiazione per la città Monreale (località Sirignano) su superficie incidente (elaborazione su Meteonorm 8.1). Radiazione globale annua sulla superficie incidente piano collettori strutture tracker: 2078.5 kWh/m2.

Sulla base delle indicazioni generali del layout sviluppato, sono state adottate ai fini del calcolo le seguenti caratteristiche dell'impianto fotovoltaico:

- Area 1 (strutture fisse)
  - potenza installata lato DC: 66.2 MWp;
  - potenza dei singoli moduli: 665 Wp;
  - numero dei moduli: 100184;
  - potenza totale 63.0 MWac;
  - numero degli inverter centralizzati: 15
  - lunghezza del cavidotto MT di collegamento dalle cabine di trasformazione con la cabina di raccolta: circa 40000 m;
  - lunghezza del cavidotto AT di collegamento dalla sottostazione elettrica con la stazione elettrica: circa 545 m;
  - energia prodotta attesa all'anno 0: 100172 MWh/anno.

- Area 2 (strutture tracker)
  - potenza installata lato DC: 26.89 MWp;
  - potenza dei singoli moduli: 665 Wp;
  - numero dei moduli: 40432;
  - potenza dell'inverter in c.a.: 25.20 MWac;
  - numero degli inverter centralizzati: 6

- lunghezza del cavidotto MT di collegamento dalle cabine di trasformazione con la cabina di raccolta: circa 1535 m;
- lunghezza del cavidotto AT di collegamento dalla sottostazione elettrica con la stazione elettrica: circa 545 m;
- energia prodotta attesa all'anno 0: 44920 MWh/anno.

Per determinare la producibilità del sistema fotovoltaico sono stati adottati i seguenti parametri nella simulazione:

- perdite per LID (Light Induced Degradation): 1,5%;
- perdite per sporco: 1,5%;
- perdite ausiliari: 2% per il sistema fisso e 2,5% per il sistema tracker;
- perdite per indisponibilità: 1%;
- perdite cablaggio DC: 1,5%;
- perdite cablaggio AC:
  - Linea uscita inverter sino al trasformatore MV[1]: 0,6% (frazione calcolata con il software PvSyst);
  - Linea MV fino al trasformatore HV[2]: 7,63% per sistema fisso e 0,28% per sistema tracker (frazione calcolata con il software PvSyst);
  - Linea HV[3] fino al punto di immissione: 0,0% (frazione calcolata con il software PvSyst);
- perdite nei trasformatori:
  - Trasformatori MV[4]: 1,1% (frazione calcolata con il software PvSyst);
  - Trasformatori HV[5]: 0,08% (frazione calcolata con il software PvSyst);

Quale risultato il software ha generato, per l'Area 1 una previsione di producibilità pari a circa **1504 ore equivalenti annue (kWh/kWp)**, e per l'Area 2 una previsione di producibilità pari a circa **1671 ore equivalenti annue (kWh/kWp)**. In coda alla presente relazione sono allegati i reports di output del programma.

[1] Trasformatori MT interni al campo
[2] Linea MT fino al locale quadri interno alla cabina di raccolta utente
[3] Linea AT
[4] Trasformatori interni al campo
[5] Trasformatore della SSE

Version 7.4.0

PVsyst - Simulation report

Grid-Connected System

Project: Monreale

Variant: Sistema Fissi

Sheds on ground

System power: 66.62 MWp

Sirignano - Italy

Autore

STUDIO TECNICO BFP SRL (Italia)

Project summary

Geographical Site
Sirignano
Italy

Situation

Latitude	37.84 °N
Longitude	13.02 °E
Altitude	213 m
Time zone	UTC+1

Project settings
Albedo 0.20

Meteo data
Sirignano
Meteonorm 8.1 (1991-2009), Sat=100% - Sintetico

System summary

Grid-Connected System
Sheds on ground

PV Field Orientation
Fixed plane
Tilt/Azimuth 25 / 0 °

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

System information

PV Array		Inverters	
Nb. of modules	100184 units	Nb. of units	15 units
Pnom total	66.62 MWp	Pnom total	63.00 MWac
		Pnom ratio	1.057

Results summary

Produced Energy	100172342 kWh/year	Specific production	1504 kWh/kWp/year	Perf. Ratio PR	81.10 %

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General parameters

Grid-Connected System

Sheds on ground

PV Field Orientation

Orientation		Sheds configuration		Models used	
Fixed plane		Nb. of sheds	3945 units	Transposition	Perez
Tilt/Azimuth	25 / 0 °	**Sizes**		Diffuse	Perez, Meteonorm
		Sheds spacing	9.85 m	Circumsolar	separate
		Collector width	4.79 m		
		Ground Cov. Ratio (GCR)	48.6 %		
		Shading limit angle			
		Limit profile angle	20.2 °		

Horizon		Near Shadings	User's needs
Average Height	4.5 °	Linear shadings	Unlimited load (grid)

Bifacial system

Model: 2D Calculation unlimited sheds

Bifacial model geometry		Bifacial model definitions	
Sheds spacing	9.85 m	Ground albedo	0.20
Sheds width	4.79 m	Bifaciality factor	72 %
Limit profile angle	20.2 °	Rear shading factor	5.0 %
GCR	48.6 %	Rear mismatch loss	10.0 %
Height above ground	2.00 m	Shed transparent fraction	0.0 %

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG21C-20-665Wp Vertex
(Original PVsyst database)	
Unit Nom. Power	665 Wp
Number of PV modules	100184 units
Nominal (STC)	66.62 MWp

Inverter

Manufacturer	SMA
Model	Sunny Central 4200 UP
(Original PVsyst database)	
Unit Nom. Power	4200 kWac
Number of inverters	15 units
Total power	63000 kWac

Array #1 - Area3

Number of PV modules	36148 units	Number of inverters	5 units
Nominal (STC)	24.04 MWp	Total power	21000 kWac
Modules	1291 Strings x 28 In series		
At operating cond. (50°C)		Operating voltage	921-1325 V
Pmpp	22.03 MWp	Pnom ratio (DC:AC)	1.14
U mpp	973 V		
I mpp	22644 A		

Array #2 - Area 2

Number of PV modules	39172 units	Number of inverters	6 units
Nominal (STC)	26.05 MWp	Total power	25200 kWac
Modules	1399 Strings x 28 In series		
At operating cond. (50°C)		Operating voltage	921-1325 V
Pmpp	23.87 MWp	Pnom ratio (DC:AC)	1.03
U mpp	973 V		
I mpp	24538 A		

PV Array Characteristics

Array #3 - Area SUD

Number of PV modules	24864 units	Number of inverters	4 units
Nominal (STC)	16.53 MWp	Total power	16800 kWac
Modules	888 Strings x 28 In series		
At operating cond. (50°C)		Operating voltage	921-1325 V
Pmpp	15.15 MWp	Pnom ratio (DC:AC)	0.98
U mpp	973 V		
I mpp	15575 A		

Total PV power		**Total inverter power**	
Nominal (STC)	66622 kWp	Total power	63000 kWac
Total	100184 modules	Number of inverters	15 units
Module area	311207 m²	Pnom ratio	1.06

Array losses

Array Soiling Losses
Loss Fraction 2.0 %

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 1.5 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

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

DC wiring losses

Global wiring resistance 0.25 mΩ
Loss Fraction 1.5 % at STC

Array #1 - Area3
Global array res. 0.71 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Area 2
Global array res. 0.65 mΩ
Loss Fraction 1.5 % at STC

Array #3 - Area SUD
Global array res. 1.0 mΩ
Loss Fraction 1.5 % at STC

System losses

Unavailability of the system
Time fraction 1.0 %
3.7 days,
3 periods

Auxiliaries loss
Proportionnal to Power 2.0 W/kW
0.0 kW from Power thresh.

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage	630 Vac tri
Loss Fraction	0.60 % at STC

Inverter: Sunny Central 4200 UP

Wire section (15 Inv.)	Alu 15 x 3 x 4000 mm²
Average wires length	70 m

MV line up to HV Transfo

MV Voltage	30 kV
Wires	Alu 3 x 1200 mm²
Length	40000 m
Loss Fraction	7.63 % at STC

HV line up to Injection

HV line voltage	220 kV
Wires	Copper 3 x 2500 mm²
Length	545 m
Loss Fraction	0.00 % at STC

AC losses in transformers

MV transfo

Medium voltage	30 kV

Transformer parameters

Nominal power at STC	65.41 MVA
Iron Loss (24/24 Connexion)	66.07 kVA
Iron loss fraction	0.10 % at STC
Copper loss	648.23 kVA
Copper loss fraction	0.99 % at STC
Coils equivalent resistance	3 x 0.06 mΩ

HV transfo

Grid voltage	220 kV

Transformer from Datasheets

Nominal power	105000 kVA
Iron Loss (24/24 Connexion)	81.00 kVA
Iron loss fraction	0.08 % of PNom
Copper loss	629.00 kVA
Copper loss fraction	0.60 % at PNom
Coils equivalent resistance	3 x 51.35 mΩ

Horizon definition

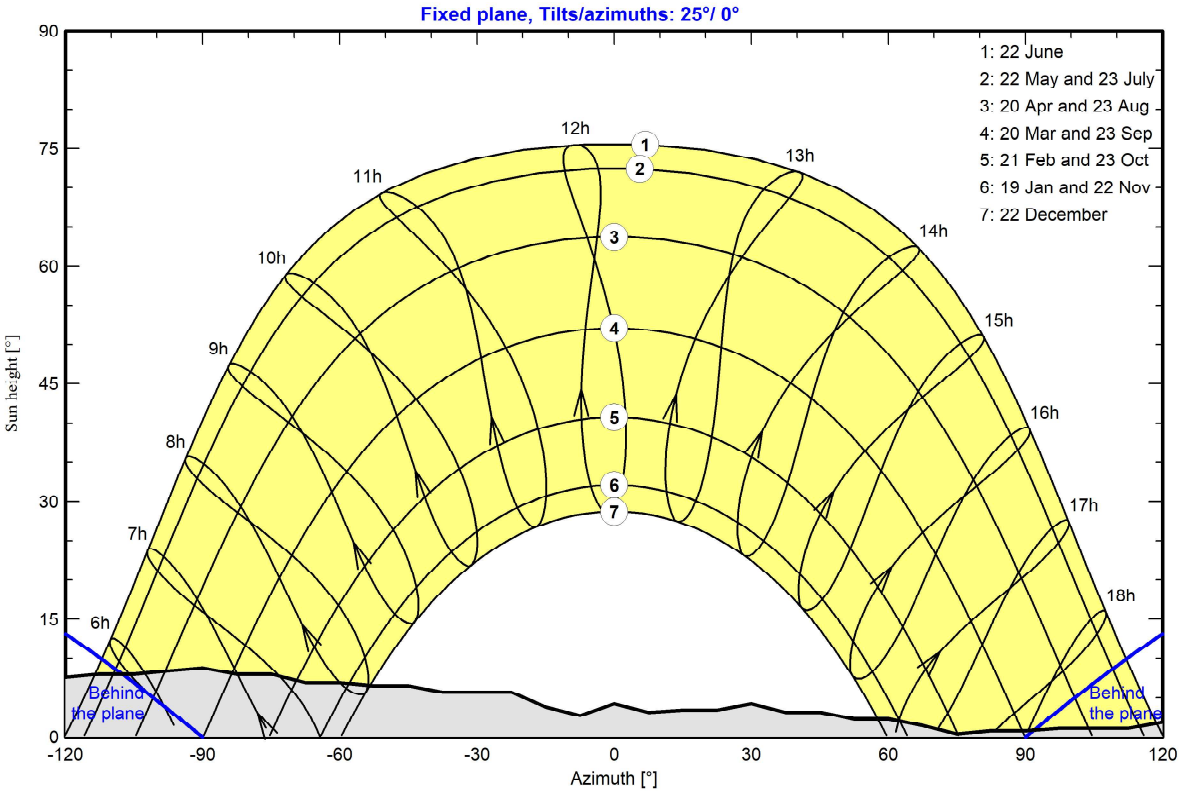
Horizon from PVGIS website API, Lat=37°50'35', Long=13°1'29', Alt=213m

Average Height	4.5 °	Albedo Factor	0.79
Diffuse Factor	0.98	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-135	-128	-120	-113	-105
Height [°]	4.2	4.6	5.3	6.1	6.1	7.3	8.0	8.0	7.6	8.0	8.0
Azimuth [°]	-98	-90	-83	-75	-68	-60	-53	-45	-38	-23	-15
Height [°]	8.4	8.8	8.0	8.0	6.9	6.9	6.5	6.5	5.7	5.7	3.8
Azimuth [°]	-8	0	8	15	23	30	38	45	53	60	68
Height [°]	2.7	4.2	3.1	3.4	3.4	4.2	3.1	3.1	2.3	2.3	1.5
Azimuth [°]	75	83	90	98	113	120	135	143	165	173	180
Height [°]	0.4	0.8	0.8	1.1	1.1	1.9	1.9	3.8	3.8	4.2	4.2

Sun Paths (Height / Azimuth diagram)



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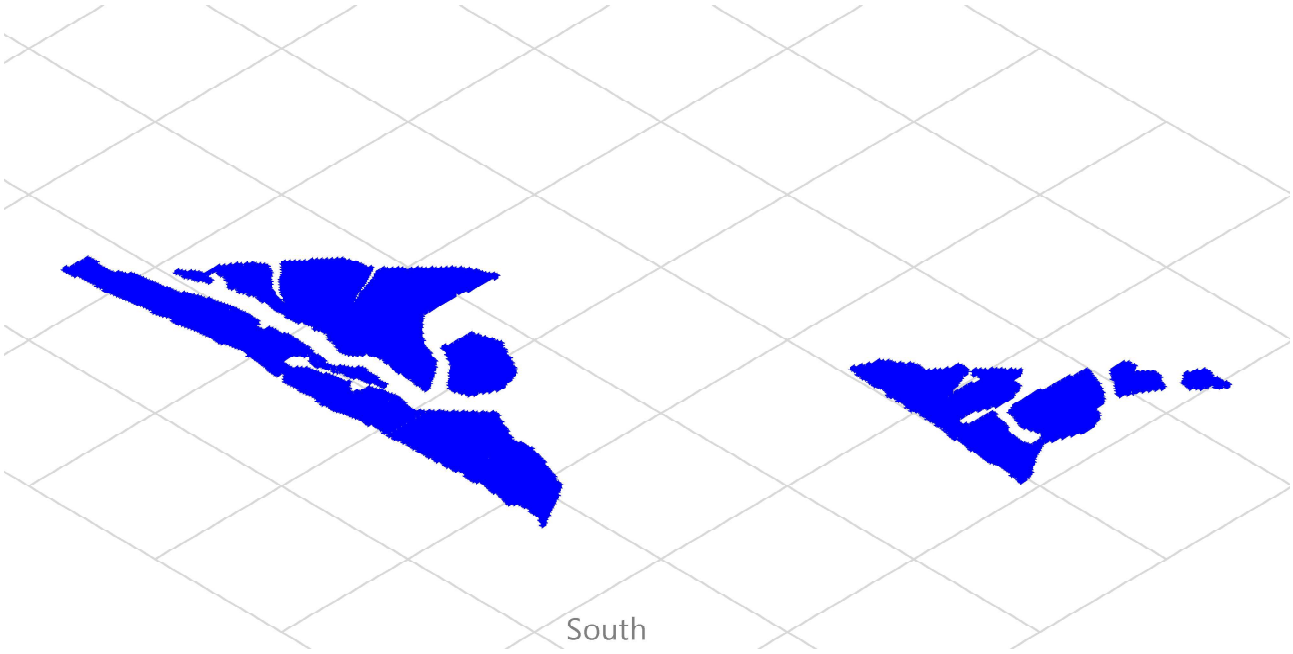
with v7.4.0

Near shadings parameter

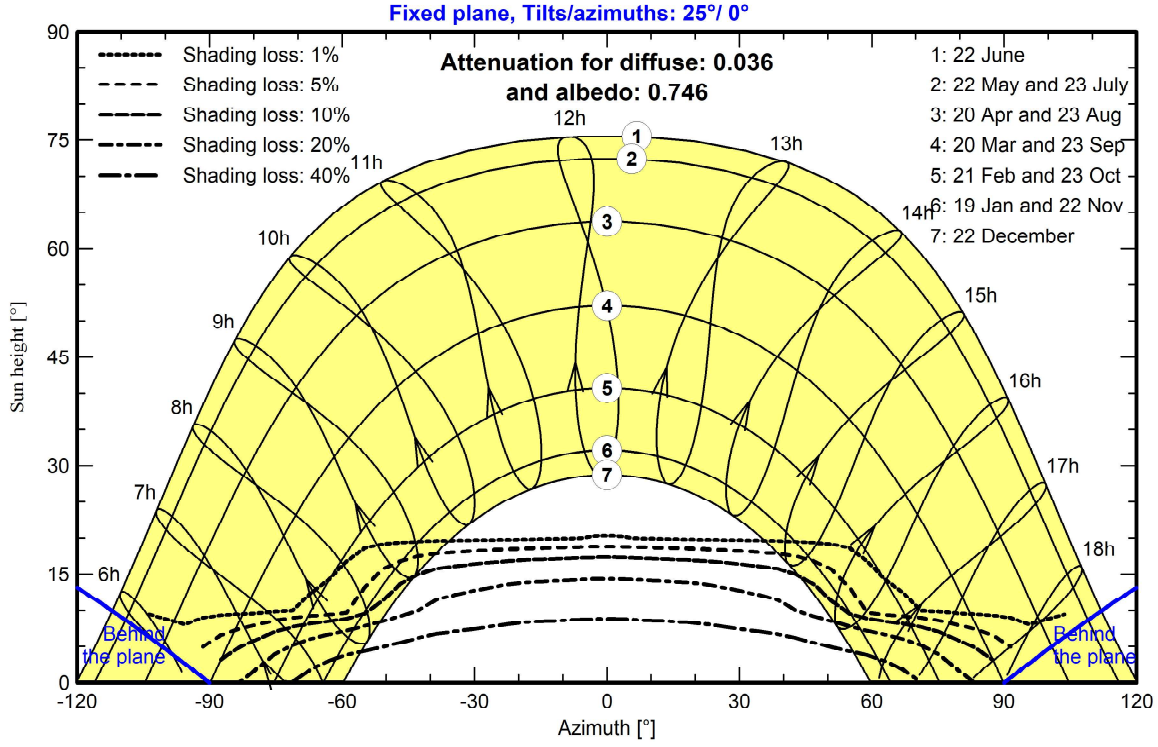
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 25°/ 0°



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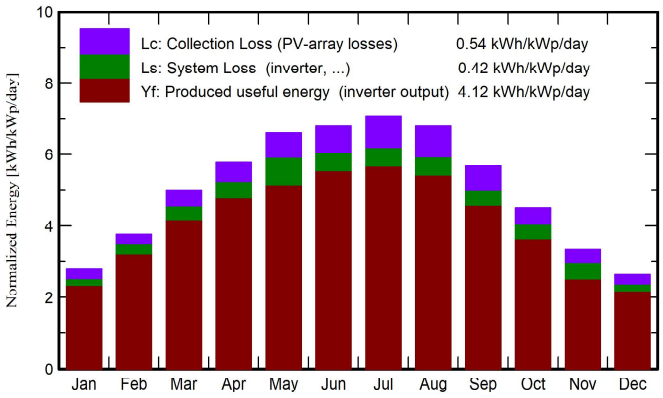
Main results

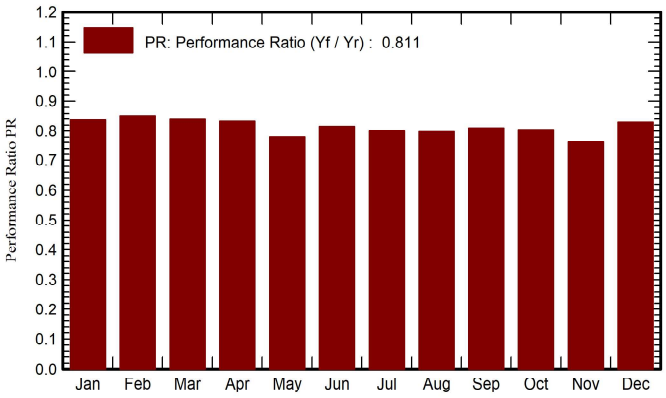
System Production

Produced Energy	100172342 kWh/year	Specific production	1504 kWh/kWp/year
		Perf. Ratio PR	81.10 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	61.7	33.86	11.99	86.9	80.5	5260993	4844476	0.837
February	81.2	39.80	11.82	106.0	100.0	6547140	6012750	0.852
March	129.0	55.39	14.10	154.9	146.2	9453261	8654151	0.839
April	161.1	72.74	16.24	173.4	163.4	10502434	9620019	0.833
May	205.3	77.93	20.70	205.0	193.7	12254798	10668671	0.781
June	213.1	79.26	24.51	204.5	193.0	12110862	11103816	0.815
July	223.9	74.37	27.58	219.9	208.1	12815519	11733442	0.801
August	201.4	73.72	27.75	211.3	199.9	12270623	11241102	0.799
September	147.3	58.89	23.84	170.3	160.6	10018463	9186981	0.810
October	109.6	50.58	21.18	140.1	132.2	8371210	7512154	0.805
November	69.8	30.78	16.85	99.9	93.2	5957892	5066874	0.761
December	55.9	28.76	13.40	81.9	76.2	4928375	4527906	0.829
Year	1659.4	676.08	19.21	1854.1	1747.1	110491570	100172342	0.811

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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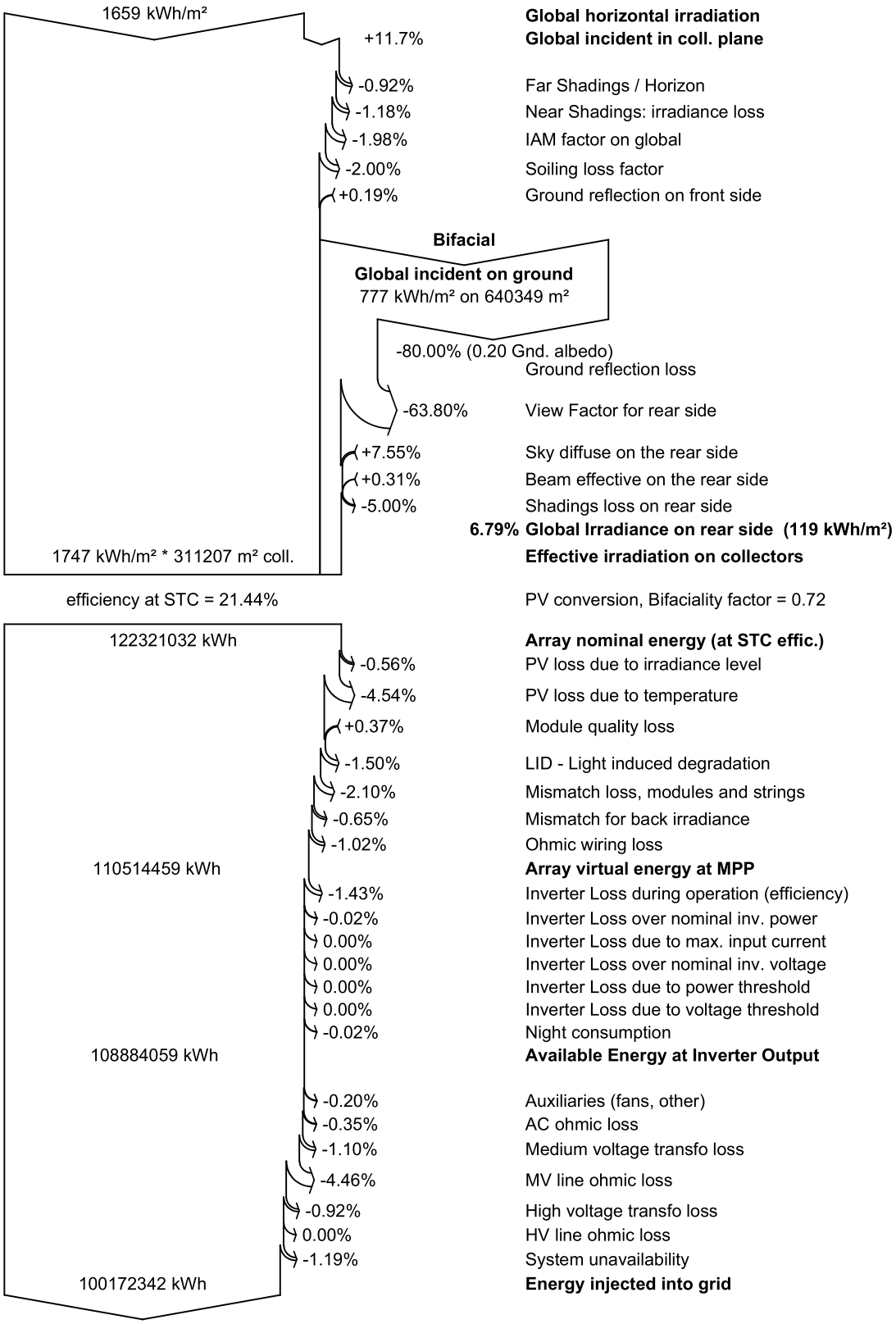
Loss diagram



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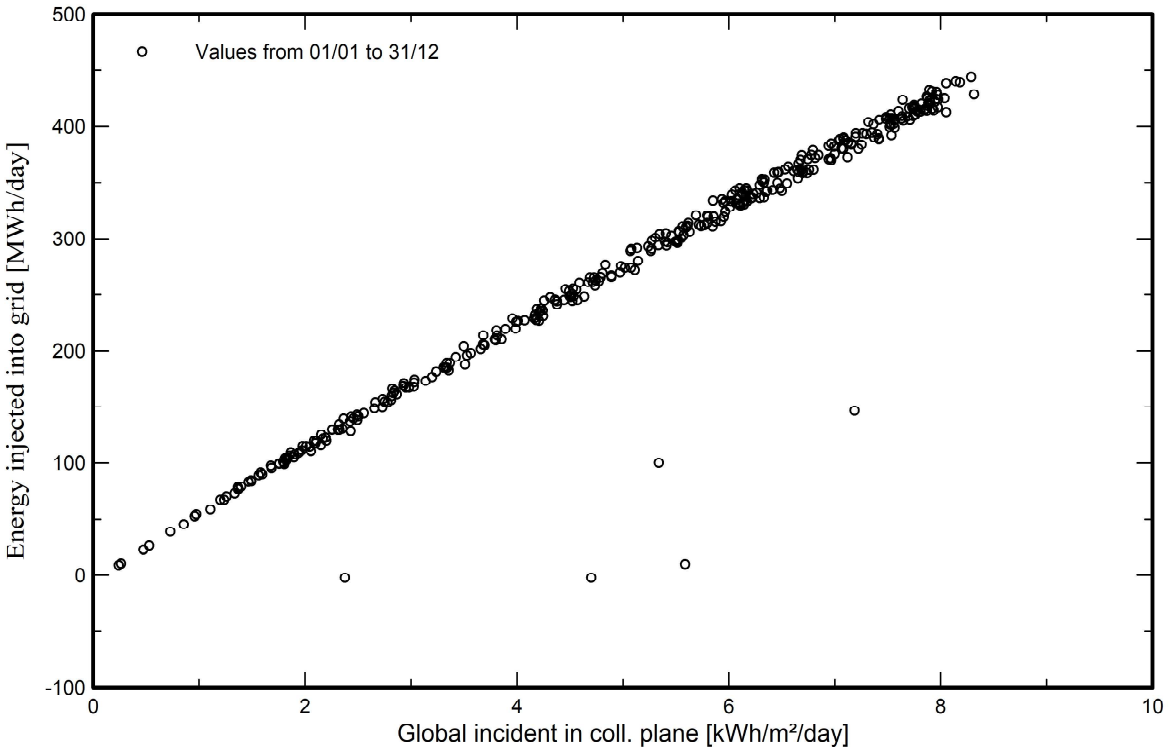
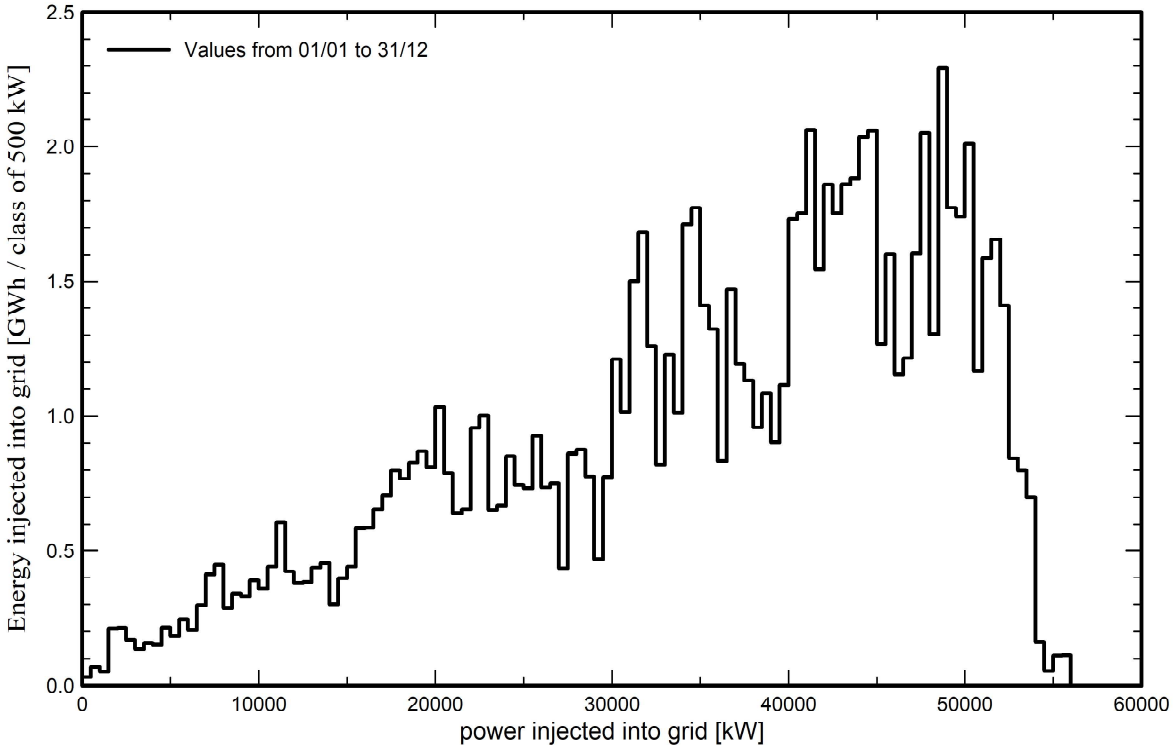
Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1991-2009), Sat=100%
Kind	Monthly averages
Sintetico - Multi-year average	
Year-to-year variability(Variance)	4.0 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	4.4 %

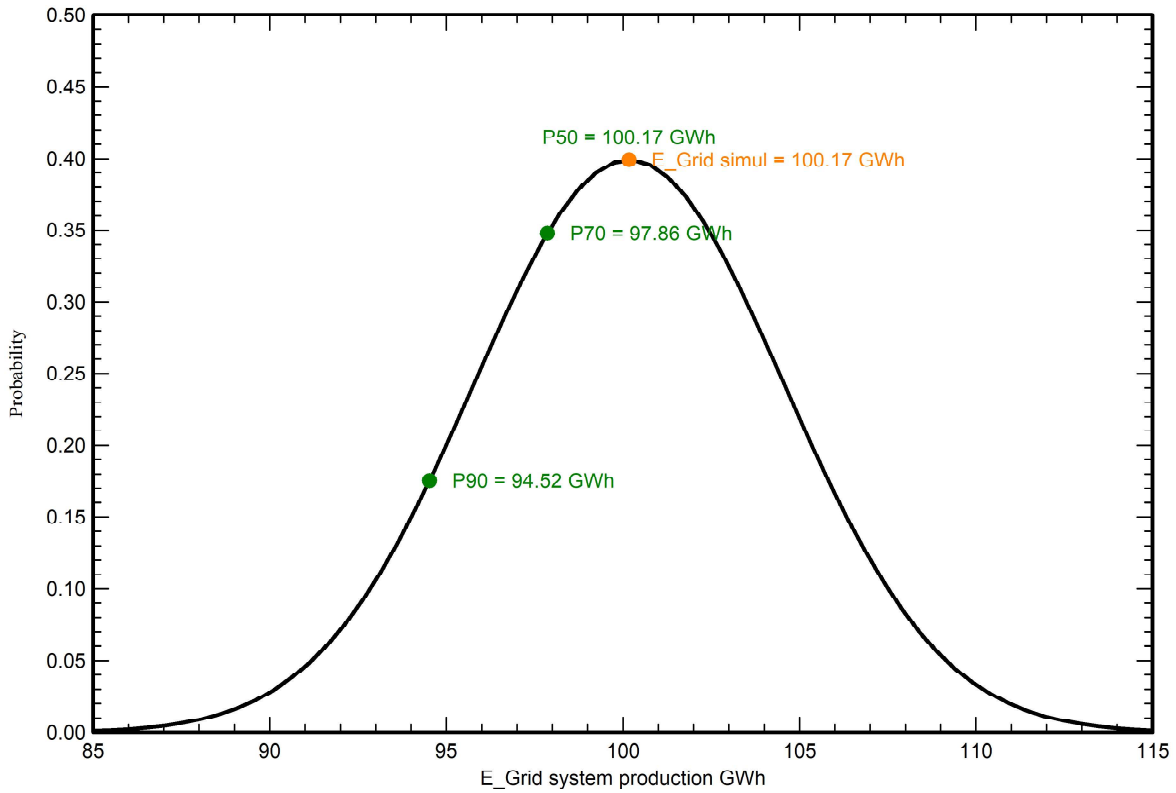
Simulation and parameters uncertainties

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	4.41 GWh
P50	100.17 GWh
P70	97.86 GWh
P90	94.52 GWh

Probability distribution



Single-line diagram

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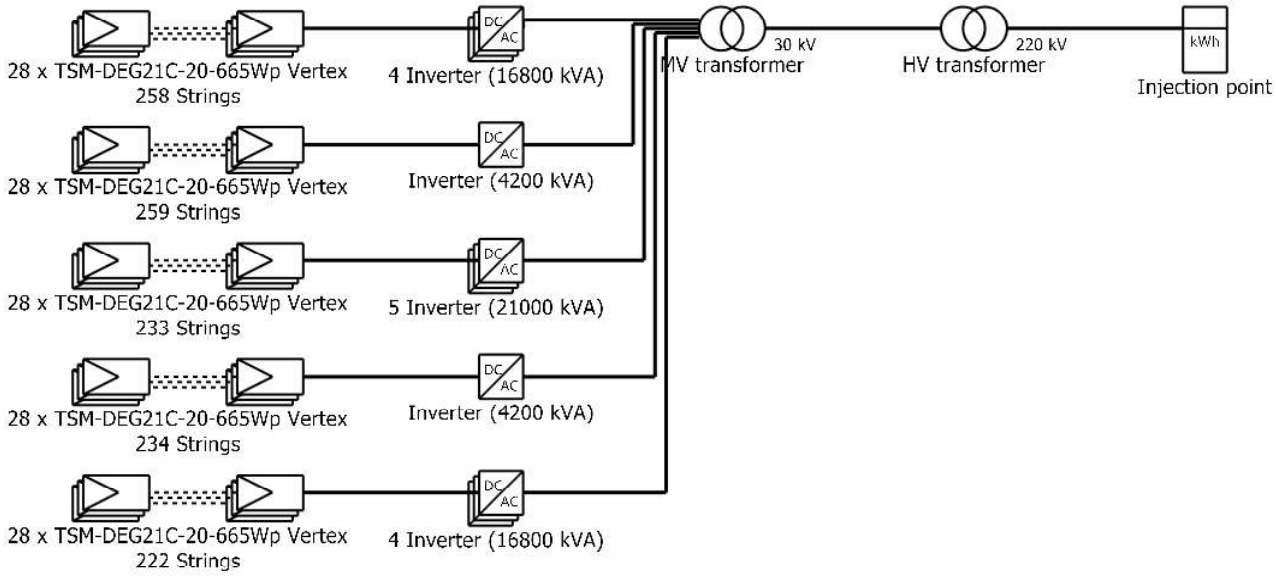

PV module	TSM-DEG21C-20-665Wp Vertex
Inverter	Sunny Central 4200 UP
String	28 x TSM-DEG21C-20-665Wp Vertex

	Monreale	STUDIO TECNICO BFP SRL (Italia)
	VC2 : Sistema Fissi	19/07/23

Version 7.4.0

PVsyst - Simulation report

Grid-Connected System

Project: Monreale

Variant: SistemaTracker

Tracking system with backtracking

System power: 26.89 MWp

Sirignano - Italia

Autore

STUDIO TECNICO BFP SRL (Italia)

Project: Monreale

Variant: SistemaTracker

STUDIO TECNICO BFP SRL (Italia)

Project summary

Geographical Site
Sirignano
Italia

Situation

Latitude	37.84 °N
Longitude	13.02 °E
Altitude	213 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Sirignano
Meteonorm 8.1 (1991-2009), Sat=100% - Sintetico

System summary

Grid-Connected System

Tracking system with backtracking

PV Field Orientation

Orientation	
Tracking plane, tilted axis	
Avg axis tilt	-1.5 °
Avg axis azim.	0 °

Tracking algorithm
Astronomic calculation
Backtracking activated

Near Shadings
According to strings

Electrical effect	100 %
Diffuse shading	Automatic

System information

PV Array

Nb. of modules	40432 units
Pnom total	26.89 MWp

Inverters

Nb. of units	6 units
Pnom total	25.20 MWac
Pnom ratio	1.067

User's needs
Unlimited load (grid)

Results summary

Produced Energy	44920265 kWh/year	Specific production	1671 kWh/kWp/year	Perf. Ratio PR	80.38 %

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General parameters

Grid-Connected System

Tracking system with backtracking

PV Field Orientation

Orientation

Tracking plane, tilted axis	
Avg axis tilt	-1.5 °
Avg axis azim.	0 °

Tracking algorithm

Astronomic calculation	
Backtracking activated	

Backtracking array

Nb. of trackers	1593 units

Sizes

Tracker Spacing	4.88 m
Collector width	2.38 m
Ground Cov. Ratio (GCR)	48.8 %
Phi min / max.	-/+ 55.0 °

Backtracking strategy

Phi limits for BT	-/+ 60.6 °
Backtracking pitch	4.88 m
Backtracking width	2.38 m

Models used

Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon

Average Height	4.5 °

Near Shadings

According to strings	
Electrical effect	100 %
Diffuse shading	Automatic

User's needs

Unlimited load (grid)

Bifacial system

Model: 2D Calculation
unlimited trackers

Bifacial model geometry

Tracker Spacing	4.88 m
Tracker width	2.38 m
GCR	48.8 %
Axis height above ground	1.67 m

Bifacial model definitions

Ground albedo	0.20
Bifaciality factor	72 %
Rear shading factor	5.0 %
Rear mismatch loss	10.0 %
Shed transparent fraction	0.0 %

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG21C-20-665Wp Vertex
(Original PVsyst database)	
Unit Nom. Power	665 Wp
Number of PV modules	40432 units
Nominal (STC)	26.89 MWp
Modules	1444 Strings x 28 In series

At operating cond. (50°C)

Pmpp	24.64 MWp
U mpp	973 V
I mpp	25327 A

Inverter

Manufacturer	SMA
Model	Sunny Central 4200 UP
(Original PVsyst database)	
Unit Nom. Power	4200 kWac
Number of inverters	6 units
Total power	25200 kWac
Operating voltage	921-1325 V
Pnom ratio (DC:AC)	1.07

Total PV power

Nominal (STC)	26887 kWp
Total	40432 modules
Module area	125596 m²

Total inverter power

Total power	25200 kWac
Number of inverters	6 units
Pnom ratio	1.07

Array losses

Array Soiling Losses
Loss Fraction 2.0 %

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

DC wiring losses
Global array res. 0.63 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 1.5 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

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

System losses

Unavailability of the system
Time fraction 1.0 %
3.7 days,
3 periods

Auxiliaries loss
Proportionnal to Power 2.5 W/kW
0.0 kW from Power thresh.

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 630 Vac tri
Loss Fraction 0.60 % at STC

Inverter: Sunny Central 4200 UP
Wire section (6 Inv.) Alu 6 x 3 x 4000 mm²
Average wires length 69 m

MV line up to Injection
MV Voltage 30 kV
Wires Alu 3 x 500 mm²
Length 1535 m
Loss Fraction 0.28 % at STC

AC losses in transformers

MV transfo
Medium voltage 30 kV

Transformer parameters
Nominal power at STC 26.40 MVA
Iron Loss (24/24 Connexion) 26.40 kVA
Iron loss fraction 0.10 % at STC
Copper loss 263.97 kVA
Copper loss fraction 1.00 % at STC
Coils equivalent resistance 3 x 0.15 mΩ

Horizon definition

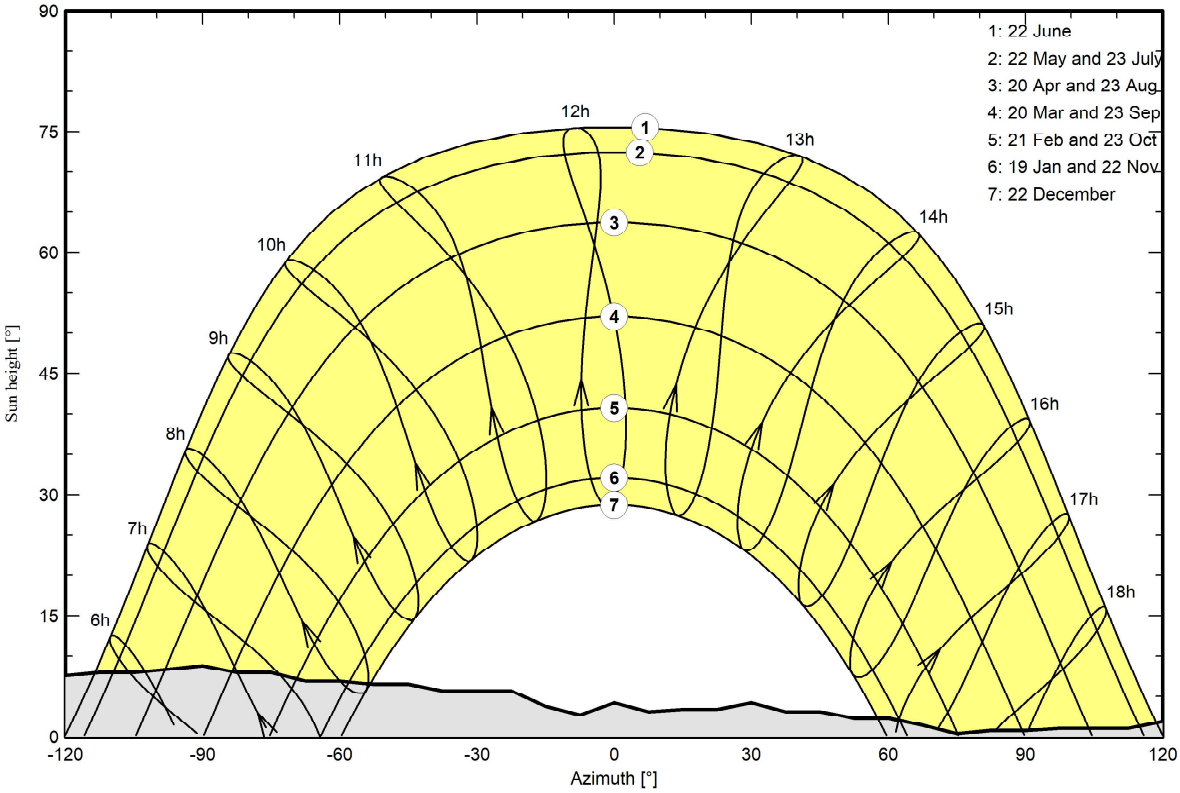
Horizon from PVGIS website API, Lat=37°50"35', Long=13°1"29', Alt=213m

Average Height	4.5 °	Albedo Factor	0.91
Diffuse Factor	0.98	Albedo Fraction	100 %

Horizon profile

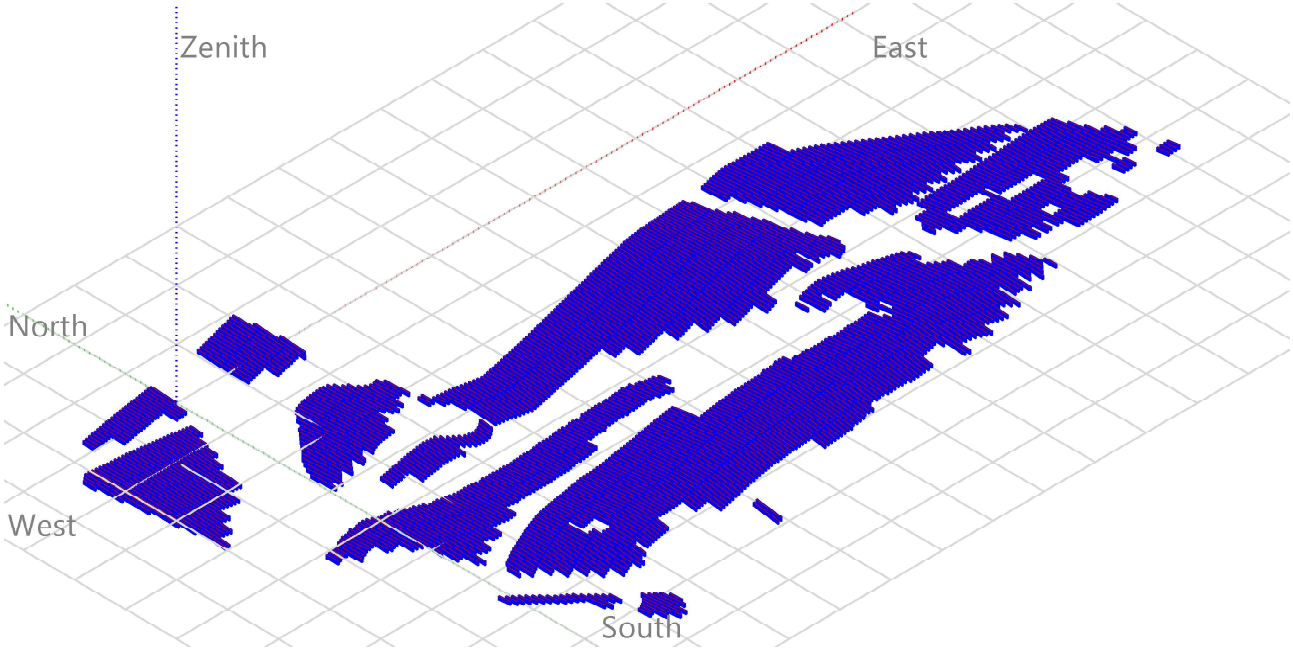
Azimuth [°]	-180	-173	-165	-158	-150	-143	-135	-128	-120	-113	-105
Height [°]	4.2	4.6	5.3	6.1	6.1	7.3	8.0	8.0	7.6	8.0	8.0
Azimuth [°]	-98	-90	-83	-75	-68	-60	-53	-45	-38	-23	-15
Height [°]	8.4	8.8	8.0	8.0	6.9	6.9	6.5	6.5	5.7	5.7	3.8
Azimuth [°]	-8	0	8	15	23	30	38	45	53	60	68
Height [°]	2.7	4.2	3.1	3.4	3.4	4.2	3.1	3.1	2.3	2.3	1.5
Azimuth [°]	75	83	90	98	113	120	135	143	165	173	180
Height [°]	0.4	0.8	0.8	1.1	1.1	1.9	1.9	3.8	3.8	4.2	4.2

Sun Paths (Height / Azimuth diagram)



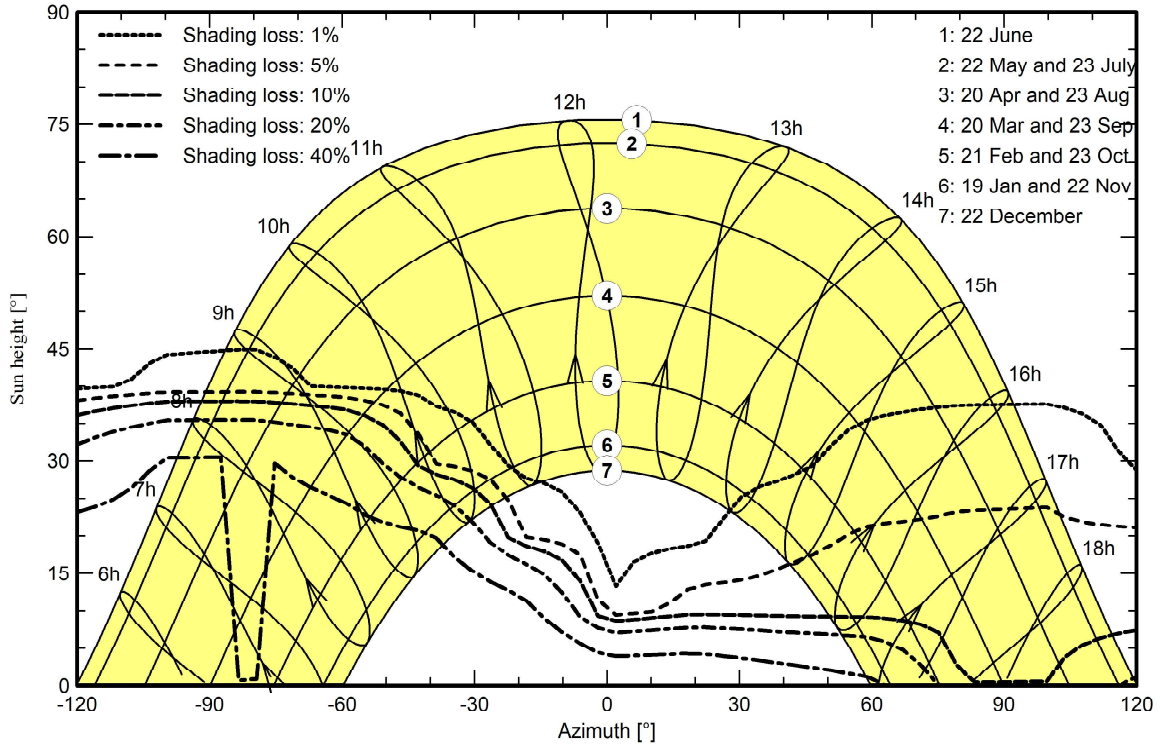
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1



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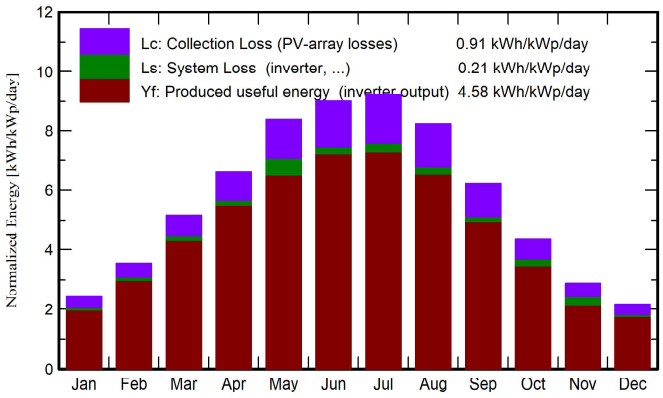
with v7.4.0

Main results

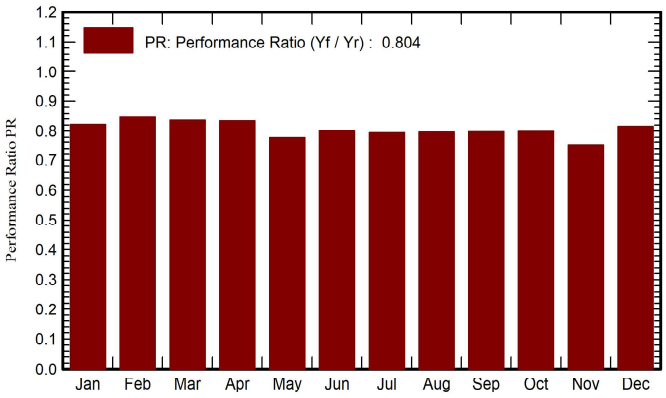
System Production

Produced Energy	44920265 kWh/year	Specific production	1671 kWh/kWp/year
		Perf. Ratio PR	80.38 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	61.7	33.86	11.99	74.4	66.0	1704955	1644538	0.822
February	81.2	39.80	11.82	99.0	90.3	2338757	2261188	0.849
March	129.0	55.39	14.10	160.1	147.2	3721960	3600122	0.836
April	161.1	72.74	16.24	198.6	183.7	4602054	4450492	0.834
May	205.3	77.93	20.70	259.7	242.2	5903839	5440395	0.779
June	213.1	79.26	24.51	270.4	251.6	6021751	5823387	0.801
July	223.9	74.37	27.58	285.6	267.3	6309656	6101873	0.795
August	201.4	73.72	27.75	255.4	237.8	5654827	5471828	0.797
September	147.3	58.89	23.84	187.0	171.8	4145534	4012488	0.798
October	109.6	50.58	21.18	134.6	122.8	3061649	2894255	0.800
November	69.8	30.78	16.85	86.6	77.5	1957115	1747287	0.751
December	55.9	28.76	13.40	67.1	59.4	1528264	1472411	0.816
Year	1659.4	676.08	19.21	2078.5	1917.6	46950362	44920265	0.804

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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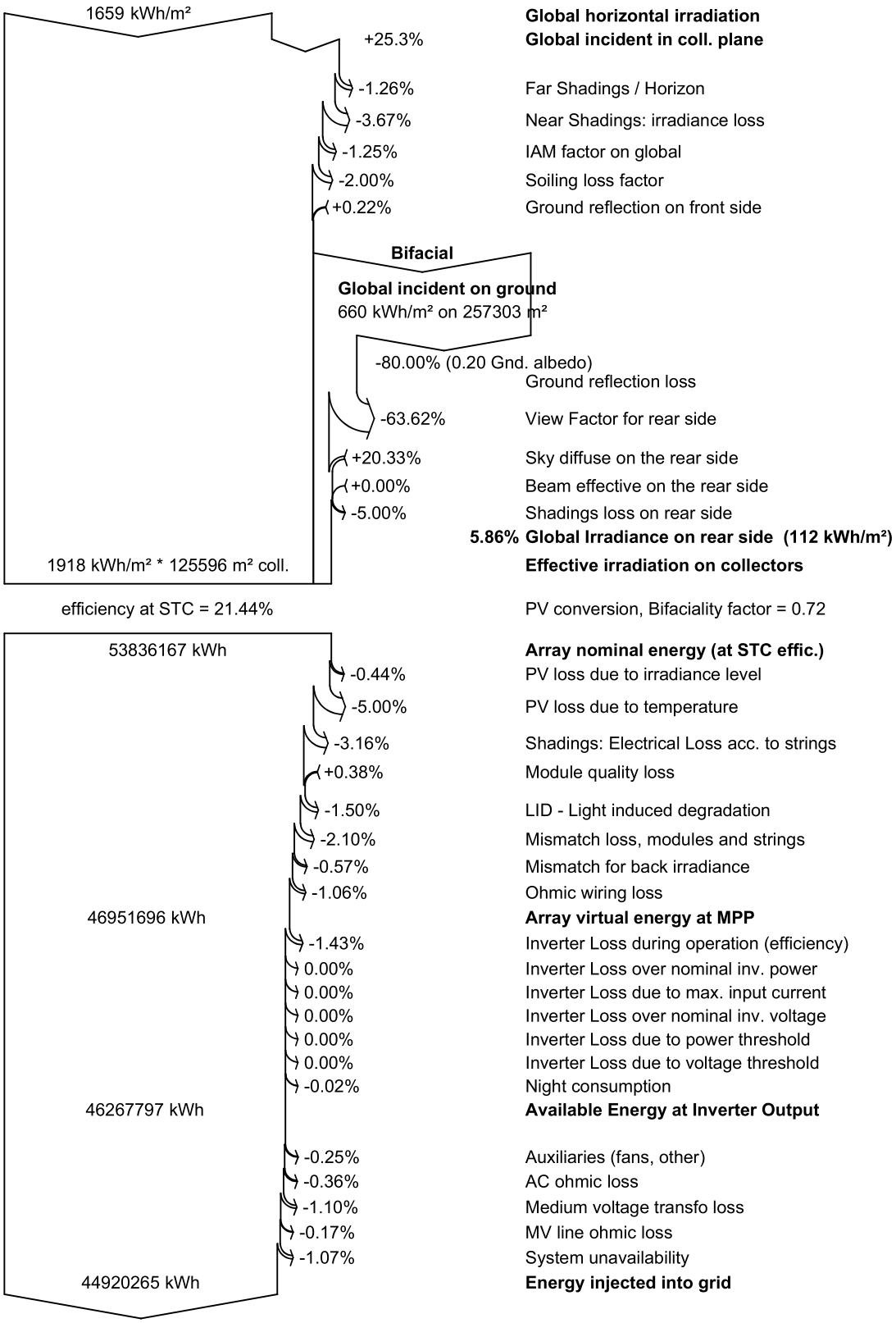
Loss diagram



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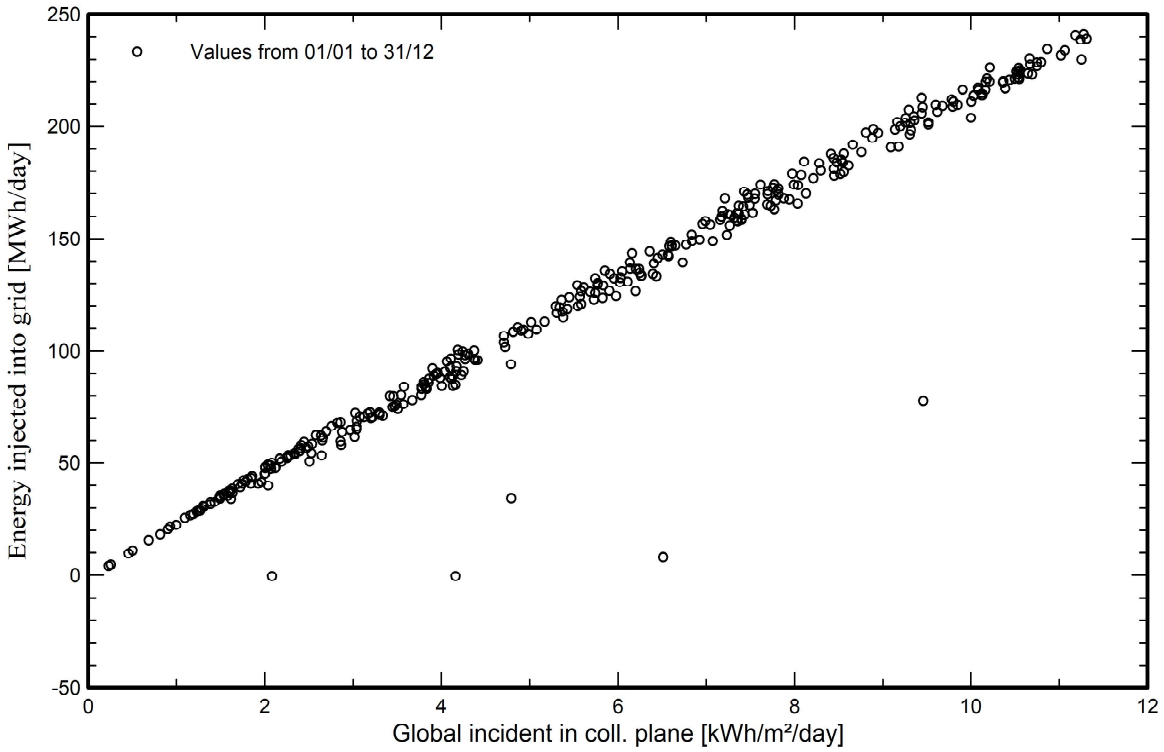
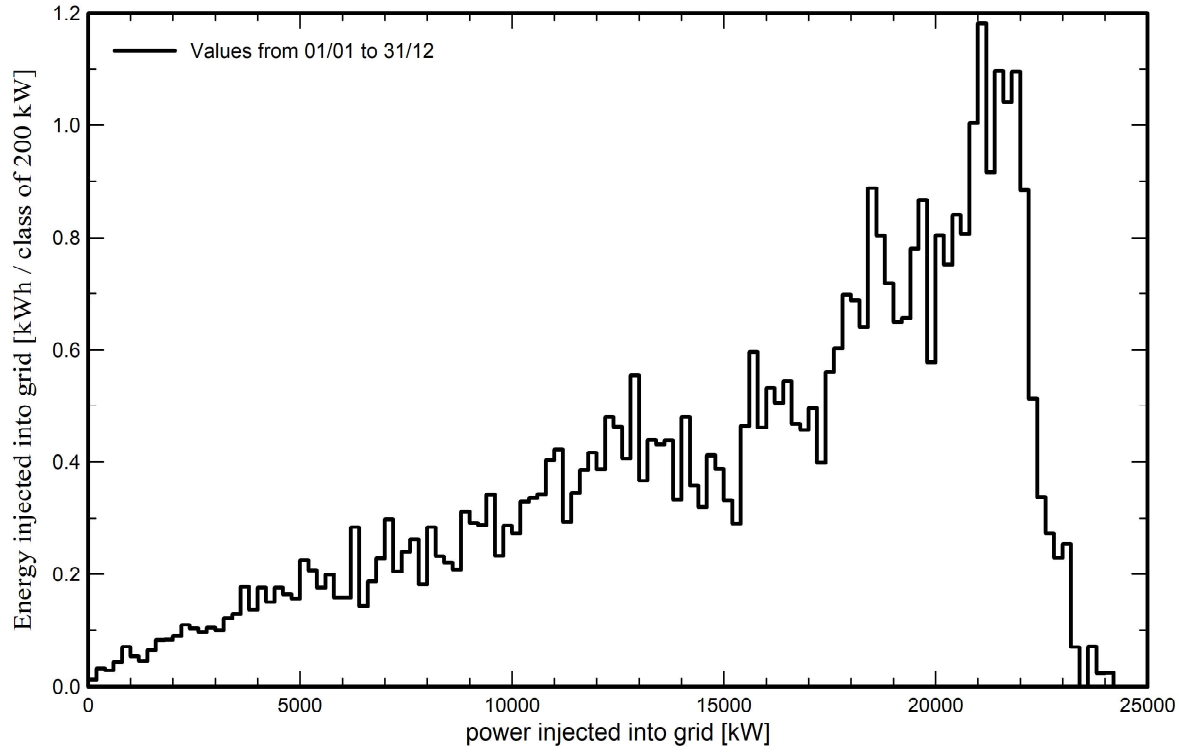
Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



P50 - P90 evaluation

Meteo data

Source	Meteonorm 8.1 (1991-2009), Sat=100%
Kind	Monthly averages
Sintetico - Multi-year average	
Year-to-year variability(Variance)	4.0 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	4.4 %

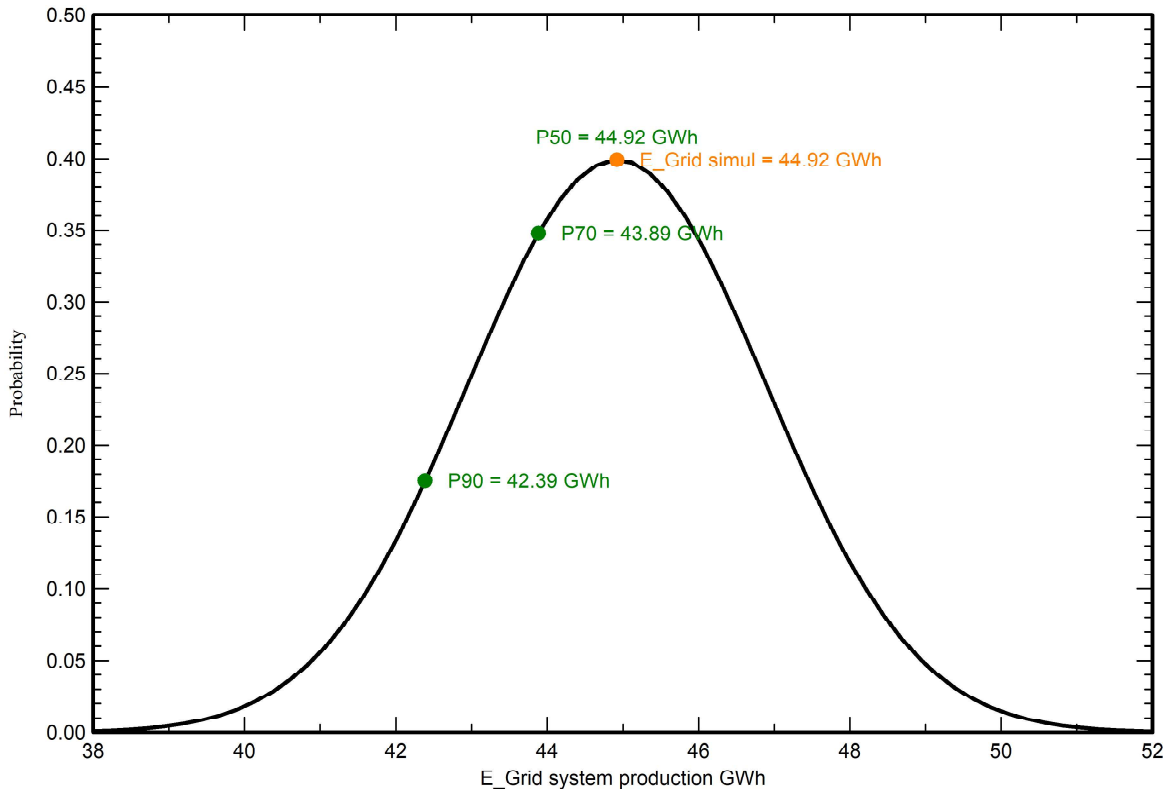
Simulation and parameters uncertainties

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	1.98 GWh
P50	44.92 GWh
P70	43.89 GWh
P90	42.39 GWh

Probability distribution



Single-line diagram

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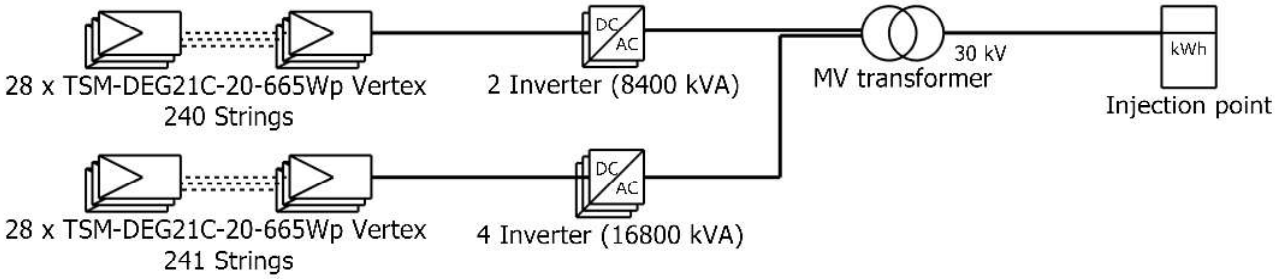

PV module	TSM-DEG21C-20-665Wp Vertex
Inverter	Sunny Central 4200 UP
String	28 x TSM-DEG21C-20-665Wp Vertex

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