



IMPIANTO AGRIVOLTAICO DA 42 MWp

Comuni: Montorio nei Frentani- Ururi - Rotello

Provincia: Campobasso (CB)

Regione: Molise

PROPONENTE: PV ITALY 1 S.r.l.

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Pec:pv_italy1@pec.it
P.Iva: 11515530969



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Coordinamento sviluppo:

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P.Iva: 11670160966



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Pec: fullservicecompany@legalmail.it
P.Iva: 02743840429



Progettazione tecnica opere di rete:

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Dott. Agronomo Alberto Massa Saluzzo: aspetti agronomici

Rev.	Data	Descrizione	Dis.	Contr.	App.
0	Giu.23	Progetto definitivo	B.B.	R.M.	G.S.

Nome Progetto:

Impianto Agrivoltaico Montorio 42.08 MWp

Codice Documento:

PVI1KMEPD005

Nome Documento:

Relazione specialistica e calcolo producibilità

Scala:

-

PVsyst - Simulation report

Grid-Connected System

Project: ProjectMontorio_CampoA

Variant: VC0_CampoA.var0

Tracking system with backtracking

System power: 14.20 MWp

Montorio nei Frentani - Italia

**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 09:46
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

Project summary**Geographical Site**

Montorio nei Frentani

Italia

Situation

Latitude 41.78 °N

Longitude 14.97 °E

Altitude 275 m

Time zone UTC+1

Project settings

Albedo 0.20

Meteo data

Montorio nei Frentani

SolarGIS Monthly aver. , period not spec. - Sintetico

System summary**Grid-Connected System****PV Field Orientation****Orientation**

Tracking plane, tilted axis

Avg axis tilt 0.6 °

Avg axis azim. 0 °

Tracking system with backtracking**Tracking algorithm**

Astronomic calculation

Backtracking activated

Near Shadings

According to strings

Electrical effect 100 %

Diffuse shading Automatic

System information**PV Array**

Nb. of modules

21196 units

Pnom total

14.20 MWp

Inverters

Nb. of units

44 units

Pnom total

14.08 MWac

Pnom ratio

1.009

User's needs

Unlimited load (grid)

Results summary

Produced Energy	24389398 kWh/year	Specific production	1717 kWh/kWp/year	Perf. Ratio PR	85.27 %
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**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 09:46
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

General parameters**Grid-Connected System****PV Field Orientation****Orientation**

Tracking plane, tilted axis

Avg axis tilt 0.6 °

Avg axis azim. 0 °

Tracking system with backtracking**Tracking algorithm**

Astronomic calculation

Backtracking activated

Backtracking array

Nb. of trackers 404 units

Sizes

Tracker Spacing 10.0 m

Collector width 4.79 m

Ground Cov. Ratio (GCR) 47.9 %

Phi min / max. -/+ 50.0 °

Backtracking strategy

Phi limits for BT -/+ 61.2 °

Backtracking pitch 10.00 m

Backtracking width 4.79 m

Models used

Transposition Perez

Diffuse Perez, Meteonorm

Circumsolar separate

Horizon

Average Height 2.3 °

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 10.00 m

Tracker width 4.79 m

GCR 47.9 %

Axis height above ground 2.99 m

Bifacial model definitions

Ground albedo average 0.15

Bifaciality factor 81 %

Rear shading factor 5.0 %

Rear mismatch loss 10.0 %

Shed transparent fraction 0.0 %

Monthly ground albedo values

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
0.13	0.14	0.16	0.17	0.18	0.20	0.20	0.17	0.14	0.12	0.11	0.12	0.15

PV Array Characteristics**PV module**

Manufacturer Trina Solar

Model TSM-670NEG21C.20

(Custom parameters definition)

Unit Nom. Power 670 Wp

Number of PV modules 21196 units

Nominal (STC) 14.20 MWp

Modules 757 Strings x 28 In series

At operating cond. (50°C)

Pmpp 13.13 MWp

U mpp 1003 V

I mpp 13088 A

Inverter

Manufacturer Sungrow

Model SG350HX-20A

(Custom parameters definition)

Unit Nom. Power 320 kWac

Number of inverters 44 units

Total power 14080 kWac

Operating voltage 500-1500 V

Max. power (=>30°C) 352 kWac

Pnom ratio (DC:AC) 1.01

Power sharing within this inverter



PVsyst V7.3.4

VC0, Simulation date:
31/05/23 09:46
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

PV Array Characteristics

Total PV power

Nominal (STC)	14201 kWp
Total	21196 modules
Module area	65842 m ²
Cell area	61693 m ²

Total inverter power

Total power	14080 kWac
Max. power	15488 kWac
Number of inverters	44 units
Pnom ratio	1.01

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. 1.2 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation

Loss Fraction 1.0 %

Module Quality Loss

Loss Fraction -0.8 %

Module mismatch losses

Loss Fraction 0.8 % at MPP

Strings Mismatch loss

Loss Fraction 0.2 %

IAM loss factor

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.999	0.994	0.969	0.928	0.829	0.585	0.000

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 800 Vac tri
Loss Fraction 3.39 % at STC

Inverter: SG350HX-20A

Wire section (44 Inv.) Alu 44 x 3 x 240 mm²
Average wires length 520 m

MV line up to Injection

MV Voltage 20 kV
Average each inverter
Wires Copper 3 x 240 mm²
Length 1500 m
Loss Fraction 0.08 % at STC

**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 09:46
with v7.3.4

Project: ProjectMontorio_CampoA

Variant: VC0_CampoA.var0

FULL SERVICE COMPANY SRL (Italy)

AC losses in transformers**MV transfo**

Medium voltage

20 kV

One transfo parameters

Nominal power at STC

2.80 MVA

Iron Loss (24/24 Connexion)

2.82 kVA

Iron loss fraction

0.10 % at STC

Copper loss

27.77 kVA

Copper loss fraction

0.99 % at STC

Coils equivalent resistance

3 x 2.27 mΩ

Operating losses at STC (full system)

Nb. identical MV transfos

5

Nominal power at STC

13.98 MVA

Iron loss (24/24 Connexion)

14.12 kVA

Copper loss

138.86 kVA



Horizon definition

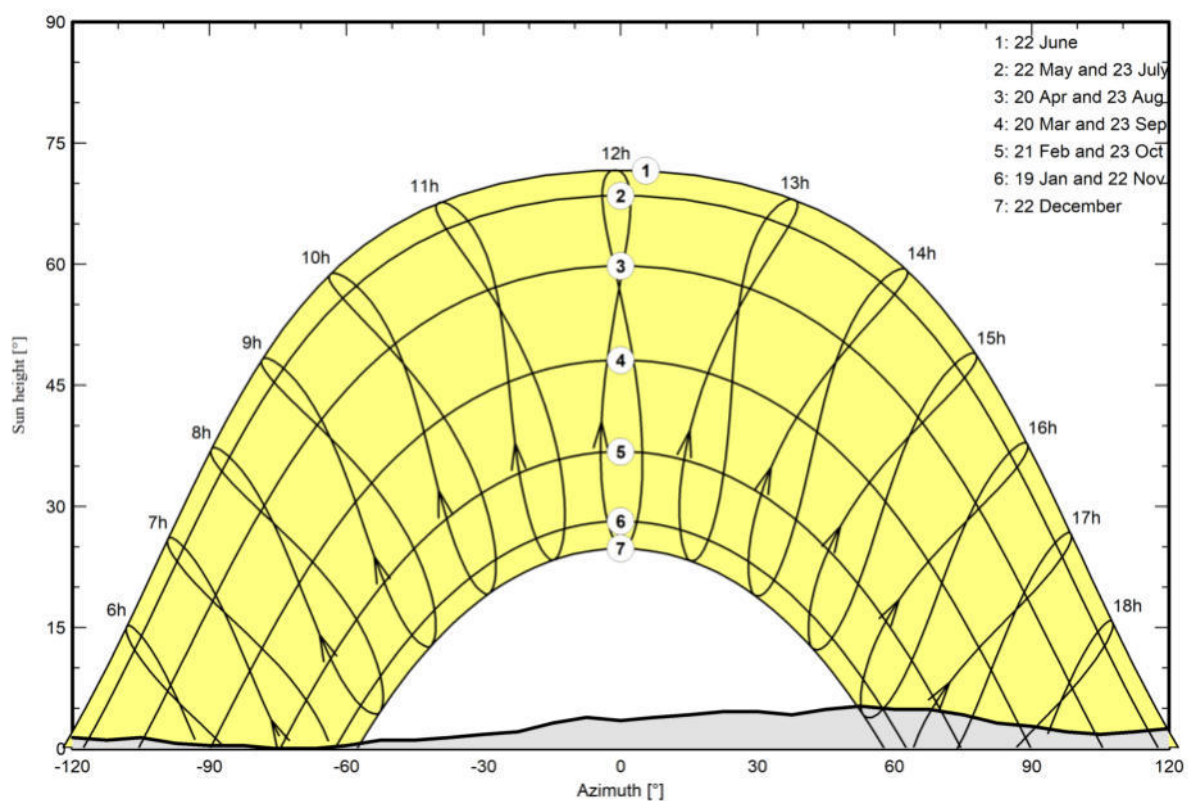
lat:41.780371, lng:14.970939, exported by solargis.info at 2023-04-17T13:28:24.3

Average Height	2.3 °	Albedo Factor	0.84
Diffuse Factor	0.96	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-135	-128	-120	-113	-105	-98
Height [°]	2.5	2.5	2.8	2.5	2.1	1.8	1.4	1.1	1.4	1.1	1.4	0.7
Azimuth [°]	-90	-83	-75	-68	-60	-53	-45	-38	-30	-23	-15	-8
Height [°]	0.4	0.4	0.0	0.0	0.4	1.1	1.1	1.4	1.8	2.1	3.2	3.9
Azimuth [°]	0	8	15	23	30	38	45	53	60	68	75	83
Height [°]	3.5	3.9	4.2	4.6	4.6	4.2	4.9	5.3	4.9	4.9	4.2	3.2
Azimuth [°]	90	98	105	113	120	128	135	143	150	158	165	173
Height [°]	2.8	2.1	1.8	2.1	2.5	1.8	1.1	1.1	1.4	1.8	2.1	2.1

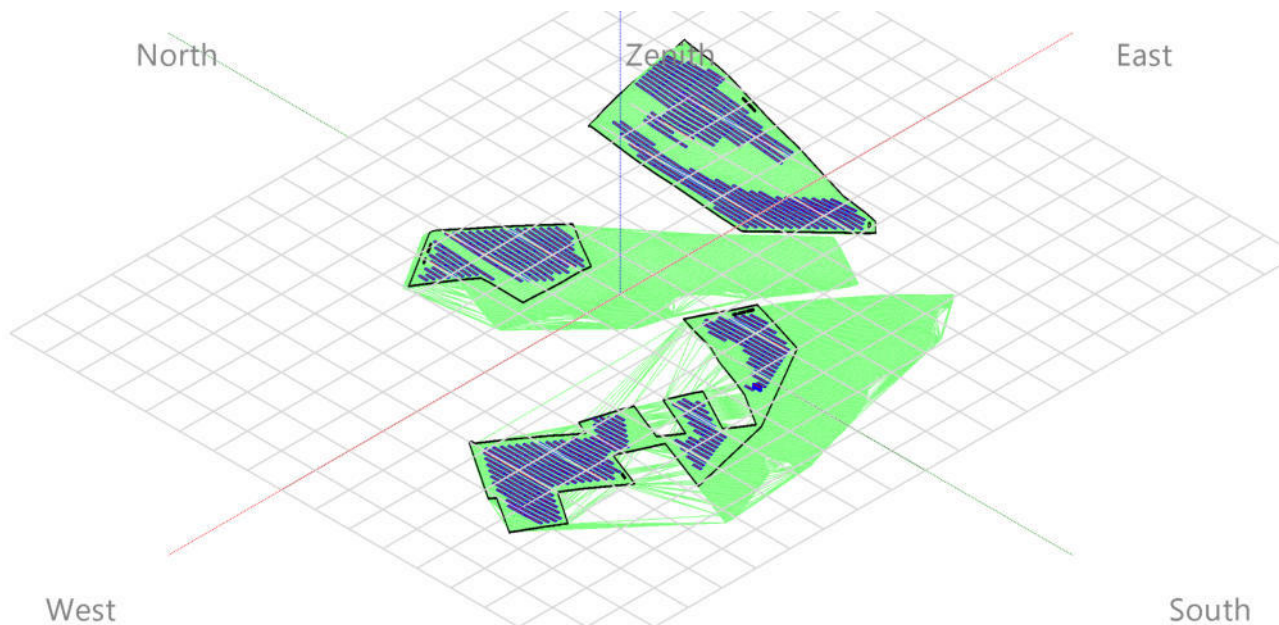
Sun Paths (Height / Azimuth diagram)





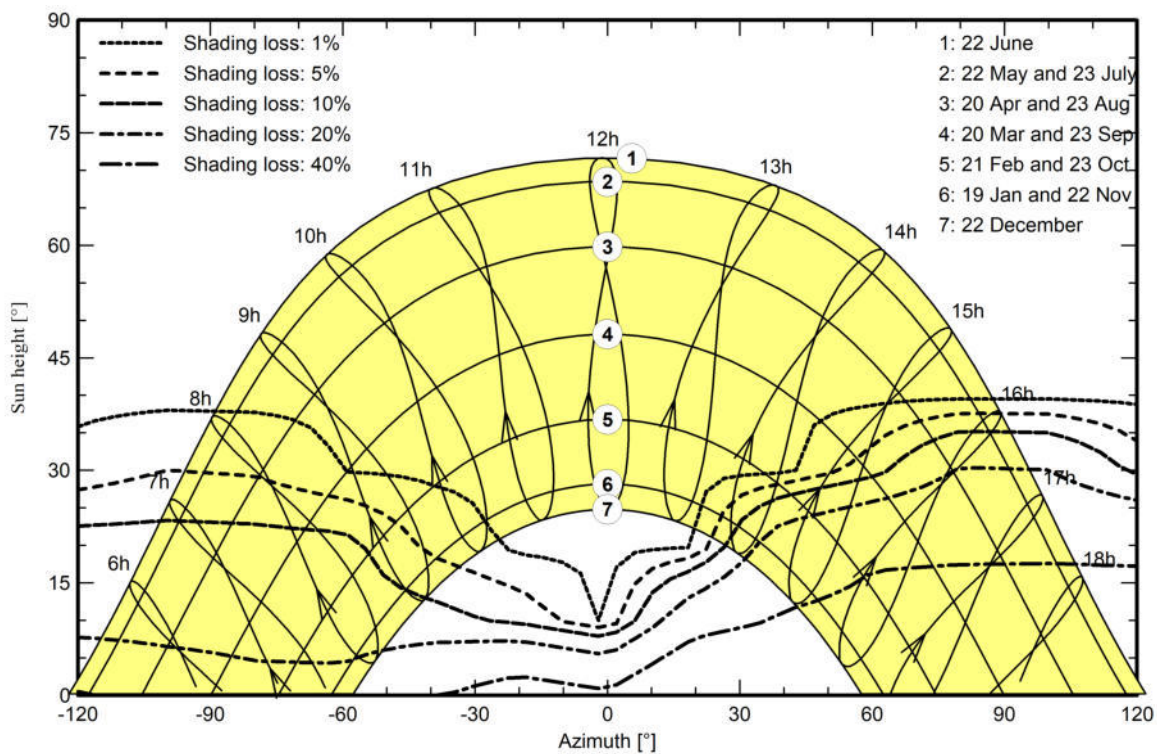
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1





Main results

System Production

Produced Energy

24389398 kWh/year

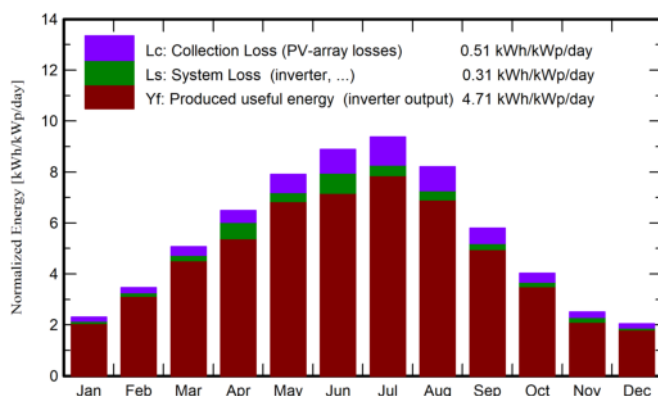
Specific production

1717 kWh/kWp/year

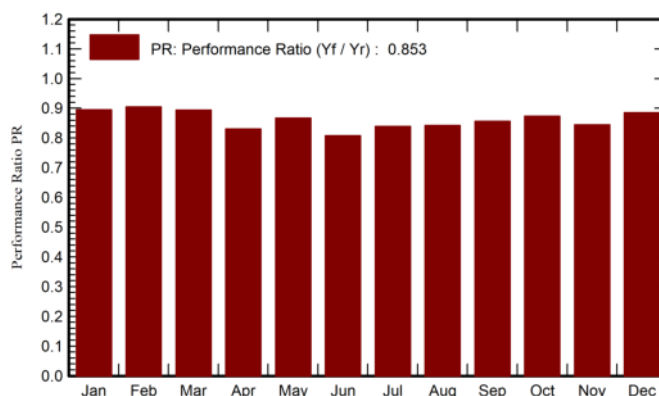
Perf. Ratio PR

85.27 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	kWh	kWh	ratio
January	54.5	25.40	6.40	71.4	67.1	949946	908241	0.895
February	74.1	32.60	7.00	96.9	91.7	1300778	1245958	0.905
March	120.9	50.30	9.50	157.0	149.3	2088573	1992594	0.894
April	152.2	63.00	12.80	194.7	186.1	2568653	2296858	0.831
May	192.3	77.30	17.40	245.0	234.2	3173721	3015845	0.867
June	208.8	76.10	22.10	266.6	255.7	3396706	3059199	0.808
July	223.4	70.40	24.60	290.6	278.6	3649189	3463706	0.839
August	195.0	65.80	24.40	254.4	243.7	3202743	3042096	0.842
September	134.9	56.20	19.80	174.0	165.5	2219144	2116295	0.856
October	96.1	43.20	15.70	124.8	118.3	1620148	1547677	0.873
November	58.8	28.40	11.40	75.3	70.7	982316	902995	0.845
December	47.7	22.80	7.50	63.4	58.9	834029	797934	0.886
Year	1558.7	611.50	14.93	2014.2	1919.8	25985948	24389398	0.853

Legends

GlobHor Global horizontal irradiation

DiffHor Horizontal diffuse irradiation

T_Amb Ambient Temperature

GlobInc Global incident in coll. plane

GlobEff Effective Global, corr. for IAM and shadings

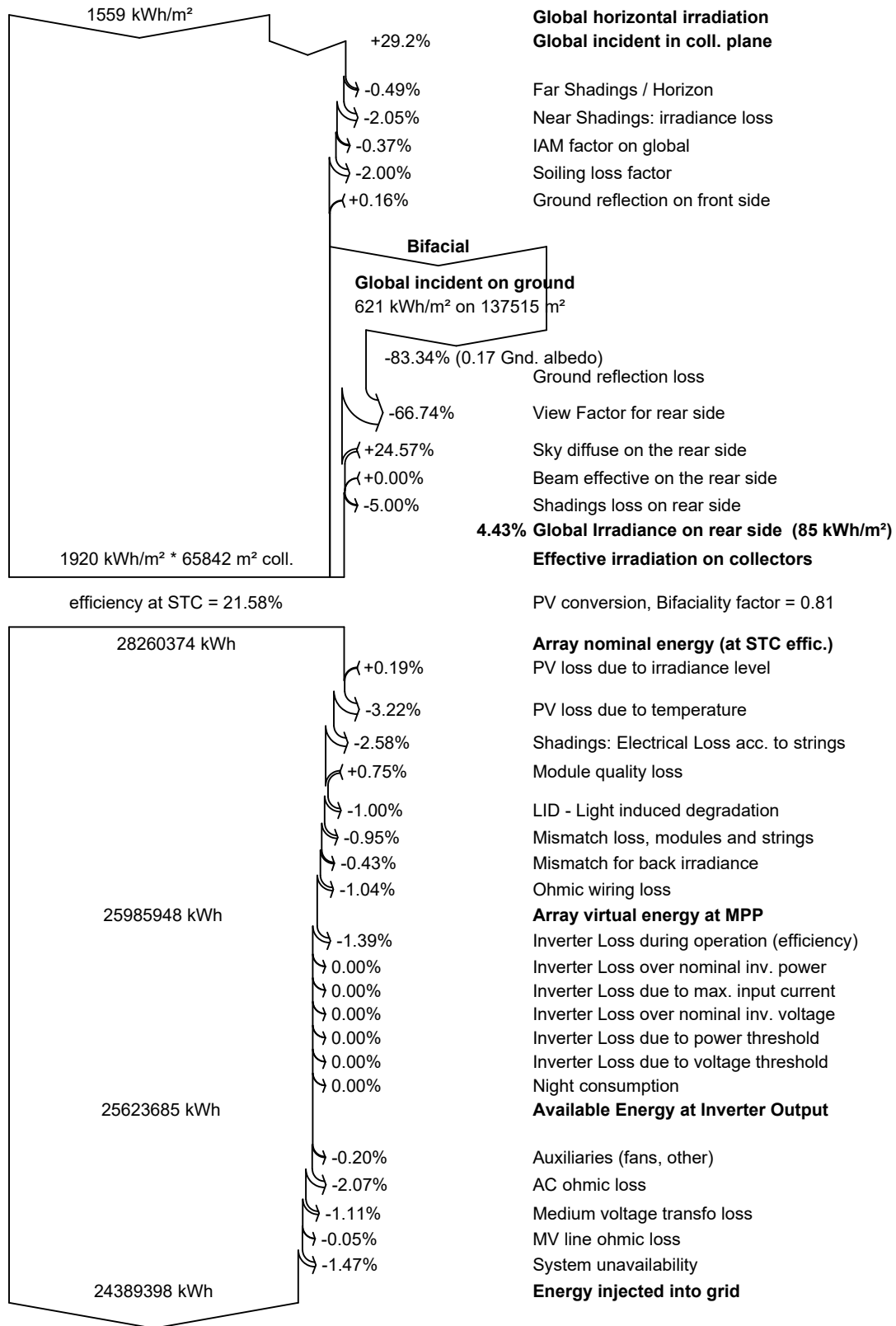
EArray Effective energy at the output of the array

E_Grid Energy injected into grid

PR Performance Ratio



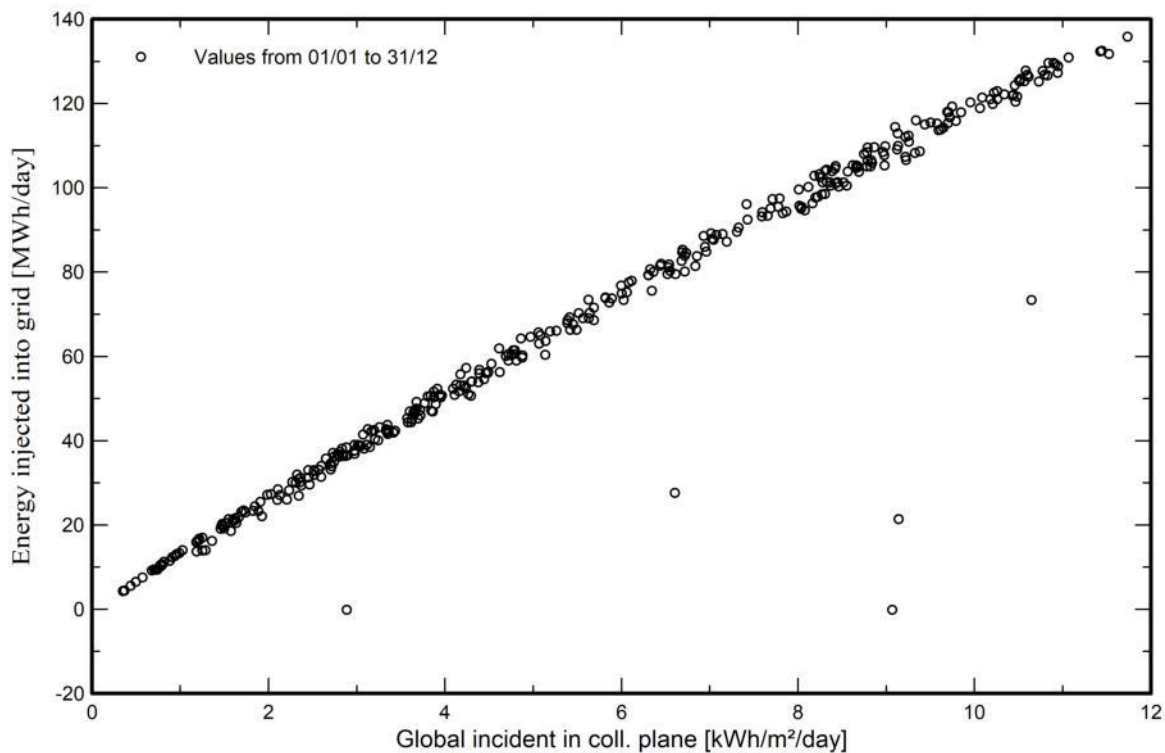
Loss diagram



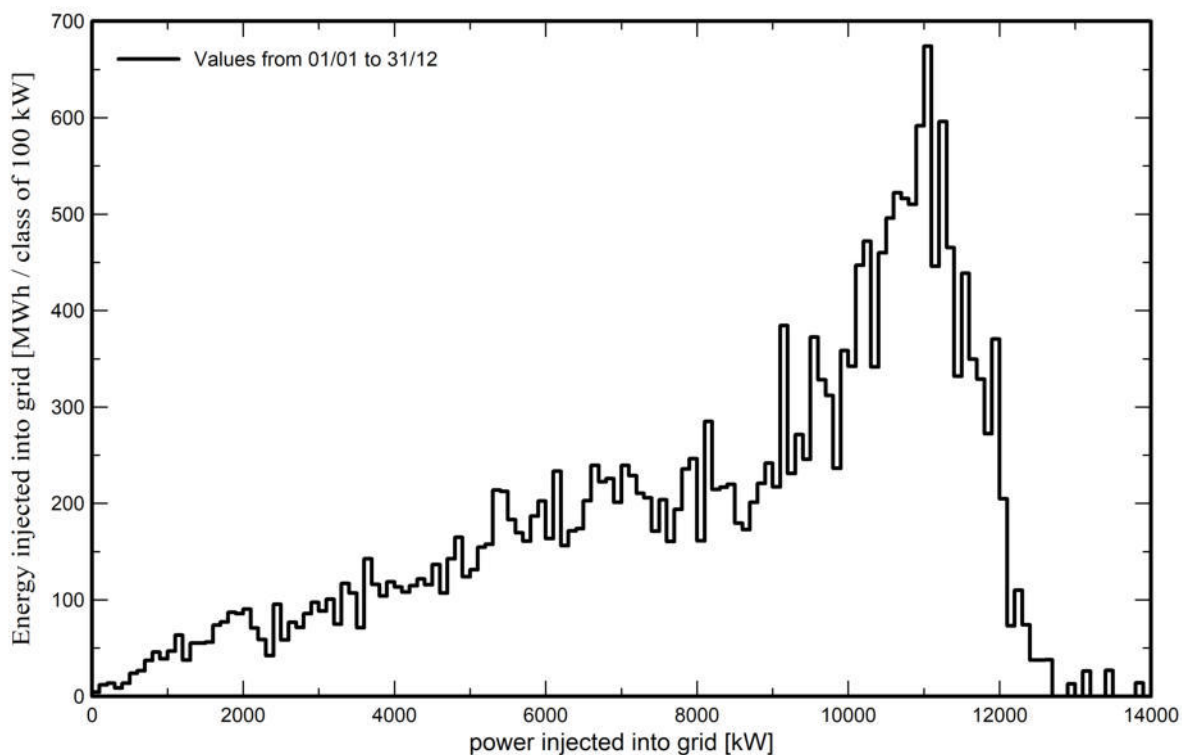


Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema





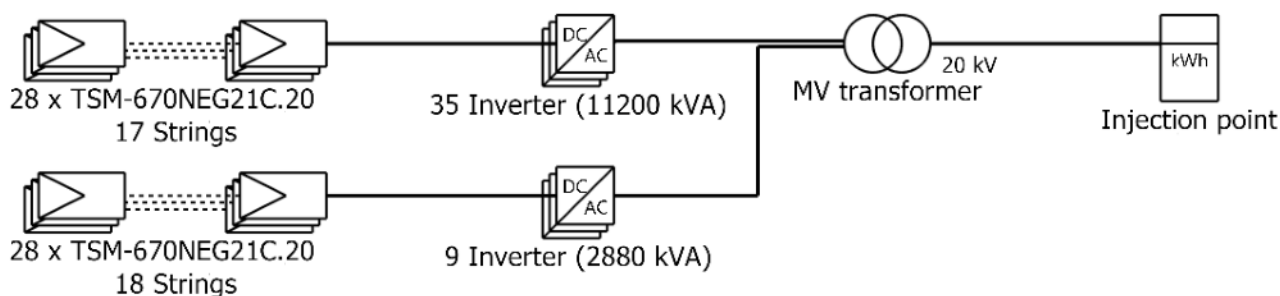
PVsyst V7.3.4

VC0, Simulation date:

31/05/23 09:46

with v7.3.4

Single-line diagram



PV module	TSM-670NEG21C.20
Inverter	SG350HX-20A
String	28 x TSM-670NEG21C.20

ProjectMontorio_CampoA

FULL SERVICE CO
MPANY SRL (Italy)

VC0 : VC0_CampoA.var0

31/05/23

PVsyst - Simulation report

Grid-Connected System

Project: ProjectMontorio_CampoB

Variant: VC0_CampoB_var.0

Tracking system with backtracking

System power: 8686 kWp

Montorio nei Frentani_B - Italia

**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 09:56
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

Project summary**Geographical Site**

Montorio nei Frentani_B

Italia

Situation

Latitude 41.78 °N

Longitude 15.00 °E

Altitude 283 m

Time zone UTC+1

Project settings

Albedo 0.20

Meteo data

Montorio nei Frentani_B

SolarGIS Monthly aver. , period not spec. - Sintetico

System summary**Grid-Connected System****PV Field Orientation****Orientation**

Tracking plane, tilted axis

Avg axis tilt 1.6 °

Avg axis azim. 0 °

Tracking system with backtracking**Tracking algorithm**

Astronomic calculation

Backtracking activated

Near Shadings

According to strings

Electrical effect 100 %

Diffuse shading Automatic

System information**PV Array**

Nb. of modules

12964 units

Pnom total

8686 kWp

Inverters

Nb. of units

25 units

Pnom total

8000 kWac

Pnom ratio

1.086

User's needs

Unlimited load (grid)

Results summary

Produced Energy	15028713 kWh/year	Specific production	1730 kWh/kWp/year	Perf. Ratio PR	85.28 %
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**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 09:56
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

General parameters**Grid-Connected System****PV Field Orientation****Orientation**

Tracking plane, tilted axis

Avg axis tilt 1.6 °

Avg axis azim. 0 °

Tracking system with backtracking**Tracking algorithm**

Astronomic calculation

Backtracking activated

Backtracking array

Nb. of trackers 260 units

Sizes

Tracker Spacing 10.00 m

Collector width 4.79 m

Ground Cov. Ratio (GCR) 47.9 %

Phi min / max. -/+ 50.0 °

Backtracking strategy

Phi limits for BT -/+ 61.2 °

Backtracking pitch 10.00 m

Backtracking width 4.79 m

Models used

Transposition Perez

Diffuse Perez, Meteonorm

Circumsolar separate

Horizon

Average Height 3.2 °

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 10.00 m

Tracker width 4.79 m

GCR 47.9 %

Axis height above ground 2.99 m

Bifacial model definitions

Ground albedo average 0.16

Bifaciality factor 81 %

Rear shading factor 5.0 %

Rear mismatch loss 10.0 %

Shed transparent fraction 0.0 %

Monthly ground albedo values

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
0.13	0.15	0.17	0.18	0.18	0.20	0.20	0.17	0.15	0.13	0.13	0.13	0.16

PV Array Characteristics**PV module**

Manufacturer Trina Solar

Model TSM-670NEG21C.20

(Custom parameters definition)

Unit Nom. Power 670 Wp

Number of PV modules 12964 units

Nominal (STC) 8686 kWp

Modules 463 Strings x 28 In series

At operating cond. (50°C)

Pmpp 8032 kWp

U mpp 1003 V

I mpp 8005 A

Inverter

Manufacturer Sungrow

Model SG350HX-20A

(Custom parameters definition)

Unit Nom. Power 320 kWac

Number of inverters 25 units

Total power 8000 kWac

Operating voltage 500-1500 V

Max. power (=>30°C) 352 kWac

Pnom ratio (DC:AC) 1.09

Power sharing within this inverter



PVsyst V7.3.4

VC0, Simulation date:
31/05/23 09:56
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

PV Array Characteristics

Total PV power

Nominal (STC)	8686 kWp
Total	12964 modules
Module area	40271 m ²
Cell area	37733 m ²

Total inverter power

Total power	8000 kWac
Max. power	8800 kWac
Number of inverters	25 units
Pnom ratio	1.09

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. 2.0 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation

Loss Fraction 1.0 %

Module Quality Loss

Loss Fraction -0.8 %

Module mismatch losses

Loss Fraction 0.8 % at MPP

Strings Mismatch loss

Loss Fraction 0.2 %

IAM loss factor

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.999	0.994	0.969	0.928	0.829	0.585	0.000

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 800 Vac tri
Loss Fraction 3.51 % at STC

Inverter: SG350HX-20A

Wire section (25 Inv.) Alu 25 x 3 x 240 mm²
Average wires length 500 m

MV line up to Injection

MV Voltage 20 kV
Average each inverter
Wires Copper 3 x 185 mm²
Length 1400 m
Loss Fraction 0.10 % at STC

**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 09:56
with v7.3.4

Project: ProjectMontorio_CampoB

Variant: VC0_CampoB_var.0

FULL SERVICE COMPANY SRL (Italy)

AC losses in transformers**MV transfo**

Medium voltage

20 kV

One transfo parameters

Nominal power at STC

2.85 MVA

Iron Loss (24/24 Connexion)

2.68 kVA

Iron loss fraction

0.09 % at STC

Copper loss

30.47 kVA

Copper loss fraction

1.07 % at STC

Coils equivalent resistance

3 x 2.40 mΩ

Operating losses at STC (full system)

Nb. identical MV transfos

3

Nominal power at STC

8.55 MVA

Iron loss (24/24 Connexion)

8.04 kVA

Copper loss

91.40 kVA



Horizon definition

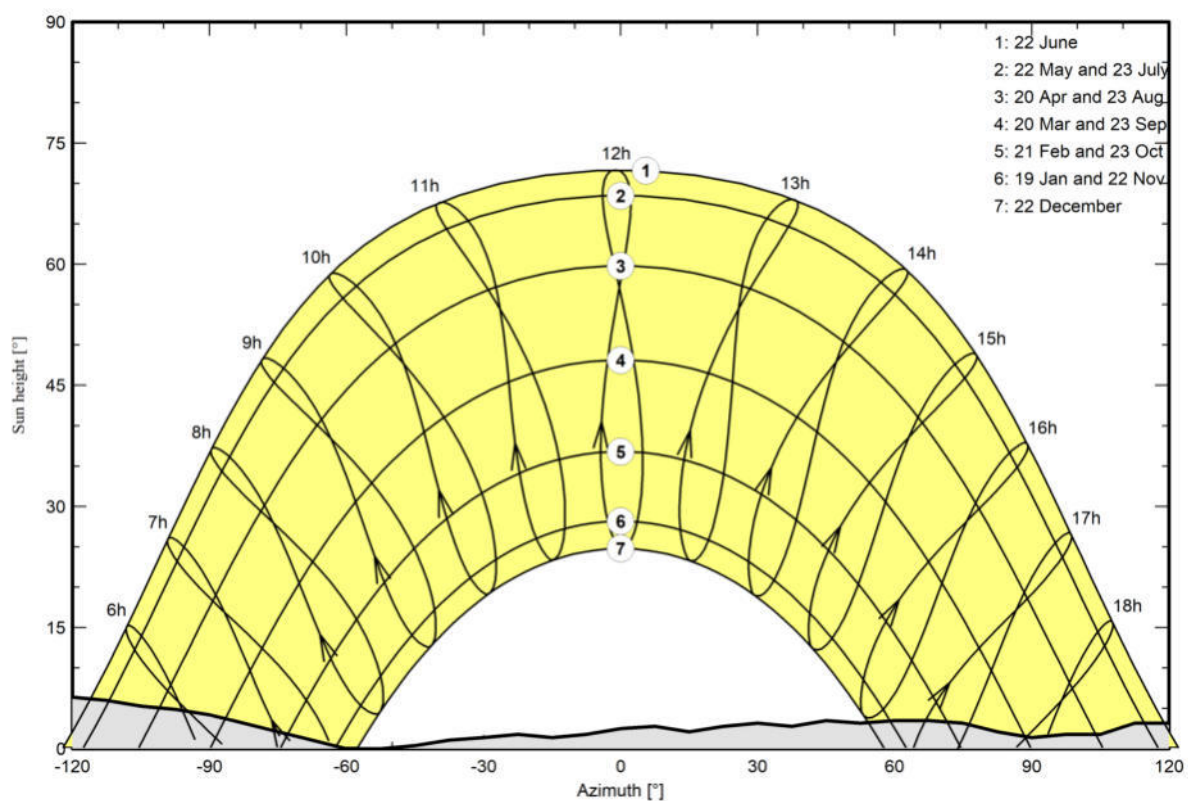
lat:41.781502, lng:14.997014, exported by solargis.info at 2023-04-17T13:32:11.0

Average Height	3.2 °	Albedo Factor	0.88
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-135	-128	-120	-113	-105	-98
Height [°]	5.6	6.0	6.4	6.7	6.7	7.1	6.7	6.7	6.4	6.0	5.3	4.9
Azimuth [°]	-90	-83	-75	-68	-60	-53	-45	-38	-30	-23	-15	-8
Height [°]	4.2	3.2	2.1	1.1	0.0	0.0	0.4	1.1	1.4	1.8	1.4	1.8
Azimuth [°]	0	8	15	23	30	38	45	53	60	68	75	83
Height [°]	2.5	2.8	2.1	2.8	3.2	2.8	3.5	3.2	3.5	3.5	3.2	2.1
Azimuth [°]	90	98	105	113	120	128	135	143	150	158	165	173
Height [°]	1.4	1.8	1.8	3.2	3.2	2.1	1.1	1.4	1.4	2.1	3.5	4.6

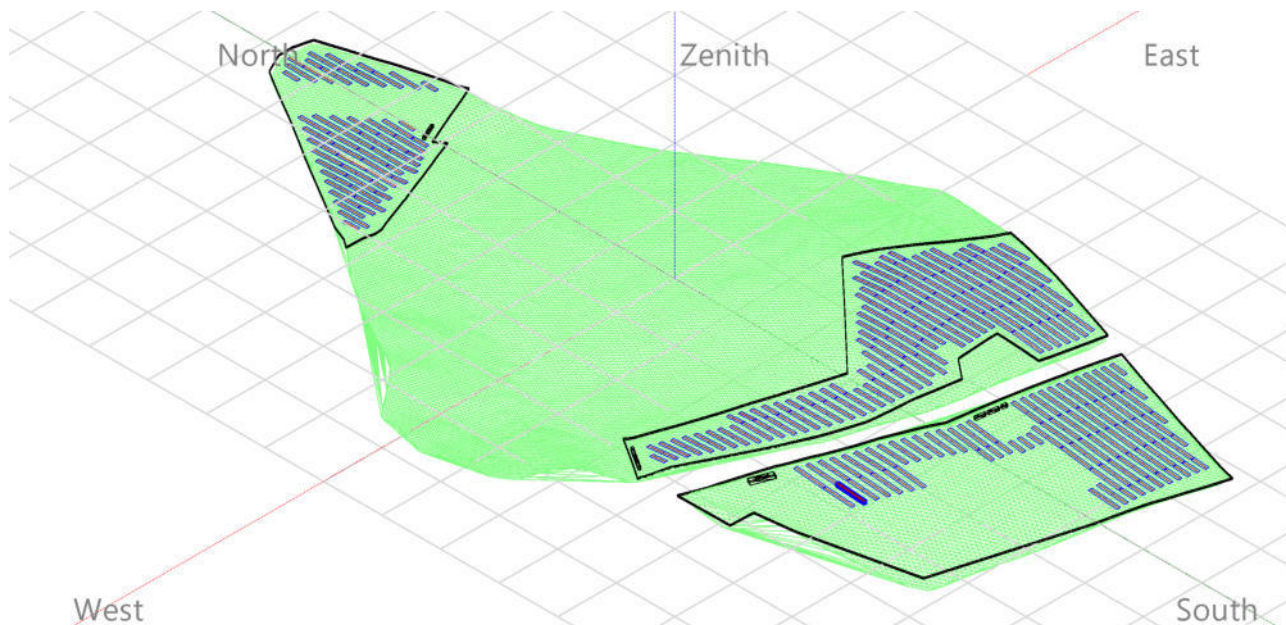
Sun Paths (Height / Azimuth diagram)





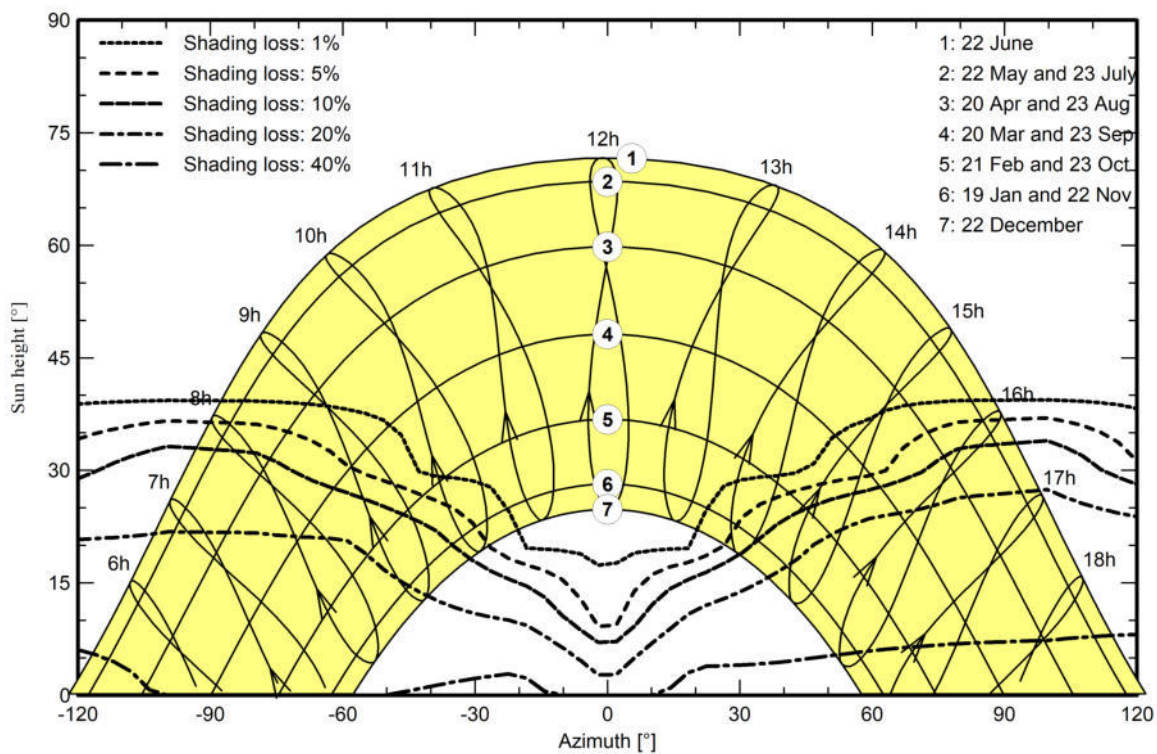
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1





Main results

System Production

Produced Energy 15028713 kWh/year

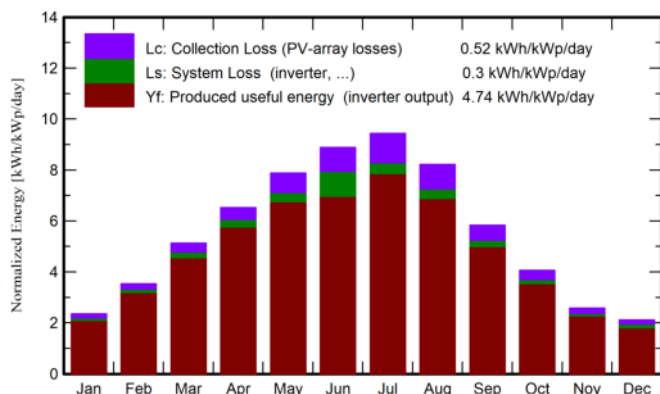
Specific production

1730 kWh/kWp/year

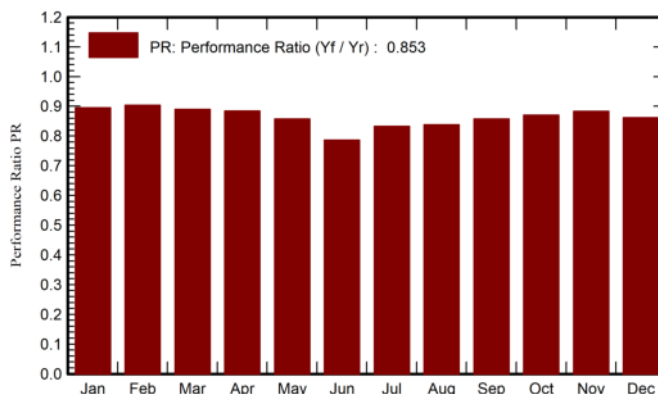
Perf. Ratio PR

85.28 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	kWh	kWh	ratio
January	54.5	25.60	6.60	72.8	68.6	592160	566301	0.895
February	74.4	32.60	7.20	98.9	93.7	811667	777069	0.904
March	121.4	50.60	9.70	159.0	151.3	1289282	1228610	0.890
April	152.6	63.20	13.00	195.8	187.1	1581827	1504632	0.885
May	192.5	77.40	17.60	244.5	233.2	1918047	1819600	0.857
June	209.0	76.30	22.30	266.4	255.2	2074386	1819321	0.786
July	224.0	70.30	24.80	292.6	279.8	2235179	2117389	0.833
August	195.4	65.80	24.60	254.8	244.2	1956293	1854741	0.838
September	135.5	56.40	20.00	175.1	166.8	1370155	1303601	0.857
October	96.5	43.30	15.90	126.1	119.6	998136	953961	0.871
November	58.9	28.50	11.60	77.3	73.0	620712	593273	0.884
December	47.9	22.90	7.80	65.5	61.5	529605	490215	0.861
Year	1562.6	612.90	15.14	2028.8	1934.3	15977449	15028713	0.853

Legends

GlobHor Global horizontal irradiation

DiffHor Horizontal diffuse irradiation

T_Amb Ambient Temperature

GlobInc Global incident in coll. plane

GlobEff Effective Global, corr. for IAM and shadings

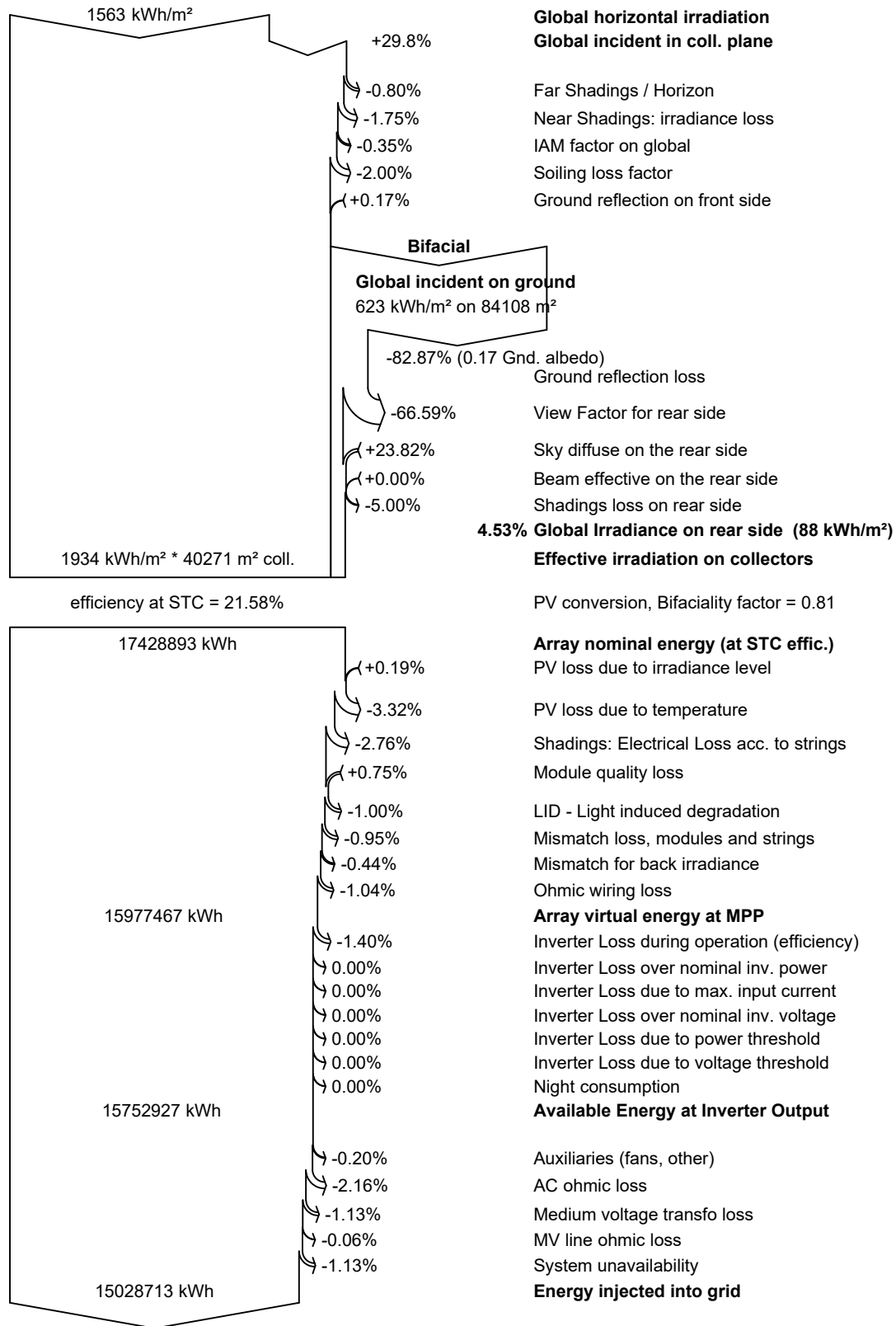
EArray Effective energy at the output of the array

E_Grid Energy injected into grid

PR Performance Ratio



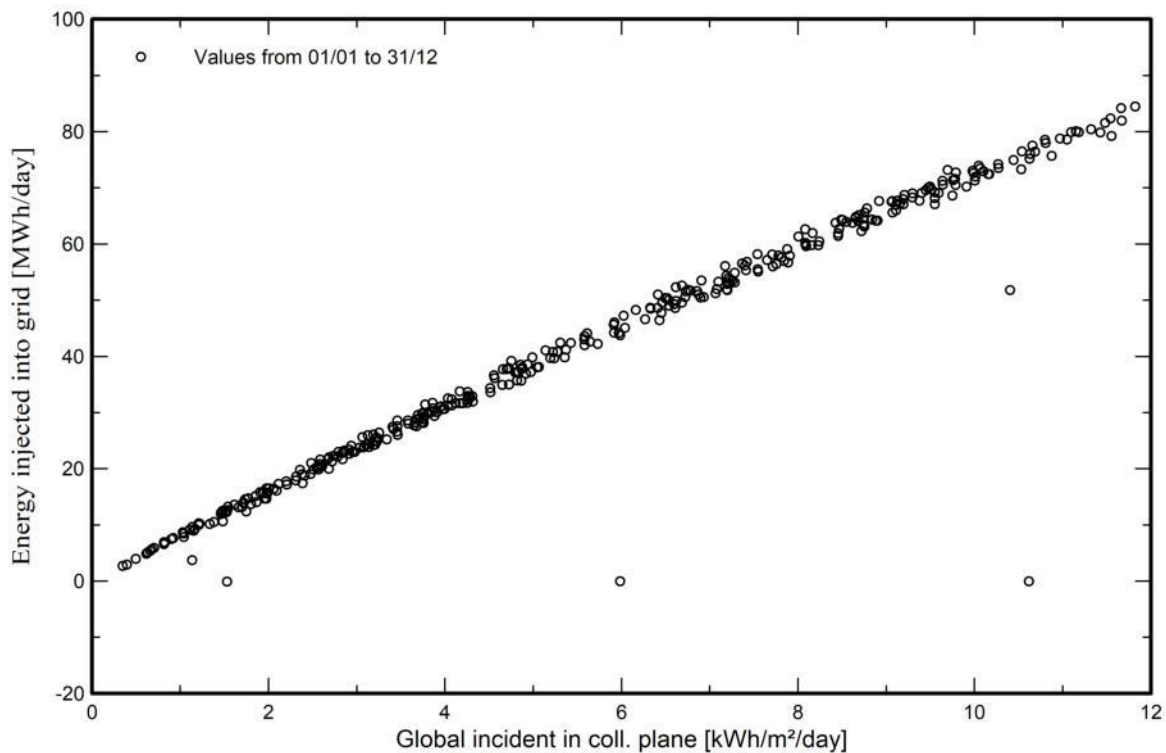
Loss diagram



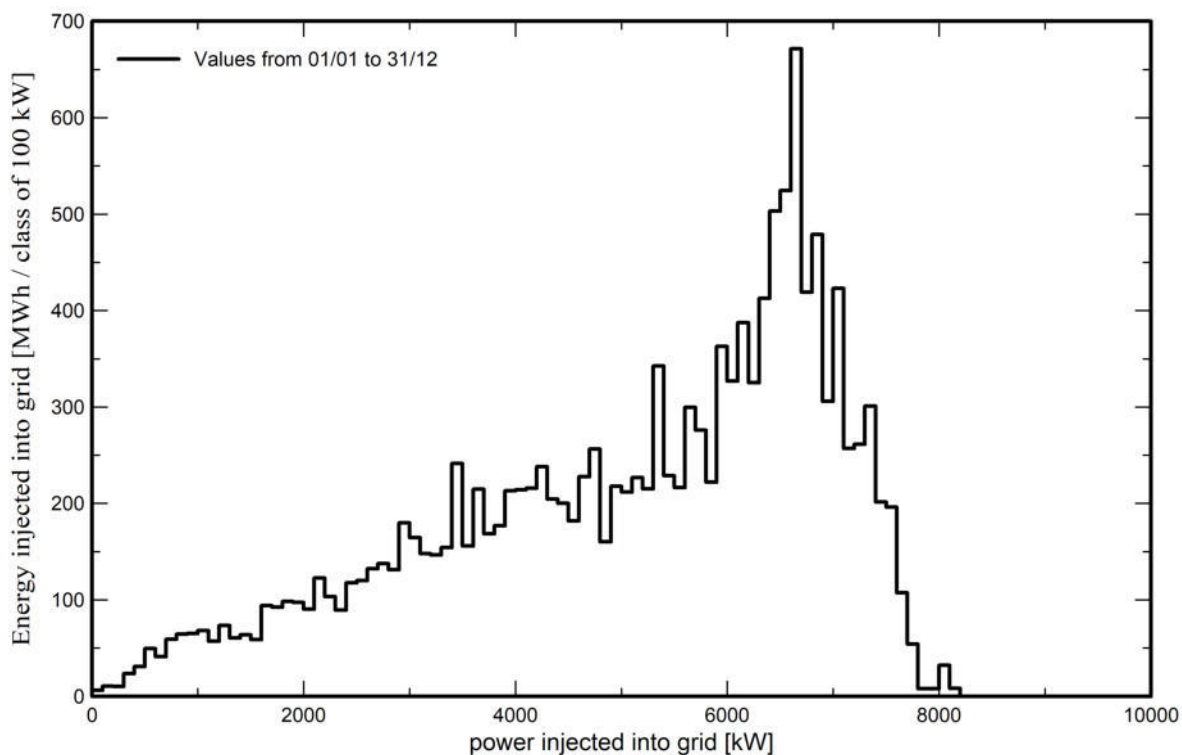


Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema





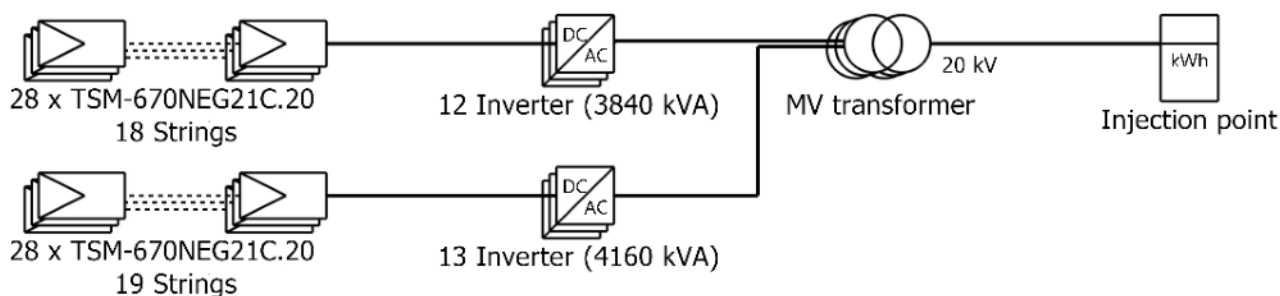
PVsyst V7.3.4

VC0, Simulation date:

31/05/23 09:56

with v7.3.4

Single-line diagram



PV module	TSM-670NEG21C.20
Inverter	SG350HX-20A
String	28 x TSM-670NEG21C.20

ProjectMontorio_CampoB

FULL SERVICE CO
MPANY SRL (Italy)

VC0 : VC0_CampoB_var.0

31/05/23

PVsyst - Simulation report

Grid-Connected System

Project: ProjectMontorio_CampoC

Variant: VC0_CampoC.var0

Tracking system with backtracking

System power: 8311 kWp

Ururi - Italia



Project: ProjectMontorio_CampoC

Variant: VC0_CampoC.var0

PVsyst V7.3.4

VC0, Simulation date:
31/05/23 10:01
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

Project summary

Geographical Site

Ururi
Italia

Situation

Latitude 41.79 °N
Longitude 15.01 °E
Altitude 271 m
Time zone UTC+1

Project settings

Albedo 0.20

Meteo data

Ururi
SolarGIS Monthly aver. , period not spec. - Sintetico

System summary

Grid-Connected System

PV Field Orientation

Orientation

Tracking plane, tilted axis
Avg axis tilt 1.4 °
Avg axis azim. 0 °

Tracking system with backtracking

Tracking algorithm

Astronomic calculation
Backtracking activated

Near Shadings

According to strings
Electrical effect 100 %
Diffuse shading Automatic

System information

PV Array

Nb. of modules 12404 units
Pnom total 8311 kWp

Inverters

Nb. of units 26 units
Pnom total 8320 kWac
Pnom ratio 0.999

User's needs

Unlimited load (grid)

Results summary

Produced Energy 14502168 kWh/year Specific production 1745 kWh/kWp/year Perf. Ratio PR 85.94 %

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Near shading definition - Iso-shadings diagram	7
Main results	8
Loss diagram	9
Predef. graphs	10
Single-line diagram	11

**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 10:01
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

General parameters**Grid-Connected System****PV Field Orientation****Orientation**

Tracking plane, tilted axis

Avg axis tilt 1.4 °

Avg axis azimuth 0 °

Models used

Transposition Perez

Diffuse Perez, Meteonorm

Circumsolar separate

Horizon

Average Height 3.4 °

Tracking system with backtracking**Tracking algorithm**

Astronomic calculation

Backtracking activated

Backtracking array

Nb. of trackers 236 units

Identical arrays

Sizes

Tracker Spacing 10.0 m

Collector width 4.79 m

Ground Cov. Ratio (GCR) 47.9 %

Phi min / max. -/+ 50.0 °

Backtracking strategy

Phi limits for BT -/+ 61.2 °

Backtracking pitch 10.00 m

Backtracking width 4.79 m

Bifacial system

Model 2D Calculation
unlimited trackers

Bifacial model geometry

Tracker Spacing 10.00 m

Tracker width 4.79 m

GCR 47.9 %

Axis height above ground 2.10 m

Bifacial model definitions

Ground albedo average 0.16

Bifaciality factor 81 %

Rear shading factor 5.0 %

Rear mismatch loss 10.0 %

Shed transparent fraction 0.0 %

Monthly ground albedo values

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
0.13	0.15	0.17	0.18	0.18	0.21	0.20	0.17	0.15	0.13	0.13	0.13	0.16

PV Array Characteristics**PV module**

Manufacturer Trina Solar

Model TSM-670NEG21C.20

(Custom parameters definition)

Unit Nom. Power 670 Wp

Number of PV modules 12404 units

Nominal (STC) 8311 kWp

Modules 443 Strings x 28 In series

At operating cond. (50°C)

Pmpp 7685 kWp

U mpp 1003 V

I mpp 7659 A

Inverter

Manufacturer Sungrow

Model SG350HX-20A

(Custom parameters definition)

Unit Nom. Power 320 kWac

Number of inverters 26 units

Total power 8320 kWac

Operating voltage 500-1500 V

Max. power (=>30°C) 352 kWac

Pnom ratio (DC:AC) 1.00

Power sharing within this inverter



PVsyst V7.3.4

VC0, Simulation date:
31/05/23 10:01
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

PV Array Characteristics

Total PV power

Nominal (STC)	8311 kWp
Total	12404 modules
Module area	38531 m ²
Cell area	36103 m ²

Total inverter power

Total power	8320 kWac
Max. power	9152 kWac
Number of inverters	26 units
Pnom ratio	1.00

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. 2.1 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation

Loss Fraction 1.0 %

Module Quality Loss

Loss Fraction -0.8 %

Module mismatch losses

Loss Fraction 0.8 % at MPP

Strings Mismatch loss

Loss Fraction 0.2 %

IAM loss factor

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.999	0.994	0.969	0.928	0.829	0.585	0.000

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 800 Vac tri
Loss Fraction 2.26 % at STC

Inverter: SG350HX-20A

Wire section (26 Inv.) Alu 26 x 3 x 240 mm²
Average wires length 350 m

MV line up to Injection

MV Voltage 20 kV
Average each inverter
Wires Copper 3 x 120 mm²
Length 350 m
Loss Fraction 0.06 % at STC



AC losses in transformers

MV transfo

Medium voltage

20 kV

One transfo parameters

Nominal power at STC

4.09 MVA

Iron Loss (24/24 Connexion)

4.17 kVA

Iron loss fraction

0.10 % at STC

Copper loss

40.22 kVA

Copper loss fraction

0.98 % at STC

Coils equivalent resistance

3 x 1.54 mΩ

Operating losses at STC (full system)

Nb. identical MV transfos

2

Nominal power at STC

8.18 MVA

Iron loss (24/24 Connexion)

8.35 kVA

Copper loss

80.45 kVA



PVsyst V7.3.4

VC0, Simulation date:
31/05/23 10:01
with v7.3.4

FULL SERVICE COMPANY SRL (Italy)

Horizon definition

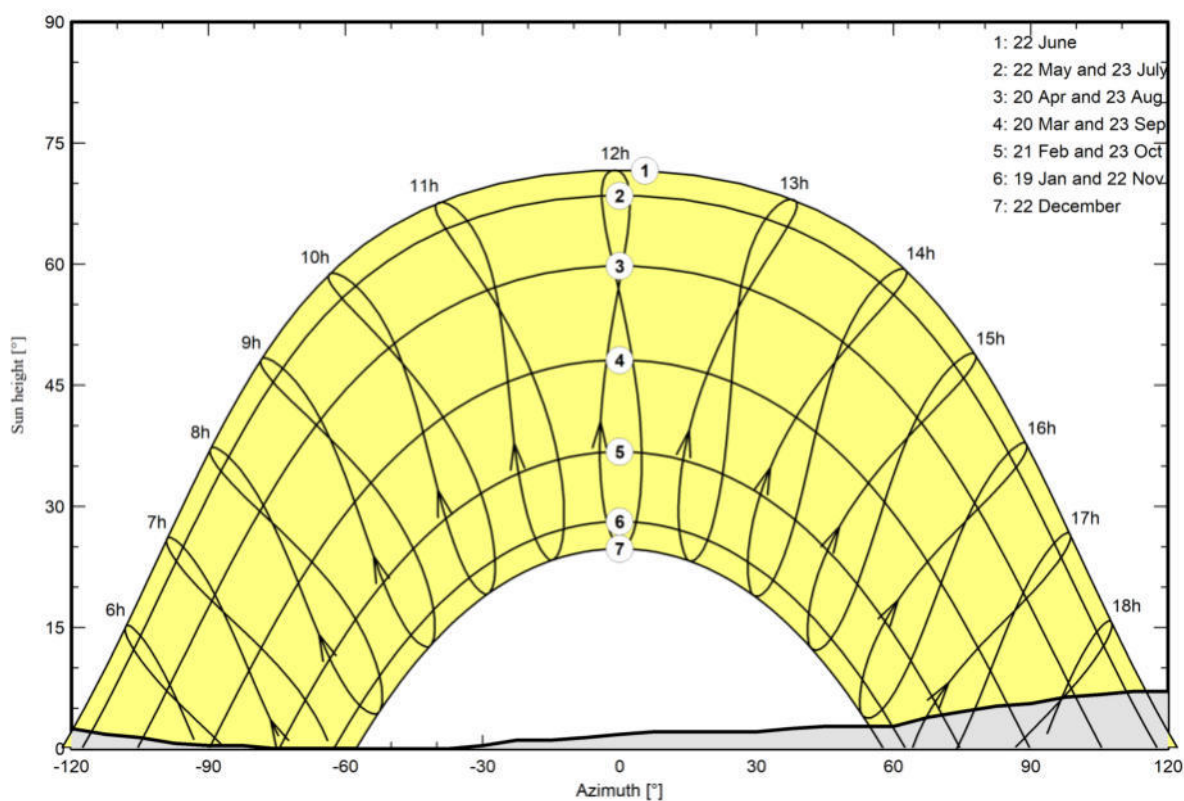
lat:41.794925, lng:15.00698, exported by solargis.info at 2023-04-17T13:33:44.05

Average Height	3.4 °	Albedo Factor	0.75
Diffuse Factor	0.95	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-135	-128	-120	-113	-105	-98
Height [°]	6.4	6.0	5.6	4.9	4.6	4.2	3.5	3.2	2.5	1.8	1.4	0.7
Azimuth [°]	-90	-83	-75	-68	-60	-53	-45	-38	-30	-23	-15	-8
Height [°]	0.4	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	1.1	1.1	1.4
Azimuth [°]	0	8	15	23	30	38	45	53	60	68	75	83
Height [°]	1.8	2.1	2.1	2.1	2.1	2.5	2.8	2.8	2.8	3.9	4.6	5.3
Azimuth [°]	90	98	105	113	120	128	135	143	150	158	165	173
Height [°]	5.6	6.4	6.7	7.1	7.1	7.1	7.1	7.1	7.1	7.1	6.7	6.4

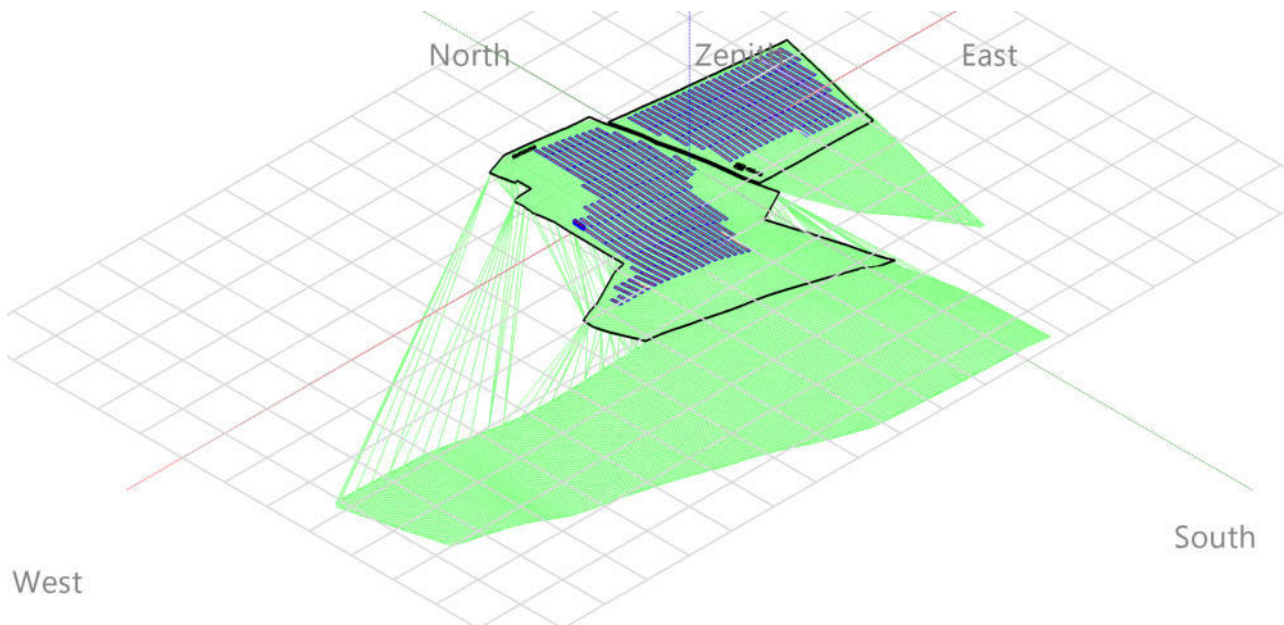
Sun Paths (Height / Azimuth diagram)





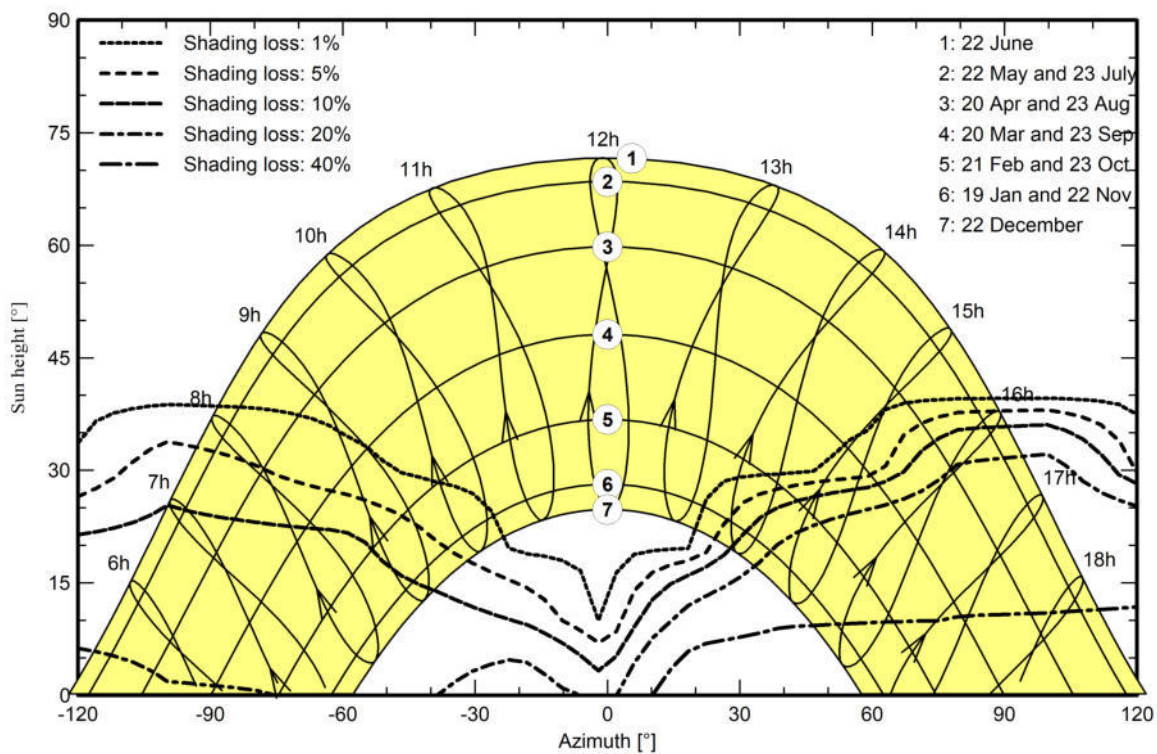
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1





Main results

System Production

Produced Energy

14502168 kWh/year

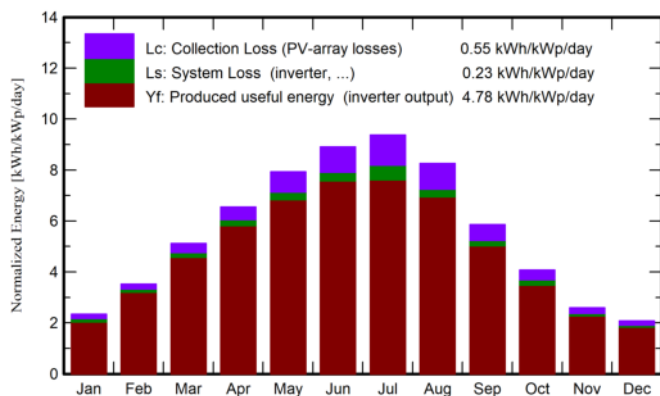
Specific production

1745 kWh/kWp/year

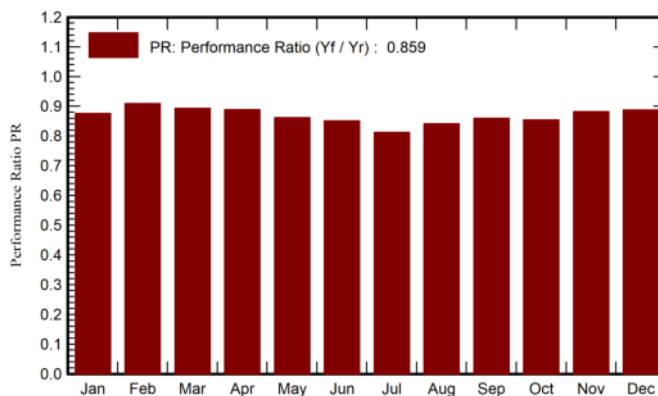
Perf. Ratio PR

85.94 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	kWh	kWh	ratio
January	54.5	25.60	6.70	72.4	68.1	560940	527126	0.876
February	74.5	32.50	7.30	98.8	93.4	774775	746071	0.909
March	121.8	50.80	9.70	158.8	150.6	1226371	1177972	0.893
April	153.0	63.20	12.90	196.3	187.3	1511161	1450852	0.889
May	192.9	77.30	17.60	245.9	234.2	1837929	1760857	0.862
June	209.8	76.00	22.30	267.3	255.5	1973588	1890843	0.851
July	224.5	70.20	24.70	290.7	277.7	2110750	1961401	0.812
August	195.9	65.70	24.60	256.1	244.8	1869216	1790582	0.841
September	135.9	56.30	20.00	175.6	166.6	1306476	1254272	0.859
October	96.7	43.40	15.90	126.4	119.4	951365	897233	0.854
November	58.8	28.50	11.70	77.7	73.1	592994	569671	0.882
December	47.9	22.90	7.79	64.4	60.2	494683	475286	0.888
Year	1566.2	612.40	15.15	2030.5	1930.9	15210249	14502168	0.859

Legends

GlobHor Global horizontal irradiation

DiffHor Horizontal diffuse irradiation

T_Amb Ambient Temperature

GlobInc Global incident in coll. plane

GlobEff Effective Global, corr. for IAM and shadings

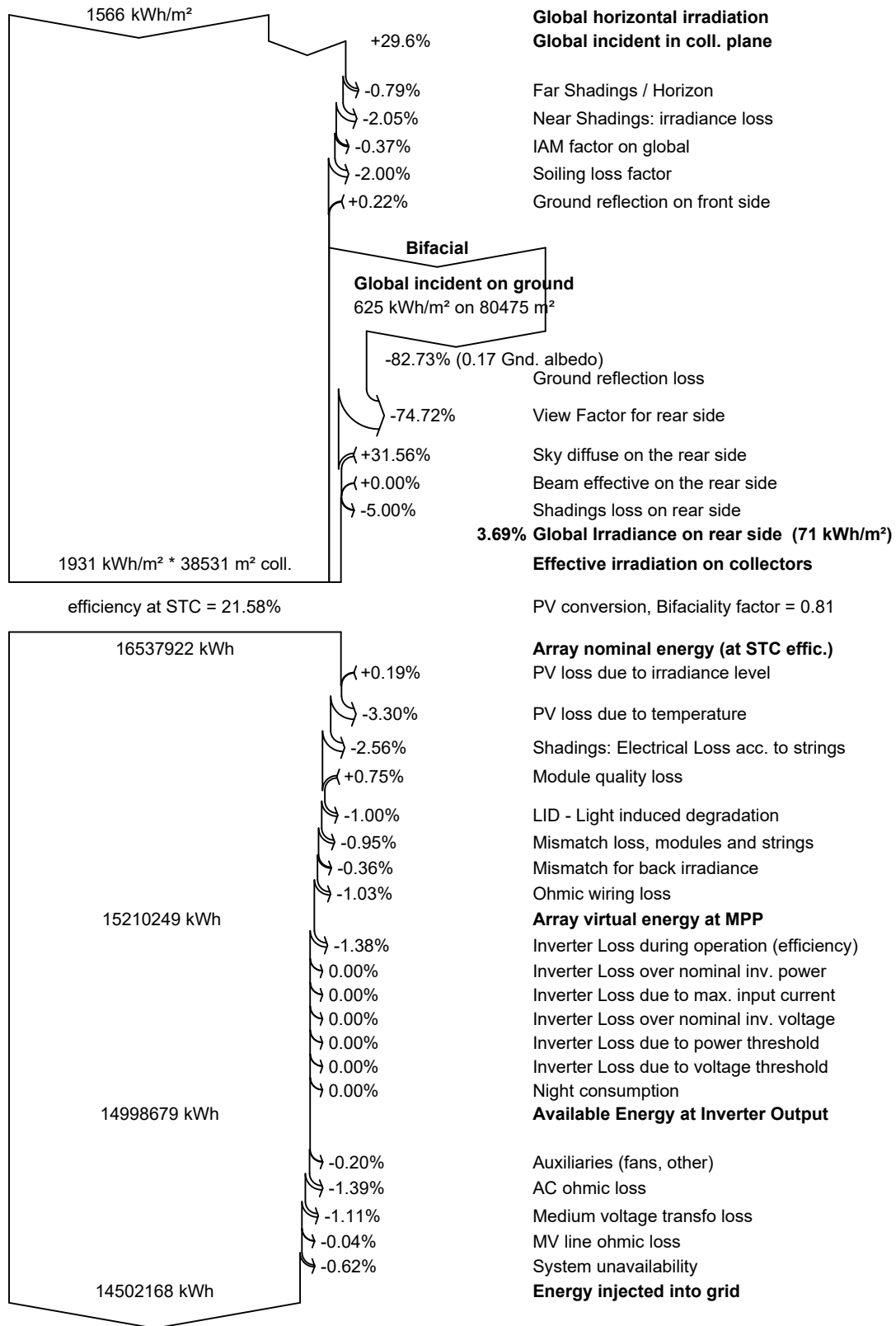
EArray Effective energy at the output of the array

E_Grid Energy injected into grid

PR Performance Ratio



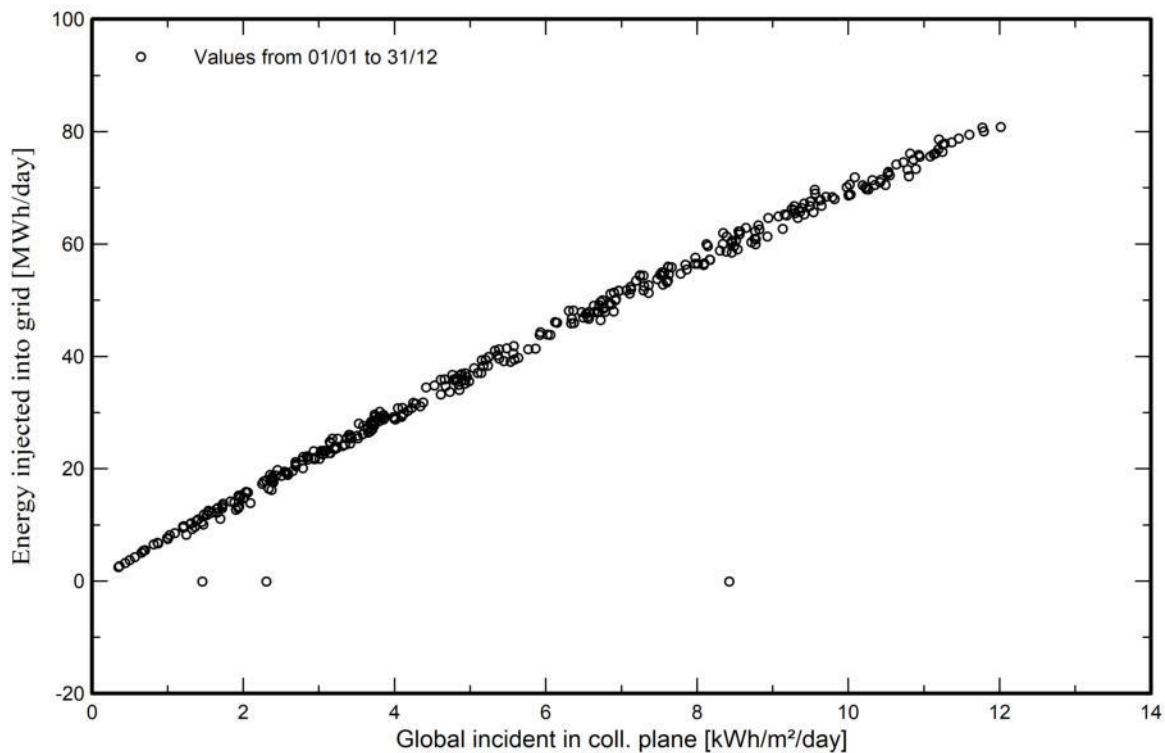
Loss diagram



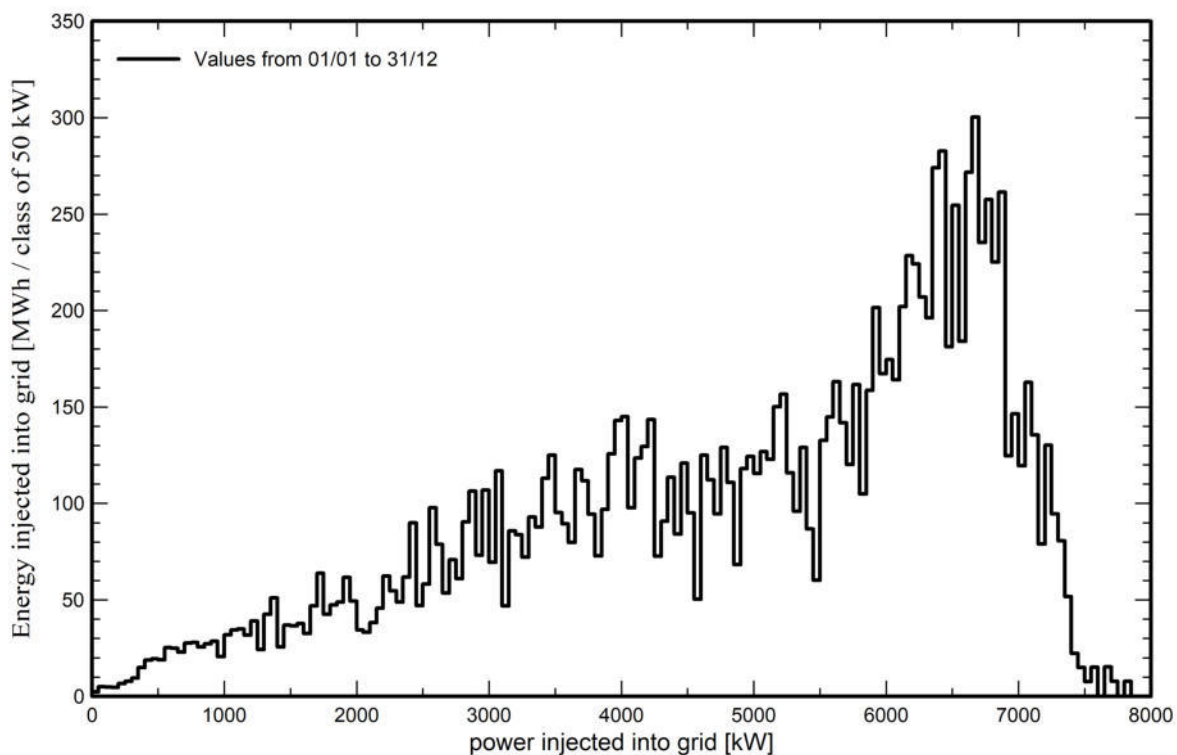


Predef. graphs

Diagramma giornaliero entrata/uscita



Distribuzione potenza in uscita sistema

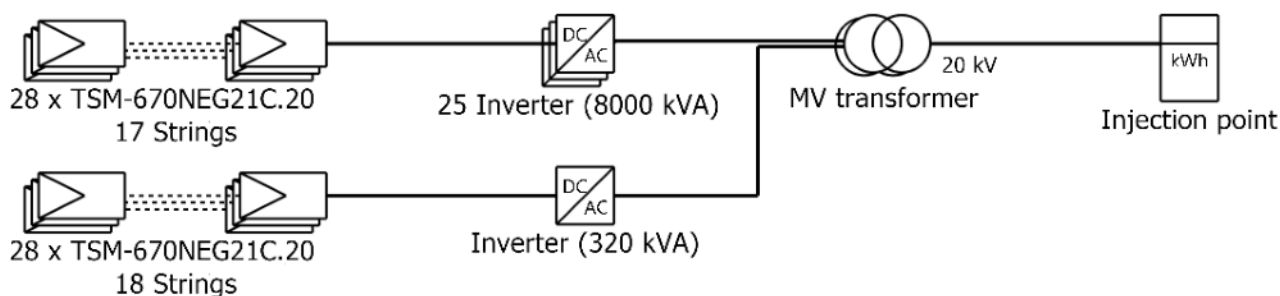




PVsyst V7.3.4

VC0, Simulation date:
31/05/23 10:01
with v7.3.4

Single-line diagram



PV module	TSM-670NEG21C.20
Inverter	SG350HX-20A
String	28 x TSM-670NEG21C.20

ProjectMontorio_CampoC

FULL SERVICE CO
MPANY SRL (Italy)

VC0 : VC0_CampoC.var0

31/05/23

PVsyst - Simulation report

Grid-Connected System

Project: Project Montorio_CampoD

Variant: V0_campoA_var.0

Tracking system with backtracking

System power: 10.88 MWp

Rotello - Italy

Autore

Kiwa Moroni S.r.l (Italy)

**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 10:39
with v7.3.4

Kiwa Moroni S.r.l (Italy)

Project summary**Geographical Site****Rotello**

Italy

Situation

Latitude 41.78 °N

Longitude 15.04 °E

Altitude 173 m

Time zone UTC+1

Project settings

Albedo 0.20

Meteo data

Rotello

SolarGIS Monthly aver. , period not spec. - Sintetico

System summary**Grid-Connected System****Tracking system with backtracking****PV Field Orientation****Orientation**

Tracking plane, tilted axis

Avg axis tilt 3.1 °

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

16240 units

Pnom total

10.88 MWp

Inverters

Nb. of units

34 units

Pnom total

10.88 MWac

Pnom ratio

1.000

User's needs

Unlimited load (grid)

Results summary

Produced Energy	18925616 kWh/year	Specific production	1739 kWh/kWp/year	Perf. Ratio PR	84.76 %
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**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 10:39
with v7.3.4

Kiwa Moroni S.r.l (Italy)

General parameters**Grid-Connected System****PV Field Orientation****Orientation**

Tracking plane, tilted axis

Avg axis tilt 3.1 °

Avg axis azim. 0 °

Models used

Transposition Perez

Diffuse Perez, Meteonorm

Circumsolar separate

Horizon

Average Height 3.1 °

Tracking system with backtracking**Tracking algorithm**

Astronomic calculation

Backtracking activated

Backtracking array

Nb. of trackers 308 units

Sizes

Tracker Spacing 10.00 m

Collector width 4.79 m

Ground Cov. Ratio (GCR) 47.9 %

Phi min / max. -/+ 50.0 °

Backtracking strategy

Phi limits for BT -/+ 61.2 °

Backtracking pitch 10.00 m

Backtracking width 4.79 m

Bifacial system

Model 2D Calculation
unlimited trackers

Bifacial model geometry

Tracker Spacing 10.00 m

Tracker width 4.79 m

GCR 47.9 %

Axis height above ground 2.99 m

Bifacial model definitions

Ground albedo average 0.15

Bifaciality factor 81 %

Rear shading factor 5.0 %

Rear mismatch loss 10.0 %

Shed transparent fraction 0.0 %

Monthly ground albedo values

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
0.13	0.14	0.16	0.17	0.17	0.20	0.19	0.16	0.14	0.12	0.11	0.12	0.15

PV Array Characteristics**PV module**

Manufacturer Trina Solar

Model TSM-670NEG21C.20

(Custom parameters definition)

Unit Nom. Power 670 Wp

Number of PV modules 16240 units

Nominal (STC) 10.88 MWp

Modules 580 Strings x 28 In series

At operating cond. (50°C)

Pmpp 10.06 MWp

U mpp 1003 V

I mpp 10028 A

Inverter

Manufacturer Sungrow

Model SG350HX-20A

(Custom parameters definition)

Unit Nom. Power 320 kWac

Number of inverters 34 units

Total power 10880 kWac

Operating voltage 500-1500 V

Max. power (=>30°C) 352 kWac

Pnom ratio (DC:AC) 1.00

Power sharing within this inverter



PVsyst V7.3.4

VC0, Simulation date:
31/05/23 10:39
with v7.3.4

Kiwa Moroni S.r.l (Italy)

PV Array Characteristics

Total PV power

Nominal (STC)	10881 kWp
Total	16240 modules
Module area	50447 m ²
Cell area	47268 m ²

Total inverter power

Total power	10880 kWac
Max. power	11968 kWac
Number of inverters	34 units
Pnom ratio	1.00

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. 1.6 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation

Loss Fraction 1.0 %

Module Quality Loss

Loss Fraction -0.8 %

Module mismatch losses

Loss Fraction 0.8 % at MPP

Strings Mismatch loss

Loss Fraction 0.2 %

IAM loss factor

Incidence effect (IAM): User defined profile

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.999	0.994	0.969	0.928	0.829	0.585	0.000

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 800 Vac tri
Loss Fraction 2.91 % at STC

Inverter: SG350HX-20A

Wire section (34 Inv.) Alu 34 x 3 x 240 mm²
Average wires length 450 m

MV line up to Injection

MV Voltage 20 kV
Average each inverter
Wires Copper 3 x 150 mm²
Length 750 m
Loss Fraction 0.08 % at STC

**PVsyst V7.3.4**

VC0, Simulation date:
31/05/23 10:39
with v7.3.4

Project: Project Montorio_CampoD

Variant: V0_campoA_var.0

Kiwa Moroni S.r.l (Italy)

AC losses in transformers**MV transfo**

Medium voltage 20 kV

One transfo parameters

Nominal power at STC	3.57 MVA
Iron Loss (24/24 Connexion)	3.64 kVA
Iron loss fraction	0.10 % at STC
Copper loss	35.18 kVA
Copper loss fraction	0.99 % at STC
Coils equivalent resistance	3 x 1.77 mΩ

Operating losses at STC (full system)

Nb. identical MV transfos	3
Nominal power at STC	10.71 MVA
Iron loss (24/24 Connexion)	10.93 kVA
Copper loss	105.54 kVA



PVsyst V7.3.4

VC0, Simulation date:
31/05/23 10:39
with v7.3.4

Kiwa Moroni S.r.l (Italy)

Horizon definition

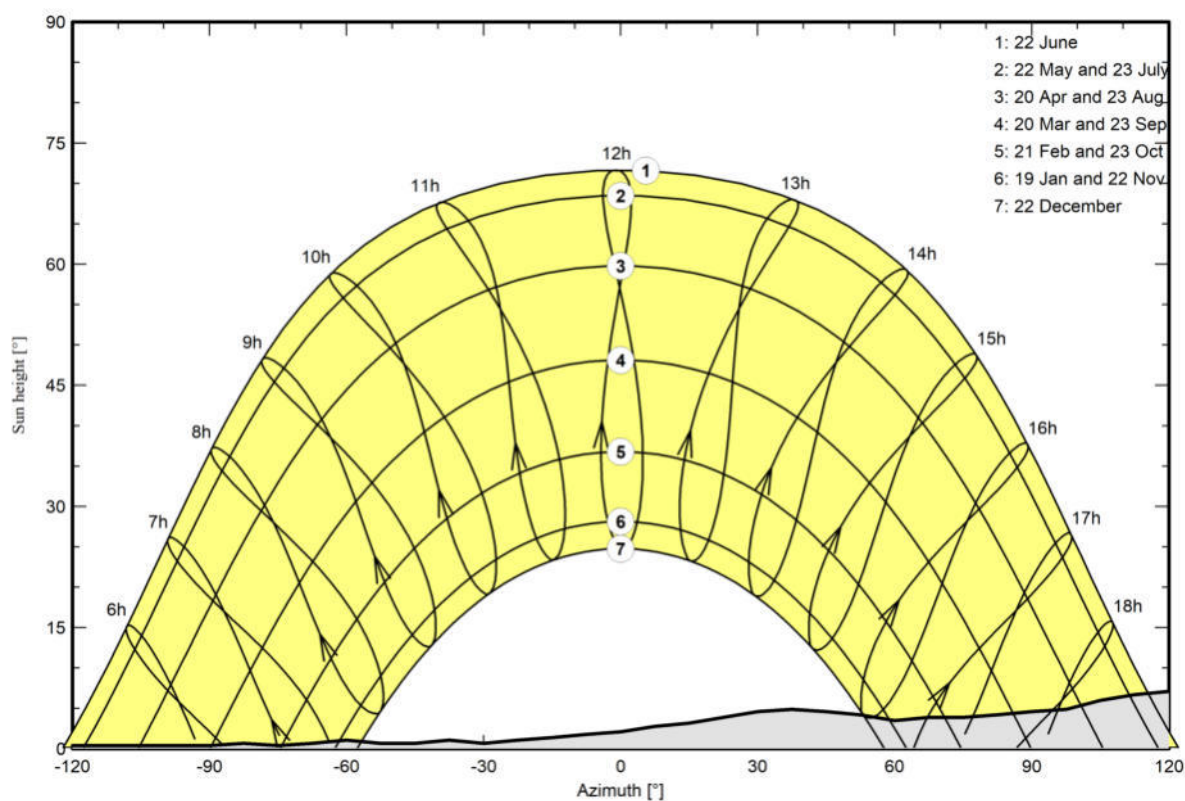
lat:41.784852, lng:15.036079, exported by solargis.info at 2023-04-17T13:35:02.6

Average Height	3.1 °	Albedo Factor	0.74
Diffuse Factor	0.95	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-180	-173	-165	-158	-150	-143	-135	-128	-120	-113	-105	-98
Height [°]	4.9	3.9	2.8	1.8	1.1	0.4	0.0	0.0	0.4	0.4	0.4	0.4
Azimuth [°]	-90	-83	-75	-68	-60	-53	-45	-38	-30	-23	-15	-8
Height [°]	0.4	0.7	0.4	0.7	1.1	0.7	0.7	1.1	0.7	1.1	1.4	1.8
Azimuth [°]	0	8	15	23	30	38	45	53	60	68	75	83
Height [°]	2.1	2.8	3.2	3.9	4.6	4.9	4.6	4.2	3.5	3.9	3.9	4.2
Azimuth [°]	90	98	105	113	120	128	135	143	150	158	165	173
Height [°]	4.6	4.9	6.0	6.7	7.1	7.4	7.4	7.4	7.1	6.4	6.0	5.3

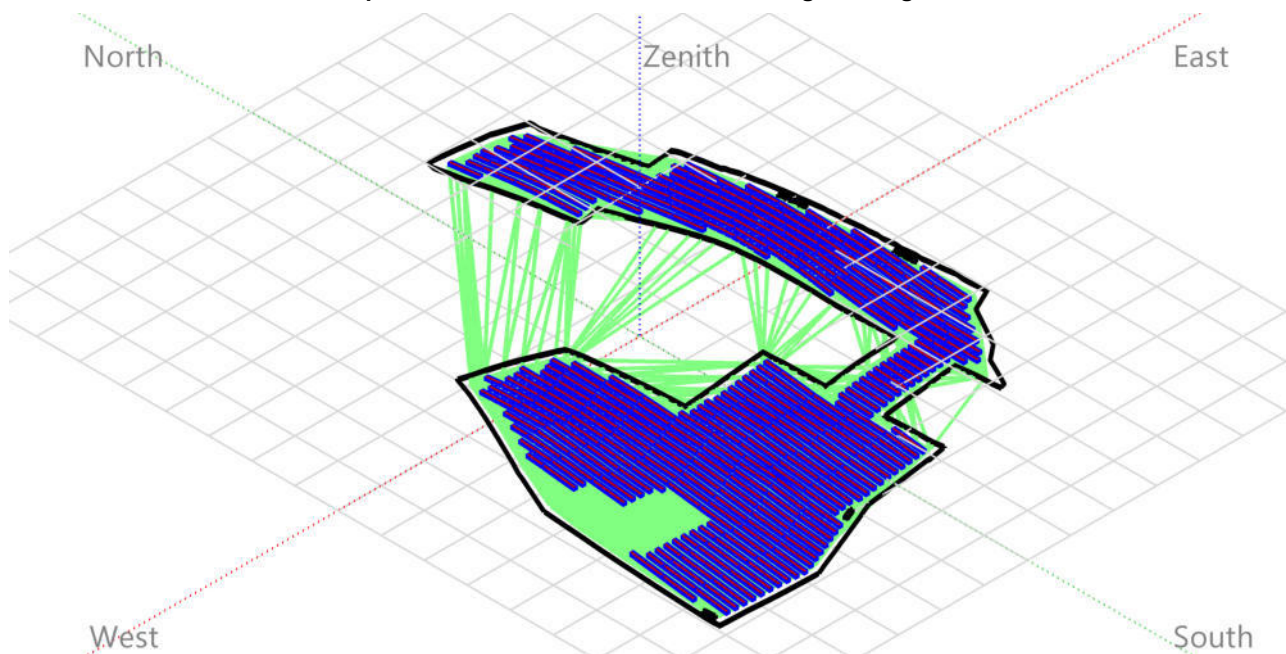
Sun Paths (Height / Azimuth diagram)





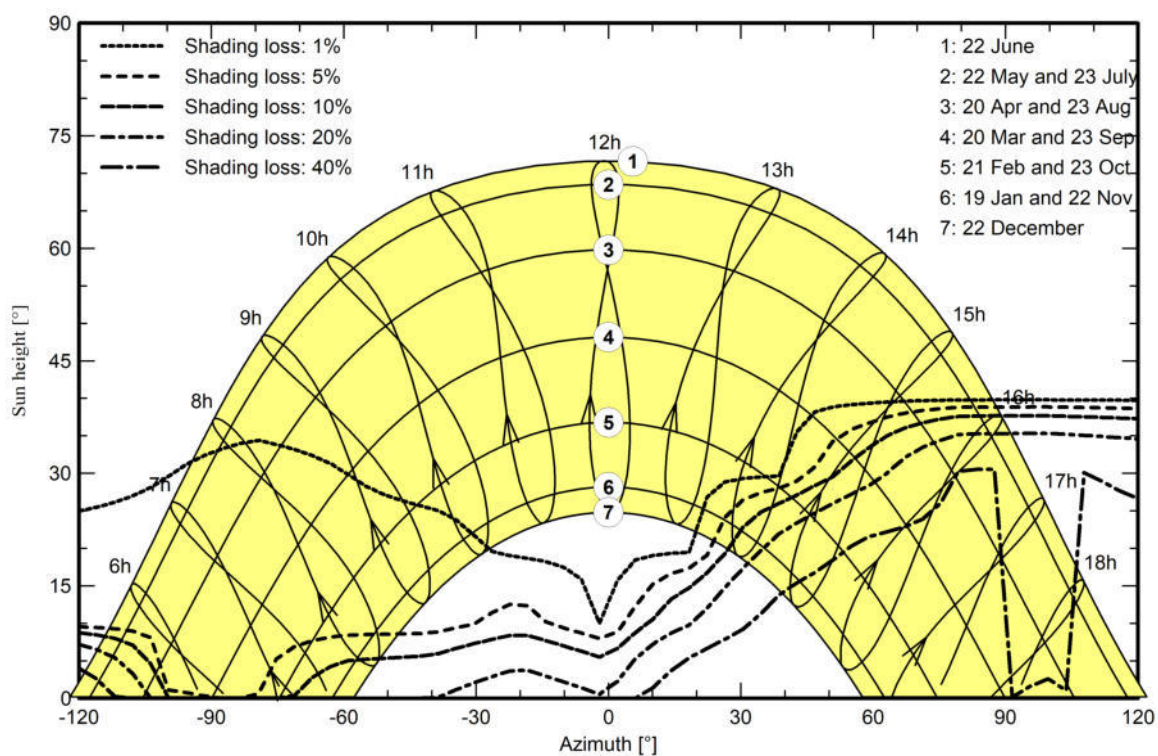
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1





Main results

System Production

Produced Energy

18925616 kWh/year

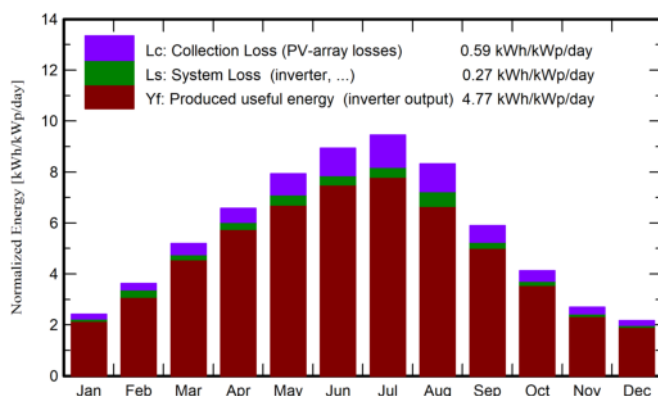
Specific production

1739 kWh/kWp/year

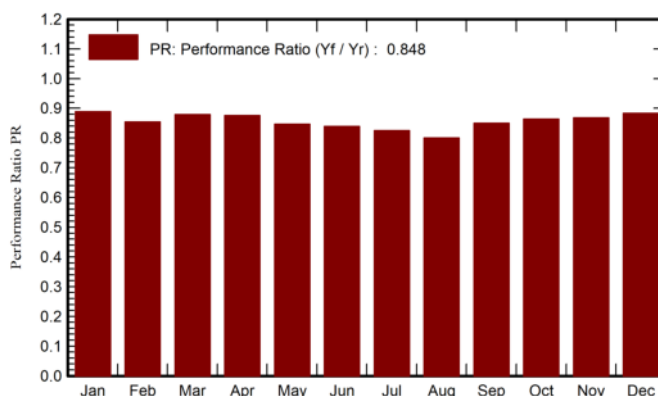
Perf. Ratio PR

84.76 %

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m ²	DiffHor kWh/m ²	T_Amb °C	GlobInc kWh/m ²	GlobEff kWh/m ²	EArray kWh	E_Grid kWh	PR ratio
January	54.7	25.70	7.40	75.0	69.5	757299	725150	0.889
February	74.7	32.70	8.00	101.3	94.7	1033036	941657	0.854
March	122.0	51.00	10.40	160.9	150.7	1609787	1539077	0.879
April	153.0	63.40	13.60	197.3	186.1	1968089	1879814	0.875
May	192.8	77.60	18.30	245.9	231.9	2401138	2265502	0.847
June	209.7	76.30	23.00	268.0	253.0	2569752	2448376	0.839
July	224.7	70.30	25.40	293.1	276.2	2763761	2632430	0.825
August	195.9	65.90	25.30	257.8	243.5	2442419	2246255	0.801
September	136.4	56.60	20.70	177.0	166.4	1714259	1637372	0.850
October	96.9	43.60	16.50	127.8	119.4	1255070	1201562	0.864
November	58.8	28.60	12.30	80.8	74.7	796570	763072	0.868
December	48.0	23.00	8.60	67.1	61.6	672635	645349	0.883
Year	1567.6	614.70	15.84	2052.2	1927.7	19983814	18925616	0.848

Legends

GlobHor Global horizontal irradiation

DiffHor Horizontal diffuse irradiation

T_Amb Ambient Temperature

GlobInc Global incident in coll. plane

GlobEff Effective Global, corr. for IAM and shadings

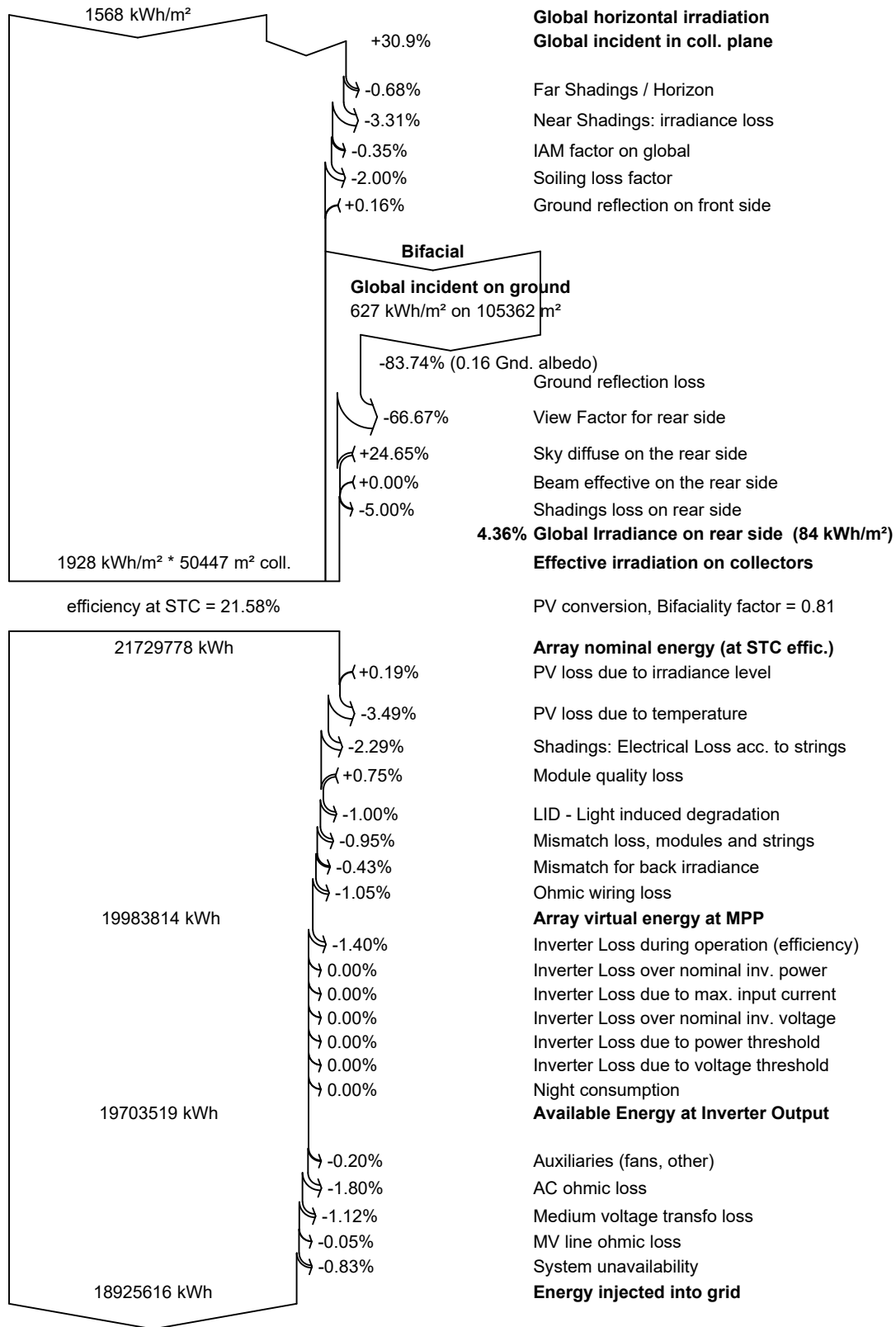
EArray Effective energy at the output of the array

E_Grid Energy injected into grid

PR Performance Ratio



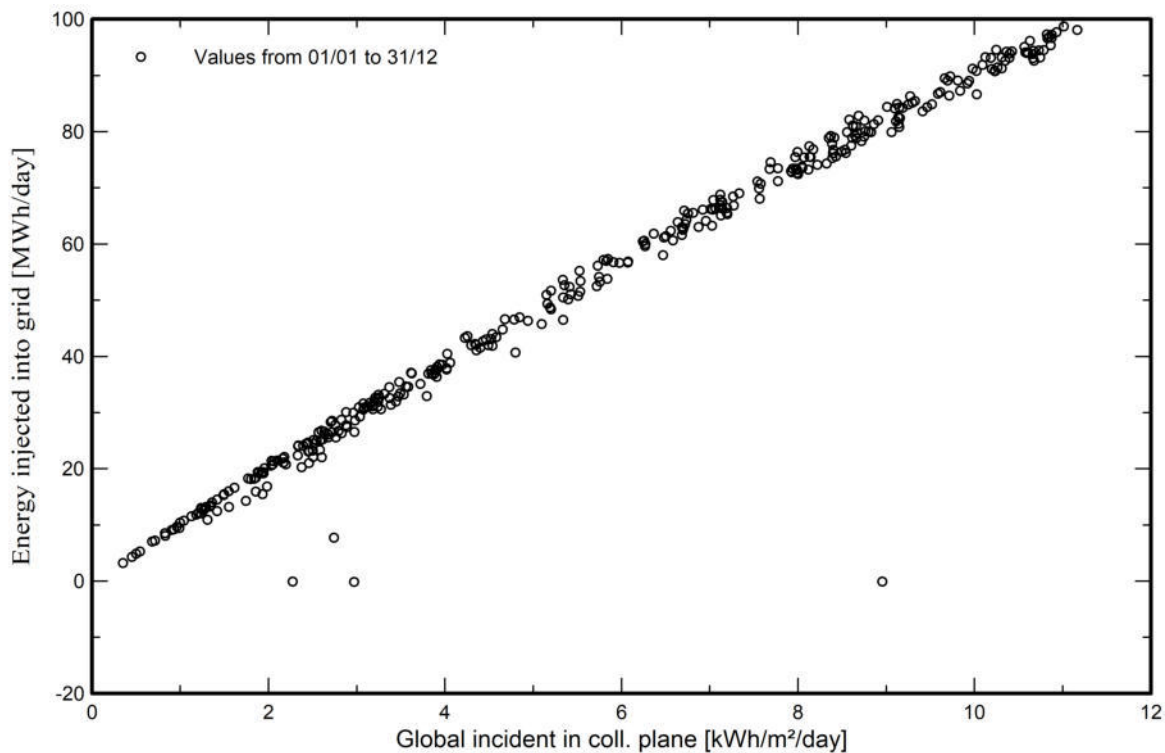
Loss diagram



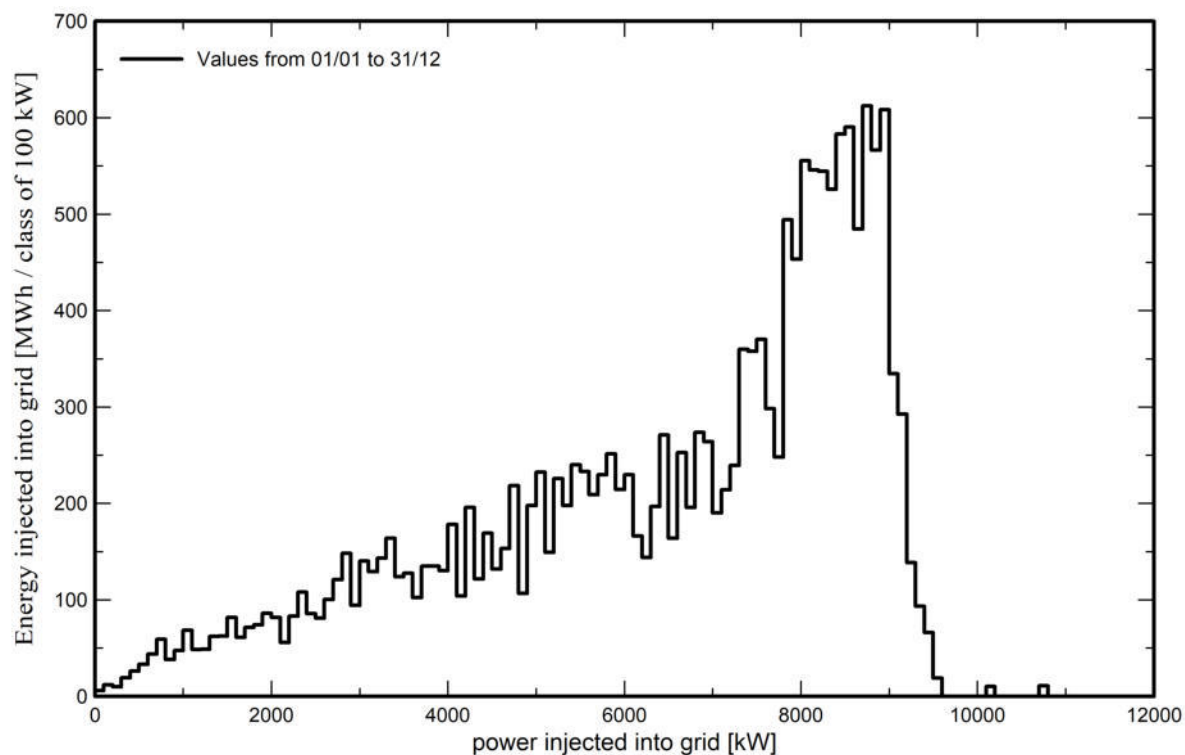


Predef. graphs

Daily Input/Output diagram



Distribuzione potenza in uscita sistema





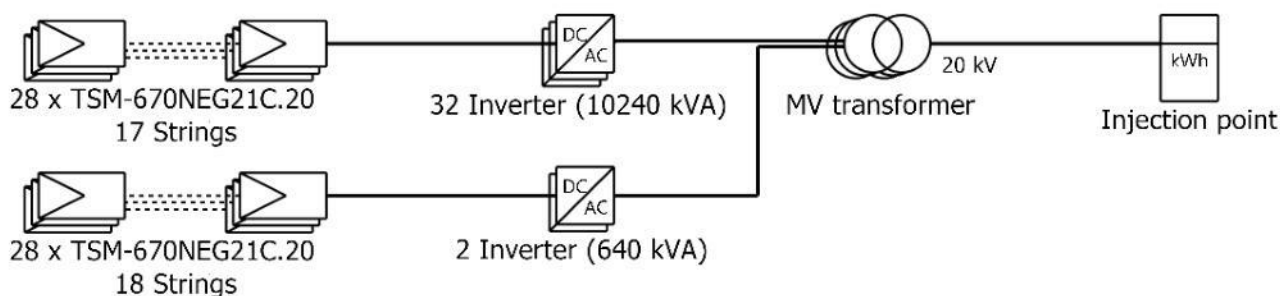
PVsyst V7.3.4

VC0, Simulation date:

31/05/23 10:39

with v7.3.4

Single-line diagram



PV module	TSM-670NEG21C.20
Inverter	SG350HX-20A
String	28 x TSM-670NEG21C.20

Project Montorio_CampoD

Kiwa Moroni S.r.l (Italy)

VC0 : V0_campoA_var.0

31/05/23