REGIONE SICILIA

Comune di Assoro
Provincia di Enna

Comune di Raddusa
Provincia di Catania

Comune di Enna

IMPIANTO AGRIVOLTAICO DA 250MWp "CAPO BIANCO"

in agro dei Comuni di Assoro (EN), Raddusa (CT), Enna

PROGETTO DEFINITIVO

PROPONENTE

CAPOBIANCO Srl

CAPOBIANCO s.r.l.
Corso Giacomo Matteotti, 1
20121 Milano
P.IVA e C.F. 12684270965
C.C.I.A. Milano – REA MI-2678645
srl.capobianco@pec.it

PROGETTAZIONE

BIOS IS
INNOVAZIONE · SOSTENIBILITÀ

BIOS IS s.r.l.
Via La Marmora, 51
50121 Firenze
P.IVA e C.F. 06393070484
C.C.I.A. Firenze – REA FI-624950
bios-is@pec.it

DIRETTORE TECNICO
ing. Giuliano Trentini

TITOLO ELABORATO	NUMERO ELABORATO
PRODUCIBILITA' IMPIANTO FOTOVOLTAICO	04.01.02.01
	FOGLIO: — / FORMATO: ODT
	SCALA:

PROGETTISTI
ing. Marcello Cei

COLLABORATORI
p.ind. Antonello Congiu

Revisione	Data	Descrizione	Preparato	Verificato	Approvato
0	26-01-2024	Emesso per progettazione definitiva	CONGIU	CEI	TRENTINI

SOMMARIO

1 PREMESSA

La presente relazione riporta il calcolo della producibilità dell'impianto agrivoltaico *"CAPOBIANCO"* i cui generatori sono collocati in agro dei comuni di Assoro (EN) e Raddusa (CT).

2 METODOLOGIA

Per il calcolo della producibilità dell'impianto, i dati di partenza sono quelli dell'irradiazione giornaliera media mensile sul piano orizzontale, nella località considerata per l'installazione dell'impianto, dedotti dai valori tabellari della norma UNI 10349.

Mediante il metodo di calcolo della norma UNI/TR 11328-1:2009, si determina il valore di irradiazione medio mensile, e quindi annuale, sul piano dei moduli comunque inclinati (rispetto all'orizzontale), ed orientati (rispetto al sud).

Il valore di irradiazione sulla superficie dei moduli può essere influenzato dalla presenza di eventuali ostruzioni dell'orizzonte visto dal campo fotovoltaico, quali edifici, alberi, rilievi o gli stessi moduli secondo la loro posizione.ecc.…

La stima di producibilità dell'impianto è stata effettuata mediante l'applicazione **PVsyst vs 7.4**, un pacchetto software completo per lo studio, il dimensionamento, la simulazione e l'analisi dei sistemi fotovoltaici.

La versione del software PVsyst utilizzata per la simulazione ingloba al suo interno il programma **Meteonorm 7.0**, in grado di generare valori climatici annuali accurati e rappresentativi per qualsiasi luogo sulla terra. Meteonorm include due dei migliori modelli sul mercato per simulazioni affidabili di grandi impianti fotovoltaici. Il database Meteonorm è composto da più di 8.000 stazioni meteorologiche, cinque satelliti geostazionari e una climatologia dell'aerosol calibrata a livello globale. Su questa base, sofisticati modelli di interpolazione, basati su oltre 30 anni di esperienza, forniscono risultati con elevata precisione in tutto il mondo.

La progettazione dell'impianto agrivoltaico è stata condotta con l'ausilio del software **PVcase vs 2.38** che permette di esportare direttamente i file di input per PVsyst, compresa la descrizione della morfologia del terreno.

3 CALCOLO DELLA PRODUCIBILITÀ

Data la complessità dell'installazione, la producibilità è stata stimata articolando la simulazione su ognuno dei 9 differenti campi e, all'interno di ognuno di essi, simulando separatamente le installazioni fisse e i tracker monoassiali.

La disposizione delle strutture, dalla quale deriva il numero di pannelli installati, è stata scelta in modo da ottimizzare lo sfruttamento della superficie disponibile, mantenendo una distanza tra le strutture tale da consentire le pratiche agronomiche da svolgere in sito e allo stesso tempo minimizzare l'ombreggiamento.

Ai fini della stima della produzione di energia, sono stati considerati vari fattori di perdita energetica dovuti ad una non perfetta efficienza nella trasmissione da un apparato all'altro, come esemplificato nel seguente schema.

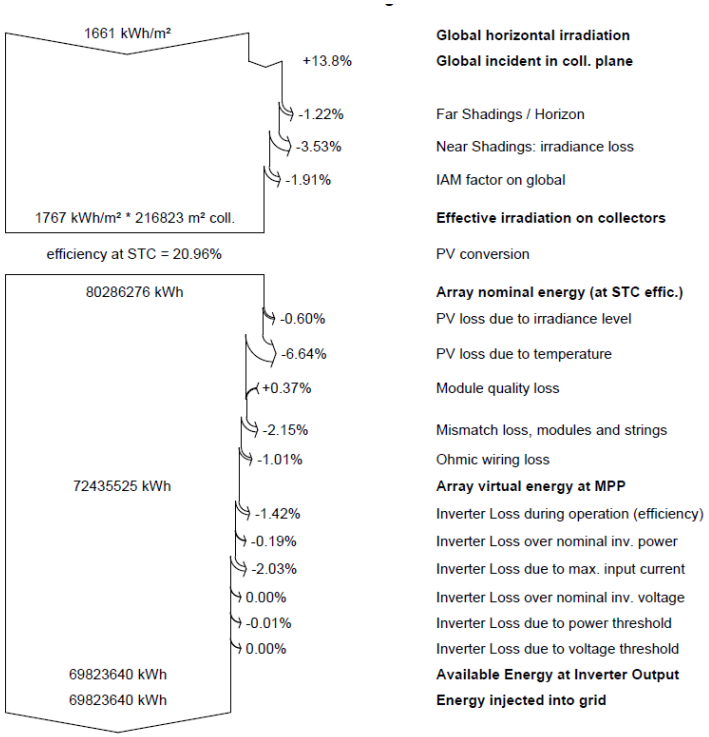

Figura 1: Diagramma delle perdite considerato nella simulazione con PVsyst, i valori percentuali sono comuni a tutte le simulazioni condotte, mentre i valori assoluti fanno riferimento alle installazioni fisse nei campi A e B.

Nella seguente tabella vengono riassunto i riultati di tutte le simulazioni condotte, mentre i tabulati di dettaglio di ogni singola simulazione sono allegati a seguire.

Campo	Tipo installazione	n moduli	Potenza	Energia prodotta	Energia prodotta
			[kWp]	*[kWh/anno]*	*[kWh/kWp/anno]*
A-B	Fissi	69 800	45 370	69 823 640	1 539
A-B	Tracker	1 960	1 274	2 446 972	1 921
C	Fissi	21 860	14 209	22 274 728	1 568
C	Tracker	5 432	3 531	6 390 258	1 810
D	Fissi	57 040	37 076	56 649 144	1 528
D	Tracker	25 536	16 598	29 661 272	1 787
E	Fissi	153 820	99 983	154 235 300	1 543
E	Tracker	35 728	23 223	42 348 140	1 824
F	Fissi	42 180	27 417	42 404 377	1 547
F	Tracker	4 676	3 039	5 538 277	1 822
G	Fissi	29 420	19 123	29 394 051	1 537
totale fissi		**374 120**	**243 178**	**374 781 240**	**1 541**
totale tracker		**73 332**	**47 666**	**86 384 919**	**1 812**
Totale campo		**447 452**	**290 844**	**461 166 159**	**1 586**

Figura. 2: Sintesi del calcolo della producibilità.

4 CONCLUSIONI

L'impianto in oggetto ha una produzione media per i moduli installati su struttura fissa pari a 1.541 kWh/kWp/anno mentre per i tracker monoassiali di 1.812 kWh/kWp/annui. Quest'ultimo valore è inferiore al massimo valore teorico in condizioni di terreno piatto, ed è condizionato dall'ombreggiamento esercitato dalla morfologia del terreno subito dopo l'alba e poco prima del tramonto.

5 TABULATI SIMULAZIONI

Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: AB Fissi

Ground system (tables) on a hill

System power: 45.37 MWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VCA, Simulation date:
22/01/24 10:09
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System
Ground system (tables) on a hill

PV Field Orientation
Fixed plane
Tilt/Azimuth 30 / 0 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	69800 units
Pnom total	45.37 MWp

Inverters

Nb. of units	116.5 units
Pnom total	34.95 MWac
Pnom ratio	1.298

Results summary

Produced Energy	69823640 kWh/year	Specific production	1539 kWh/kWp/year	Perf. Ratio PR	81.43 %

Table of contents

PVsyst V7.4.5
VCA, Simulation date:
22/01/24 10:09
with v7.4.5

General parameters

Grid-Connected System

Ground system (tables) on a hill

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	30 / 0 °

Sheds configuration	
Nb. of sheds	1828 units
Sizes	
Sheds spacing	12.6 m
Collector width	4.87 m
Ground Cov. Ratio (GCR)	38.6 %

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)	
Unit Nom. Power	650 Wp
Number of PV modules	69800 units
Nominal (STC)	45.37 MWp
Modules	3490 string x 20 In series
At operating cond. (50°C)	
Pmpp	41.57 MWp
U mpp	685 V
I mpp	60658 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H1
(Original PVsyst database)	
Unit Nom. Power	300 kWac
Number of inverters	699 * MPPT 17% 116.5 units
Total power	34950 kWac
Operating voltage	550-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	1.30
No power sharing between MPPTs	

Total PV power

Nominal (STC)	45370 kWp
Total	69800 modules
Module area	216823 m²

Total inverter power

Total power	34950 kWac
Nb. of inverters	117 units
	0.5 unused
Pnom ratio	1.30

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 0.19 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

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

PVsyst V7.4.5
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with v7.4.5

Horizon definition

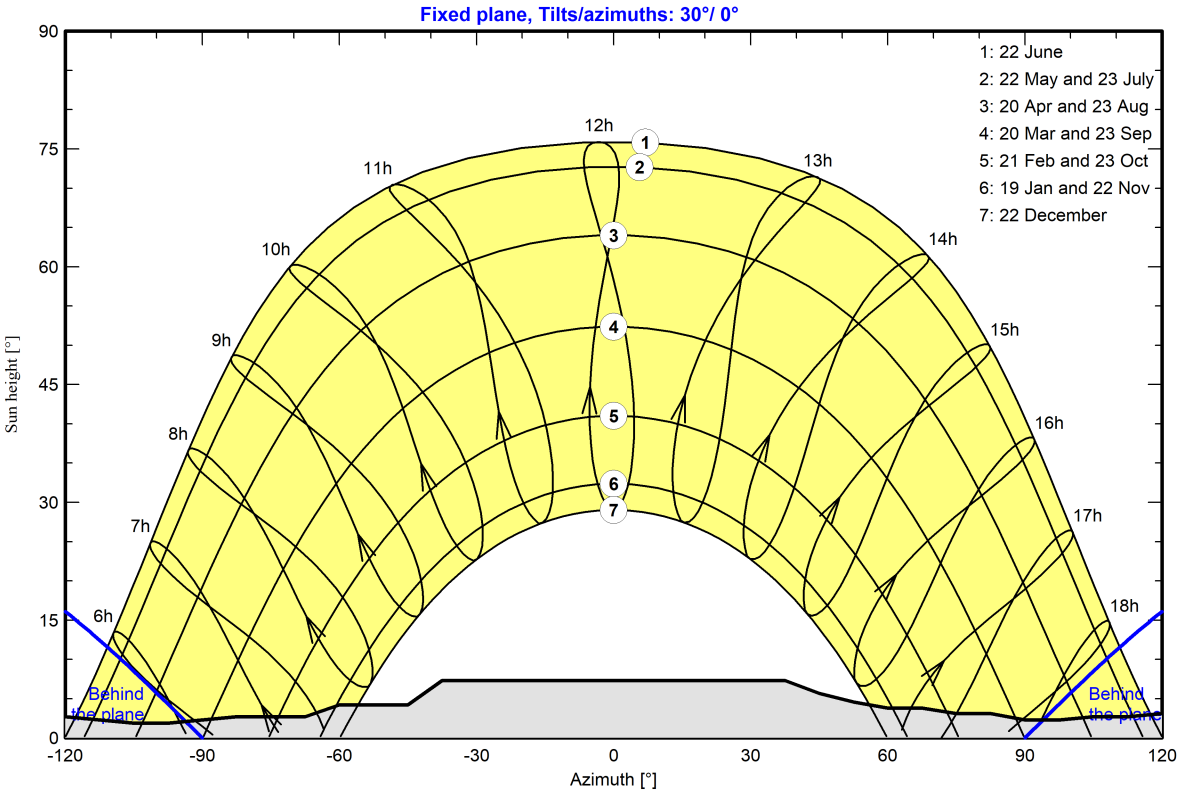
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.67
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

Sun Paths (Height / Azimuth diagram)



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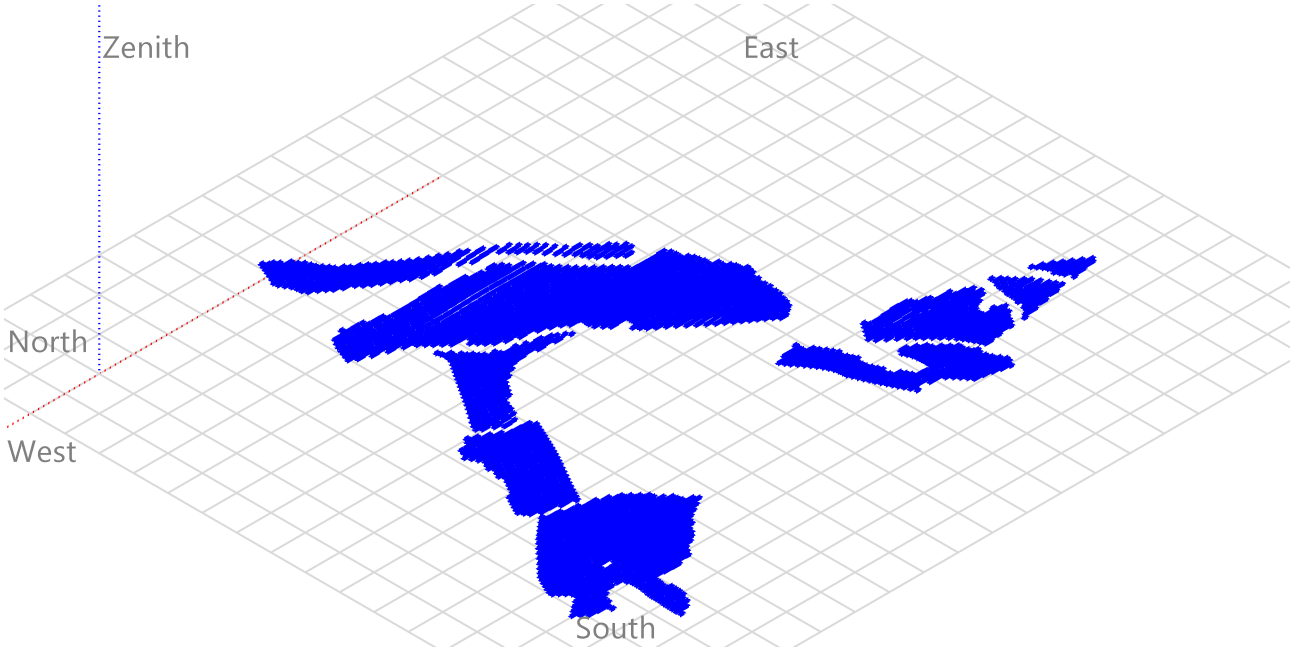
Near shadings parameter

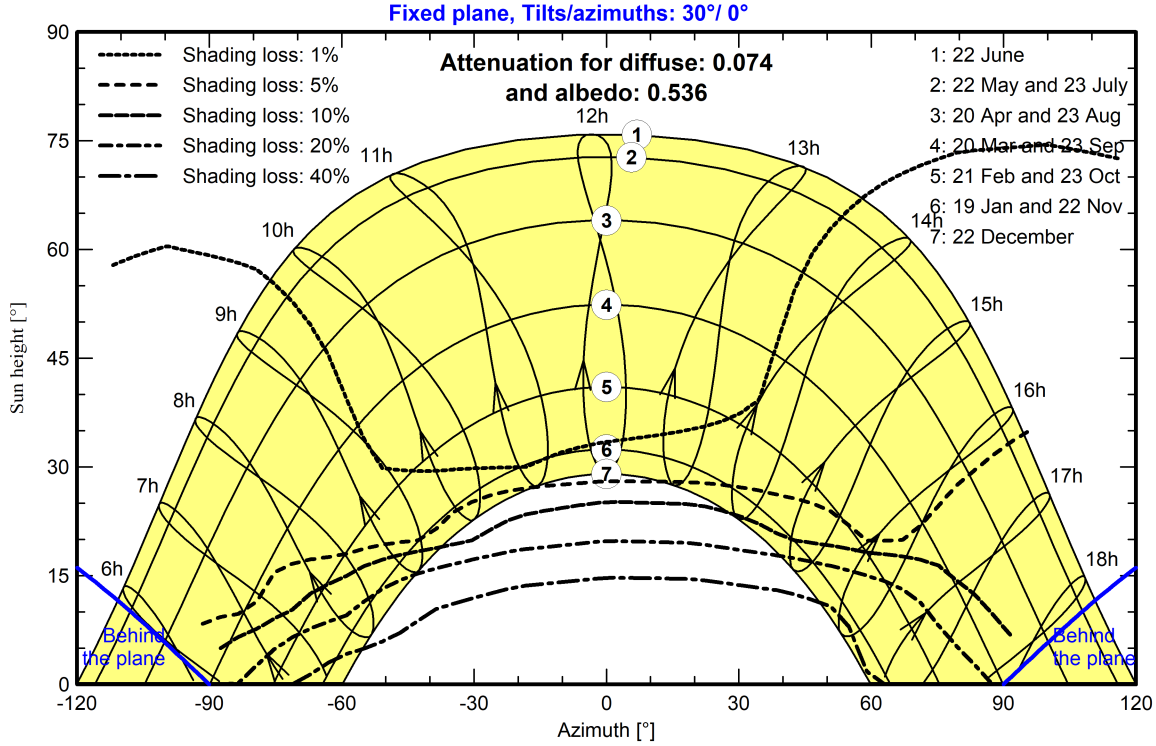
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 30°/ 0°



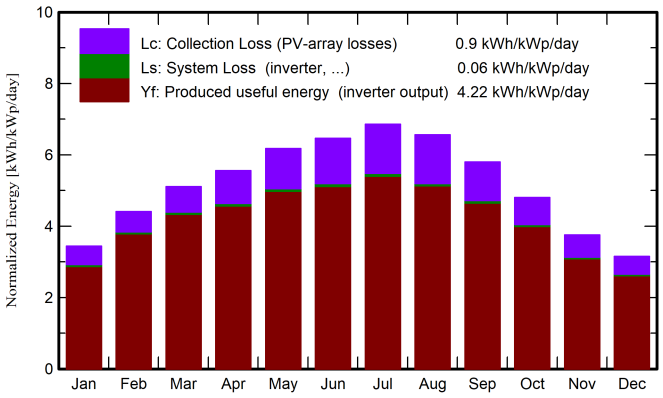
PVsyst V7.4.5
VCA, Simulation date:
22/01/24 10:09
with v7.4.5

Main results

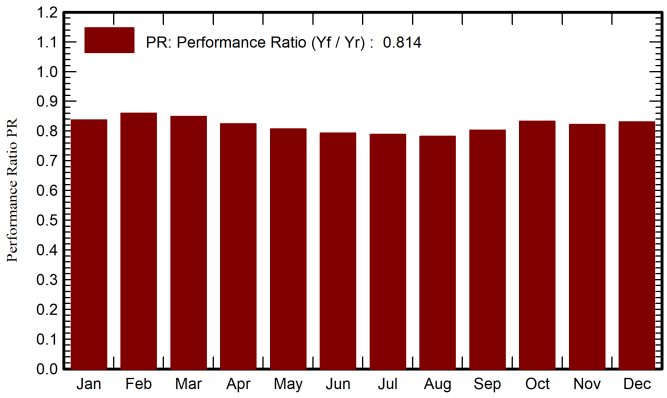
System Production

Produced Energy	69823640 kWh/year	Specific production	1539 kWh/kWp/year
		Perf. Ratio PR	81.43 %

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	67.6	26.45	9.01	106.6	97.4	4114474	4047173	0.836
February	89.8	39.57	9.10	123.4	116.3	4882983	4813715	0.860
March	130.8	59.27	11.61	158.4	149.5	6183555	6095902	0.848
April	155.9	76.96	14.11	166.6	155.7	6316412	6225993	0.824
May	196.4	80.56	18.22	191.4	179.0	7112142	7006491	0.807
June	207.5	79.46	22.53	193.9	181.3	7074800	6971000	0.793
July	221.8	83.61	25.96	212.7	199.6	7714937	7607254	0.788
August	194.7	74.58	26.33	203.5	191.4	7318114	7217979	0.782
September	149.6	60.38	22.57	174.0	164.0	6423462	6334566	0.803
October	113.1	51.11	18.98	148.9	140.7	5702631	5623062	0.832
November	73.4	28.56	14.25	112.7	103.8	4272701	4203123	0.822
December	60.7	26.83	10.59	97.6	87.8	3740068	3677383	0.830
Year	1661.3	687.34	16.99	1889.8	1766.7	70856280	69823640	0.814

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 V7.4.5
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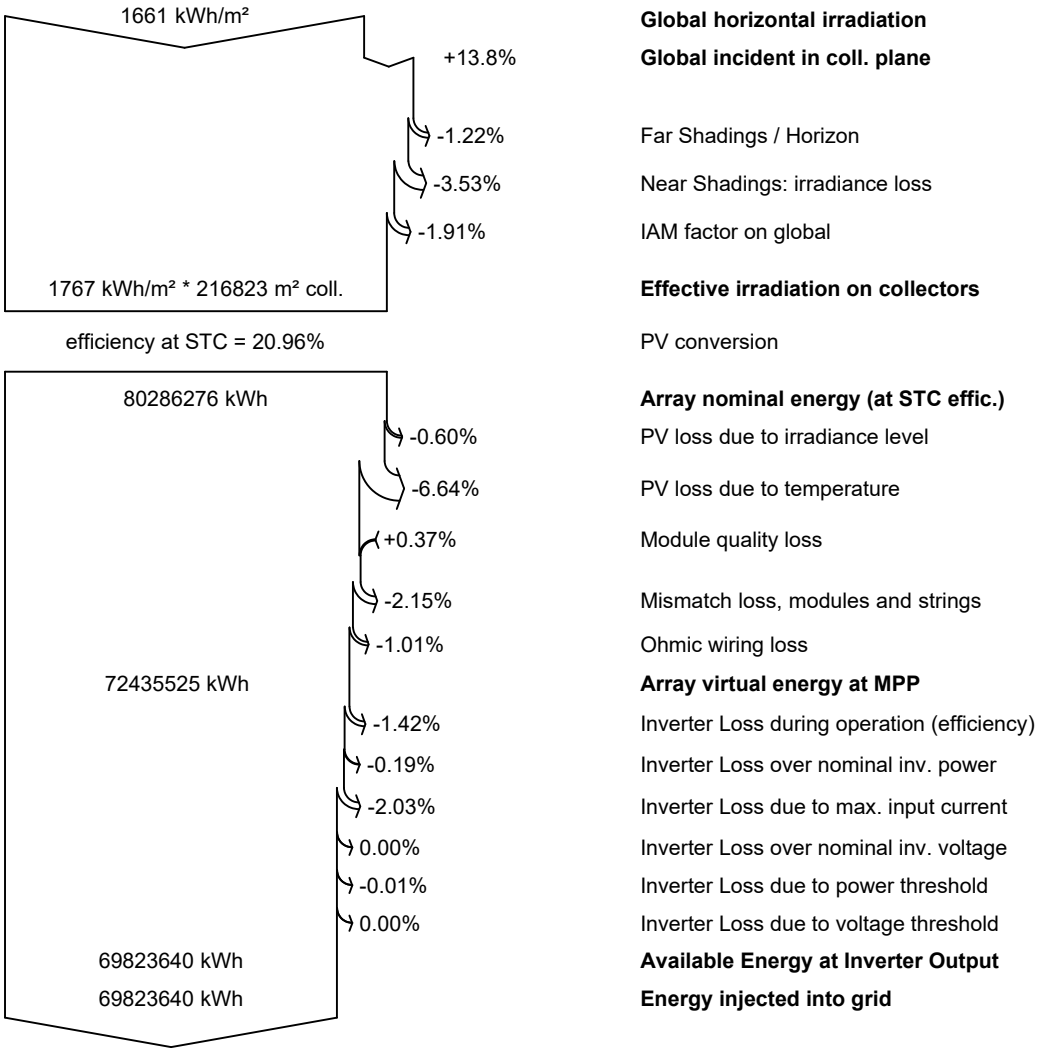
Loss diagram



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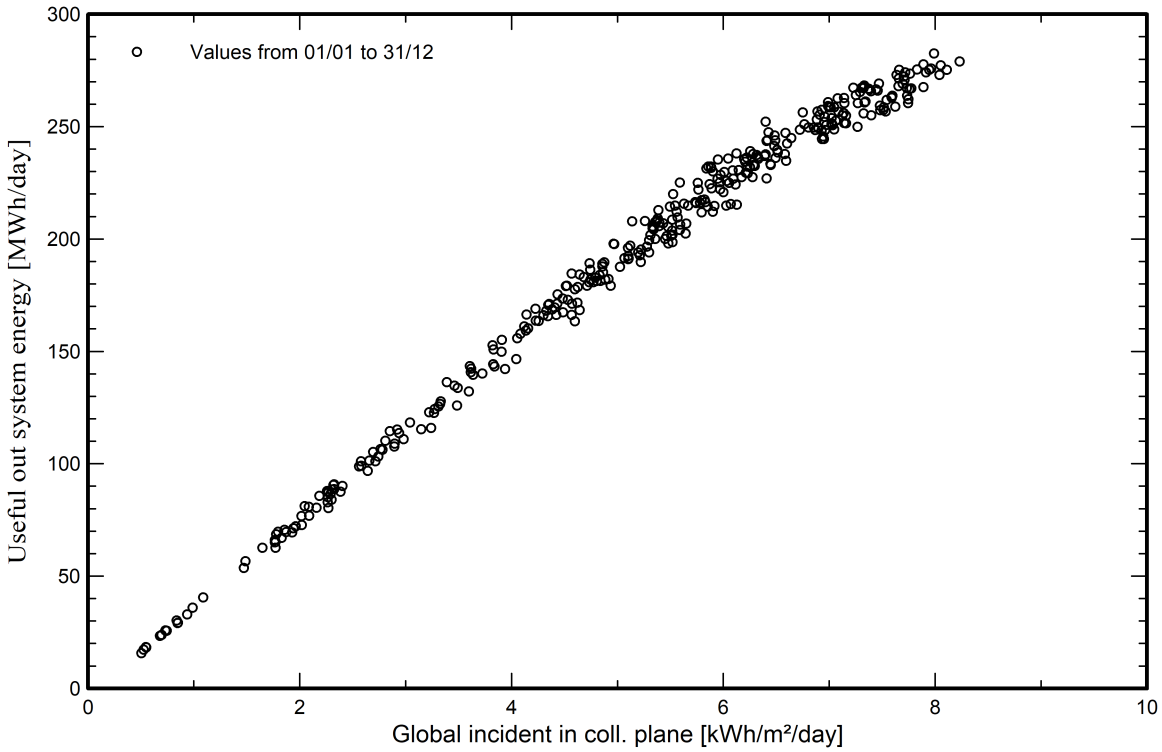
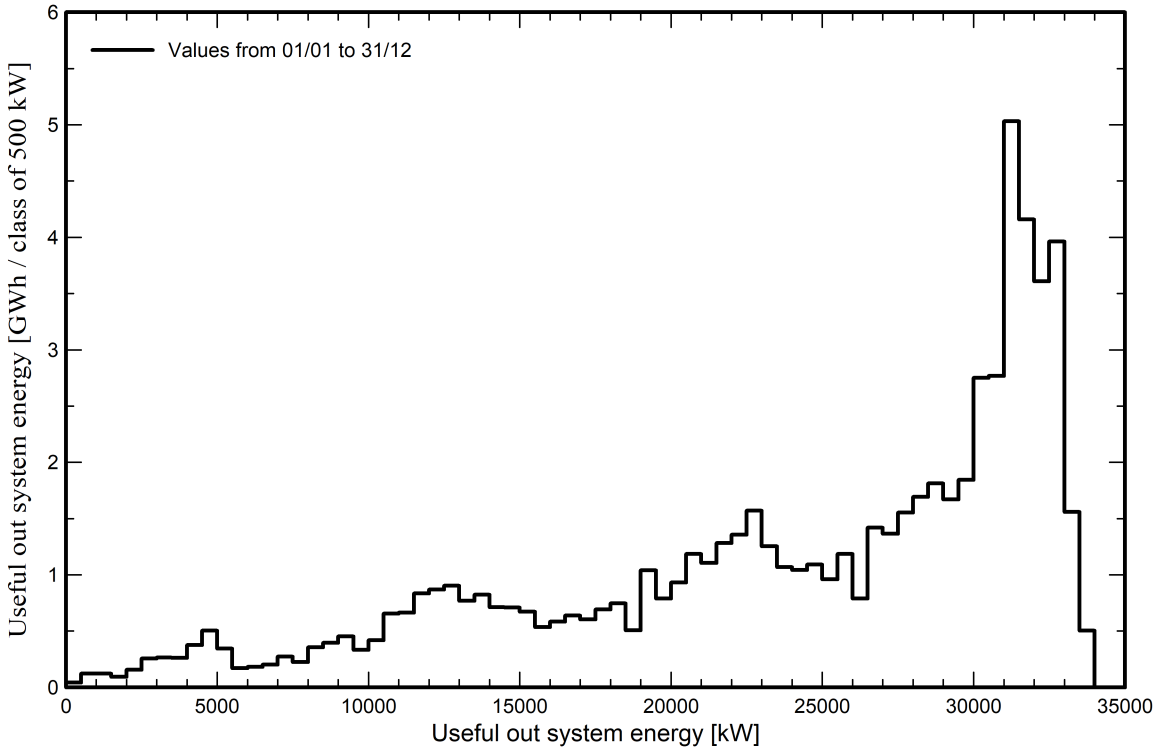
Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: AB Tracker

Tracking system

System power: 1274 kWp

Cuticchi - Italia

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VCB, Simulation date:
22/01/24 10:27
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italia

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings
Albedo 0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System

Tracking system

PV Field Orientation
Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

System information

PV Array		Inverters	
Nb. of modules	1960 units	Nb. of units	3.3 units
Pnom total	1274 kWp	Pnom total	1000 kWac
		Pnom ratio	1.274

User's needs
Unlimited load (grid)

Results summary

Produced Energy	2446972 kWh/year	Specific production	1921 kWh/kWp/year	Perf. Ratio PR	85.37 %

Table of contents

PVsyst V7.4.5
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General parameters

Grid-Connected System

Tracking system

PV Field Orientation

Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Trackers configuration
Nb. of trackers 70 units

Sizes
Tracker Spacing 10.5 m
Collector width 4.79 m
Ground Cov. Ratio (GCR) 45.6 %
Phi min / max. -/+ 55.0 °

Shading limit angles
Phi limits for BT -/+ 62.7 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module
Manufacturer Trina Solar
Model TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)
Unit Nom. Power 650 Wp
Number of PV modules 1960 units
Nominal (STC) 1274 kWp
Modules 70 string x 28 In series
At operating cond. (50°C)
Pmpp 1167 kWp
U mpp 959 V
I mpp 1217 A

Inverter
Manufacturer Huawei Technologies
Model SUN2000-330KTL-H1
(Original PVsyst database)
Unit Nom. Power 300 kWac
Number of inverters 20 * MPPT 17% 3.3 units
Total power 1000 kWac
Operating voltage 550-1500 V
Max. power (=>30°C) 330 kWac
Pnom ratio (DC:AC) 1.27
No power sharing between MPPTs

Total PV power
Nominal (STC) 1274 kWp
Total 1960 modules
Module area 6088 m²

Total inverter power
Total power 1000 kWac
Nb. of inverters 4 units
0.7 unused
Pnom ratio 1.27

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 13 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

PVsyst V7.4.5
VCB, Simulation date:
22/01/24 10:27
with v7.4.5

Array losses

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

PVsyst V7.4.5
VCB, Simulation date:
22/01/24 10:27
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Horizon definition

Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.83
Diffuse Factor	0.96	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
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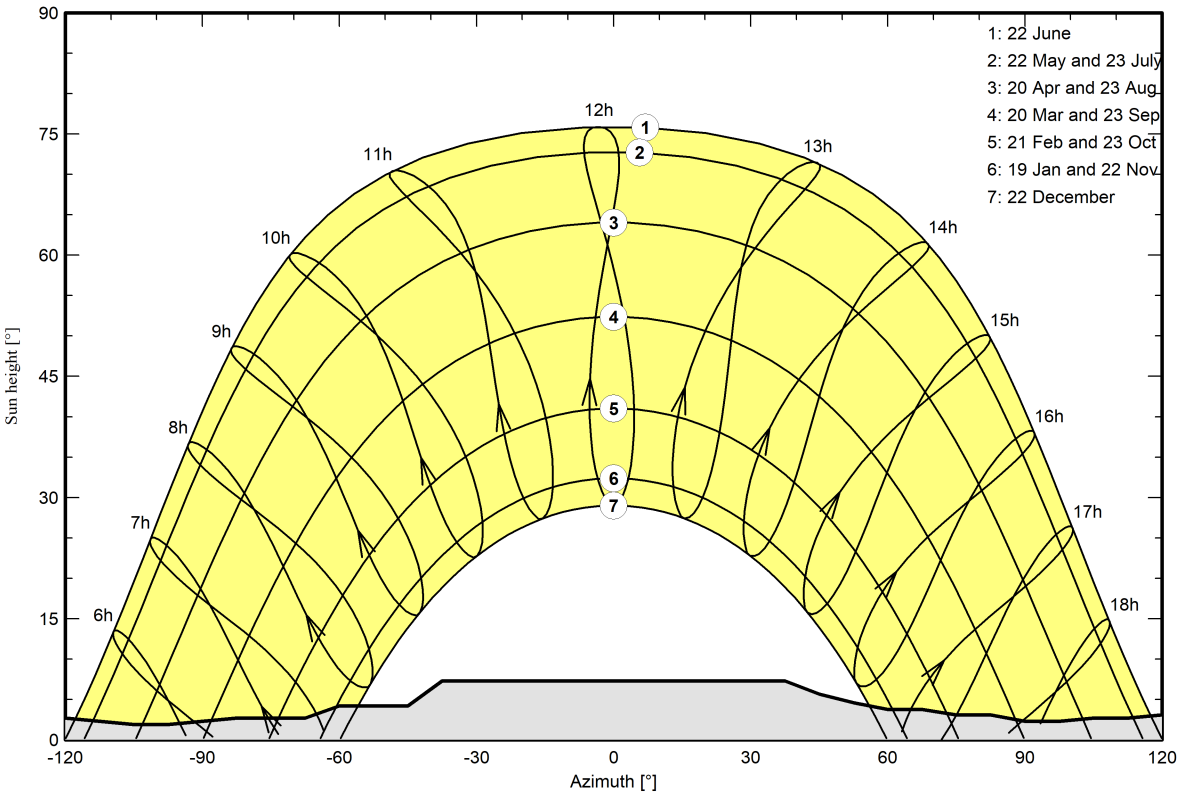
Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
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22/01/24 10:27
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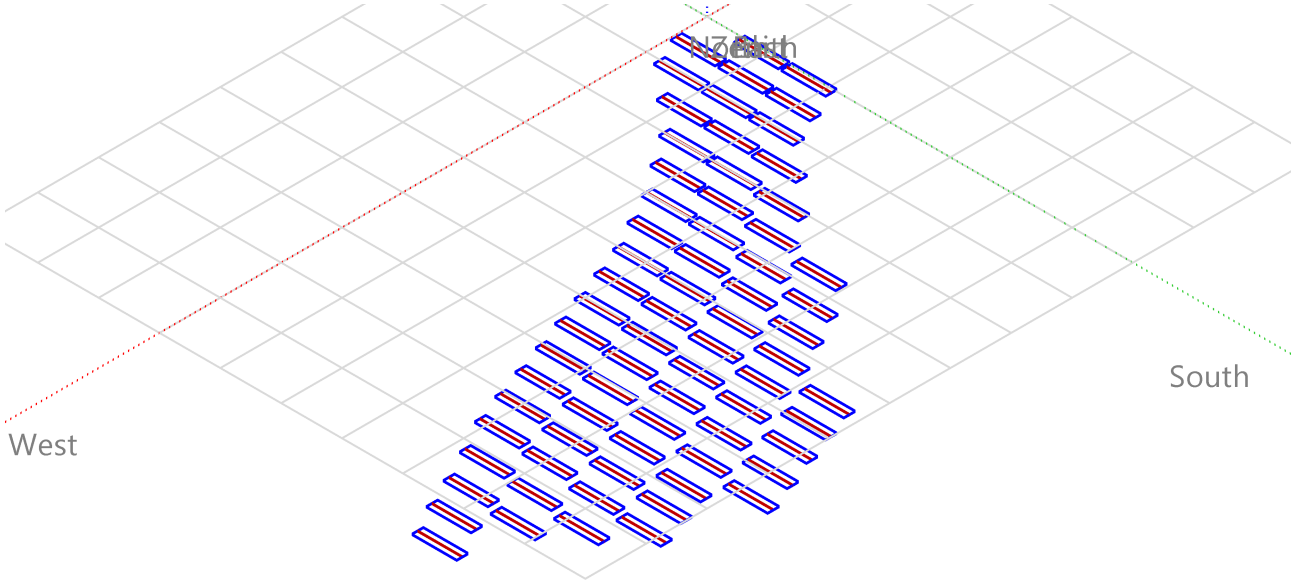
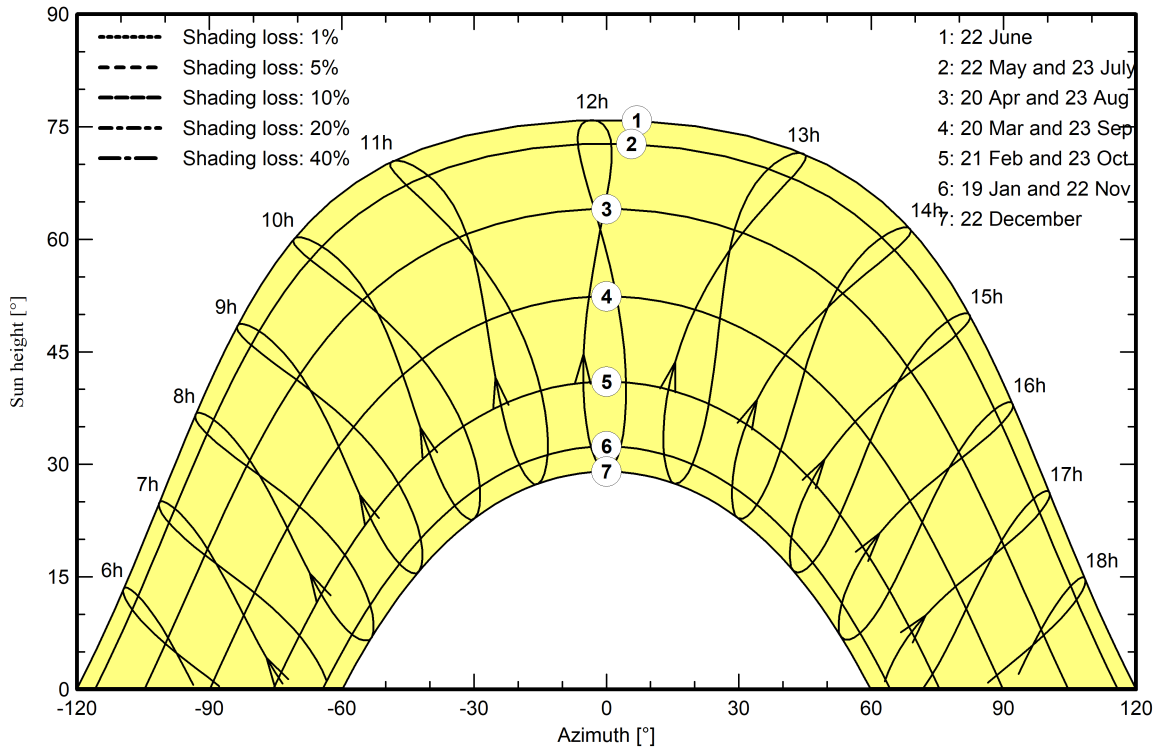
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1



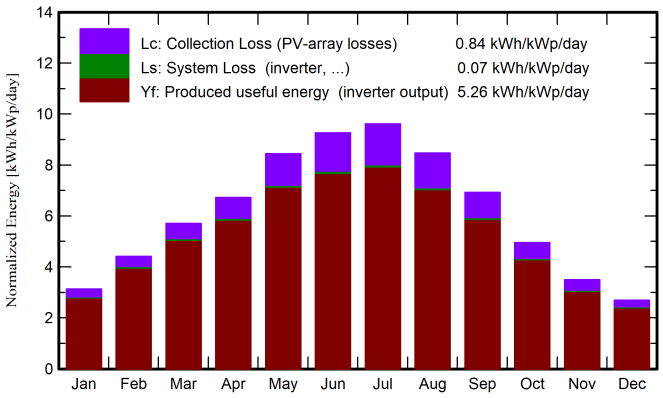
PVsyst V7.4.5
VCB, Simulation date:
22/01/24 10:27
with v7.4.5

Main results

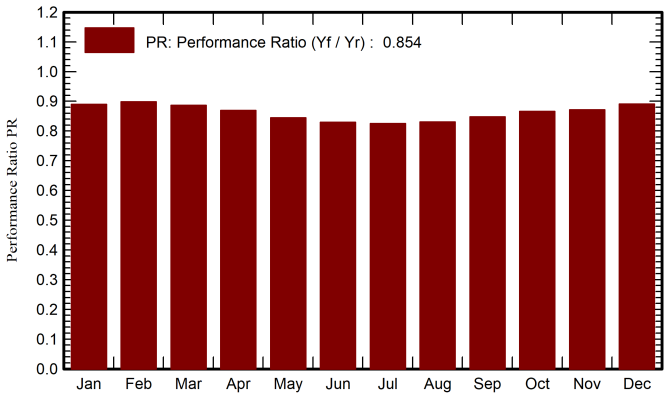
System Production

Produced Energy	2446972 kWh/year	Specific production	1921 kWh/kWp/year
		Perf. Ratio PR	85.37 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

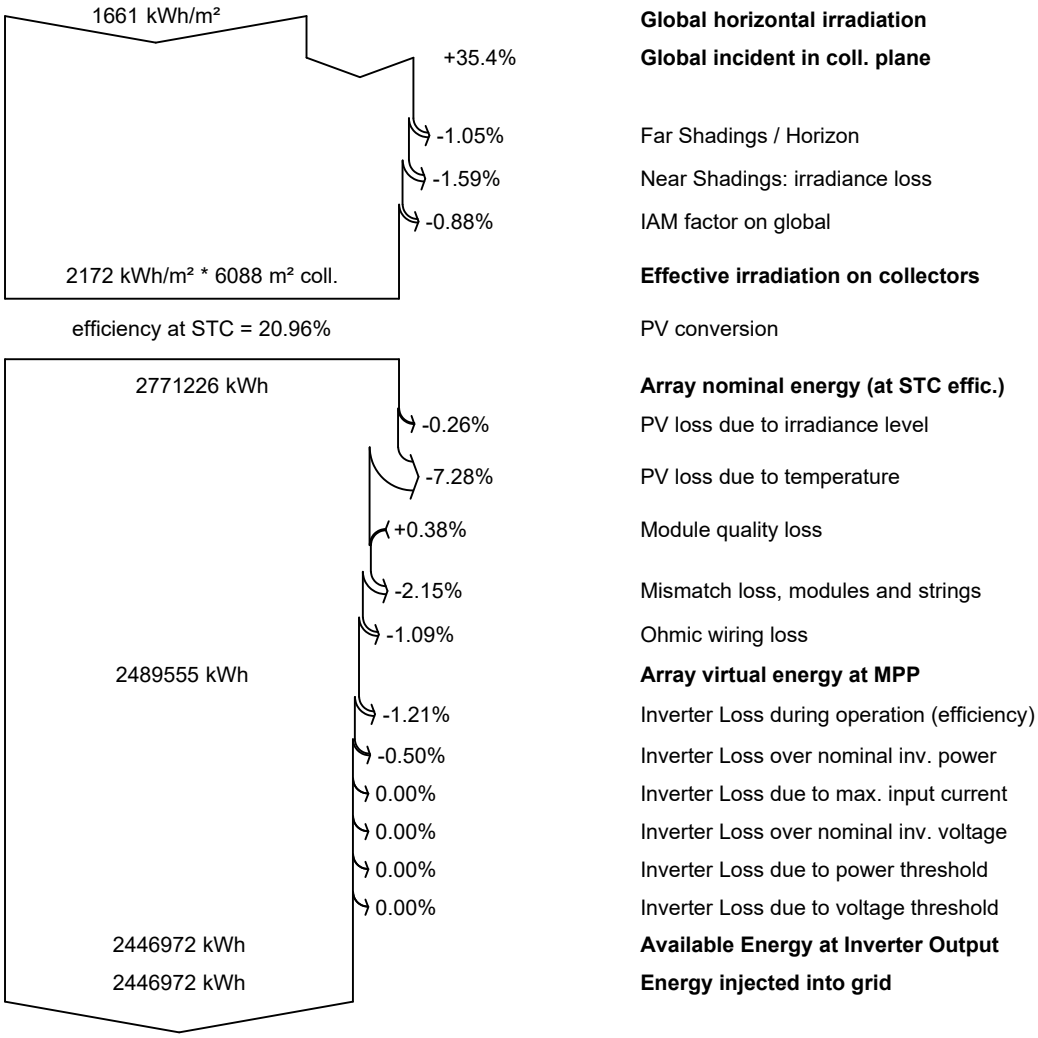
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	67.6	26.45	9.01	97.2	92.0	111904	110149	0.890
February	89.8	39.57	9.10	123.7	118.4	143387	141524	0.898
March	130.8	59.27	11.61	176.8	170.1	202184	199685	0.887
April	155.9	76.96	14.11	201.8	194.7	226281	223562	0.869
May	196.4	80.56	18.22	261.8	253.7	285140	281785	0.845
June	207.5	79.46	22.53	277.8	270.1	296917	293556	0.829
July	221.8	83.61	25.96	298.1	289.8	316684	313226	0.825
August	194.7	74.58	26.33	262.7	255.7	281131	278046	0.831
September	149.6	60.38	22.57	207.9	201.1	227161	224514	0.848
October	113.1	51.11	18.98	153.5	147.2	171515	169367	0.866
November	73.4	28.56	14.25	105.0	99.5	118449	116625	0.871
December	60.7	26.83	10.59	83.6	79.4	96523	94931	0.891
Year	1661.3	687.34	16.99	2249.8	2171.6	2477274	2446972	0.854

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 V7.4.5
VCB, Simulation date:
22/01/24 10:27
with v7.4.5

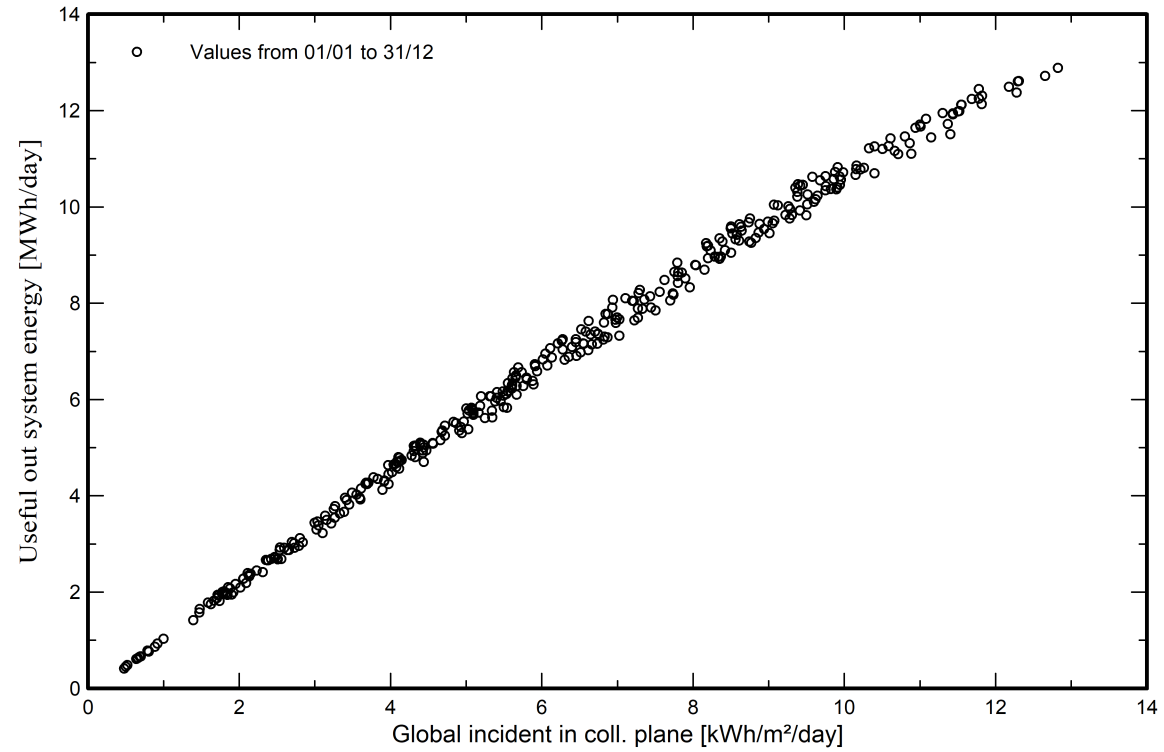
Loss diagram



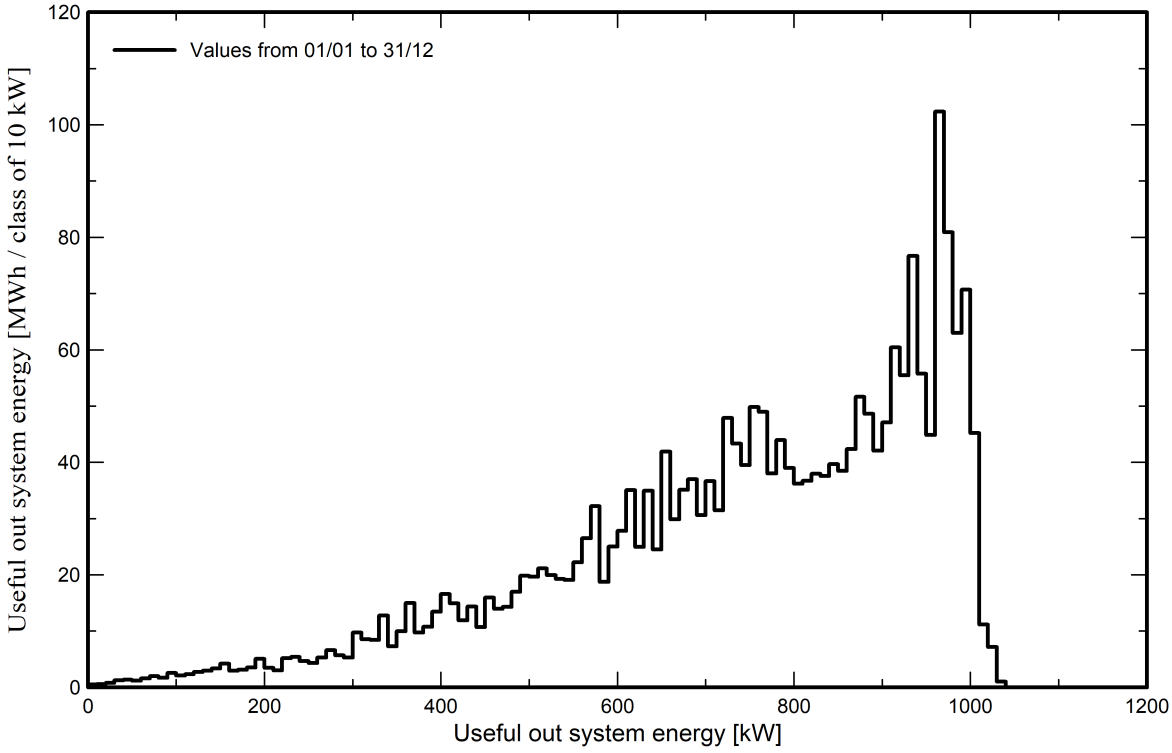
PVsyst V7.4.5
VCB, Simulation date:
22/01/24 10:27
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: C Fissi

Ground system (tables) on a hill

System power: 14.21 MWp

Cuticchi - Italia

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC1, Simulation date:
18/01/24 12:32
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italia

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings
Albedo 0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System
Ground system (tables) on a hill

PV Field Orientation
Fixed plane
Tilt/Azimuth 30 / 0 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	21860 units
Pnom total	14.21 MWp

Inverters

Nb. of units	36.5 units
Pnom total	10.95 MWac
Pnom ratio	1.298

Results summary

Produced Energy	22274728 kWh/year	Specific production	1568 kWh/kWp/year	Perf. Ratio PR	82.95 %

Table of contents

PVsyst V7.4.5
VC1, Simulation date:
18/01/24 12:32
with v7.4.5

General parameters

Grid-Connected System

Ground system (tables) on a hill

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	30 / 0 °

Sheds configuration	
Nb. of sheds	587 units
Sizes	
Sheds spacing	9.93 m
Collector width	4.87 m
Ground Cov. Ratio (GCR)	49.0 %
Shading limit angle	
Limit profile angle	23.1 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)	
Unit Nom. Power	650 Wp
Number of PV modules	21860 units
Nominal (STC)	14.21 MWp
Modules	1093 string x 20 In series
At operating cond. (50°C)	
Pmpp	13.02 MWp
U mpp	685 V
I mpp	18997 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H1
(Original PVsyst database)	
Unit Nom. Power	300 kWac
Number of inverters	219 * MPPT 17% 36.5 units
Total power	10950 kWac
Operating voltage	550-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	1.30
No power sharing between MPPTs	

Total PV power

Nominal (STC)	14209 kWp
Total	21860 modules
Module area	67905 m²

Total inverter power

Total power	10950 kWac
Nb. of inverters	37 units
	0.5 unused
Pnom ratio	1.30

Array losses

Thermal Loss factor

Module temperature according to irradiance	
Uc (const)	20.0 W/m²K
Uv (wind)	0.0 W/m²K/m/s

DC wiring losses

Global array res.	0.59 mΩ
Loss Fraction	1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

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

Horizon definition

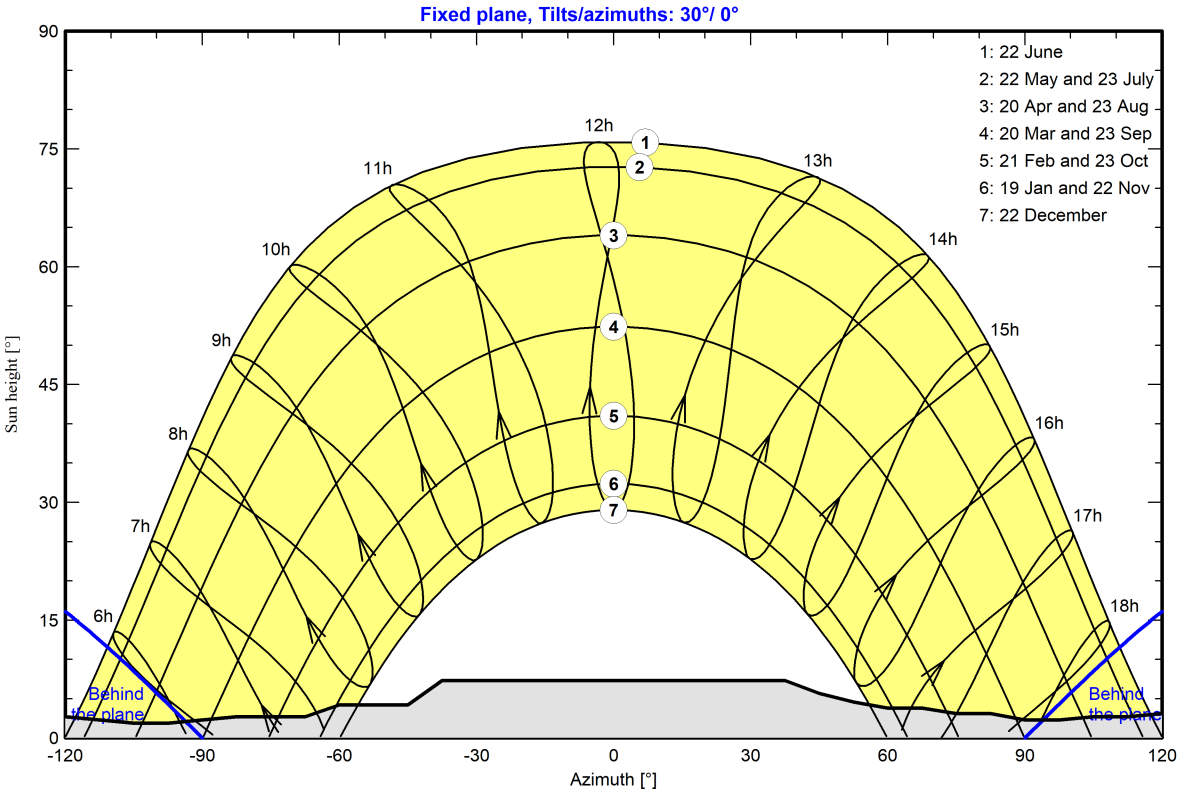
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.67
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
VC1, Simulation date:
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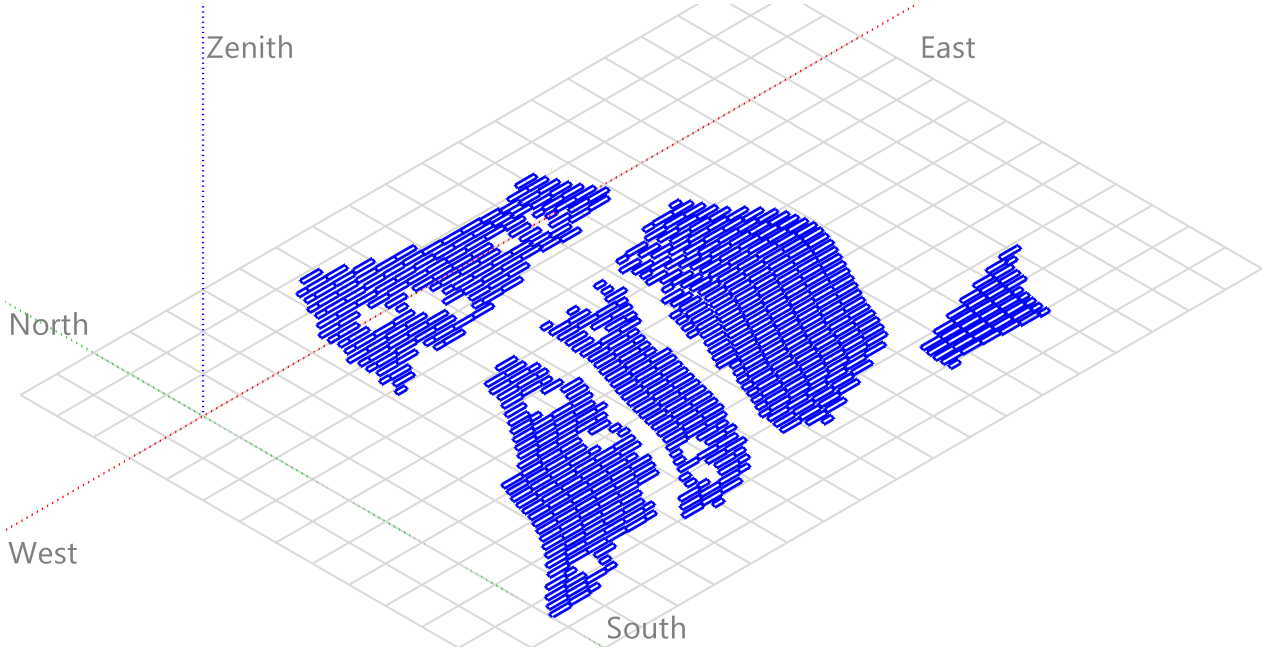
with v7.4.5

Near shadings parameter

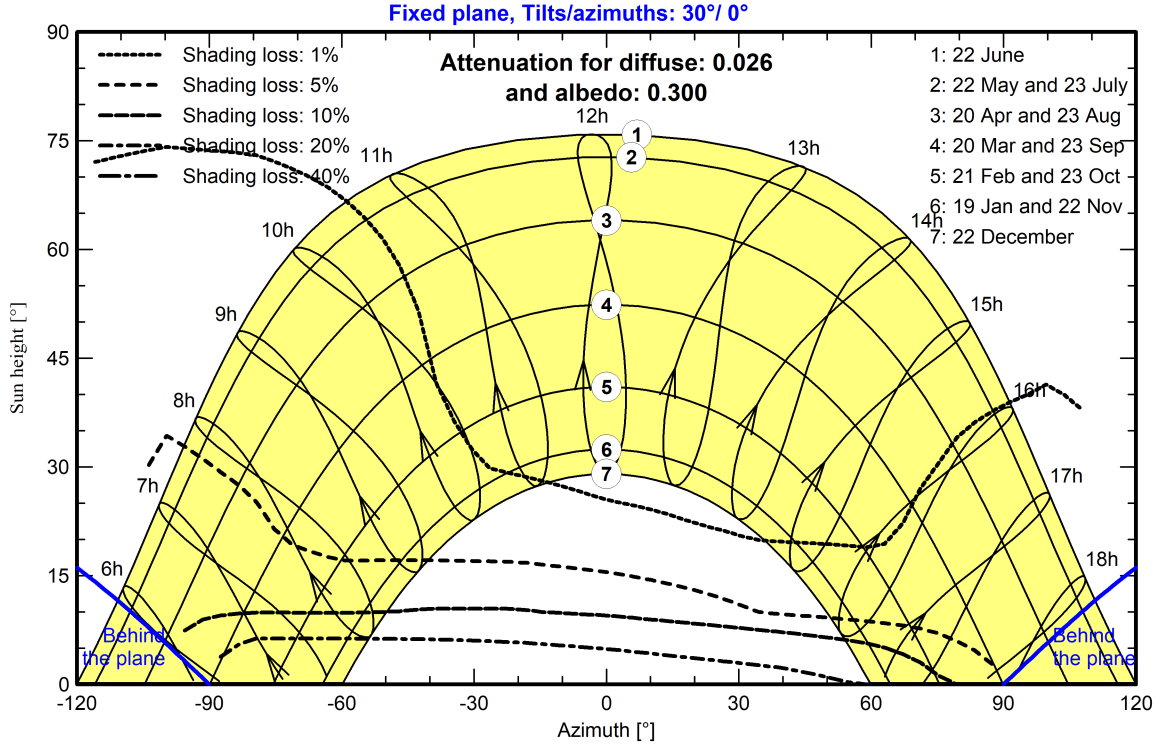
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 30°/ 0°



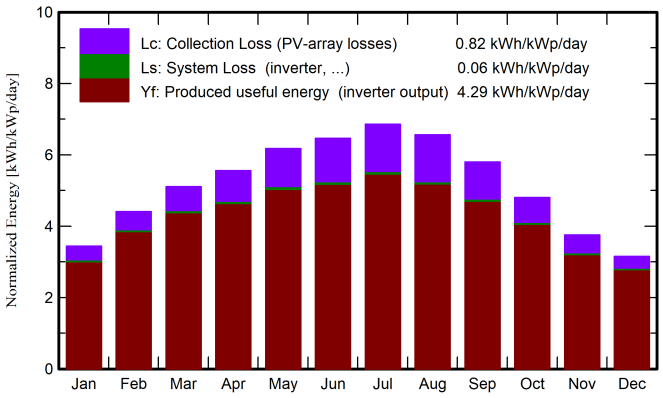
PVsyst V7.4.5
VC1, Simulation date:
18/01/24 12:32
with v7.4.5

Main results

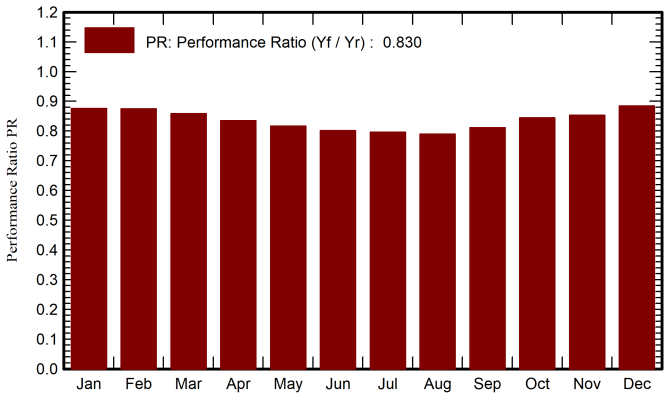
System Production

Produced Energy	22274728 kWh/year	Specific production	1568 kWh/kWp/year
		Perf. Ratio PR	82.95 %

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	67.6	26.45	9.01	106.6	102.0	1348501	1327288	0.876
February	89.8	39.57	9.10	123.4	118.4	1555802	1534037	0.875
March	130.8	59.27	11.61	158.4	151.5	1959018	1931457	0.858
April	155.9	76.96	14.11	166.6	158.2	2005739	1977327	0.835
May	196.4	80.56	18.22	191.4	181.4	2253188	2219977	0.816
June	207.5	79.46	22.53	193.9	183.7	2240716	2208107	0.802
July	221.8	83.61	25.96	212.7	202.2	2441489	2407614	0.797
August	194.7	74.58	26.33	203.5	193.8	2315614	2284132	0.790
September	149.6	60.38	22.57	174.0	166.0	2032255	2004328	0.811
October	113.1	51.11	18.98	148.9	142.9	1811849	1786853	0.844
November	73.4	28.56	14.25	112.7	107.8	1388359	1366441	0.853
December	60.7	26.83	10.59	97.6	93.6	1247011	1227167	0.885
Year	1661.3	687.34	16.99	1889.8	1801.6	22599542	22274728	0.830

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 V7.4.5
VC1, Simulation date:
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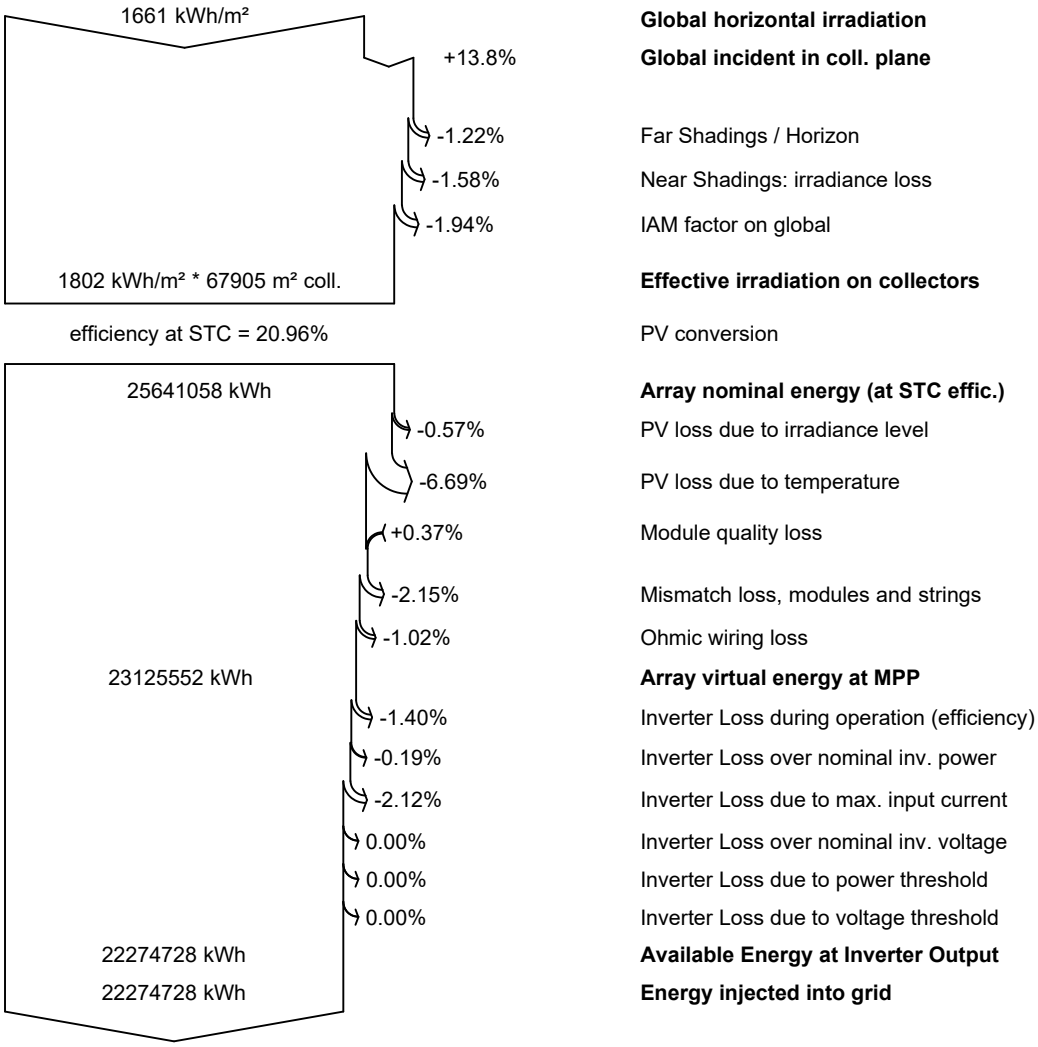
with v7.4.5

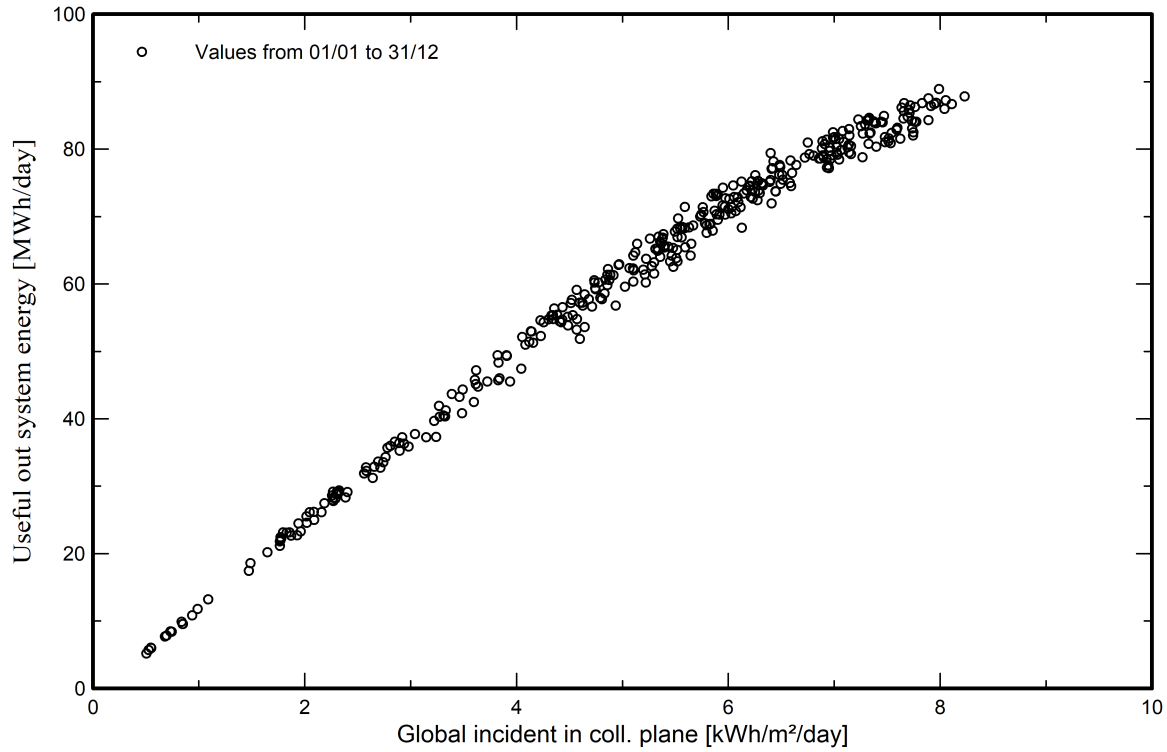
Loss diagram



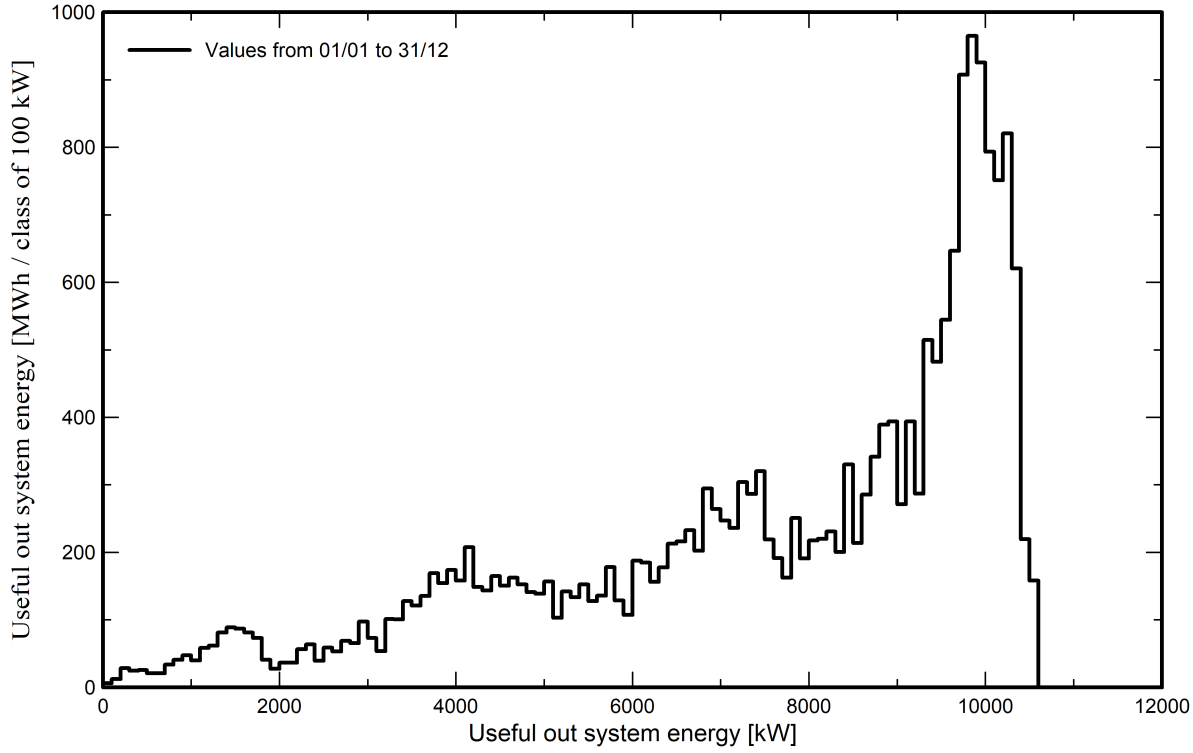
PVsyst V7.4.5
VC1, Simulation date:
18/01/24 12:32
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: C Tracker

Tracking system

System power: 3531 kWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC2, Simulation date:
22/01/24 10:31
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings
Albedo 0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System

Tracking system

PV Field Orientation
Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

System information

PV Array		Inverters	
Nb. of modules	5432 units	Nb. of units	9.2 units
Pnom total	3531 kWp	Pnom total	2750 kWac
		Pnom ratio	1.284

User's needs
Unlimited load (grid)

Results summary

Produced Energy	6390258 kWh/year	Specific production	1810 kWh/kWp/year	Perf. Ratio PR	80.44 %

Table of contents

PVsyst V7.4.5
VC2, Simulation date:
22/01/24 10:31
with v7.4.5

General parameters

Grid-Connected System

Tracking system

PV Field Orientation

Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Trackers configuration
Nb. of trackers 194 units

Sizes
Tracker Spacing 10.5 m
Collector width 4.79 m
Ground Cov. Ratio (GCR) 45.6 %
Phi min / max. -/+ 55.0 °

Shading limit angles
Phi limits for BT -/+ 62.7 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module
Manufacturer Trina Solar
Model TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)
Unit Nom. Power 650 Wp
Number of PV modules 5432 units
Nominal (STC) 3531 kWp
Modules 194 string x 28 In series
At operating cond. (50°C)
Pmpp 3235 kWp
U mpp 959 V
I mpp 3372 A

Inverter
Manufacturer Huawei Technologies
Model SUN2000-330KTL-H1
(Original PVsyst database)
Unit Nom. Power 300 kWac
Number of inverters 55 * MPPT 17% 9.2 units
Total power 2750 kWac
Operating voltage 550-1500 V
Max. power (=>30°C) 330 kWac
Pnom ratio (DC:AC) 1.28
No power sharing between MPPTs

Total PV power
Nominal (STC) 3531 kWp
Total 5432 modules
Module area 16874 m²

Total inverter power
Total power 2750 kWac
Nb. of inverters 10 units
0.8 unused
Pnom ratio 1.28

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 4.7 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

PVsyst V7.4.5
VC2, Simulation date:
22/01/24 10:31
with v7.4.5

Array losses

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

PVsyst V7.4.5
VC2, Simulation date:
22/01/24 10:31
with v7.4.5

Horizon definition

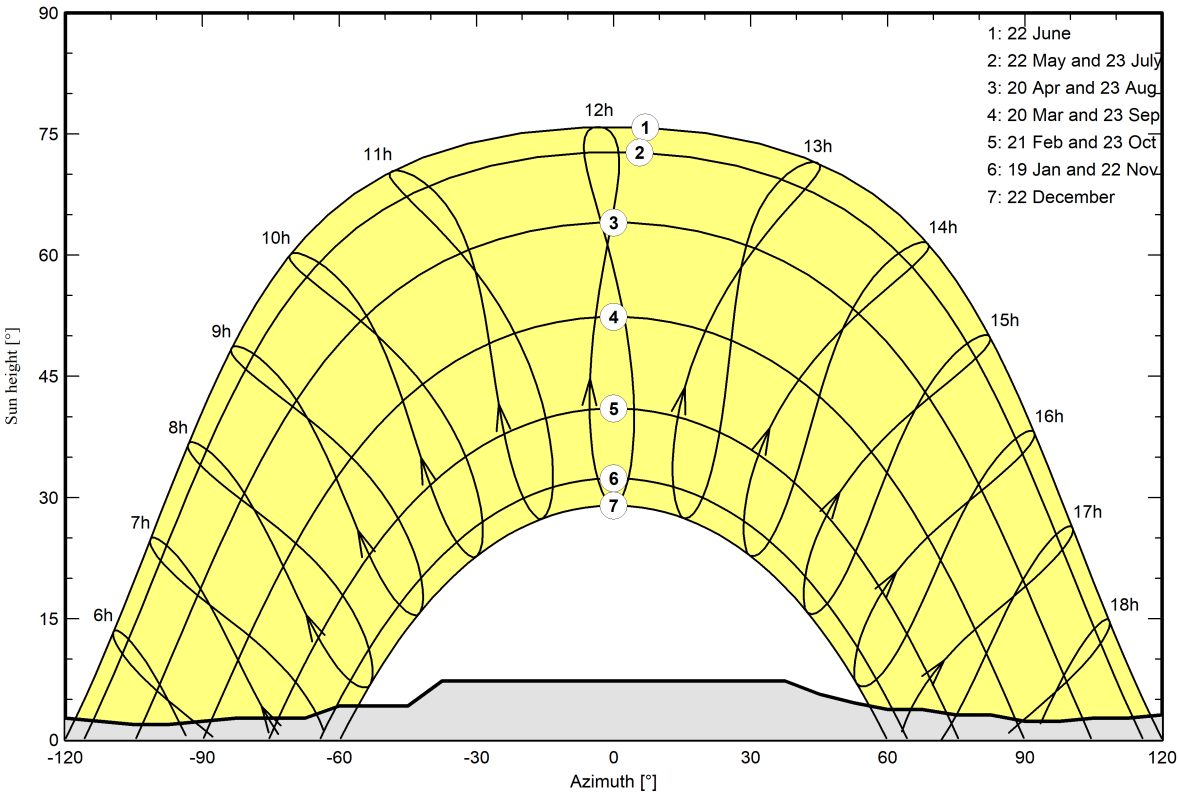
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.83
Diffuse Factor	0.96	Albedo Fraction	100 %

Horizon profile

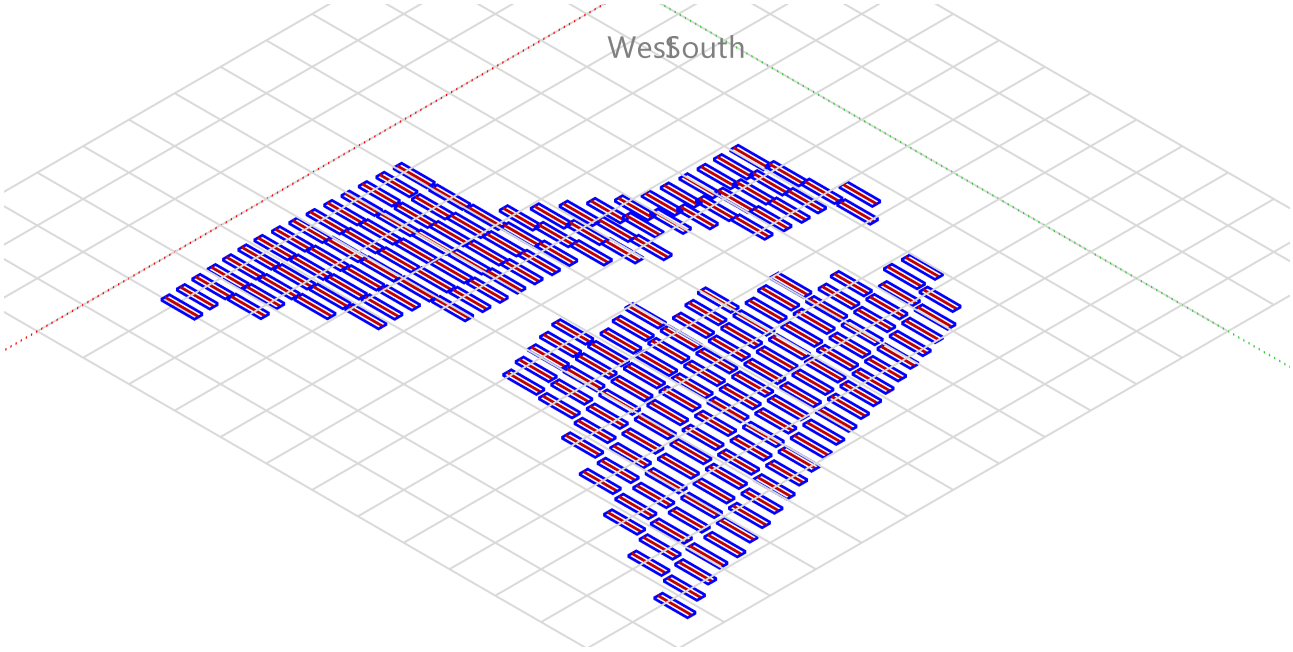
Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

Sun Paths (Height / Azimuth diagram)



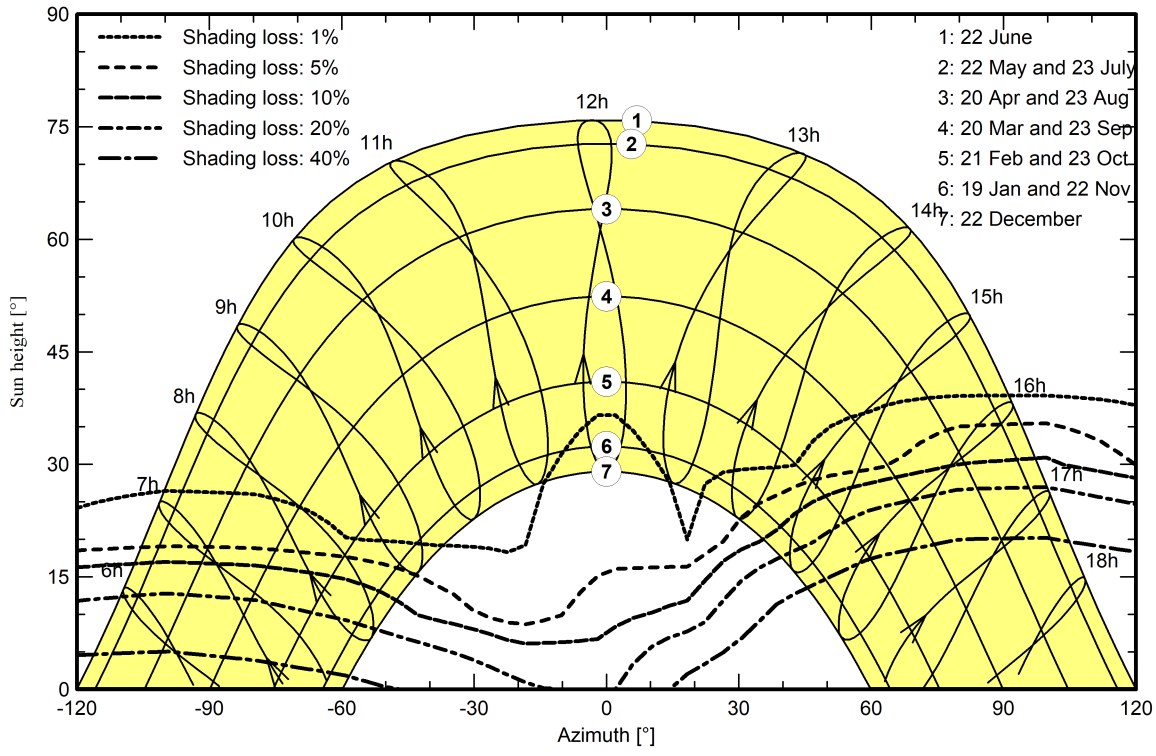
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1



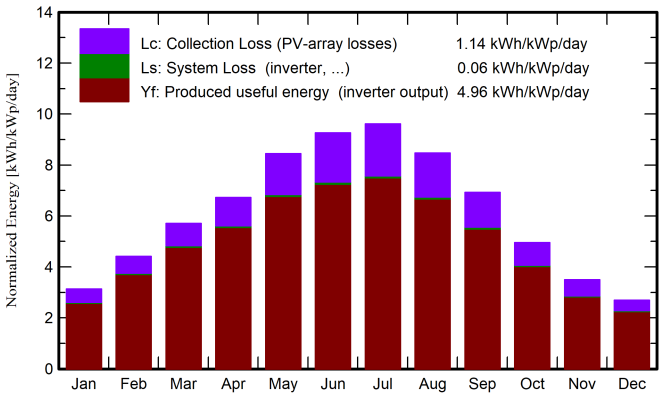
PVsyst V7.4.5
VC2, Simulation date:
22/01/24 10:31
with v7.4.5

Main results

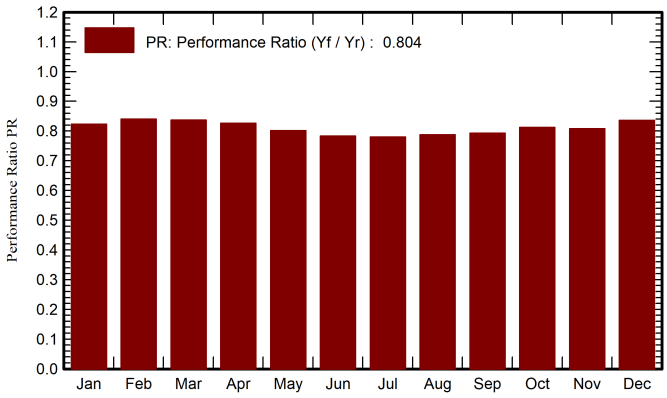
System Production

Produced Energy	6390258 kWh/year	Specific production	1810 kWh/kWp/year
		Perf. Ratio PR	80.44 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

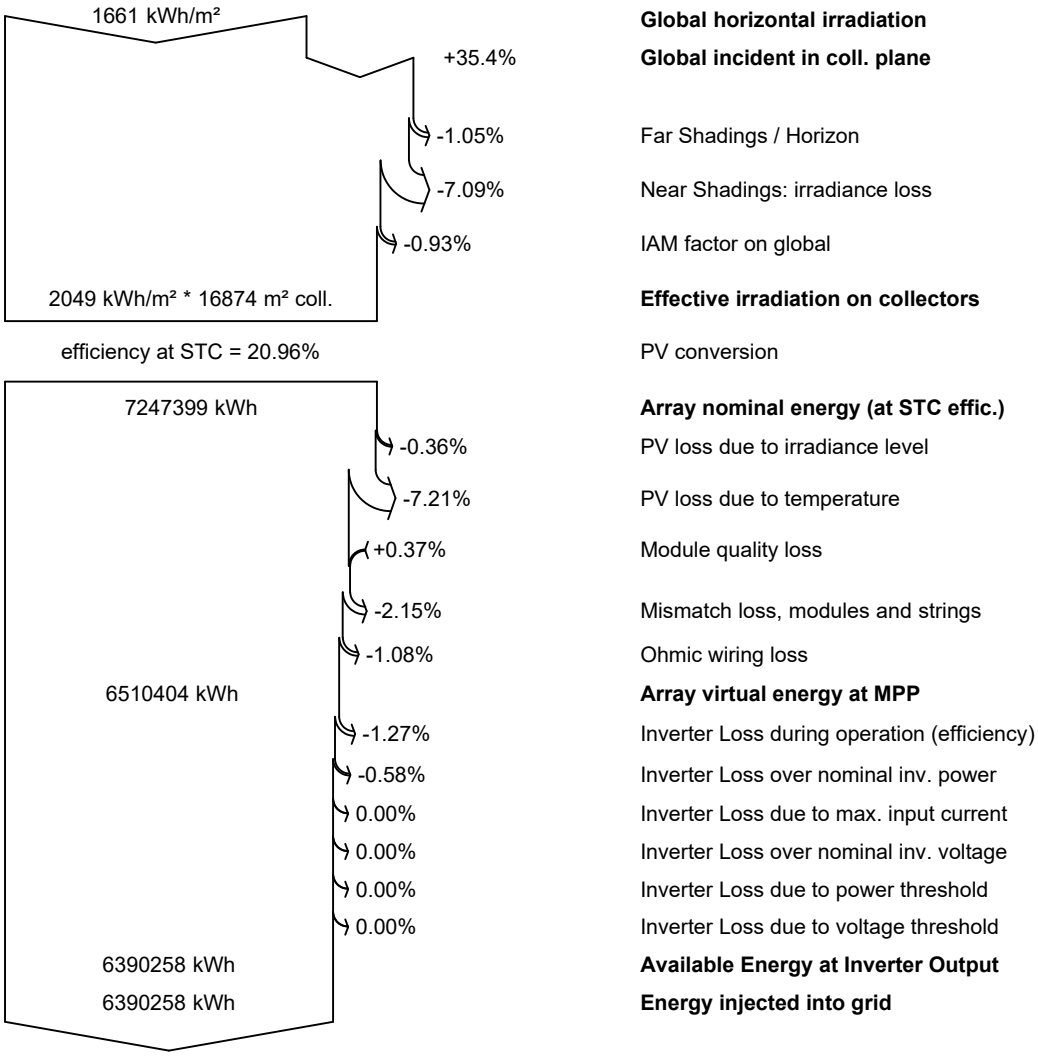
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	67.6	26.45	9.01	97.2	85.1	287291	282495	0.823
February	89.8	39.57	9.10	123.7	110.7	371838	366729	0.840
March	130.8	59.27	11.61	176.8	160.6	529470	522635	0.837
April	155.9	76.96	14.11	201.8	185.1	595961	588520	0.826
May	196.4	80.56	18.22	261.8	241.5	750248	741050	0.802
June	207.5	79.46	22.53	277.8	256.1	777412	768181	0.783
July	221.8	83.61	25.96	298.1	274.7	830233	820705	0.780
August	194.7	74.58	26.33	262.7	242.6	739232	730791	0.788
September	149.6	60.38	22.57	207.9	188.3	589590	582358	0.793
October	113.1	51.11	18.98	153.5	138.1	446360	440465	0.813
November	73.4	28.56	14.25	105.0	92.1	304573	299607	0.808
December	60.7	26.83	10.59	83.6	74.4	251104	246723	0.835
Year	1661.3	687.34	16.99	2249.8	2049.2	6473310	6390258	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

PVsyst V7.4.5
VC2, Simulation date:
22/01/24 10:31
with v7.4.5

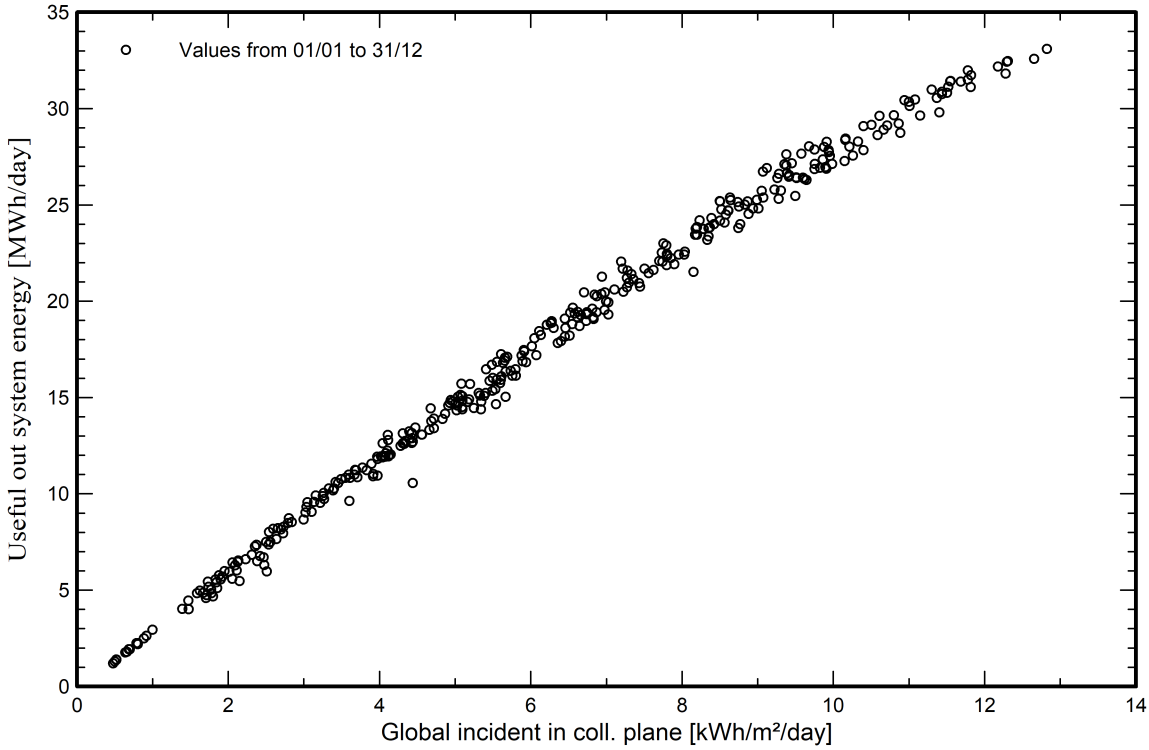
Loss diagram



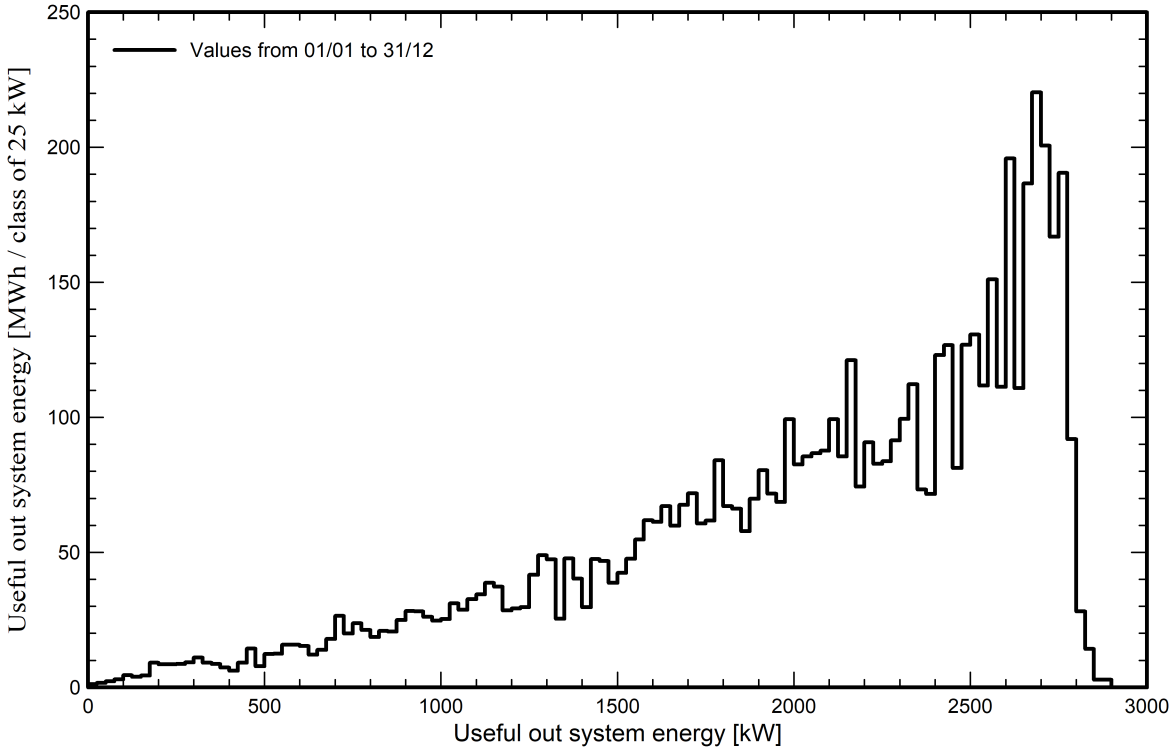
PVsyst V7.4.5
VC2, Simulation date:
22/01/24 10:31
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: D Fissi

Ground system (tables) on a hill

System power: 37.08 MWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC3, Simulation date:
18/01/24 12:39
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System
Ground system (tables) on a hill

PV Field Orientation
Fixed plane
Tilt/Azimuth 30 / 0 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	57040 units
Pnom total	37.08 MWp

Inverters

Nb. of units	95.2 units
Pnom total	28.55 MWac
Pnom ratio	1.299

Results summary

Produced Energy	56649144 kWh/year	Specific production	1528 kWh/kWp/year	Perf. Ratio PR	80.85 %

Table of contents

PVsyst V7.4.5
VC3, Simulation date:
18/01/24 12:39
with v7.4.5

General parameters

Grid-Connected System

Ground system (tables) on a hill

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	30 / 0 °

Sheds configuration	
Nb. of sheds	1515 units
Sizes	
Sheds spacing	13.3 m
Collector width	4.87 m
Ground Cov. Ratio (GCR)	36.6 %

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)	
Unit Nom. Power	650 Wp
Number of PV modules	57040 units
Nominal (STC)	37.08 MWp
Modules	2852 string x 20 In series
At operating cond. (50°C)	
Pmpp	33.97 MWp
U mpp	685 V
I mpp	49569 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H1
(Original PVsyst database)	
Unit Nom. Power	300 kWac
Number of inverters	571 * MPPT 17% 95.2 units
Total power	28550 kWac
Operating voltage	550-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	1.30
No power sharing between MPPTs	

Total PV power

Nominal (STC)	37076 kWp
Total	57040 modules
Module area	177186 m²

Total inverter power

Total power	28550 kWac
Nb. of inverters	96 units
	0.8 unused
Pnom ratio	1.30

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 0.23 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

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

Horizon definition

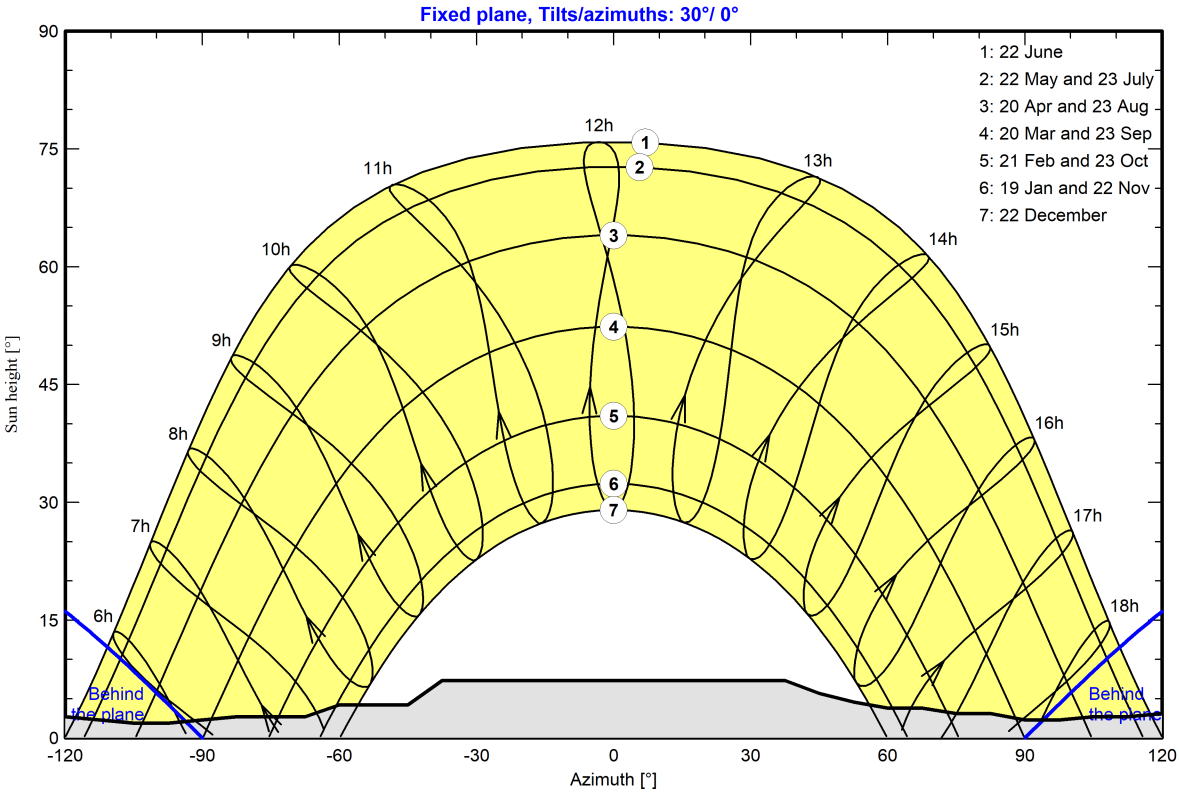
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.67
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

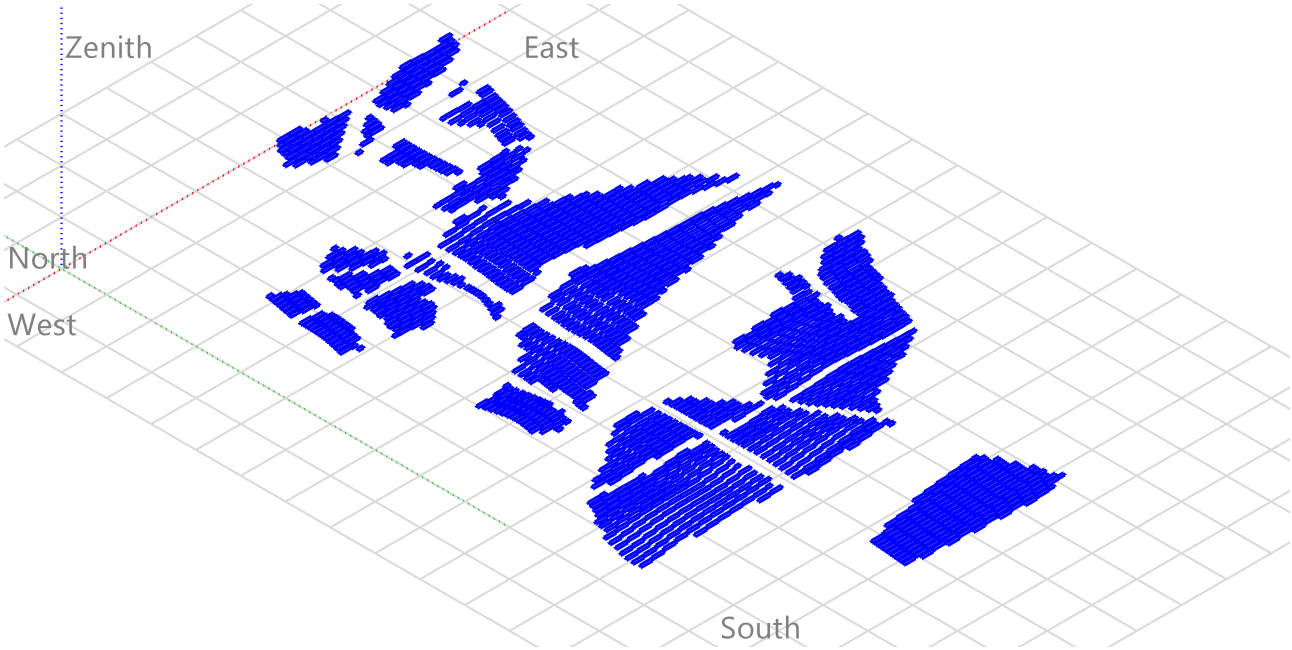
Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
VC3, Simulation date:
18/01/24 12:39
with v7.4.5

Near shadings parameter

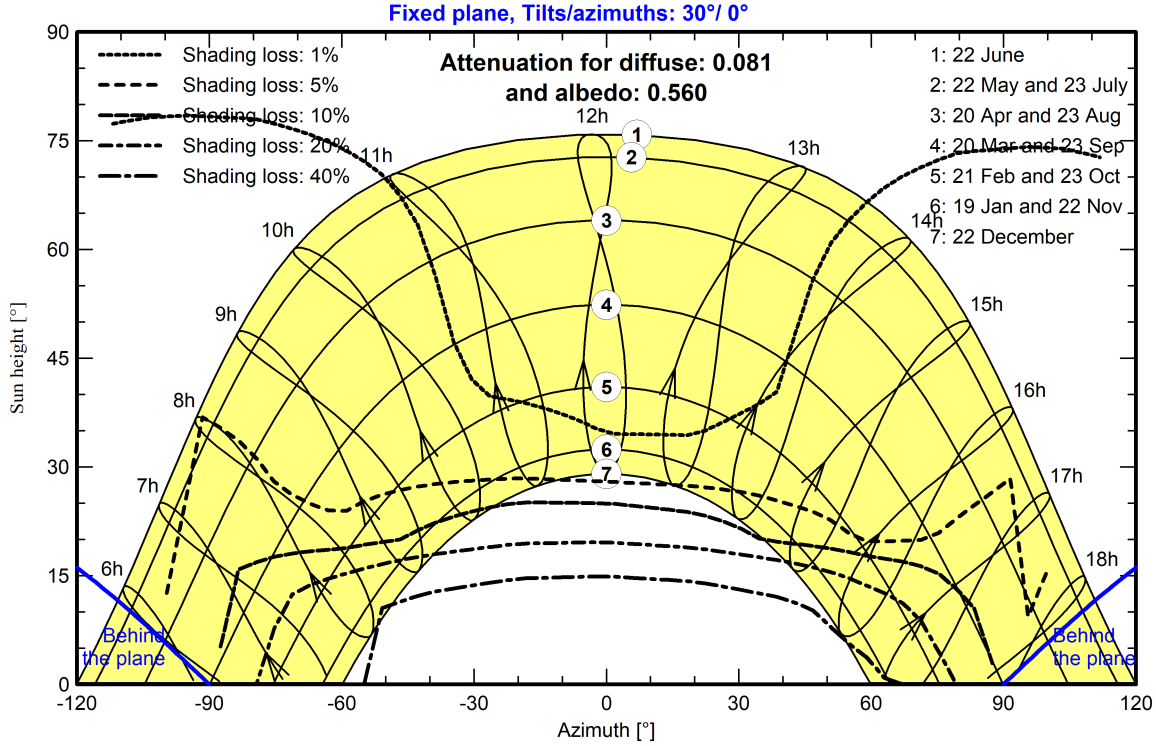
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 30°/ 0°



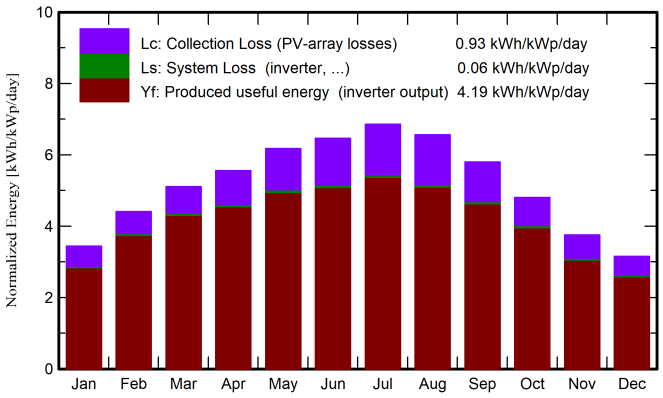
PVsyst V7.4.5
VC3, Simulation date:
18/01/24 12:39
with v7.4.5

Main results

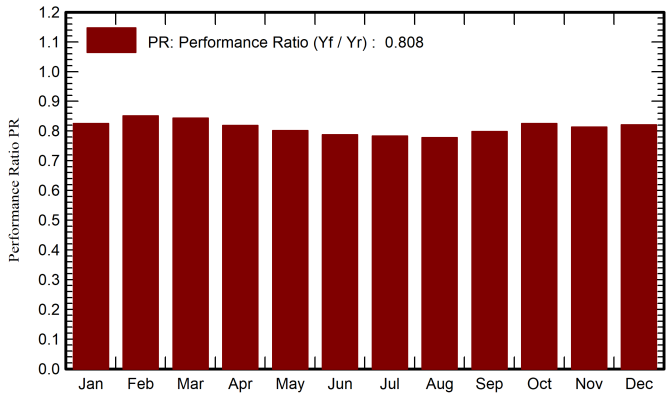
System Production

Produced Energy	56649144 kWh/year	Specific production	1528 kWh/kWp/year
		Perf. Ratio PR	80.85 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

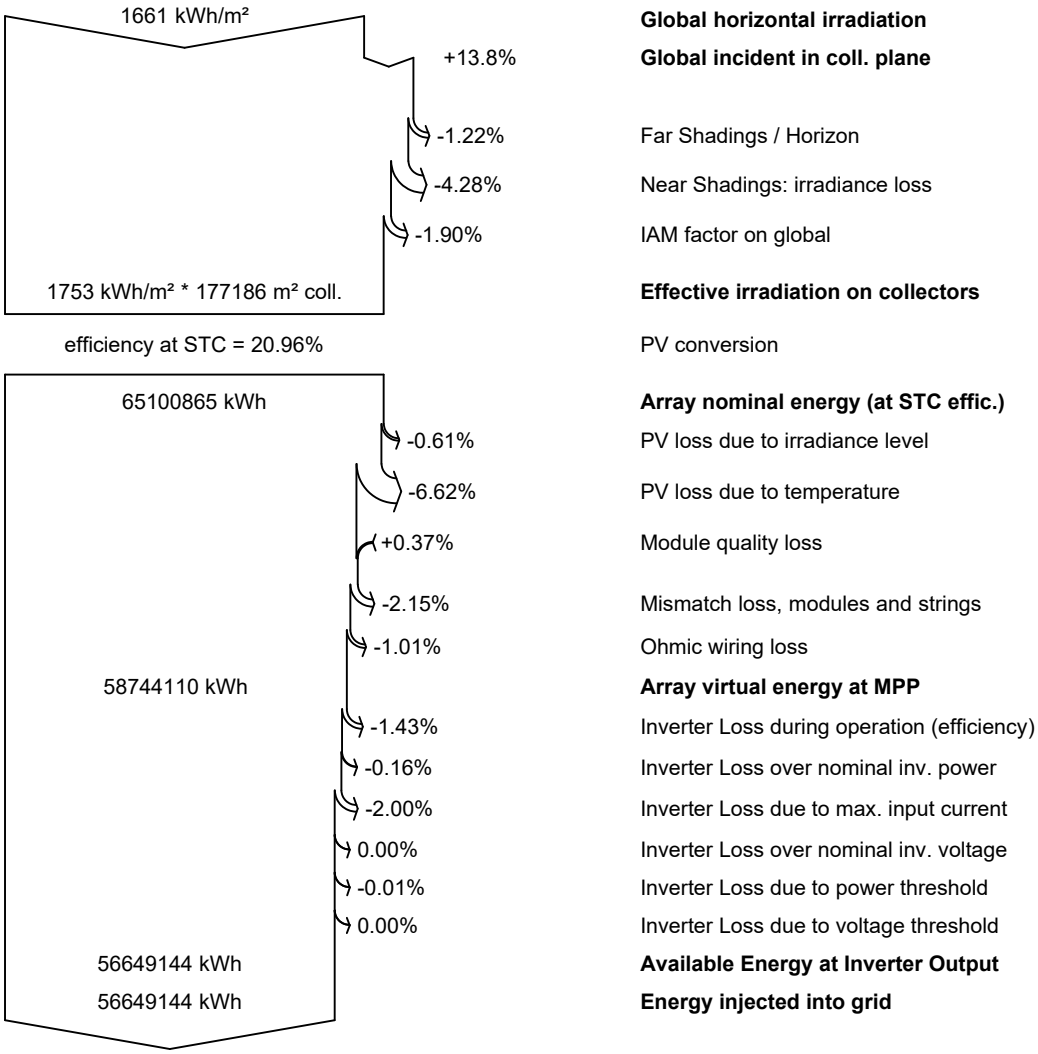
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	67.6	26.45	9.01	106.6	96.0	3317613	3262809	0.825
February	89.8	39.57	9.10	123.4	115.0	3948172	3891699	0.850
March	130.8	59.27	11.61	158.4	148.7	5025738	4954207	0.844
April	155.9	76.96	14.11	166.6	154.8	5134652	5060874	0.819
May	196.4	80.56	18.22	191.4	177.7	5776572	5690451	0.802
June	207.5	79.46	22.53	193.9	180.0	5746949	5662325	0.788
July	221.8	83.61	25.96	212.7	198.3	6268671	6180864	0.784
August	194.7	74.58	26.33	203.5	190.3	5948433	5866750	0.778
September	149.6	60.38	22.57	174.0	163.1	5223972	5151437	0.799
October	113.1	51.11	18.98	148.9	139.5	4620987	4556094	0.825
November	73.4	28.56	14.25	112.7	102.6	3455277	3398573	0.813
December	60.7	26.83	10.59	97.6	86.9	3024180	2973060	0.821
Year	1661.3	687.34	16.99	1889.8	1753.0	57491216	56649144	0.808

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 V7.4.5
VC3, Simulation date:
18/01/24 12:39
with v7.4.5

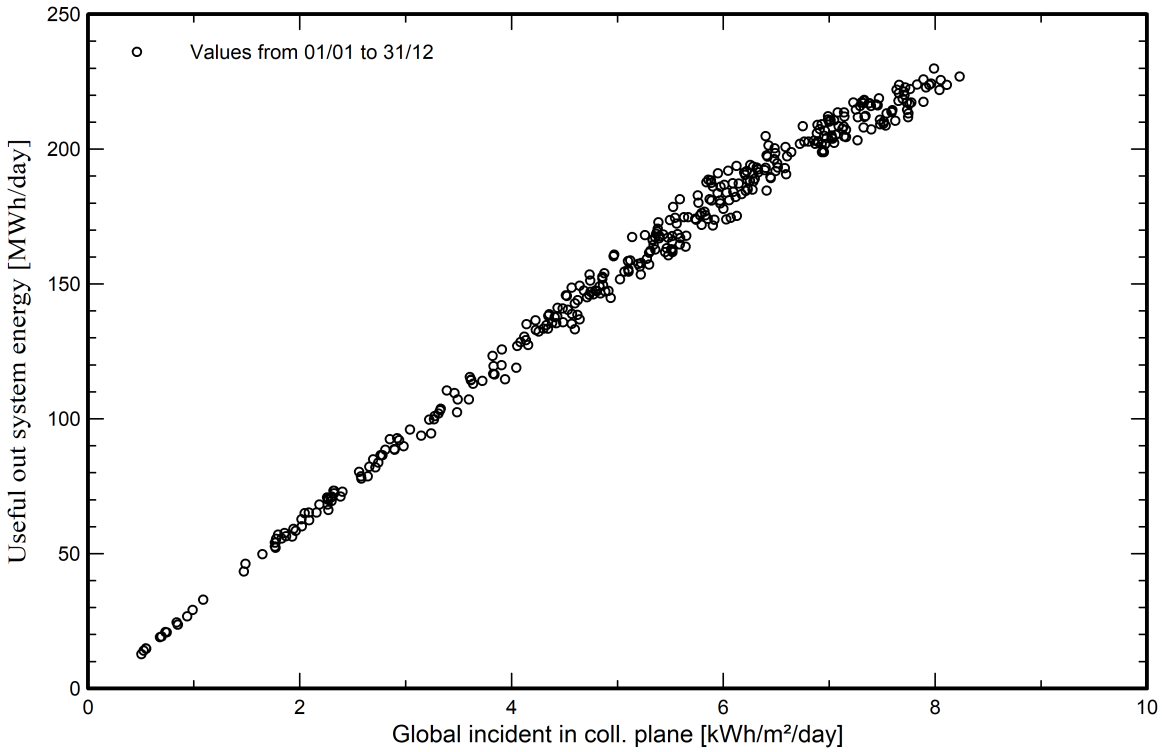
Loss diagram



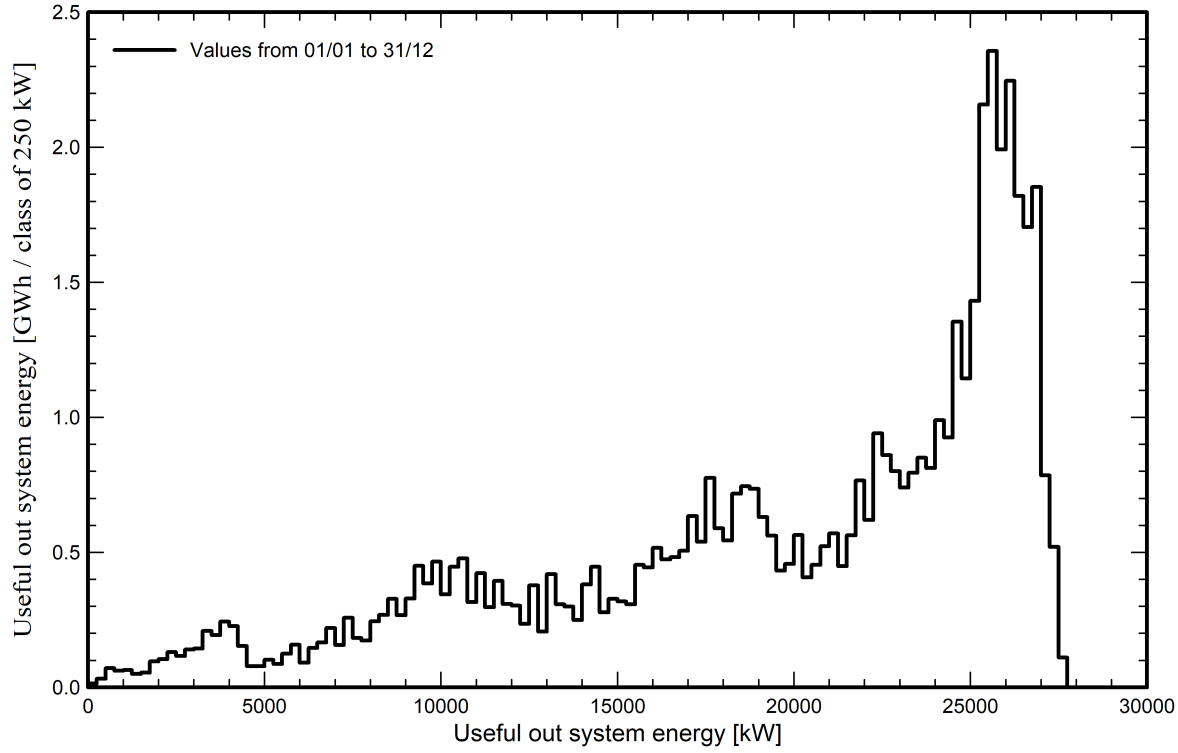
PVsyst V7.4.5
VC3, Simulation date:
18/01/24 12:39
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: D Tracker

Tracking system

System power: 16.60 MWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC4, Simulation date:
22/01/24 10:35
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings
Albedo 0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System

Tracking system

PV Field Orientation
Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

System information

PV Array		Inverters	
Nb. of modules	25536 units	Nb. of units	42.7 units
Pnom total	16.60 MWp	Pnom total	12.80 MWac
		Pnom ratio	1.297

User's needs
Unlimited load (grid)

Results summary

Produced Energy	29661272 kWh/year	Specific production	1787 kWh/kWp/year	Perf. Ratio PR	79.43 %

Table of contents

PVsyst V7.4.5
VC4, Simulation date:
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with v7.4.5

General parameters

Grid-Connected System

Tracking system

PV Field Orientation

Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Trackers configuration
Nb. of trackers 912 units

Sizes
Tracker Spacing 10.5 m
Collector width 4.79 m
Ground Cov. Ratio (GCR) 45.6 %
Phi min / max. -/+ 55.0 °

Shading limit angles
Phi limits for BT -/+ 62.7 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module
Manufacturer Trina Solar
Model TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)
Unit Nom. Power 650 Wp
Number of PV modules 25536 units
Nominal (STC) 16.60 MWp
Modules 912 string x 28 In series
At operating cond. (50°C)
Pmpp 15.21 MWp
U mpp 959 V
I mpp 15851 A

Inverter
Manufacturer Huawei Technologies
Model SUN2000-330KTL-H1
(Original PVsyst database)
Unit Nom. Power 300 kWac
Number of inverters 256 * MPPT 17% 42.7 units
Total power 12800 kWac
Operating voltage 550-1500 V
Max. power (=>30°C) 330 kWac
Pnom ratio (DC:AC) 1.30
No power sharing between MPPTs

Total PV power
Nominal (STC) 16598 kWp
Total 25536 modules
Module area 79324 m²

Total inverter power
Total power 12800 kWac
Nb. of inverters 43 units
0.3 unused
Pnom ratio 1.30

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 0.99 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

PVsyst V7.4.5
VC4, Simulation date:
22/01/24 10:35
with v7.4.5

Array losses

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

PVsyst V7.4.5
VC4, Simulation date:
22/01/24 10:35
with v7.4.5

Horizon definition

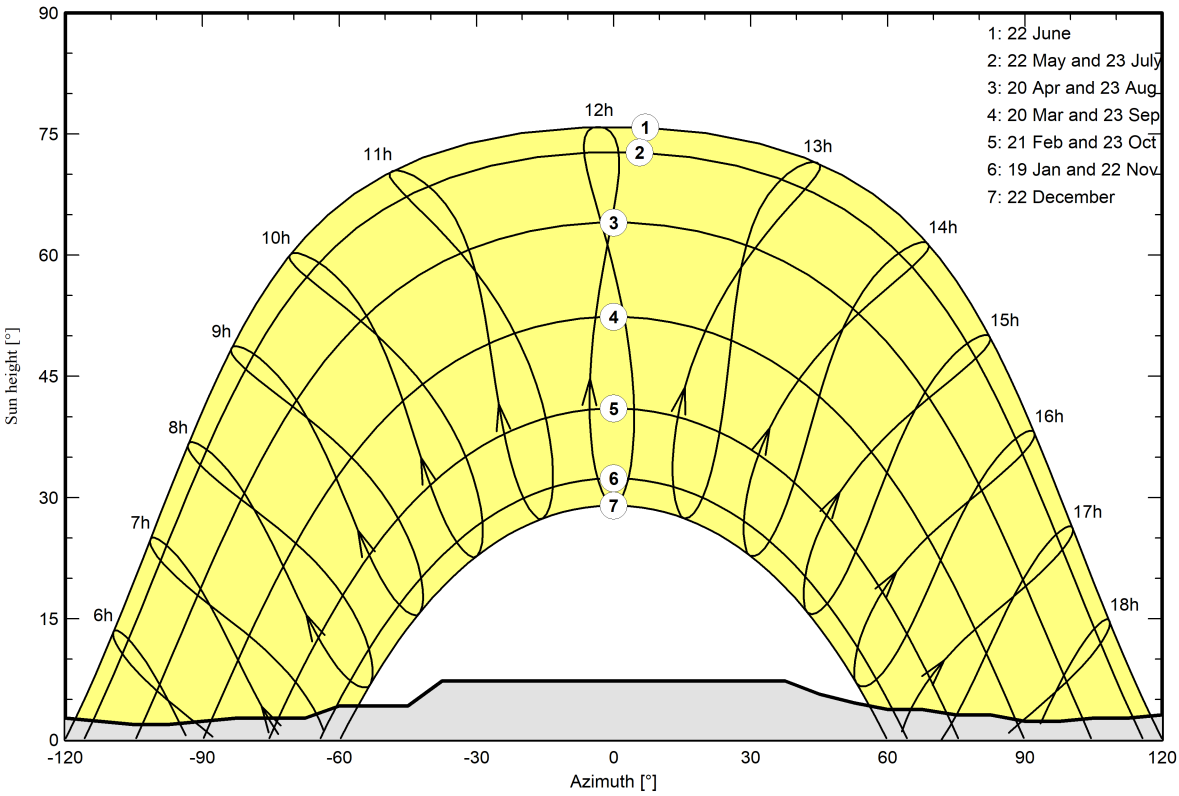
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.83
Diffuse Factor	0.96	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

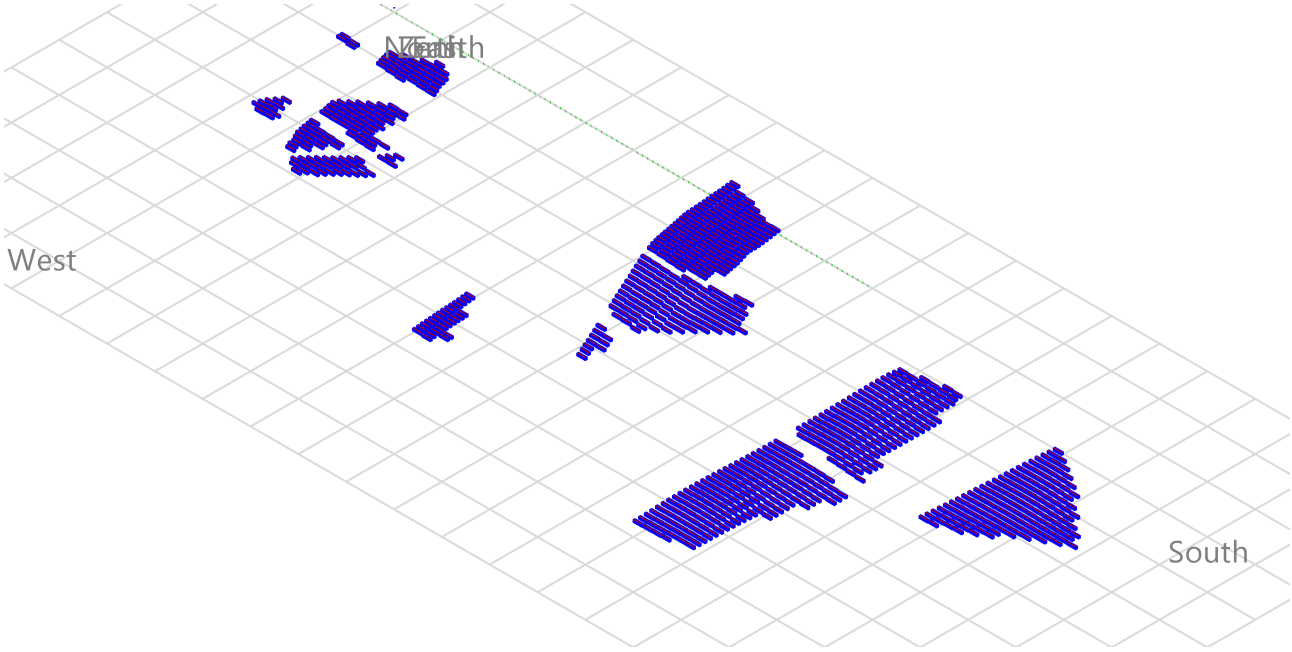
Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
VC4, Simulation date:
22/01/24 10:35
with v7.4.5

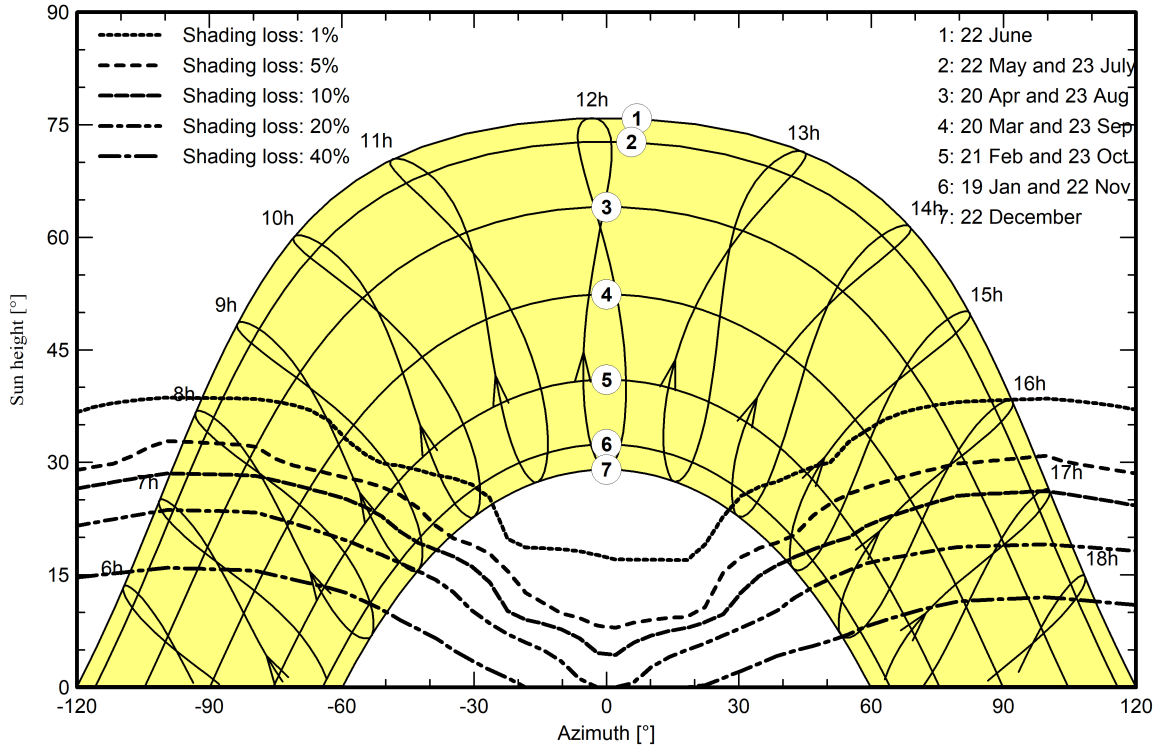
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1



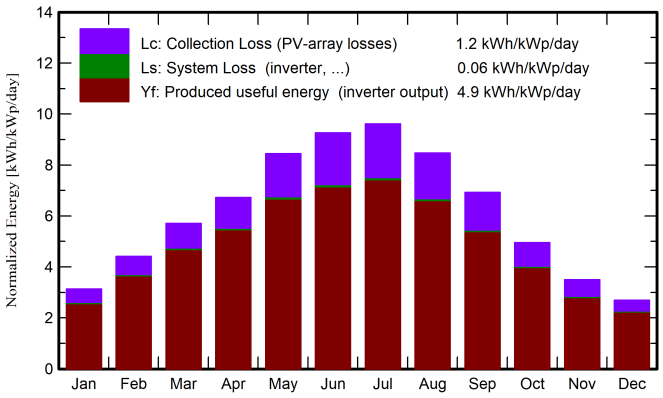
PVsyst V7.4.5
VC4, Simulation date:
22/01/24 10:35
with v7.4.5

Main results

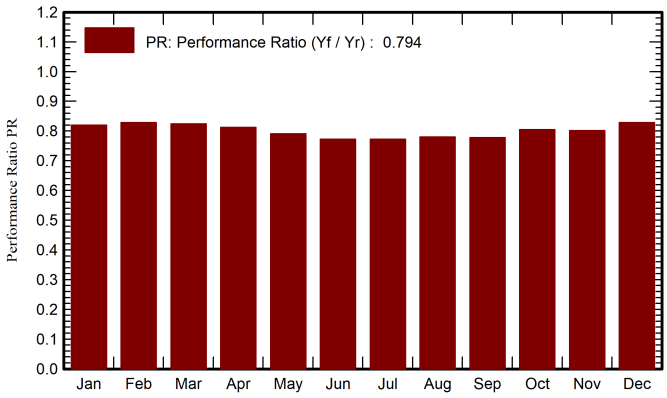
System Production

Produced Energy	29661272 kWh/year	Specific production	1787 kWh/kWp/year
		Perf. Ratio PR	79.43 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

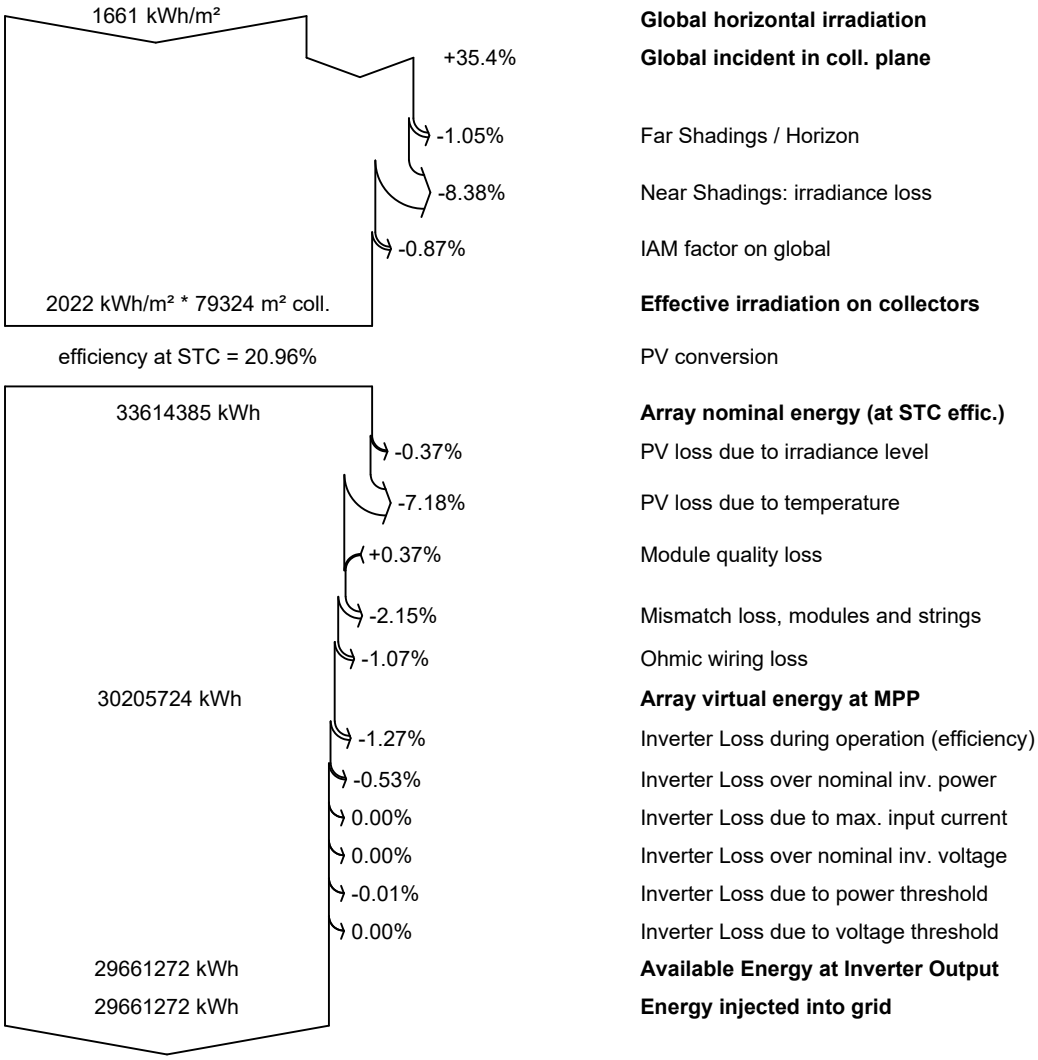
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	67.6	26.45	9.01	97.2	84.8	1344455	1322193	0.820
February	89.8	39.57	9.10	123.7	109.2	1723584	1699909	0.828
March	130.8	59.27	11.61	176.8	158.0	2448531	2416805	0.824
April	155.9	76.96	14.11	201.8	181.9	2756350	2721794	0.812
May	196.4	80.56	18.22	261.8	237.7	3479002	3436399	0.791
June	207.5	79.46	22.53	277.8	252.1	3603533	3560738	0.772
July	221.8	83.61	25.96	298.1	271.7	3864637	3820515	0.772
August	194.7	74.58	26.33	262.7	240.0	3439675	3400454	0.780
September	149.6	60.38	22.57	207.9	184.5	2718520	2685006	0.778
October	113.1	51.11	18.98	153.5	136.7	2077641	2050274	0.805
November	73.4	28.56	14.25	105.0	91.4	1419827	1396724	0.801
December	60.7	26.83	10.59	83.6	73.8	1170758	1150462	0.829
Year	1661.3	687.34	16.99	2249.8	2021.8	30046513	29661272	0.794

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 V7.4.5
VC4, Simulation date:
22/01/24 10:35
with v7.4.5

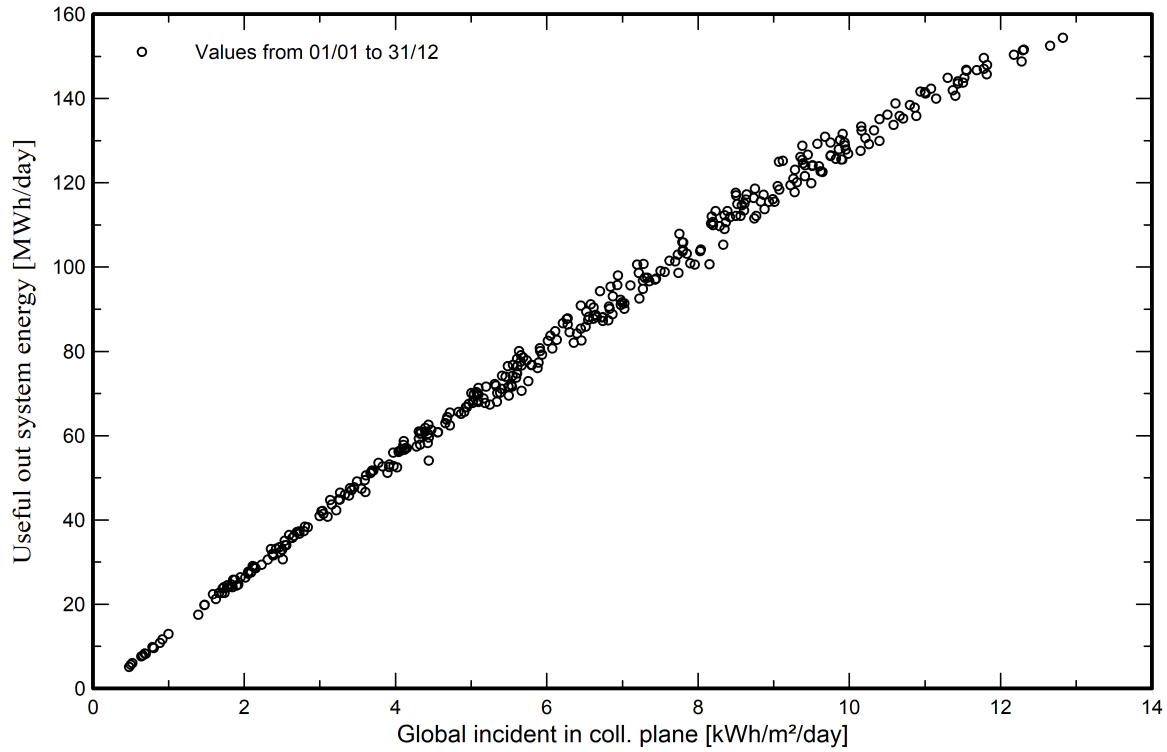
Loss diagram



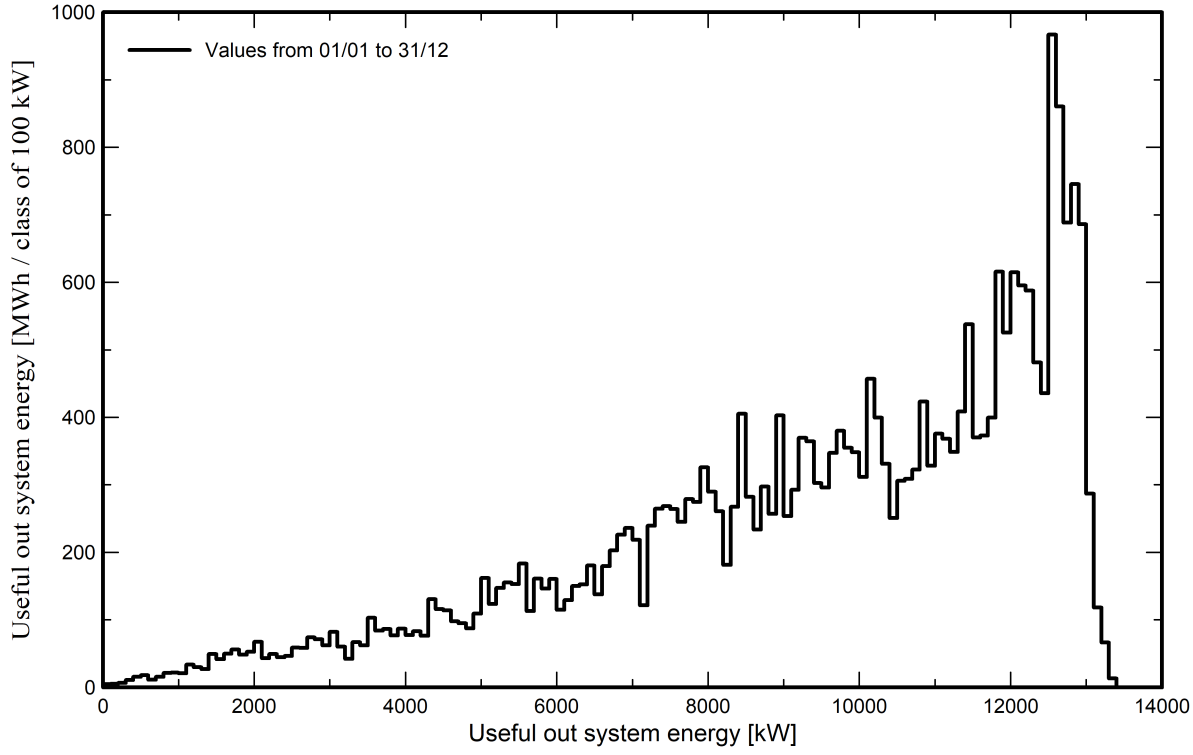
PVsyst V7.4.5
VC4, Simulation date:
22/01/24 10:35
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: E123 Fissi

Ground system (tables) on a hill

System power: 99.98 MWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC5, Simulation date:
18/01/24 12:48
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System
Ground system (tables) on a hill

PV Field Orientation
Fixed plane
Tilt/Azimuth 30 / 0 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	153820 units
Pnom total	99.98 MWp

Inverters

Nb. of units	256.5 units
Pnom total	76.95 MWac
Pnom ratio	1.299

Results summary

Produced Energy	154235300 kWh/year	Specific production	1543 kWh/kWp/year	Perf. Ratio PR	81.63 %

Table of contents

PVsyst V7.4.5
VC5, Simulation date:
18/01/24 12:48
with v7.4.5

General parameters

Grid-Connected System

Ground system (tables) on a hill

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	30 / 0 °

Sheds configuration	
Nb. of sheds	3999 units
Sizes	
Sheds spacing	11.6 m
Collector width	4.87 m
Ground Cov. Ratio (GCR)	42.0 %

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)	
Unit Nom. Power	650 Wp
Number of PV modules	153820 units
Nominal (STC)	99.98 MWp
Modules	7691 string x 20 In series
At operating cond. (50°C)	
Pmpp	91.61 MWp
U mpp	685 V
I mpp	133674 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H1
(Original PVsyst database)	
Unit Nom. Power	300 kWac
Number of inverters	1539 * MPPT 17% 256.5 units
Total power	76950 kWac
Operating voltage	550-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	1.30
No power sharing between MPPTs	

Total PV power

Nominal (STC)	99983 kWp
Total	153820 modules
Module area	477819 m²

Total inverter power

Total power	76950 kWac
Nb. of inverters	257 units
	0.5 unused
Pnom ratio	1.30

Array losses

Thermal Loss factor

Module temperature according to irradiance	
Uc (const)	20.0 W/m²K
Uv (wind)	0.0 W/m²K/m/s

DC wiring losses

Global array res.	0.084 mΩ
Loss Fraction	1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

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

Horizon definition

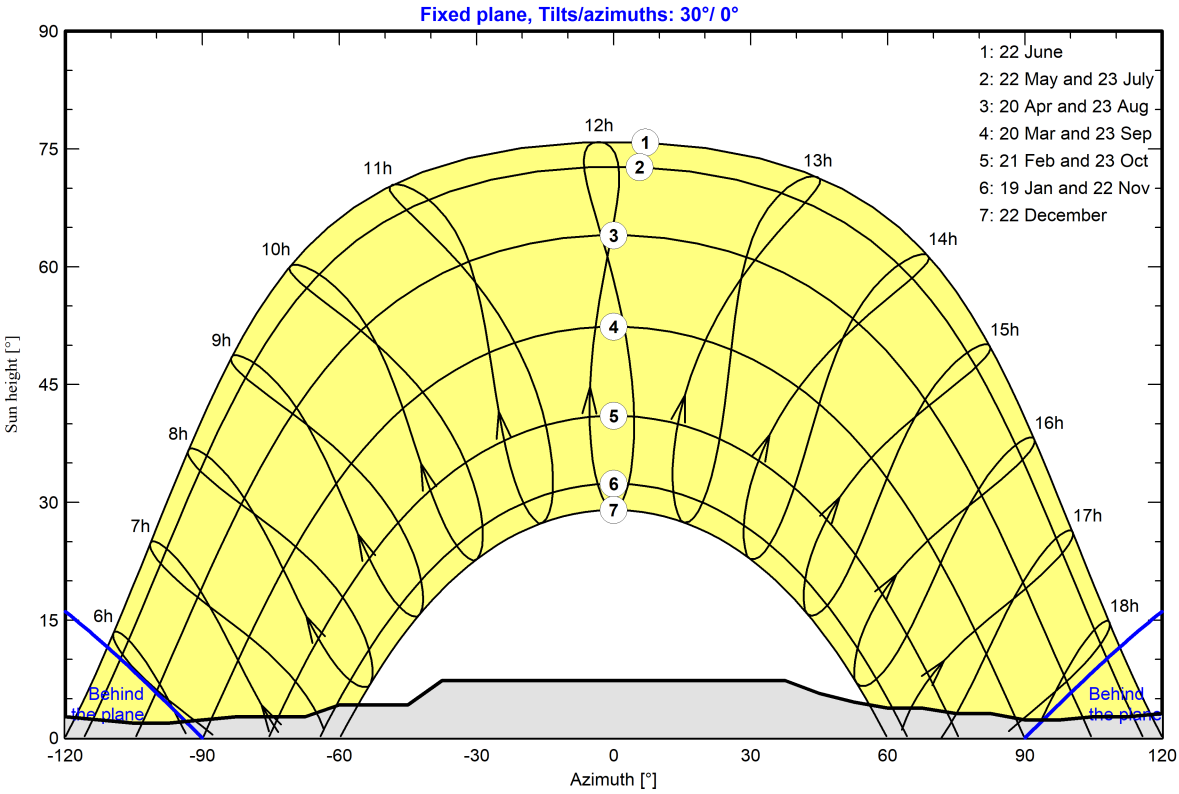
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.67
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

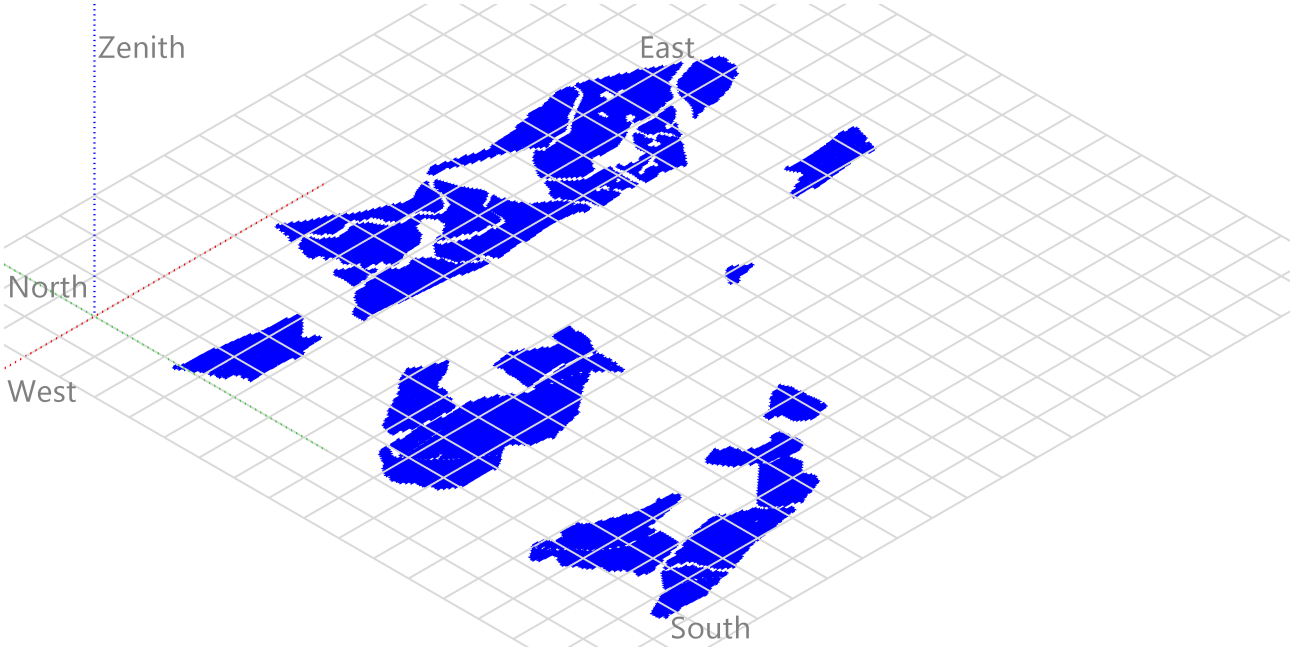
Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
VC5, Simulation date:
18/01/24 12:48
with v7.4.5

Near shadings parameter

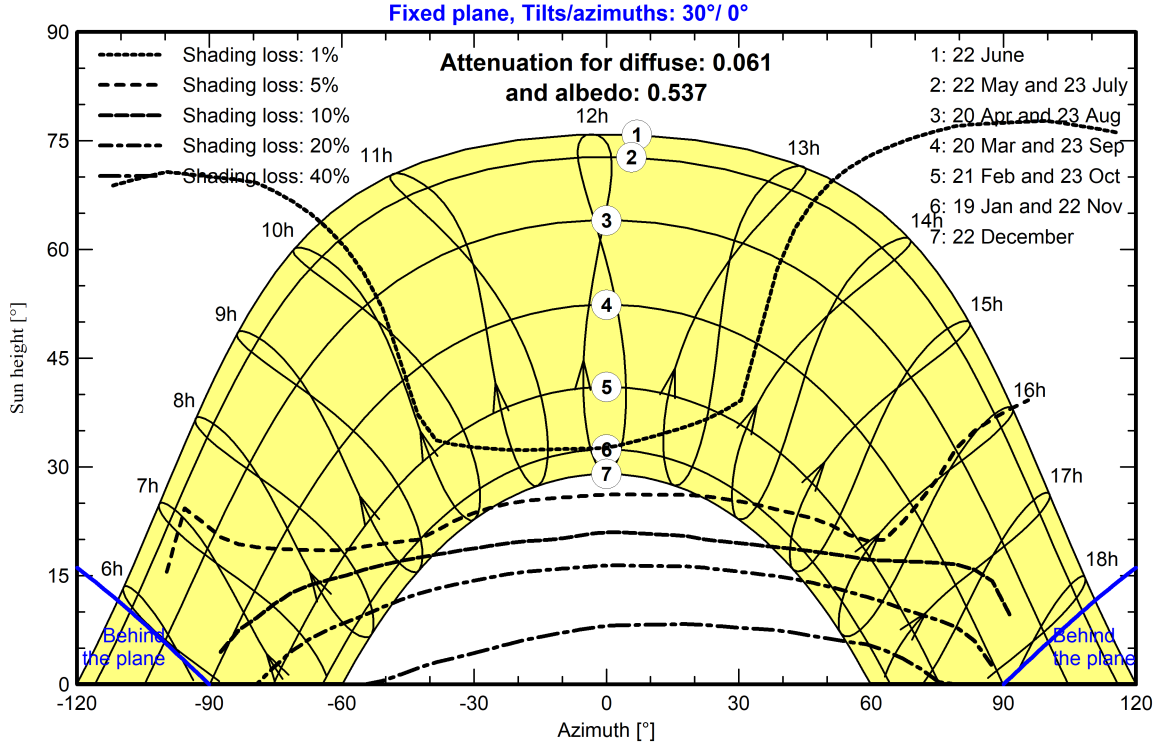
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 30°/ 0°



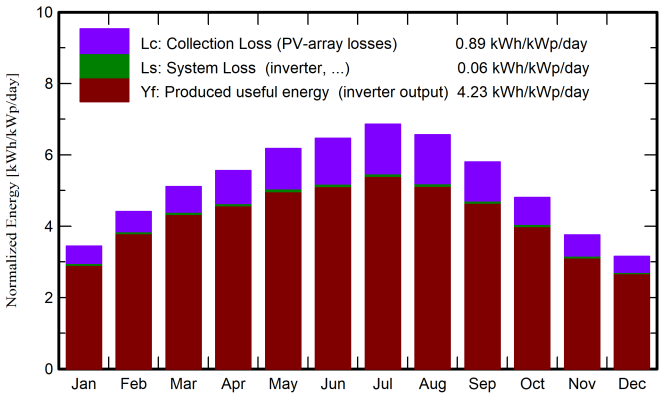
PVsyst V7.4.5
VC5, Simulation date:
18/01/24 12:48
with v7.4.5

Main results

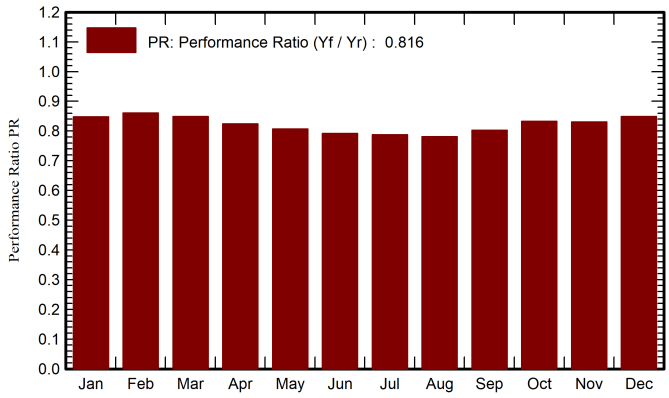
System Production

Produced Energy	154235300 kWh/year	Specific production	1543 kWh/kWp/year
		Perf. Ratio PR	81.63 %

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	67.6	26.45	9.01	106.6	98.6	9184585	9036260	0.847
February	89.8	39.57	9.10	123.4	116.5	10776433	10623868	0.861
March	130.8	59.27	11.61	158.4	149.6	13631051	13437931	0.849
April	155.9	76.96	14.11	166.6	155.8	13926615	13727473	0.824
May	196.4	80.56	18.22	191.4	178.8	15662631	15430005	0.806
June	207.5	79.46	22.53	193.9	181.1	15580058	15351568	0.792
July	221.8	83.61	25.96	212.7	199.4	16980533	16743405	0.787
August	194.7	74.58	26.33	203.5	191.2	16105678	15885159	0.781
September	149.6	60.38	22.57	174.0	164.0	14150539	13954740	0.802
October	113.1	51.11	18.98	148.9	140.8	12574626	12399359	0.833
November	73.4	28.56	14.25	112.7	104.8	9512449	9359141	0.830
December	60.7	26.83	10.59	97.6	89.7	8424794	8286392	0.849
Year	1661.3	687.34	16.99	1889.8	1770.4	156509993	154235300	0.816

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		

PVsyst V7.4.5
VC5, Simulation date:
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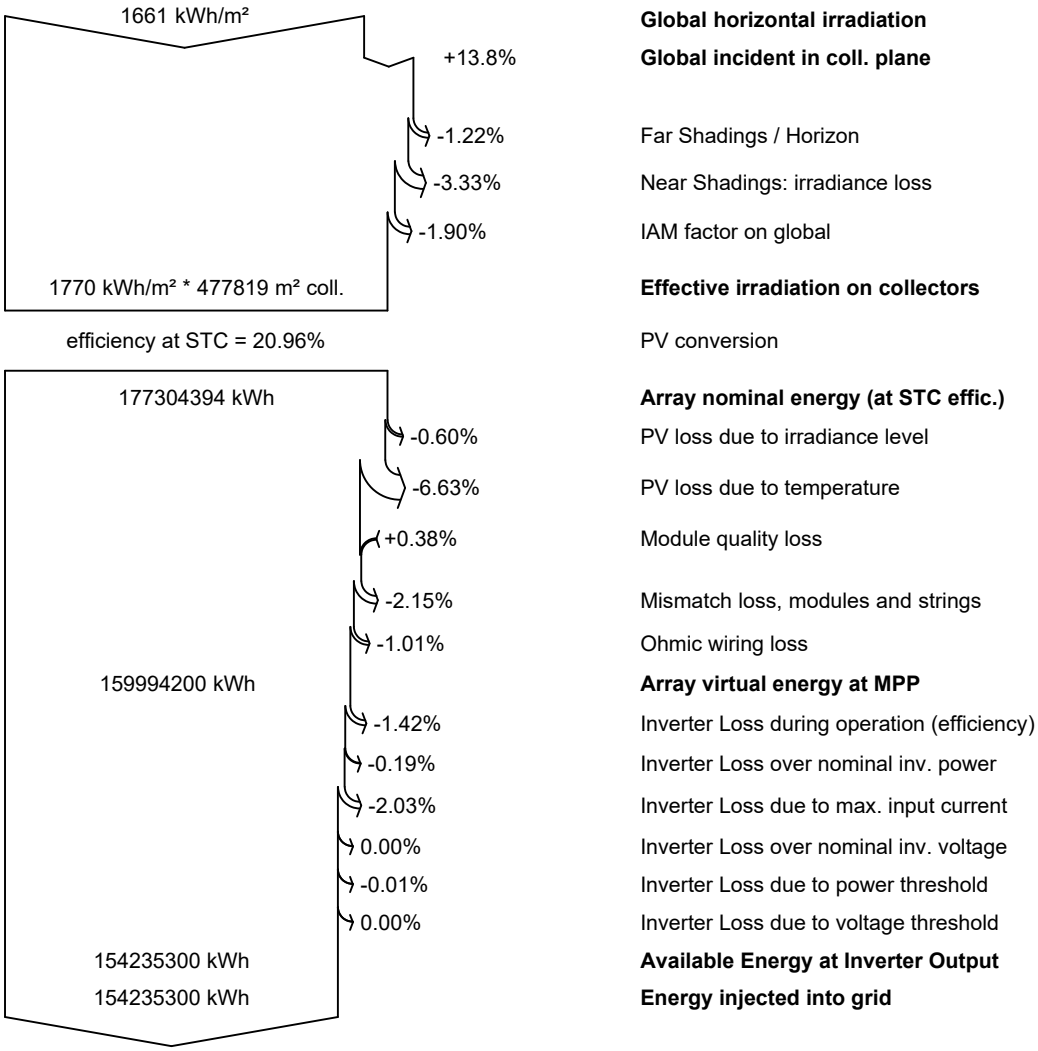
Loss diagram



PVsyst V7.4.5
VC5, Simulation date:
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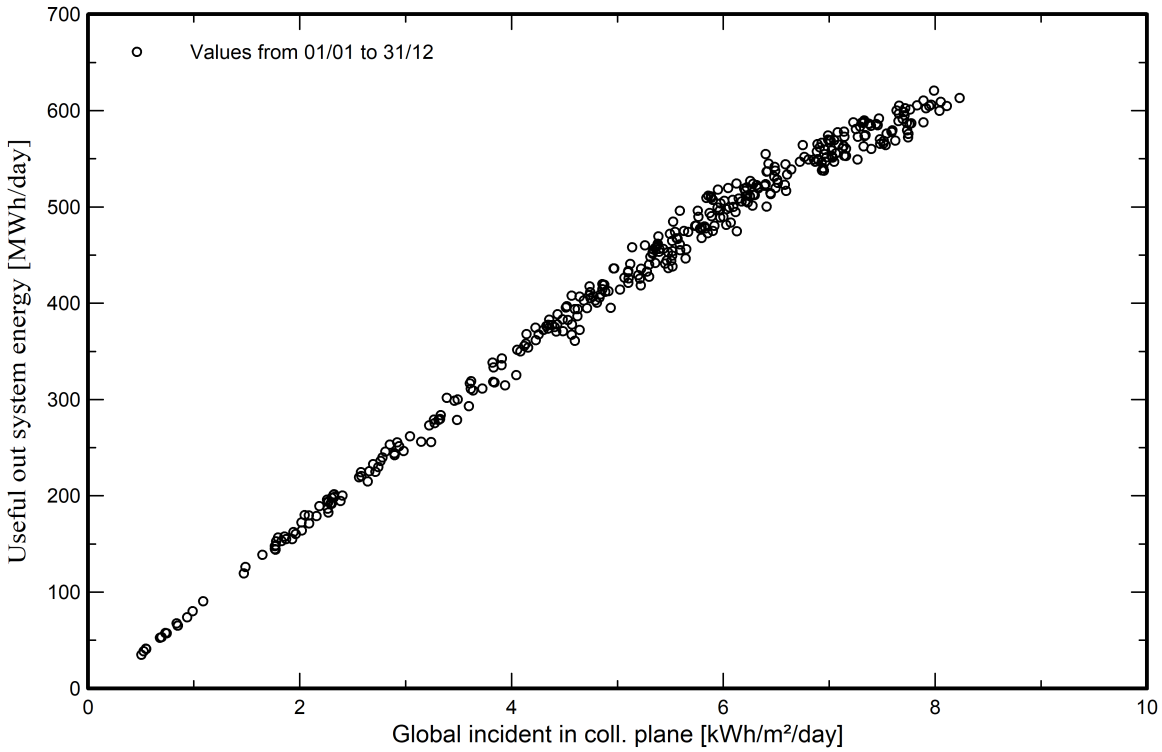
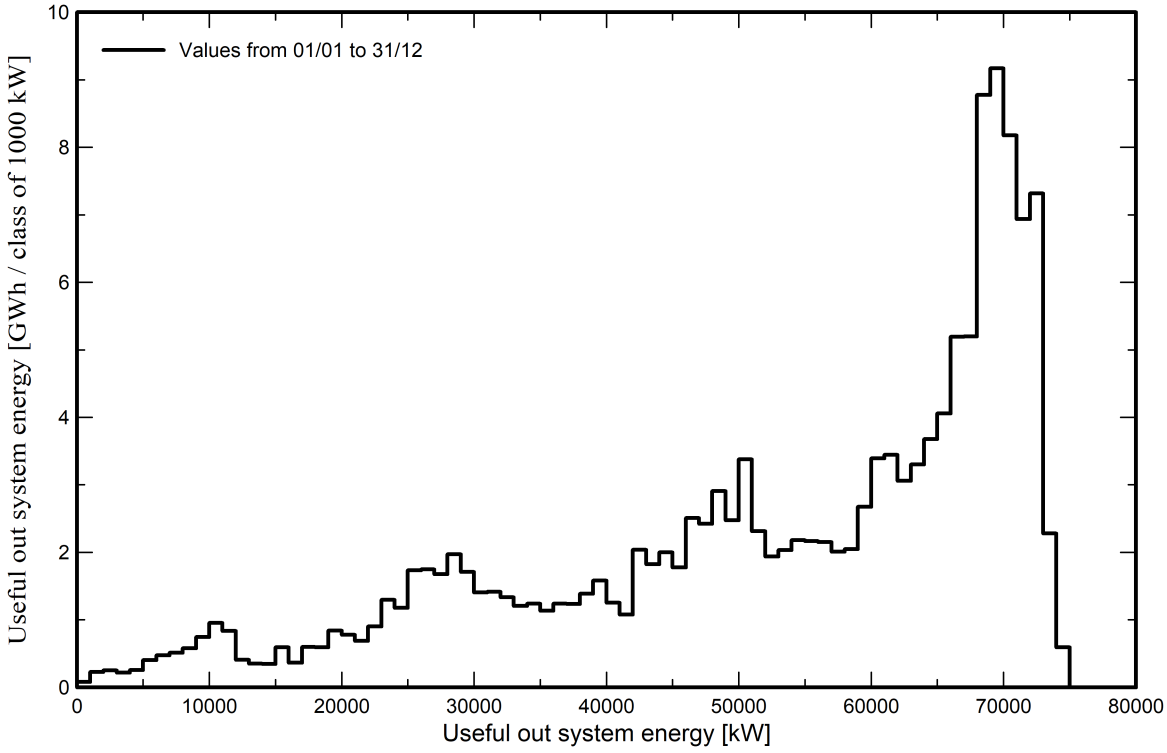
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: E123 Tracker

Tracking system

System power: 23.22 MWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC6, Simulation date:
22/01/24 10:40
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings
Albedo 0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System

Tracking system

PV Field Orientation
Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

System information

PV Array

Nb. of modules	35728 units
Pnom total	23.22 MWp

Inverters

Nb. of units	59.7 units
Pnom total	17.90 MWac
Pnom ratio	1.297

User's needs
Unlimited load (grid)

Results summary

Produced Energy	42348140 kWh/year	Specific production	1824 kWh/kWp/year	Perf. Ratio PR	81.05 %

Table of contents

PVsyst V7.4.5
VC6, Simulation date:
22/01/24 10:40
with v7.4.5

General parameters

Grid-Connected System

Tracking system

PV Field Orientation

Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Trackers configuration
Nb. of trackers 1276 units

Sizes
Tracker Spacing 10.5 m
Collector width 4.79 m
Ground Cov. Ratio (GCR) 45.6 %
Phi min / max. -/+ 55.0 °

Shading limit angles
Phi limits for BT -/+ 62.7 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module
Manufacturer Trina Solar
Model TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)
Unit Nom. Power 650 Wp
Number of PV modules 35728 units
Nominal (STC) 23.22 MWp
Modules 1276 string x 28 In series
At operating cond. (50°C)
Pmpp 21.28 MWp
U mpp 959 V
I mpp 22178 A

Inverter
Manufacturer Huawei Technologies
Model SUN2000-330KTL-H1
(Original PVsyst database)
Unit Nom. Power 300 kWac
Number of inverters 358 * MPPT 17% 59.7 units
Total power 17900 kWac
Operating voltage 550-1500 V
Max. power (=>30°C) 330 kWac
Pnom ratio (DC:AC) 1.30
No power sharing between MPPTs

Total PV power
Nominal (STC) 23223 kWp
Total 35728 modules
Module area 110984 m²

Total inverter power
Total power 17900 kWac
Nb. of inverters 60 units
0.3 unused
Pnom ratio 1.30

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 0.71 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

PVsyst V7.4.5
VC6, Simulation date:
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with v7.4.5

Array losses

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

Horizon definition

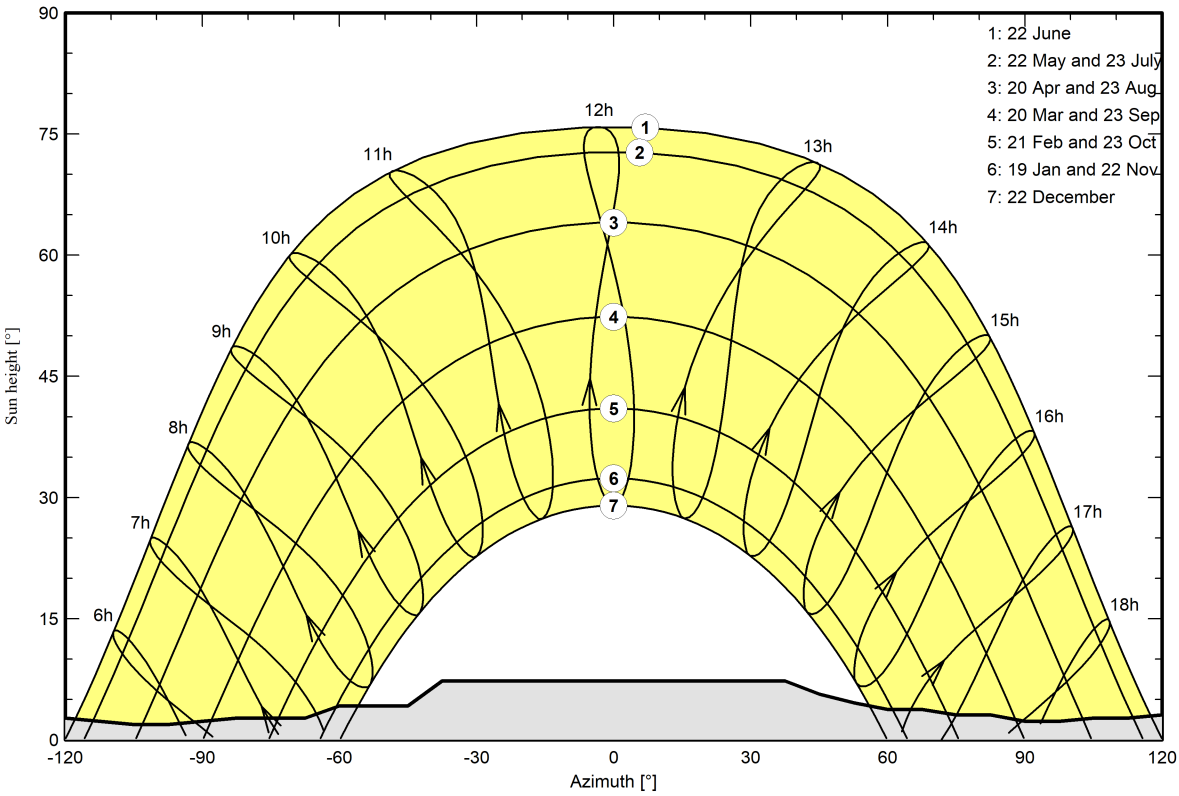
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.83
Diffuse Factor	0.96	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

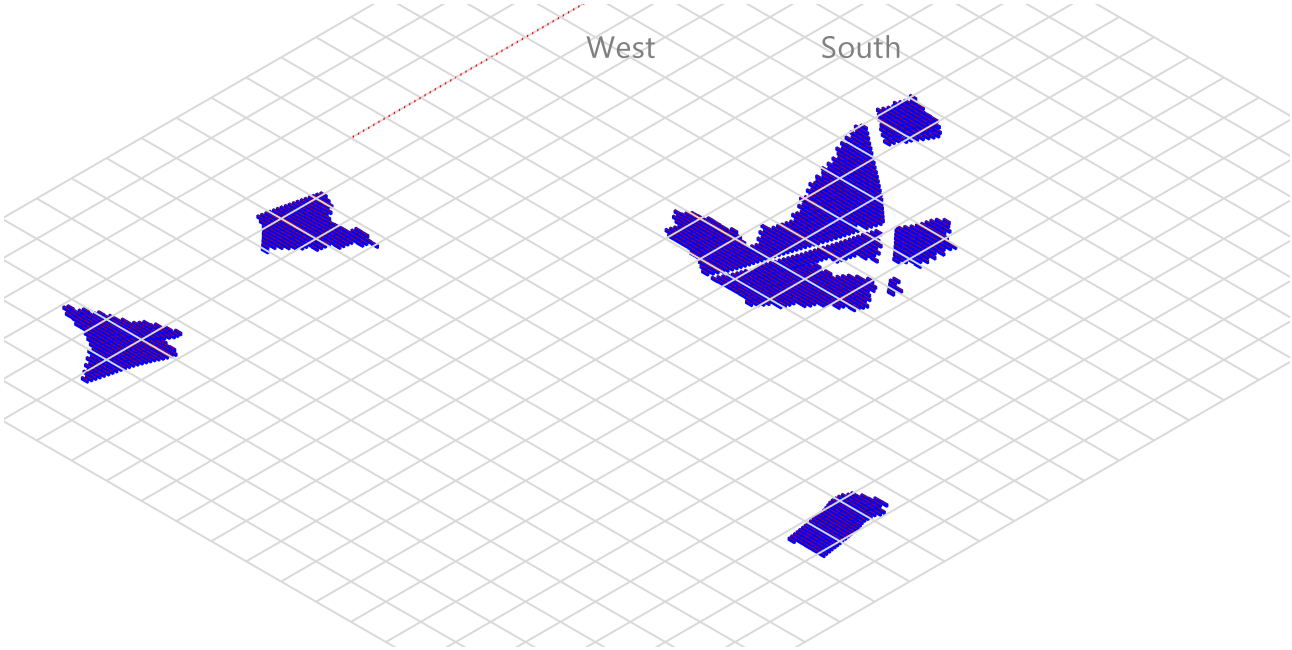
Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
VC6, Simulation date:
22/01/24 10:40
with v7.4.5

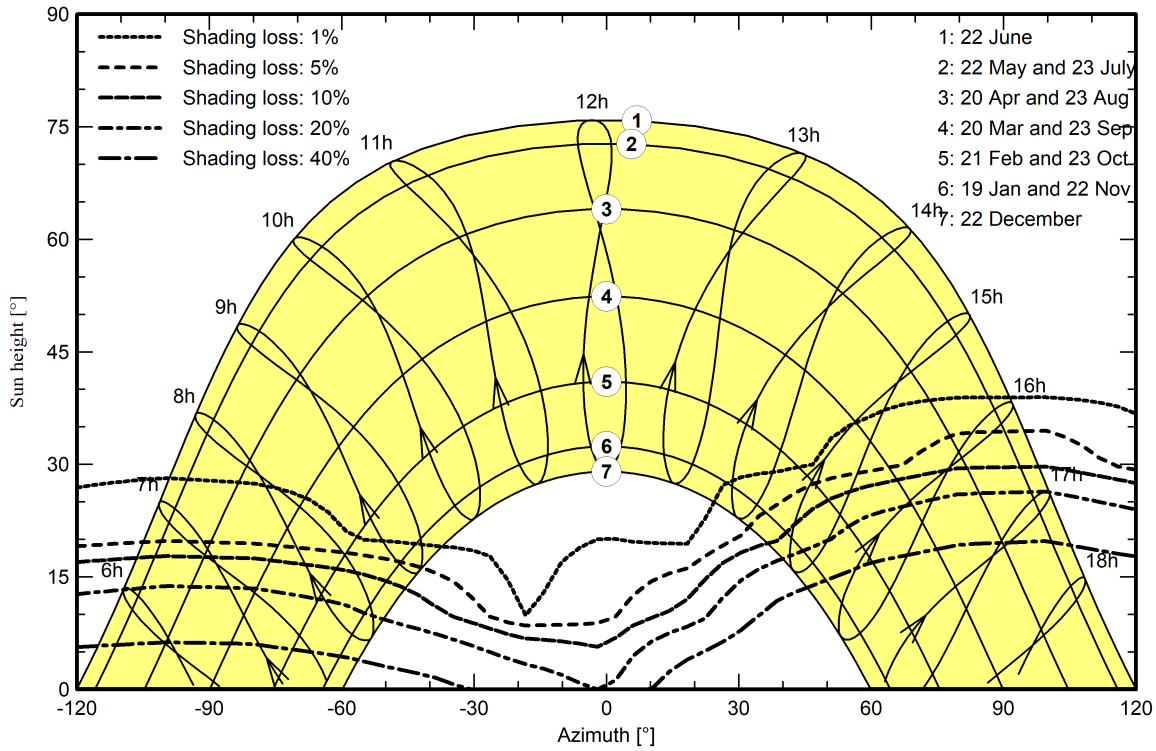
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1



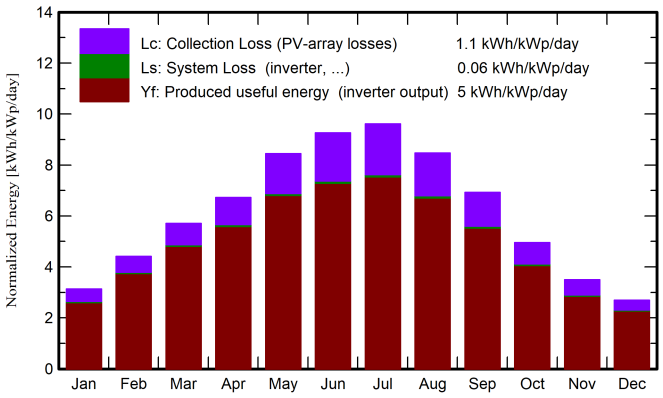
PVsyst V7.4.5
VC6, Simulation date:
22/01/24 10:40
with v7.4.5

Main results

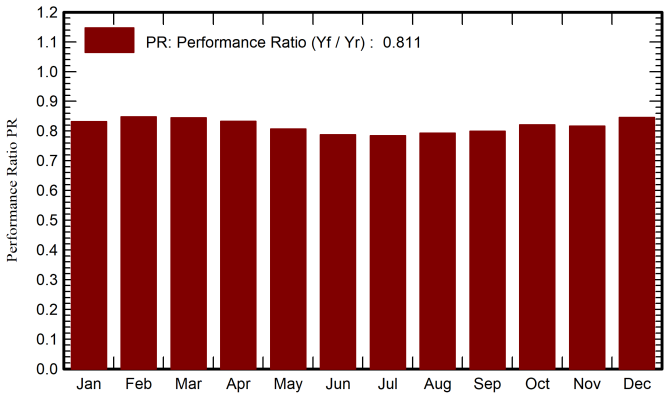
System Production

Produced Energy	42348140 kWh/year	Specific production	1824 kWh/kWp/year
		Perf. Ratio PR	81.05 %

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	67.6	26.45	9.01	97.2	86.0	1908707	1877331	0.832
February	89.8	39.57	9.10	123.7	111.8	2469706	2436196	0.848
March	130.8	59.27	11.61	176.8	162.1	3512055	3467144	0.845
April	155.9	76.96	14.11	201.8	186.7	3951304	3902468	0.833
May	196.4	80.56	18.22	261.8	243.1	4962674	4902296	0.806
June	207.5	79.46	22.53	277.8	257.9	5141839	5081289	0.788
July	221.8	83.61	25.96	298.1	276.5	5490673	5428087	0.784
August	194.7	74.58	26.33	262.7	244.3	4891652	4836076	0.793
September	149.6	60.38	22.57	207.9	189.7	3904734	3857236	0.799
October	113.1	51.11	18.98	153.5	139.6	2965802	2927171	0.821
November	73.4	28.56	14.25	105.0	93.1	2023616	1991045	0.816
December	60.7	26.83	10.59	83.6	75.3	1670380	1641801	0.845
Year	1661.3	687.34	16.99	2249.8	2066.1	42893143	42348140	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

PVsyst V7.4.5
VC6, Simulation date:
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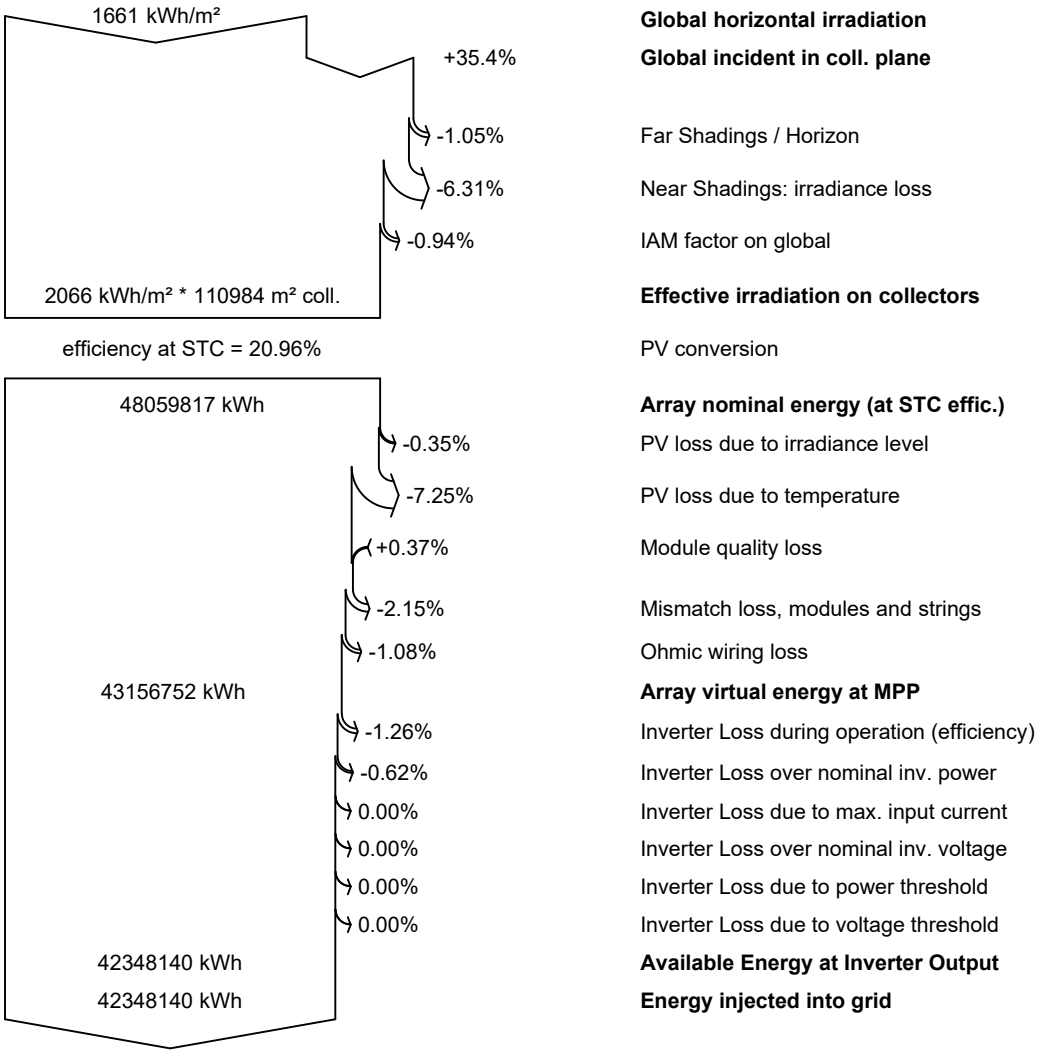
with v7.4.5

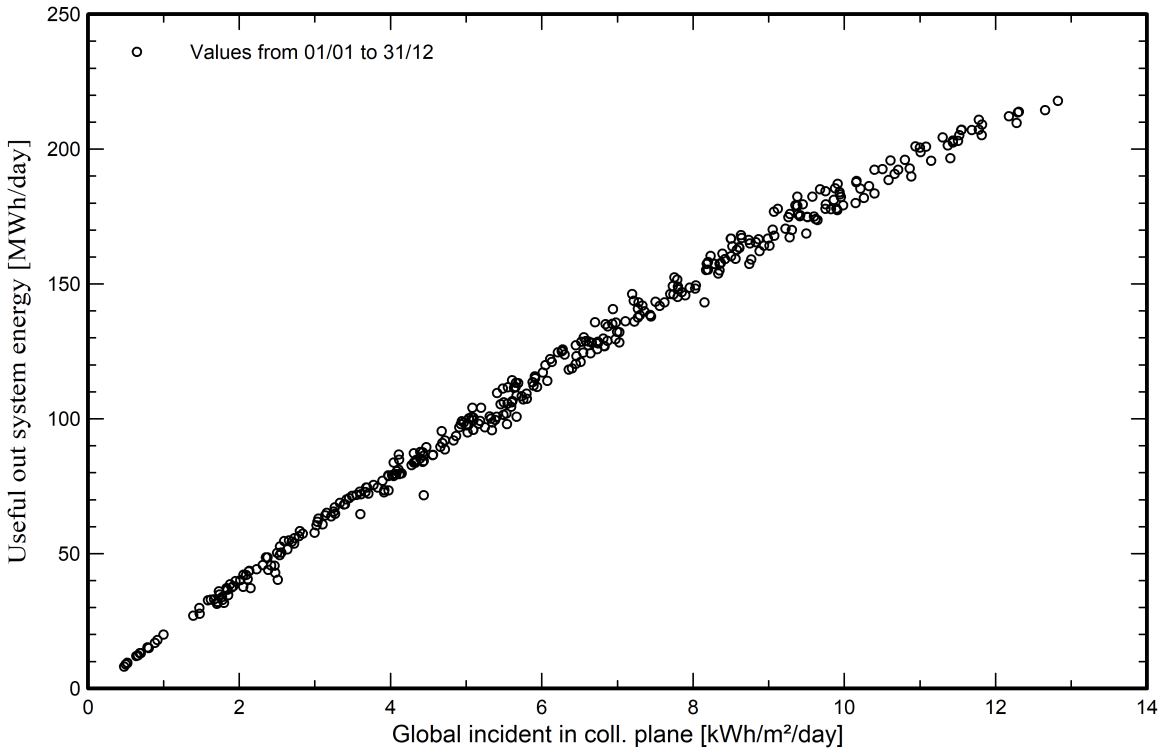
Loss diagram



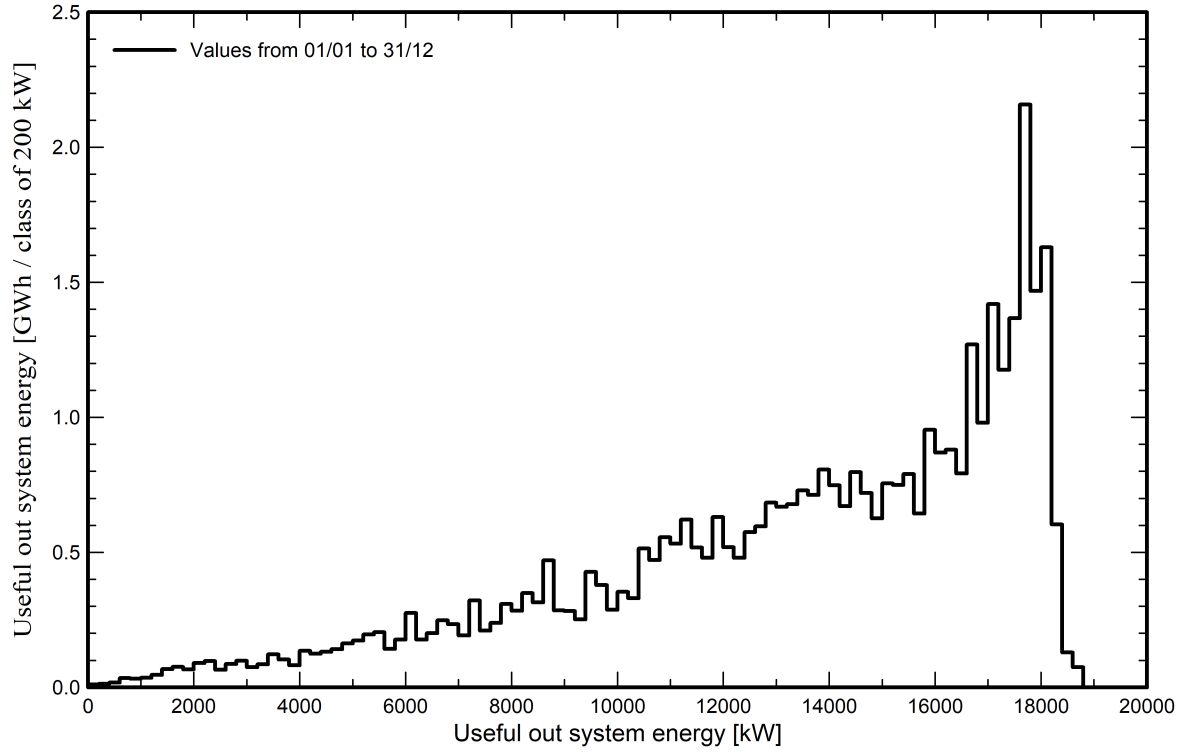
PVsyst V7.4.5
VC6, Simulation date:
22/01/24 10:40
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: F Fissi

Ground system (tables) on a hill

System power: 27.42 MWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC7, Simulation date:
18/01/24 13:06
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System
Ground system (tables) on a hill

PV Field Orientation
Fixed plane
Tilt/Azimuth 30 / 0 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	42180 units
Pnom total	27.42 MWp

Inverters

Nb. of units	70.3 units
Pnom total	21.10 MWac
Pnom ratio	1.299

Results summary

Produced Energy	42404377 kWh/year	Specific production	1547 kWh/kWp/year	Perf. Ratio PR	81.84 %

Table of contents

PVsyst V7.4.5
VC7, Simulation date:
18/01/24 13:06
with v7.4.5

General parameters

Grid-Connected System

Ground system (tables) on a hill

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	30 / 0 °

Sheds configuration	
Nb. of sheds	1104 units
Sizes	
Sheds spacing	11.3 m
Collector width	4.87 m
Ground Cov. Ratio (GCR)	43.0 %

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)	
Unit Nom. Power	650 Wp
Number of PV modules	42180 units
Nominal (STC)	27.42 MWp
Modules	2109 string x 20 In series
At operating cond. (50°C)	
Pmpp	25.12 MWp
U mpp	685 V
I mpp	36656 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H1
(Original PVsyst database)	
Unit Nom. Power	300 kWac
Number of inverters	422 * MPPT 17% 70.3 units
Total power	21100 kWac
Operating voltage	550-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	1.30
No power sharing between MPPTs	

Total PV power

Nominal (STC)	27417 kWp
Total	42180 modules
Module area	131026 m²

Total inverter power

Total power	21100 kWac
Nb. of inverters	71 units
	0.7 unused
Pnom ratio	1.30

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 0.31 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

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

PVsyst V7.4.5
VC7, Simulation date:
18/01/24 13:06
with v7.4.5

Horizon definition

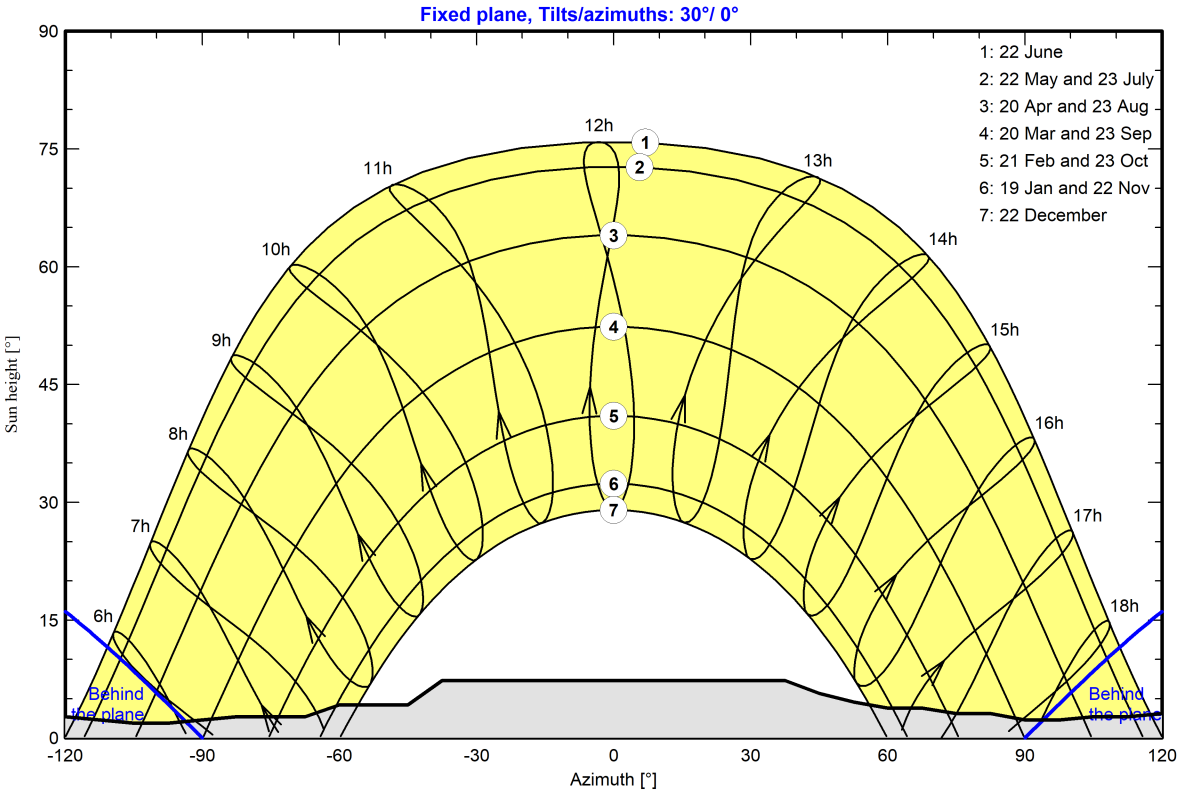
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.67
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

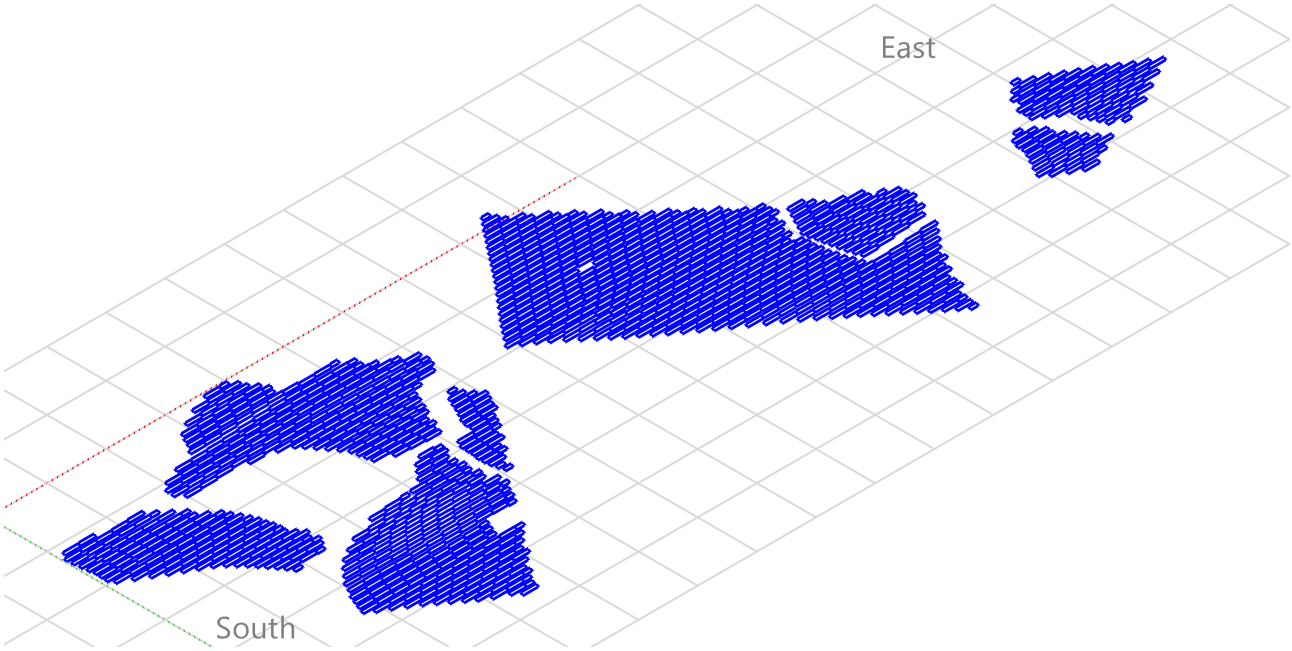
Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
VC7, Simulation date:
18/01/24 13:06
with v7.4.5

Near shadings parameter

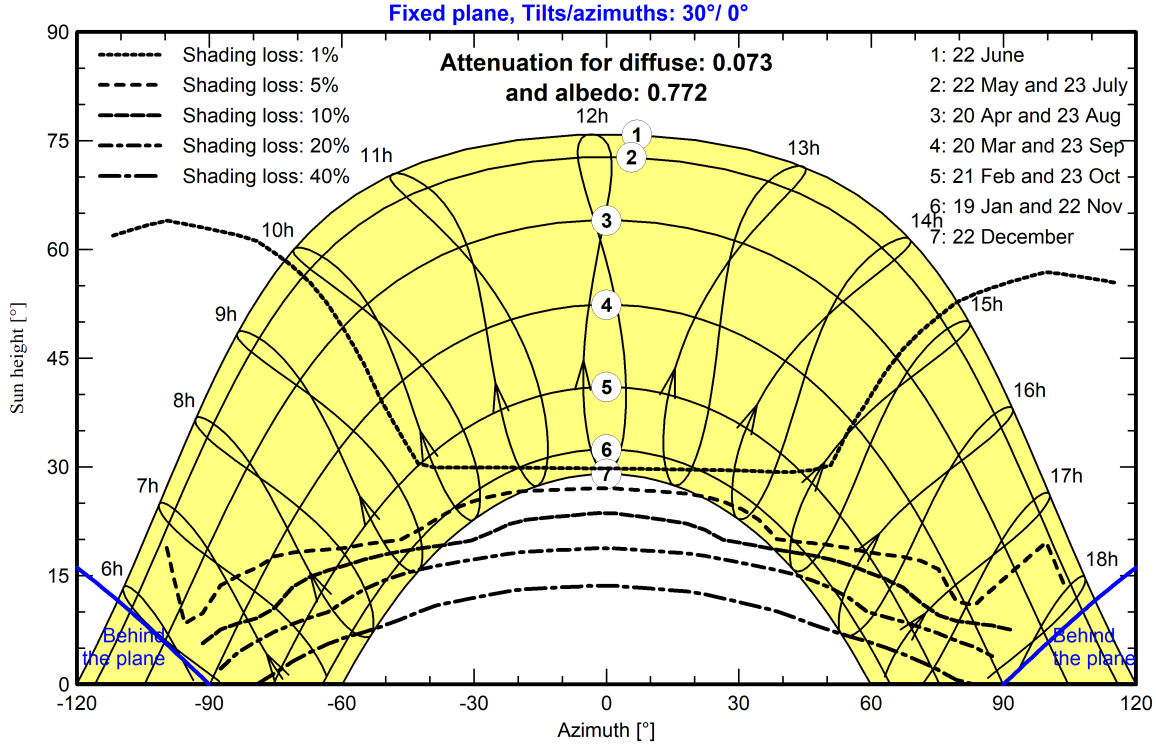
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 30°/ 0°



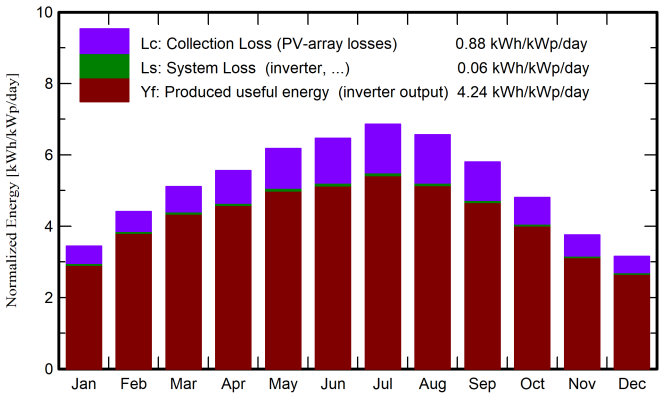
PVsyst V7.4.5
VC7, Simulation date:
18/01/24 13:06
with v7.4.5

Main results

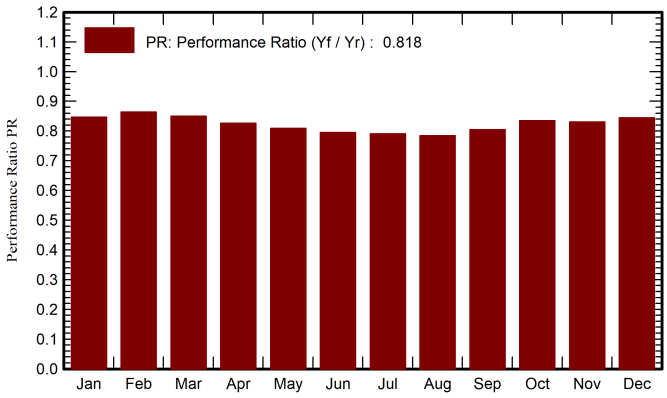
System Production

Produced Energy	42404377 kWh/year	Specific production	1547 kWh/kWp/year
		Perf. Ratio PR	81.84 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

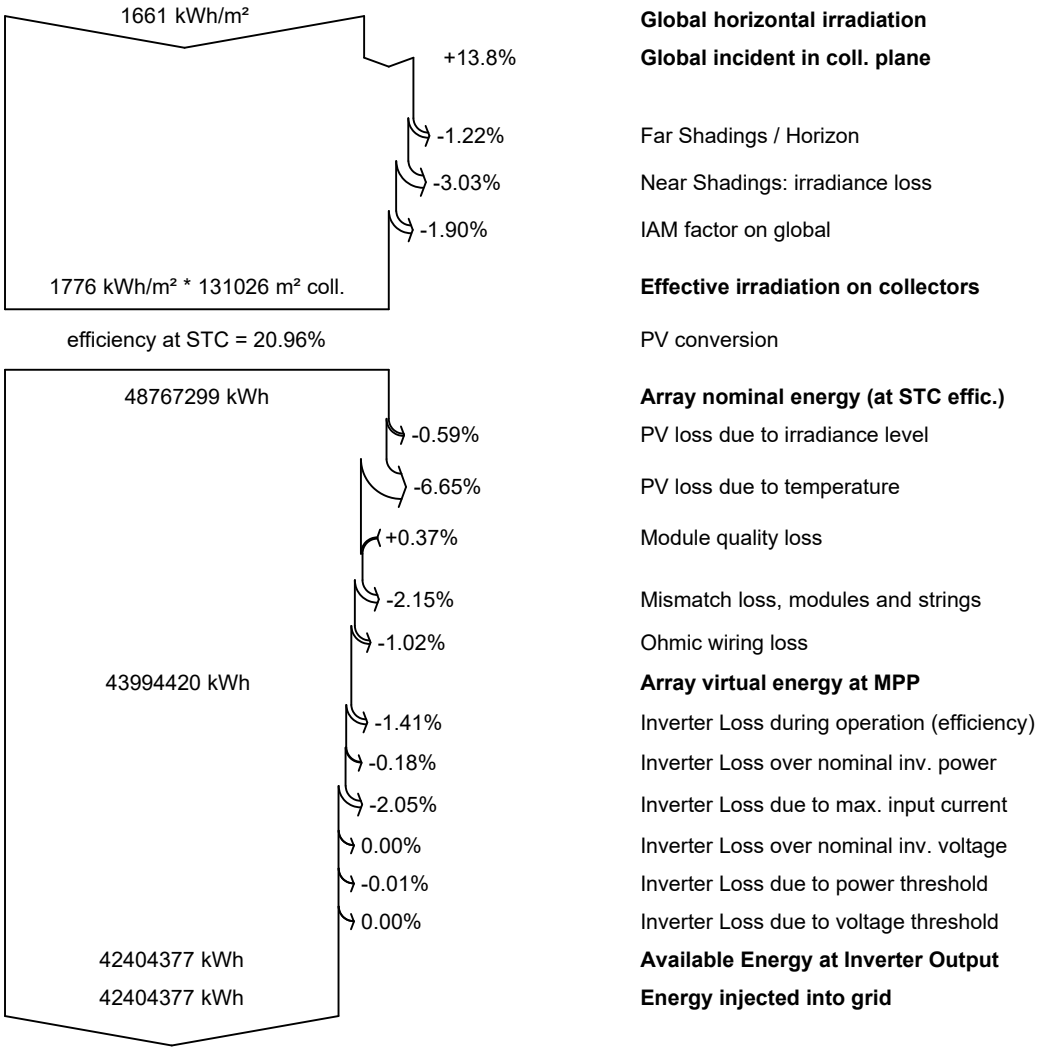
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	67.6	26.45	9.01	106.6	98.7	2517560	2476823	0.847
February	89.8	39.57	9.10	123.4	116.9	2964889	2923034	0.864
March	130.8	59.27	11.61	158.4	149.9	3745709	3692739	0.850
April	155.9	76.96	14.11	166.6	156.3	3829226	3774588	0.826
May	196.4	80.56	18.22	191.4	179.5	4310470	4246620	0.809
June	207.5	79.46	22.53	193.9	181.8	4287102	4224373	0.795
July	221.8	83.61	25.96	212.7	200.3	4676210	4611109	0.791
August	194.7	74.58	26.33	203.5	192.1	4436691	4376165	0.784
September	149.6	60.38	22.57	174.0	164.4	3891252	3837542	0.805
October	113.1	51.11	18.98	148.9	141.3	3458608	3410541	0.835
November	73.4	28.56	14.25	112.7	105.1	2610918	2568792	0.831
December	60.7	26.83	10.59	97.6	89.4	2300053	2262051	0.845
Year	1661.3	687.34	16.99	1889.8	1775.8	43028688	42404377	0.818

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 V7.4.5
VC7, Simulation date:
18/01/24 13:06
with v7.4.5

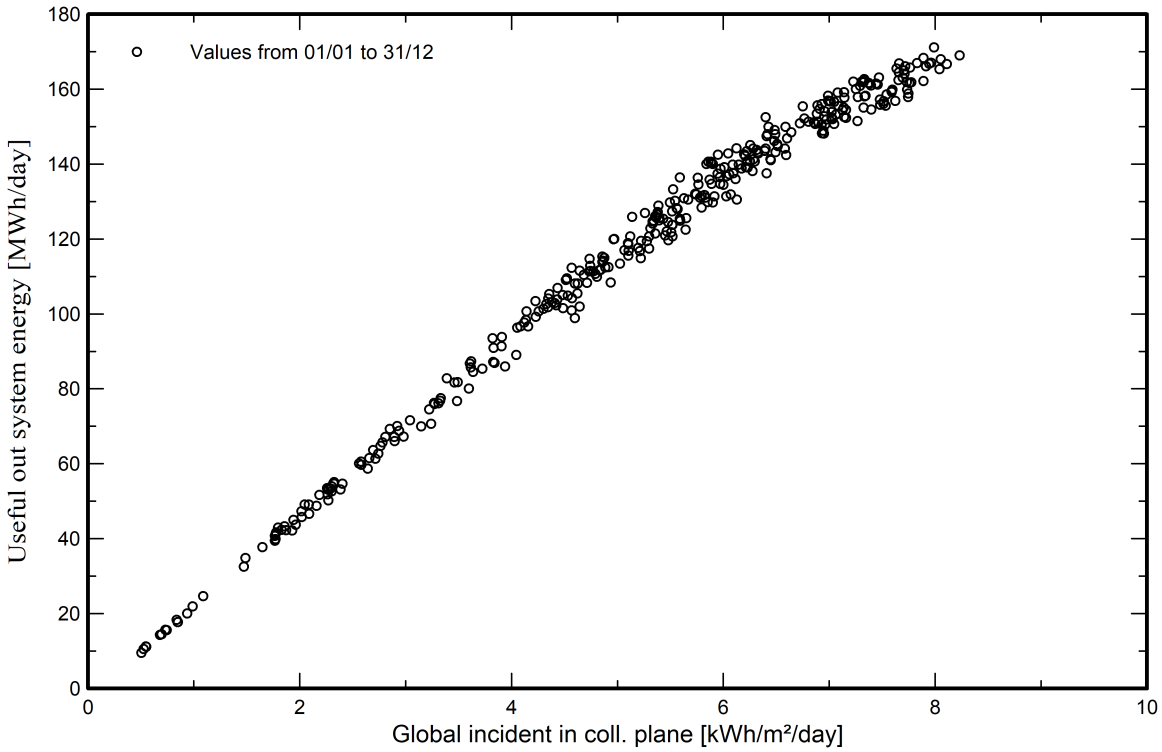
Loss diagram



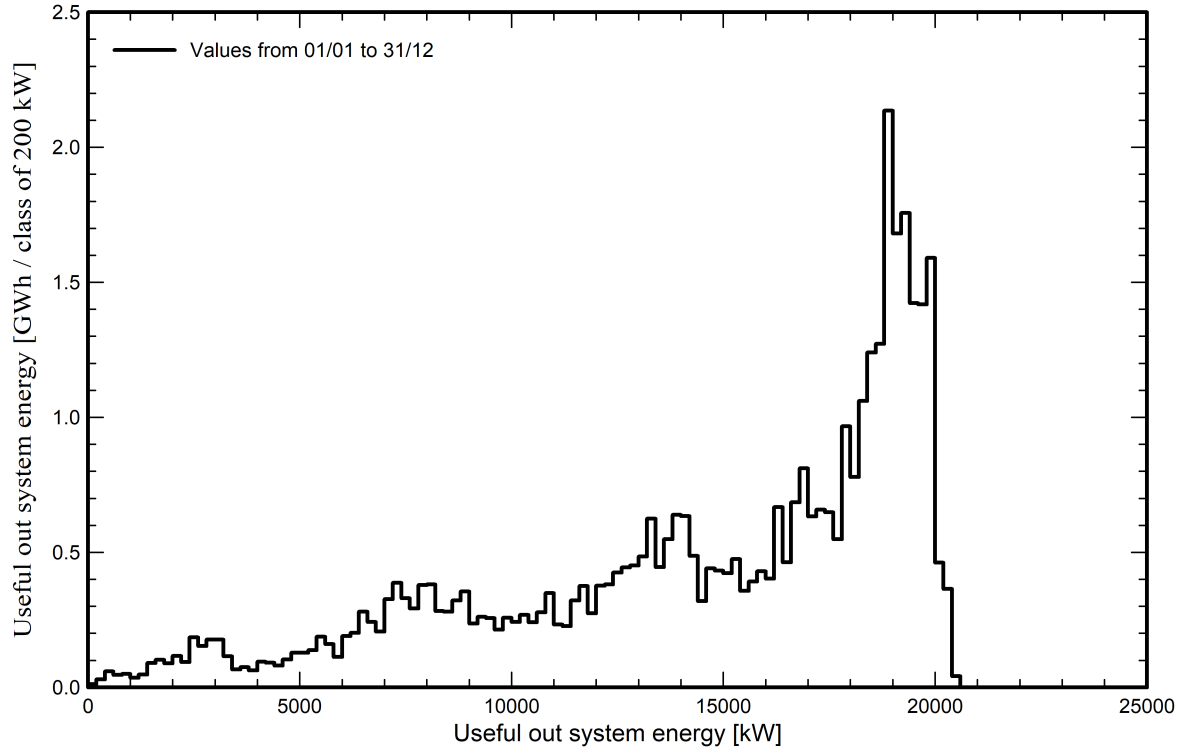
PVsyst V7.4.5
VC7, Simulation date:
18/01/24 13:06
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: F Tracker

Tracking system

System power: 3039 kWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC8, Simulation date:
22/01/24 10:46
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings
Albedo 0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System

Tracking system

PV Field Orientation
Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

System information

PV Array		Inverters	
Nb. of modules	4676 units	Nb. of units	7.8 units
Pnom total	3039 kWp	Pnom total	2350 kWac
		Pnom ratio	1.293

User's needs
Unlimited load (grid)

Results summary

Produced Energy	5538277 kWh/year	Specific production	1822 kWh/kWp/year	Perf. Ratio PR	80.99 %

Table of contents

PVsyst V7.4.5
VC8, Simulation date:
22/01/24 10:46
with v7.4.5

General parameters

Grid-Connected System

Tracking system

PV Field Orientation

Orientation
Tracking plane, horizontal N-S axis
Axis azimuth 0 °

Tracking algorithm
Astronomic calculation

Trackers configuration
Nb. of trackers 167 units

Sizes
Tracker Spacing 10.5 m
Collector width 4.79 m
Ground Cov. Ratio (GCR) 45.6 %
Phi min / max. -/+ 55.0 °

Shading limit angles
Phi limits for BT -/+ 62.7 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)
Diffuse shading Automatic

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module
Manufacturer Trina Solar
Model TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)
Unit Nom. Power 650 Wp
Number of PV modules 4676 units
Nominal (STC) 3039 kWp
Modules 167 string x 28 In series
At operating cond. (50°C)
Pmpp 2785 kWp
U mpp 959 V
I mpp 2903 A

Inverter
Manufacturer Huawei Technologies
Model SUN2000-330KTL-H1
(Original PVsyst database)
Unit Nom. Power 300 kWac
Number of inverters 47 * MPPT 17% 7.8 units
Total power 2350 kWac
Operating voltage 550-1500 V
Max. power (=>30°C) 330 kWac
Pnom ratio (DC:AC) 1.29
No power sharing between MPPTs

Total PV power
Nominal (STC) 3039 kWp
Total 4676 modules
Module area 14525 m²

Total inverter power
Total power 2350 kWac
Nb. of inverters 8 units
0.2 unused
Pnom ratio 1.29

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 5.4 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

PVsyst V7.4.5
VC8, Simulation date:
22/01/24 10:46
with v7.4.5

Array losses

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

PVsyst V7.4.5
VC8, Simulation date:
22/01/24 10:46
with v7.4.5

Horizon definition

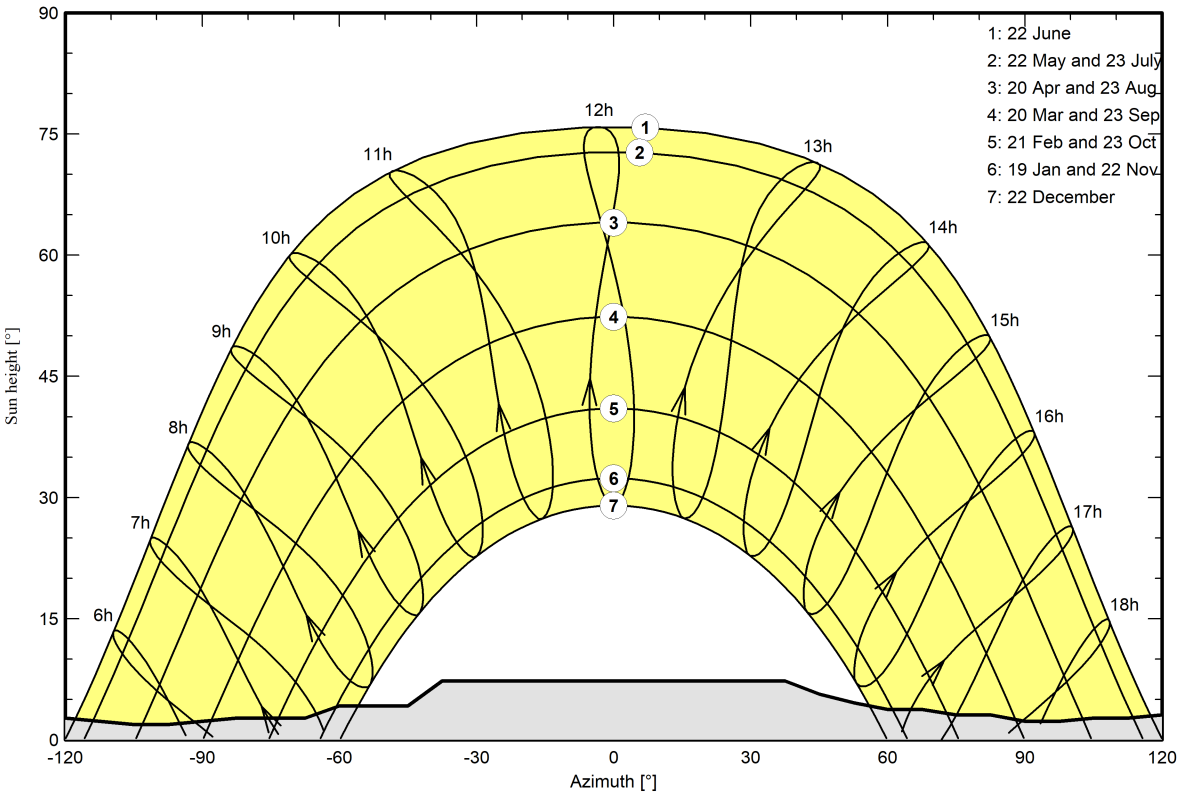
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.83
Diffuse Factor	0.96	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

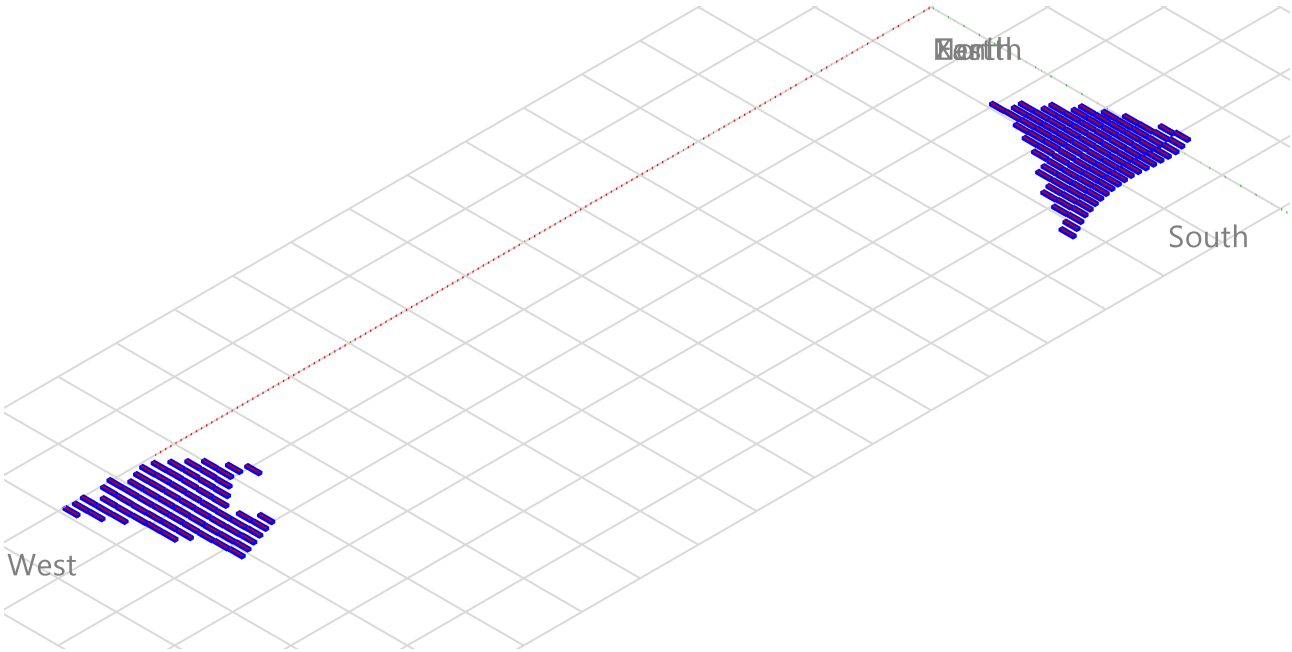
Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
VC8, Simulation date:
22/01/24 10:46
with v7.4.5

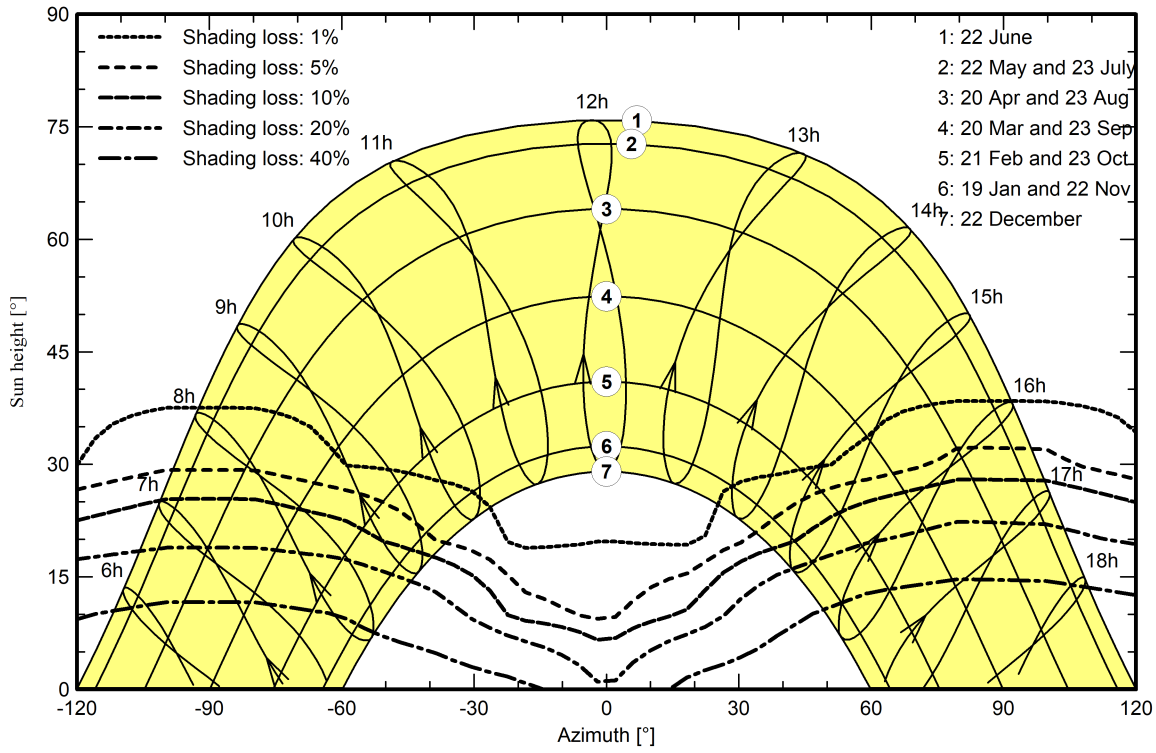
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1



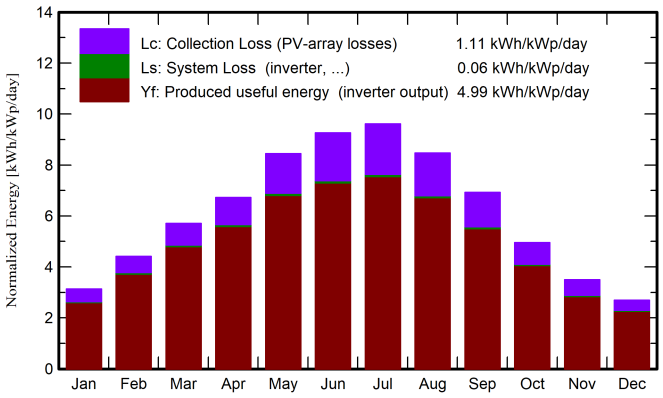
PVsyst V7.4.5
VC8, Simulation date:
22/01/24 10:46
with v7.4.5

Main results

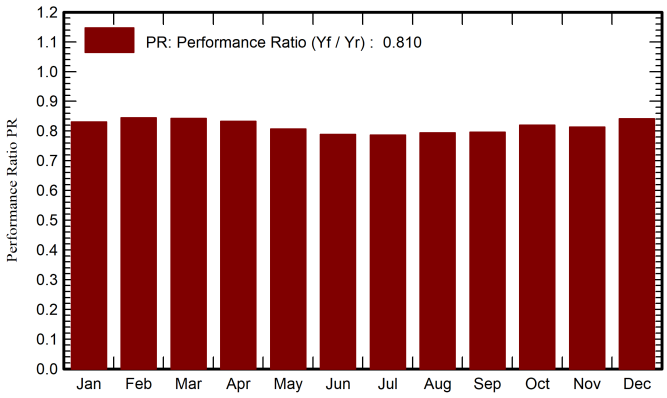
System Production

Produced Energy	5538277 kWh/year	Specific production	1822 kWh/kWp/year
		Perf. Ratio PR	80.99 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

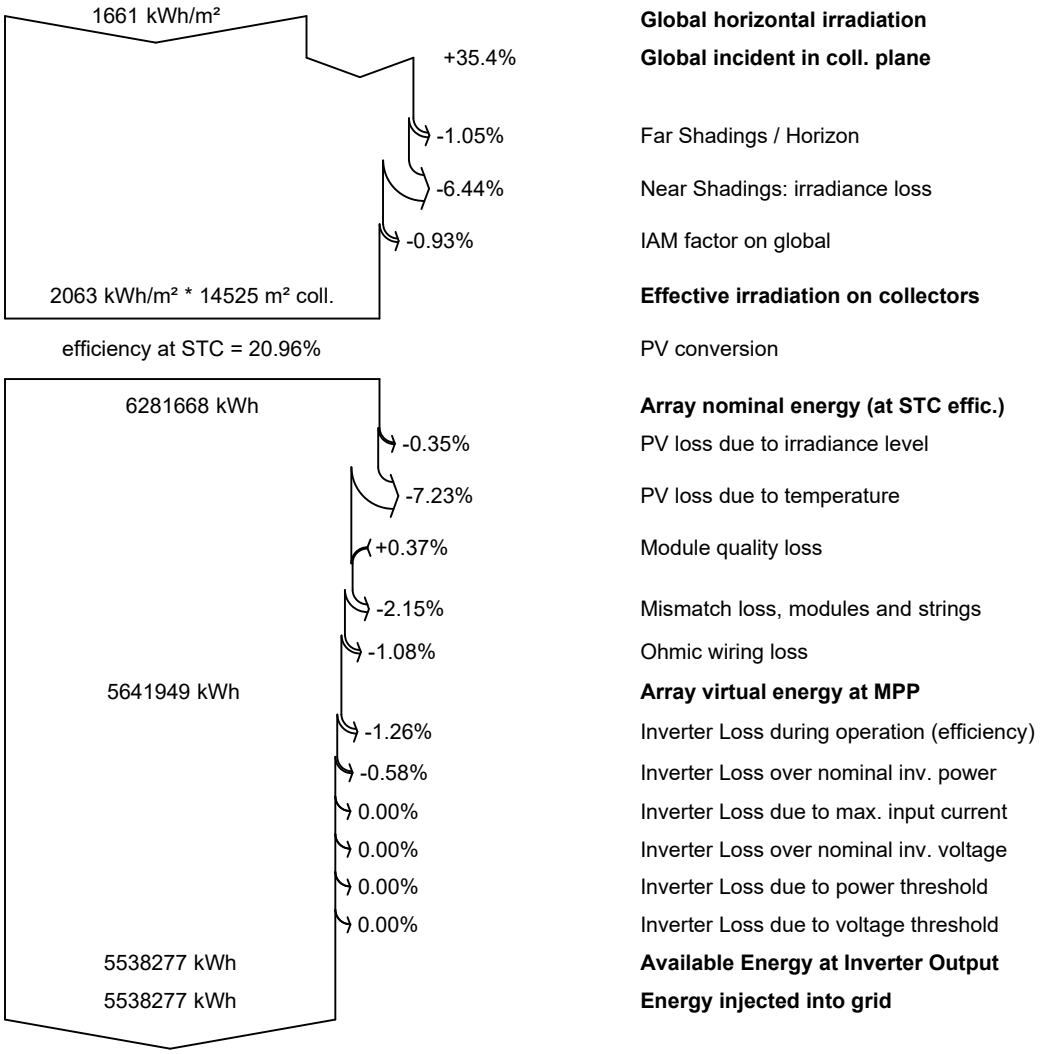
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	67.6	26.45	9.01	97.2	85.9	249395	245295	0.831
February	89.8	39.57	9.10	123.7	111.3	321736	317362	0.844
March	130.8	59.27	11.61	176.8	161.6	458338	452477	0.842
April	155.9	76.96	14.11	201.8	186.5	516915	510529	0.832
May	196.4	80.56	18.22	261.8	243.0	650184	642304	0.807
June	207.5	79.46	22.53	277.8	257.8	673656	665749	0.789
July	221.8	83.61	25.96	298.1	277.1	720555	712385	0.786
August	194.7	74.58	26.33	262.7	244.4	640779	633524	0.794
September	149.6	60.38	22.57	207.9	188.8	508924	502731	0.796
October	113.1	51.11	18.98	153.5	139.4	387654	382607	0.820
November	73.4	28.56	14.25	105.0	92.7	263784	259528	0.813
December	60.7	26.83	10.59	83.6	74.9	217526	213786	0.841
Year	1661.3	687.34	16.99	2249.8	2063.3	5609446	5538277	0.810

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 V7.4.5
VC8, Simulation date:
22/01/24 10:46
with v7.4.5

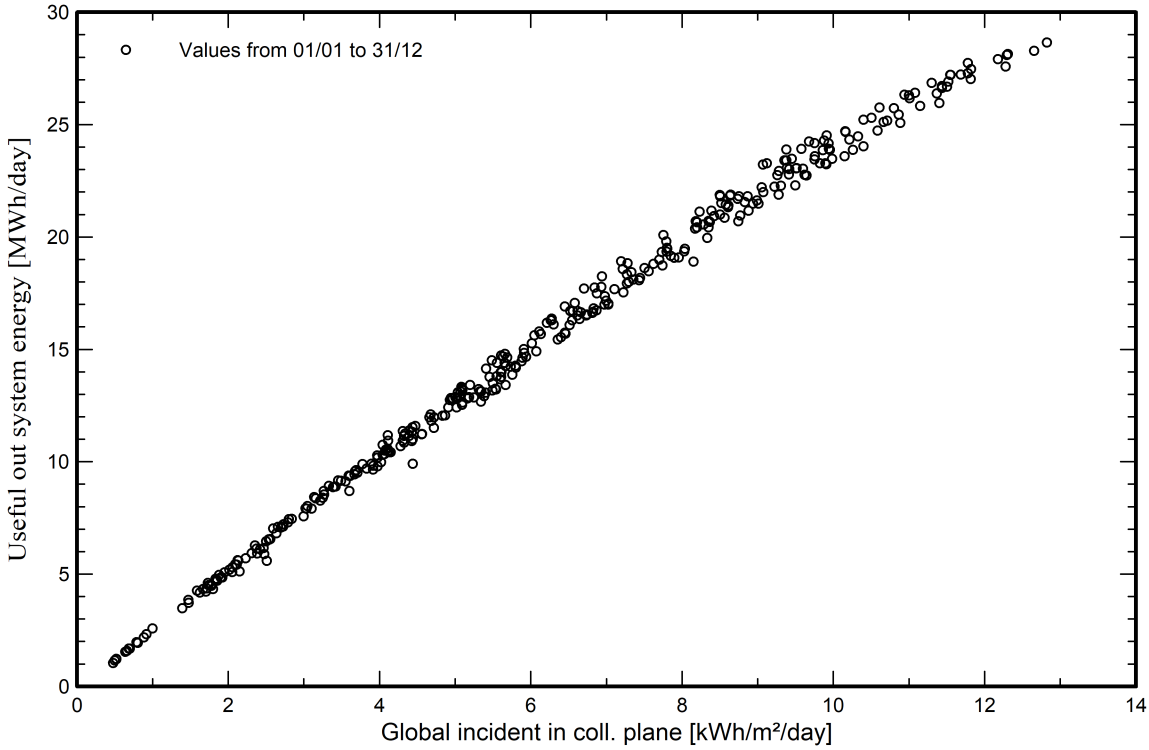
Loss diagram



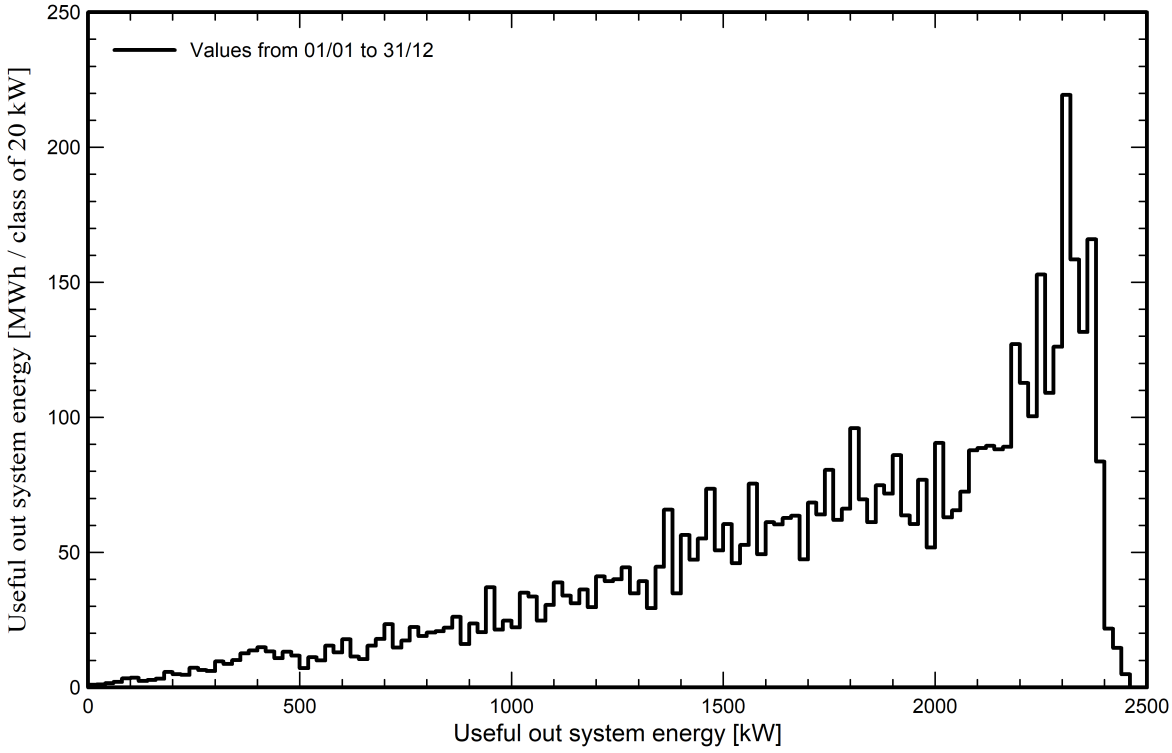
PVsyst V7.4.5
VC8, Simulation date:
22/01/24 10:46
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema



Version 7.4.5

PVsyst - Simulation report

Grid-Connected System

Project: FV-CAPOBIANCO FISSO

Variant: G Fissi

Ground system (tables) on a hill

System power: 19.12 MWp

Cuticchi - Italy

Author

tuscany engineering (Italy)

PVsyst V7.4.5
VC9, Simulation date:
18/01/24 13:11
with v7.4.5

Project summary

Geographical Site
Cuticchi
Italy

Situation

Latitude	37.54 °N
Longitude	14.49 °E
Altitude	257 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Cuticchi
Meteonorm 8.1 (1991-2006), Sat=100% - Sintetico

System summary

Grid-Connected System
Ground system (tables) on a hill

PV Field Orientation
Fixed plane
Tilt/Azimuth 30 / 0 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	29420 units
Pnom total	19.12 MWp

Inverters

Nb. of units	49.2 units
Pnom total	14.75 MWac
Pnom ratio	1.296

Results summary

Produced Energy	29394051 kWh/year	Specific production	1537 kWh/kWp/year	Perf. Ratio PR	81.33 %

Table of contents

PVsyst V7.4.5
VC9, Simulation date:
18/01/24 13:11
with v7.4.5

General parameters

Grid-Connected System

Ground system (tables) on a hill

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	30 / 0 °

Sheds configuration	
Nb. of sheds	752 units
Sizes	
Sheds spacing	12.1 m
Collector width	4.87 m
Ground Cov. Ratio (GCR)	40.3 %

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Average Height 3.8 °

Near Shadings
Linear shadings : Slow (simul.)

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG21C-20-650Wp Vertex
(Original PVsyst database)	
Unit Nom. Power	650 Wp
Number of PV modules	29420 units
Nominal (STC)	19.12 MWp
Modules	1471 string x 20 In series
At operating cond. (50°C)	
Pmpp	17.52 MWp
U mpp	685 V
I mpp	25567 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000-330KTL-H1
(Original PVsyst database)	
Unit Nom. Power	300 kWac
Number of inverters	295 * MPPT 17% 49.2 units
Total power	14750 kWac
Operating voltage	550-1500 V
Max. power (=>30°C)	330 kWac
Pnom ratio (DC:AC)	1.30
No power sharing between MPPTs	

Total PV power

Nominal (STC)	19123 kWp
Total	29420 modules
Module area	91389 m²

Total inverter power

Total power	14750 kWac
Nb. of inverters	50 units
	0.8 unused
Pnom ratio	1.30

Array losses

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses
Global array res. 0.44 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.2 %

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

Horizon definition

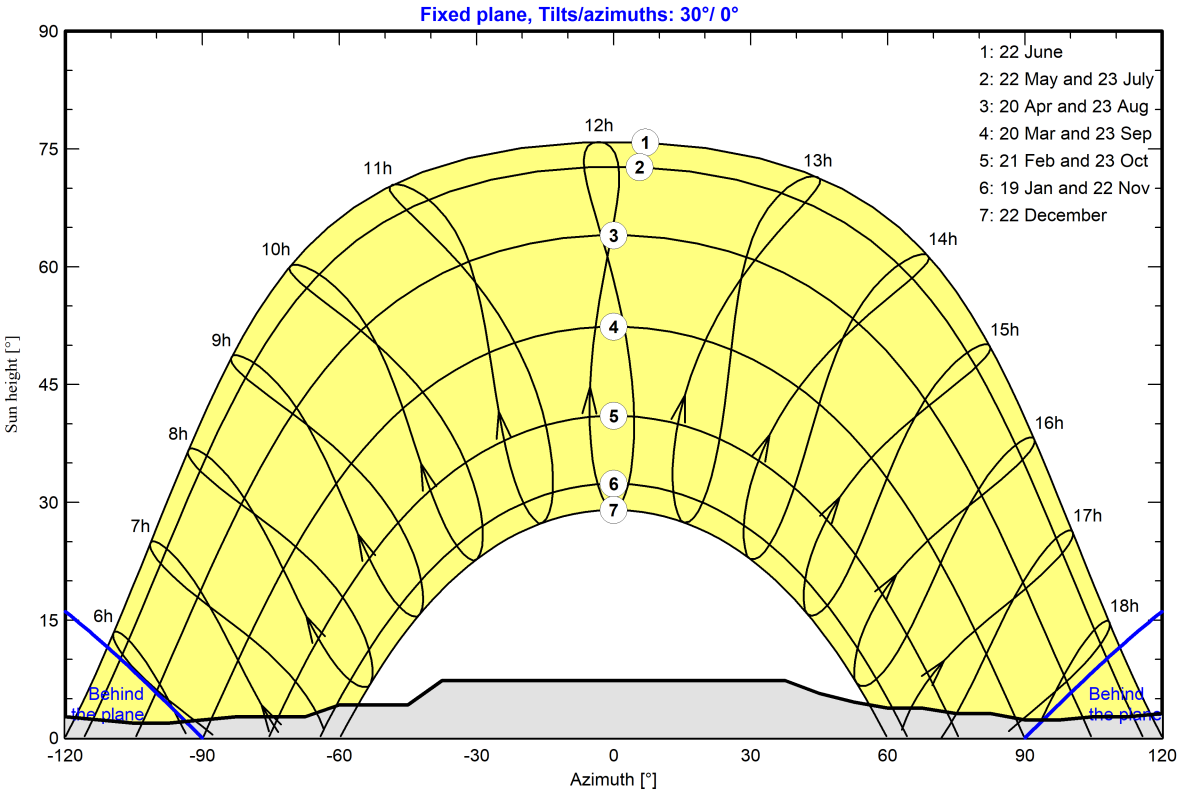
Horizon from PVGIS website API, Lat=37°32'35", Long=14°29'6", Alt=257m

Average Height	3.8 °	Albedo Factor	0.67
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-128	-120	-113	-105	-98	-90	-83
Height [°]	1.9	2.3	1.5	1.9	1.9	1.5	1.5	2.7	2.3	1.9	1.9	2.3	2.7
Azimuth [°]	-68	-60	-45	-38	38	45	53	60	68	75	83	90	98
Height [°]	2.7	4.2	4.2	7.3	7.3	5.7	4.6	3.8	3.8	3.1	3.1	2.3	2.3
Azimuth [°]	105	113	120	128	135	143	150	158	165	173	180		
Height [°]	2.7	2.7	3.1	2.7	1.9	2.3	3.1	2.7	2.7	2.3	1.9		

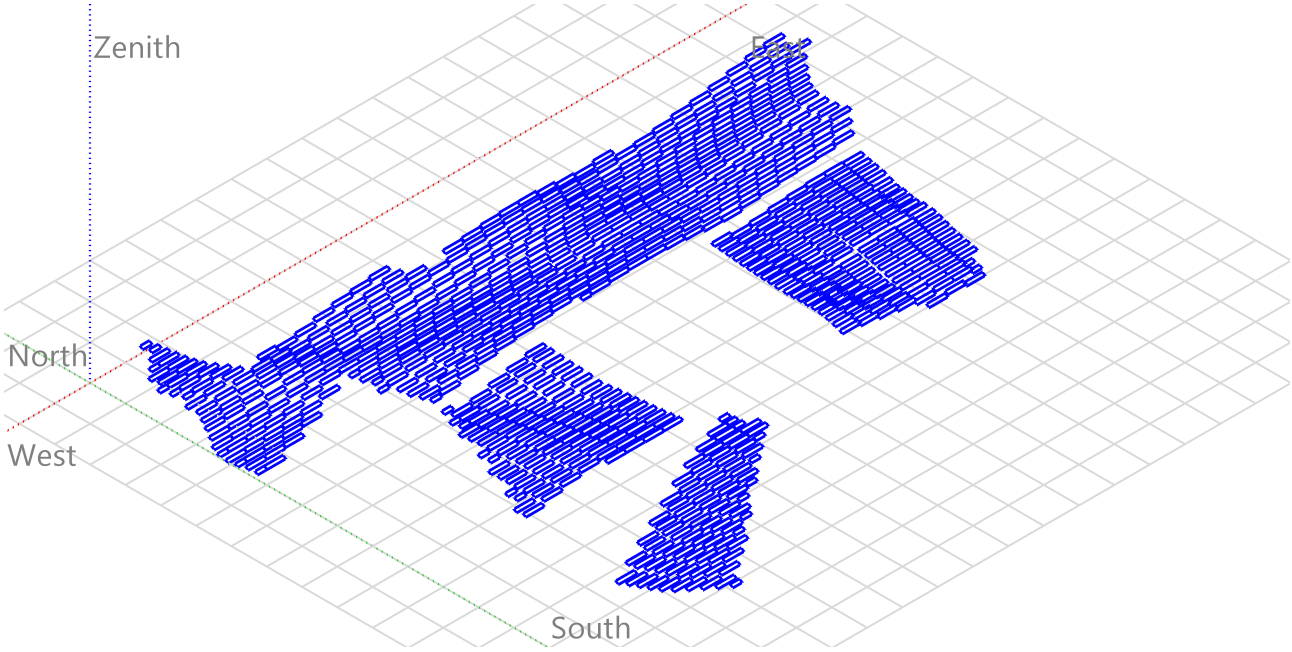
Sun Paths (Height / Azimuth diagram)



PVsyst V7.4.5
VC9, Simulation date:
18/01/24 13:11
with v7.4.5

Near shadings parameter

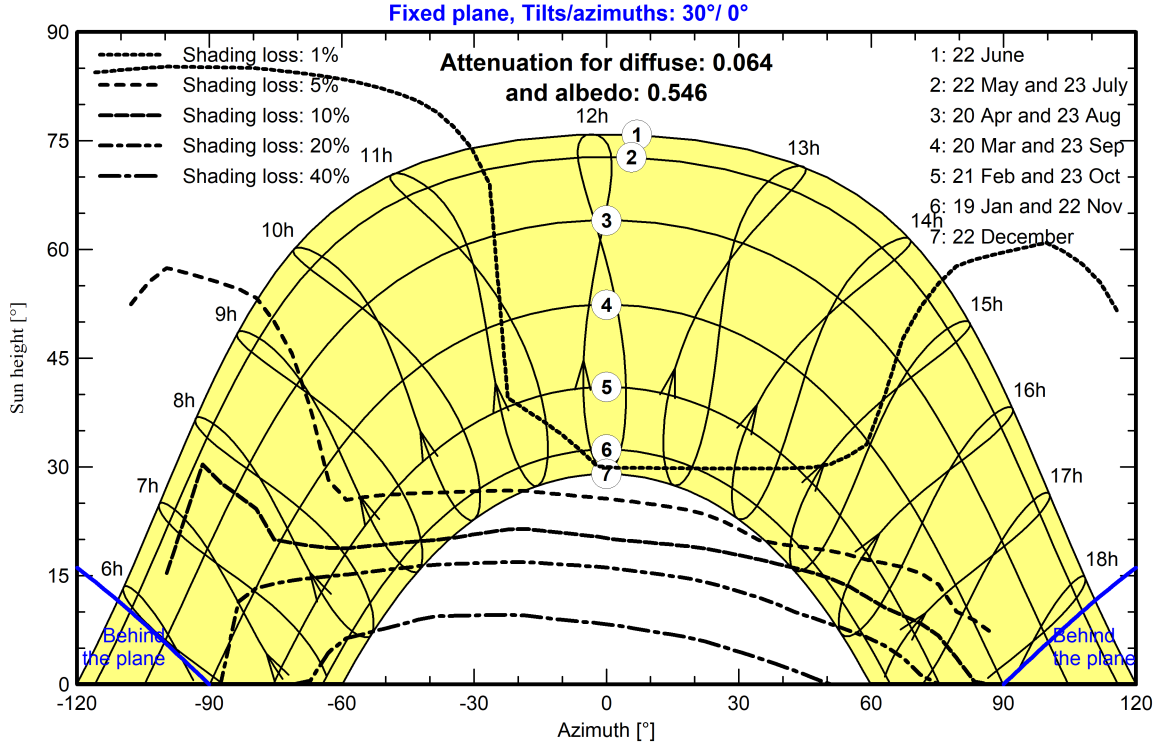
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 30°/ 0°



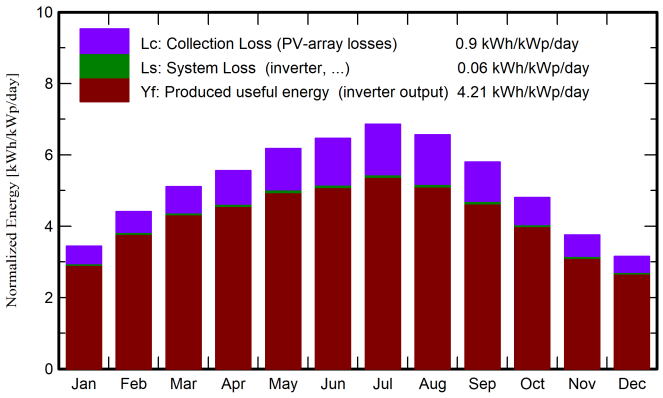
PVsyst V7.4.5
VC9, Simulation date:
18/01/24 13:11
with v7.4.5

Main results

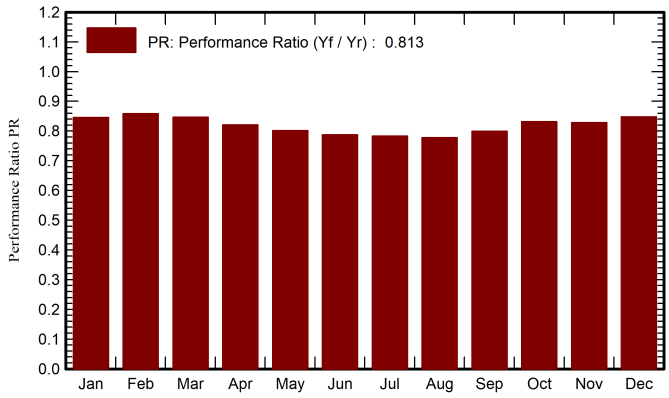
System Production

Produced Energy	29394051 kWh/year	Specific production	1537 kWh/kWp/year
		Perf. Ratio PR	81.33 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

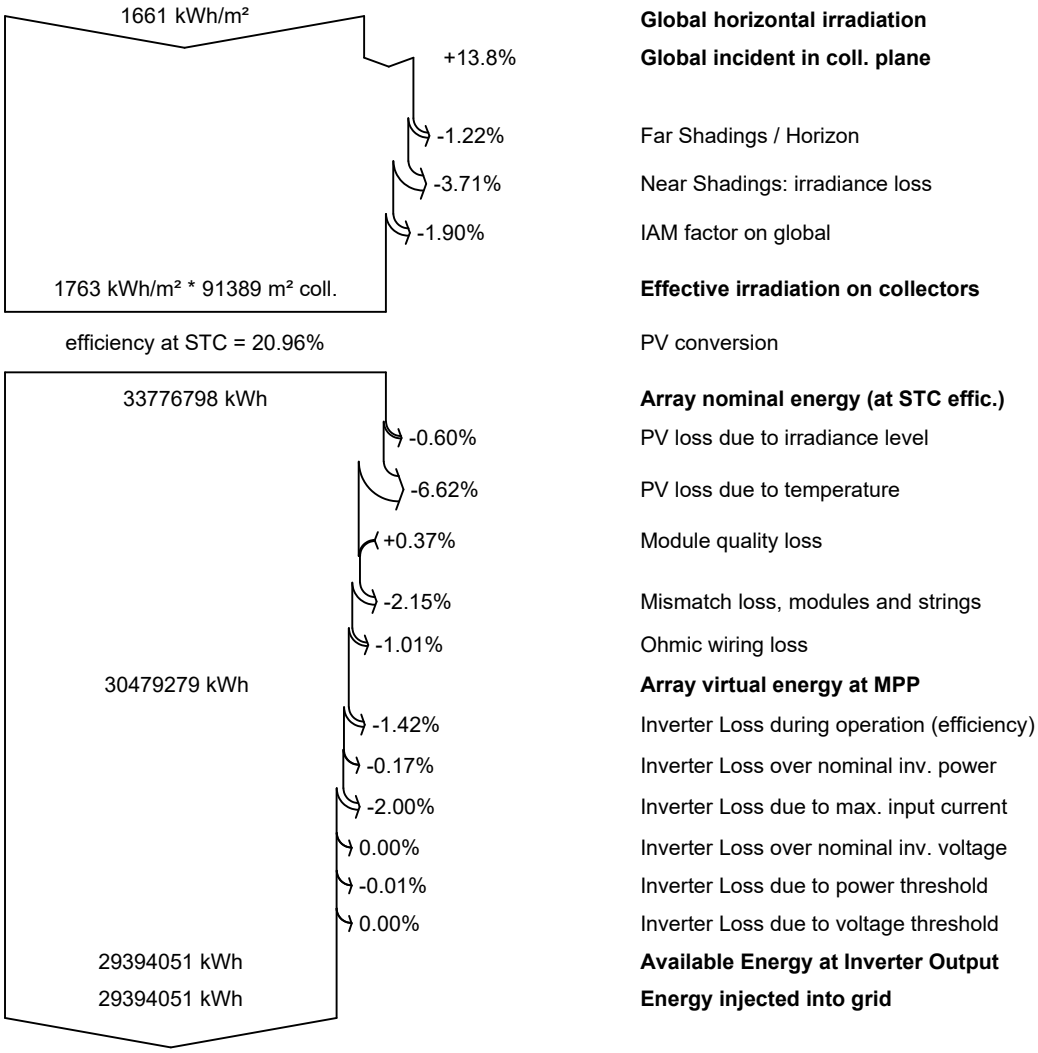
	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_Grid kWh	PR ratio
January	67.6	26.45	9.01	106.6	98.5	1753588	1725198	0.846
February	89.8	39.57	9.10	123.4	116.1	2054999	2025785	0.858
March	130.8	59.27	11.61	158.4	149.2	2600478	2563504	0.846
April	155.9	76.96	14.11	166.6	155.2	2654893	2616779	0.821
May	196.4	80.56	18.22	191.4	177.7	2979319	2934866	0.802
June	207.5	79.46	22.53	193.9	179.9	2963590	2919920	0.788
July	221.8	83.61	25.96	212.7	198.3	3231852	3186501	0.783
August	194.7	74.58	26.33	203.5	190.3	3068808	3026611	0.778
September	149.6	60.38	22.57	174.0	163.4	2698077	2660609	0.800
October	113.1	51.11	18.98	148.9	140.5	2400508	2366960	0.831
November	73.4	28.56	14.25	112.7	104.6	1814322	1784939	0.828
December	60.7	26.83	10.59	97.6	89.6	1608889	1582378	0.847
Year	1661.3	687.34	16.99	1889.8	1763.4	29829324	29394051	0.813

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 V7.4.5
VC9, Simulation date:
18/01/24 13:11
with v7.4.5

Loss diagram



PVsyst V7.4.5
VC9, Simulation date:
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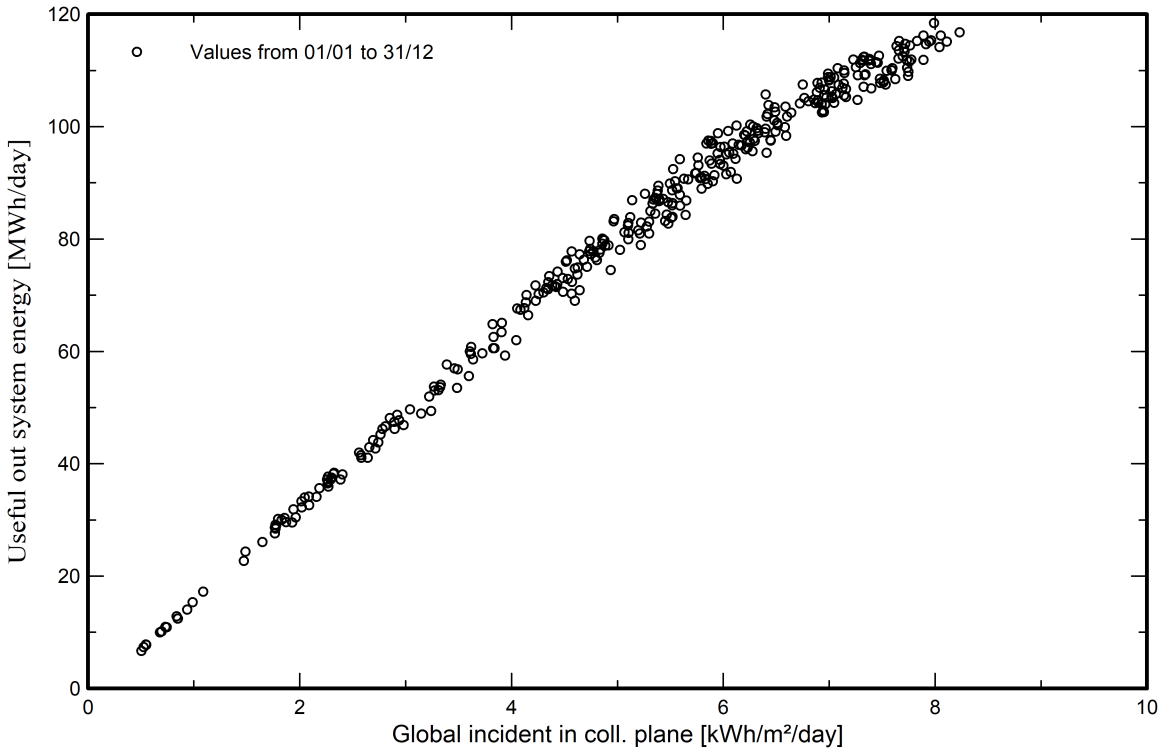
with v7.4.5

Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema