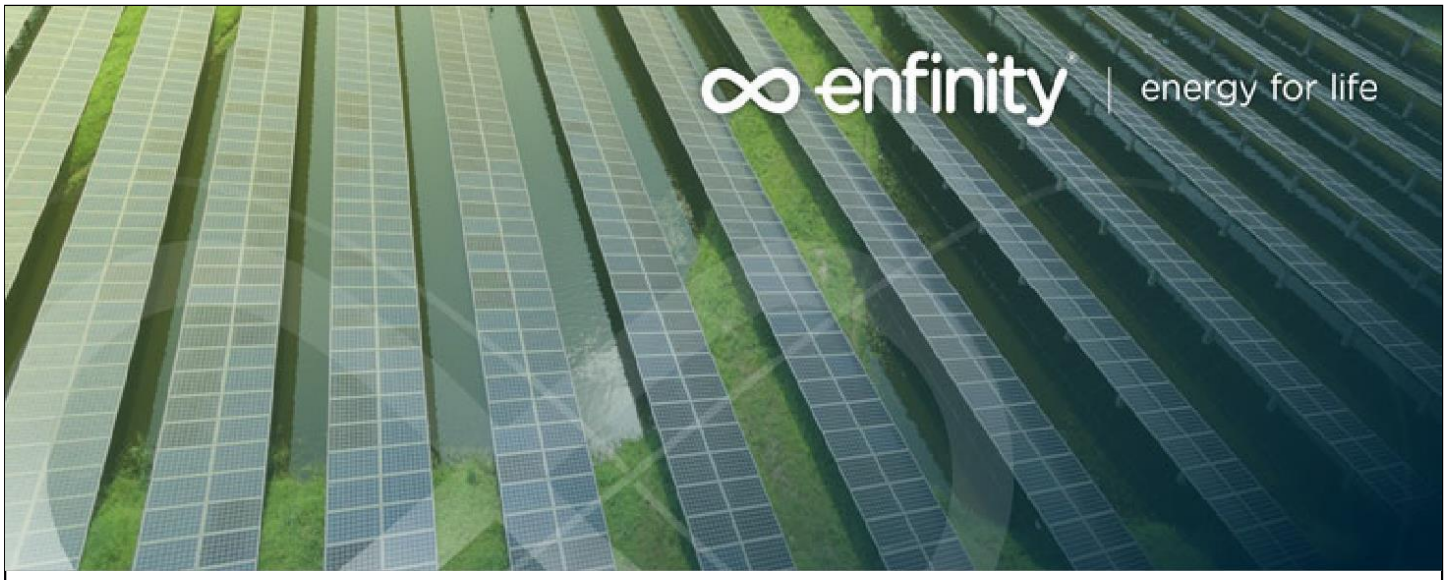

IMPIANTO AGRIVOLTAICO EG STELLA SRL E OPERE CONNESSE

POTENZA IMPIANTO 24,57 MWp - COMUNE DI ROMA (RM)

Proponente

EG STELLA S.R.L.
VIA DEI PELLEGRINI 22 – 20122 MILANO (MI) - P.IVA: 1490980965 – PEC: egstella@pec.it

Progettazione

Ing. Fabrizio Terenzi
PIAZZA GUGLIELMO MARCONI 25 – 00144 ROMA (RM) - P.IVA: 06741281007 – PEC: artelia.italia@pec.it
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Alessandro Ceschiat
27.09.2022 13:58:32 GMT+01:00

Coordinamento progettuale ARTELIA

ARTELIA ITALIA S.P.A.
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Tel.: +39 06 591 933 1 – email: contact@it.arteliagroup.com

TERENZI FABRIZIO
27.09.2022 15:19:35 UTC

Titolo Elaborato

STIMA PRODUCIBILITÀ

LIVELLO PROGETTAZIONE	CODICE ELABORATO	FILE NAME	DATA
DEFINITIVO	PD_REL04	IT-2019-0013_PD_REL04.00-Stima producibilità.docx	02/09/2022

Revisioni

REV.	DATA	DESCRIZIONE	ESEGUITO	VERIFICATO	APPROVATO
0	02/09/22	EMISSIONE PER PERMITTING	FTE	FTE	FTE

COMUNE DI ROMA (RM)

REGIONE LAZIO

STIMA PRODUCIBILITÀ

EG STELLA S.R.L. | Socio Unico | Cap. Soc. 10.000 € i.v. | P.IVA: 1490980965 |
Sede Legale: Via Dei Pellegrini 22 | 20122 Milano | Italia PEC: egstella@pec.it I www.enfinityglobal.com

Version 7.2.18

PVsyst - Simulation report

Grid-Connected System

Project: Campi di Merlo

Variant: Campi di Merlo (TR2V, 9m) (FT2V 20º, var.pitch) Canad N 690 - 24.57504MWp FT part 1563_31.08.22

Sheds system

System power: 15.53 MWp

Campi di Merlo 09102020 - Italy

Author

Enfinity Iberia SLU (Spain)

Project: Campi di Merlo

Variant: Campi di Merlo (TR2V, 9m) (FT2V 20º, var.pitch) Canad N 690 - 24.57504MWp FT part 1563_31.08.22

Enfinity Iberia SLU (Spain)

Project summary

Geographical Site
Campi di Merlo 09102020
Italy

Situation

Latitude	41.82 °N
Longitude	12.37 °E
Altitude	12 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Campi di Merlo 09102020
SolarGIS Monthly aver. , period not spec. - Synthetic

System summary

Grid-Connected System

Sheds system

PV Field Orientation

Fixed plane	
Tilt/Azimuth	20 / 0 °

Near Shadings

According to strings	
Electrical effect	80 %

User's needs
Unlimited load (grid)

System information

PV Array

Nb. of modules	22512 units
Pnom total	15.53 MWp

Inverters

Nb. of units	4 units
Pnom total	14.19 MWac
Grid power limit	12.62 MWac
Grid lim. Pnom ratio	1.231

Results summary

Produced Energy	24 GWh/year	Specific production	1563 kWh/kWp/year	Perf. Ratio PR	84.81 %
Apparent energy	24274 MVAh				

Table of contents

General parameters

Grid-Connected System

Sheds system

PV Field Orientation

Orientation

Fixed plane	
Tilt/Azimuth	20 / 0 °

Sheds configuration

Nb. of sheds	364 units
Averages of diff. arrays	

Sizes

Sheds spacing	7.14 m
Collector width	4.79 m
Ground Cov. Ratio (GCR)	67.1 %

Shading limit angle

Limit profile angle	31.8 °

Models used

Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon

Free Horizon

Near Shadings

According to strings
Electrical effect 80 %

User's needs

Unlimited load (grid)

Bifacial system

Model 2D Calculation
unlimited sheds

Bifacial model geometry

Sheds spacing	7.14 m
Sheds width	4.79 m
Limit profile angle	31.8 °
GCR	67.1 %
Height above ground	1.50 m

Bifacial model definitions

Ground albedo average	0.17
Bifaciality factor	80 %
Rear shading factor	4.0 %
Rear mismatch loss	3.5 %
Shed transparent fraction	4.0 %

Monthly ground albedo values

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

Grid injection point

Grid power limitation

Active Power	12.62 MWac
Pnom ratio	1.231

Power factor

Cos(phi) (lagging)	1.000

PV Array Characteristics

PV module

Manufacturer	CSI Solar Co., Ltd.
Model	CS7N-690TB-AG 1500V
(Custom parameters definition)	
Unit Nom. Power	690 Wp
Number of PV modules	22512 units
Nominal (STC)	15.53 MWp
Modules	804 Strings x 28 In series
At operating cond. (50°C)	
Pmpp	14.37 MWp
U mpp	1016 V
I mpp	14143 A

Inverter

Manufacturer	Ingeteam
Model	IS_3Power_3825TL_C640_IP65 [2021-12-03_up to 50°C]
(Custom parameters definition)	
Unit Nom. Power	3547 kWac
Number of inverters	4 units
Total power	14188 kWac
Operating voltage	909-1300 V
Pnom ratio (DC:AC)	1.09

Total PV power

Nominal (STC)	15533 kWp
Total	22512 modules
Module area	69930 m²

Total inverter power

Total power	14188 kWac
Number of inverters	4 units
Pnom ratio	1.09

Array losses

Array Soiling Losses
Loss Fraction 1.5 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 30.0 W/m²K
Uv (wind) 1.2 W/m²K/m/s

DC wiring losses
Global array res. 1.1 mΩ
Loss Fraction 1.5 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 0.5 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

IAM loss factor
Incidence effect (IAM): User defined profile

20°	40°	60°	65°	70°	75°	80°	85°	90°
1.000	1.000	1.000	0.990	0.960	0.920	0.840	0.720	0.000

System losses

Auxiliaries loss
Proportionnal to Power 4.0 W/kW
20.0 kW from Power thresh.
Night aux. cons. 5.00 kW

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 640 Vac tri
Loss Fraction 0.92 % at STC
Inverter: IS_3Power_3825TL_C640_IP65 [2021-12-03_up to 50°C]
Wire section (4 Inv.) Copper 4 x 3 x 2000 mm²
Average wires length 105 m

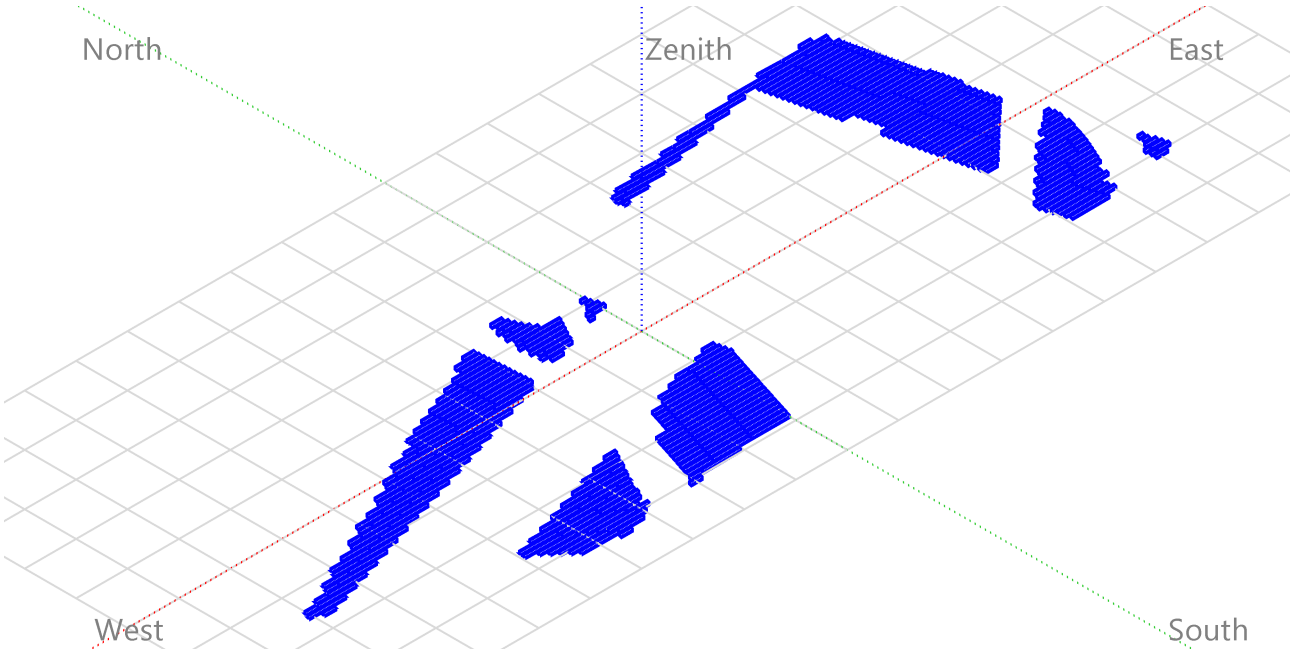
MV line up to Injection
MV Voltage 30 kV
Wires Alu 3 x 400 mm²
Length 13323 m
Loss Fraction 1.78 % at STC

AC losses in transformers

MV transfo
Grid voltage 30 kV
Operating losses at STC
Nominal power at STC 15269 kVA
Iron loss (night disconnect) 15.27 kW
Loss Fraction 0.10 % at STC
Coils equivalent resistance 3 x 0.30 mΩ
Loss Fraction 1.10 % at STC

Near shadings parameter

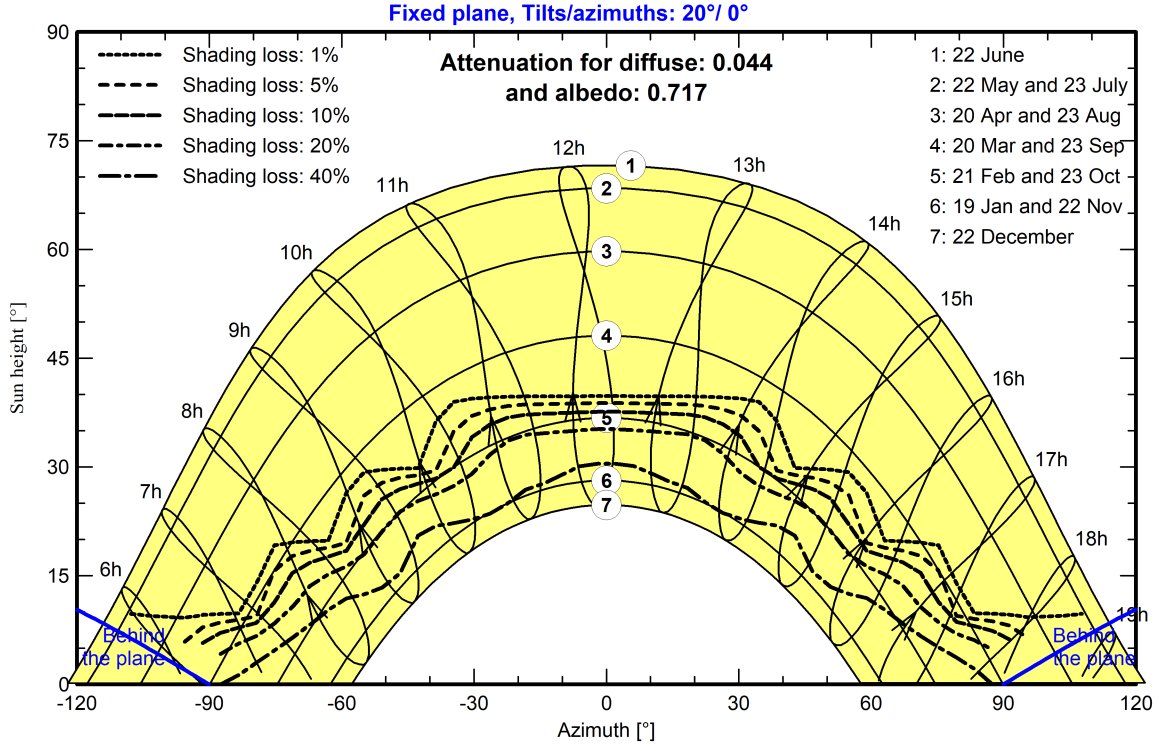
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 20°/ 0°

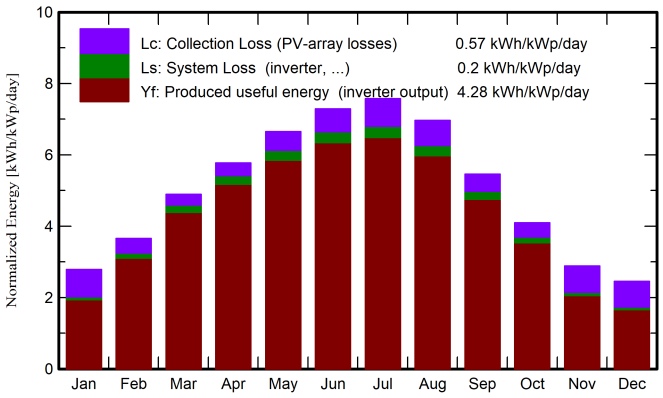


Main results

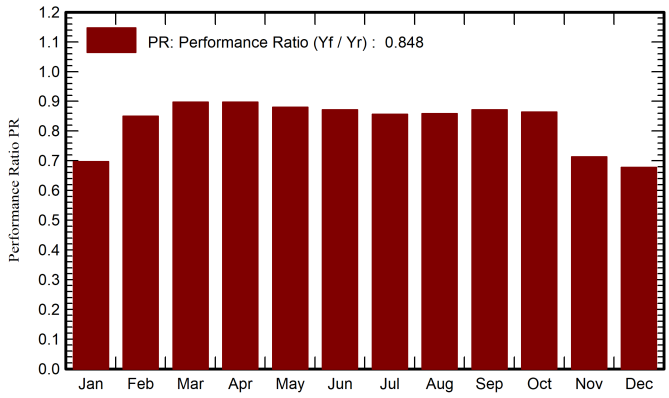
System Production

Produced Energy (P50)	24 GWh/year	Specific production (P50)	1563 kWh/kWp/year	Performance Ratio PR	84.81 %
Produced Energy (P75)	23.6 GWh/year	Specific production (P75)	1519 kWh/kWp/year		
Produced Energy (P90)	23.0 GWh/year	Specific production (P90)	1480 kWh/kWp/year		
Apparent energy	24274 MVAh				

Normalized productions (per installed kWp)



Performance Ratio PR



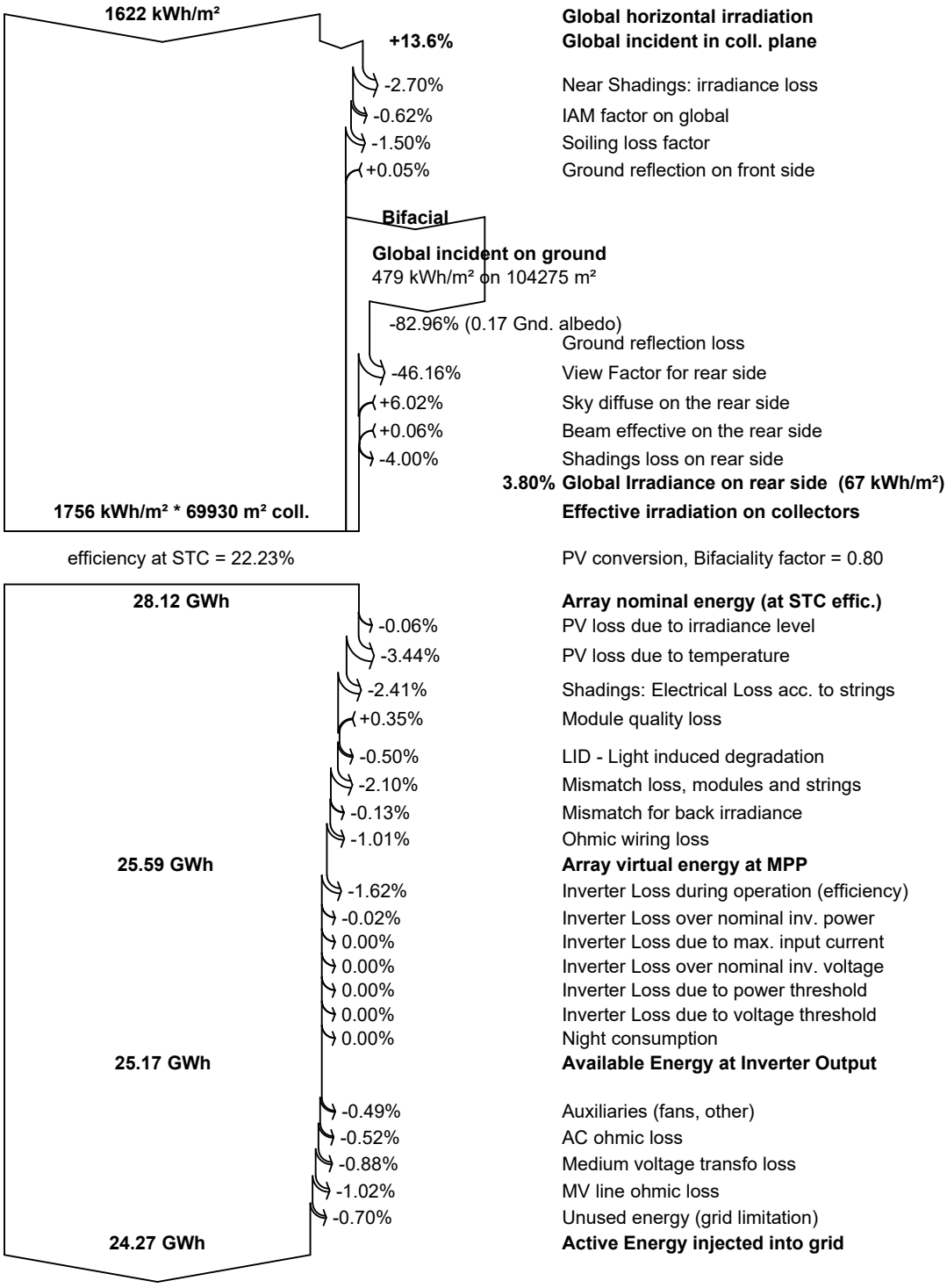
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray GWh	E_Grid GWh	PR ratio
January	58.0	26.00	10.40	86.4	76.1	0.974	0.935	0.697
February	77.0	32.00	10.30	102.4	97.2	1.414	1.353	0.850
March	126.0	52.00	12.10	151.8	146.2	2.214	2.115	0.897
April	157.0	64.00	14.50	173.2	167.2	2.527	2.413	0.897
May	201.0	76.00	18.20	206.1	199.0	2.953	2.817	0.880
June	219.0	75.00	22.10	218.6	211.5	3.102	2.958	0.871
July	232.0	69.00	24.60	234.8	227.3	3.277	3.124	0.857
August	200.0	66.00	25.10	215.9	209.0	3.019	2.879	0.859
September	141.0	56.00	21.90	163.7	158.1	2.321	2.217	0.872
October	100.0	45.00	18.80	127.1	121.3	1.780	1.704	0.863
November	61.0	29.00	14.80	86.6	77.9	1.000	0.960	0.714
December	50.0	23.00	11.39	76.0	65.0	0.834	0.800	0.678
Year	1622.0	613.00	17.06	1842.5	1755.8	25.416	24.274	0.848

Legends

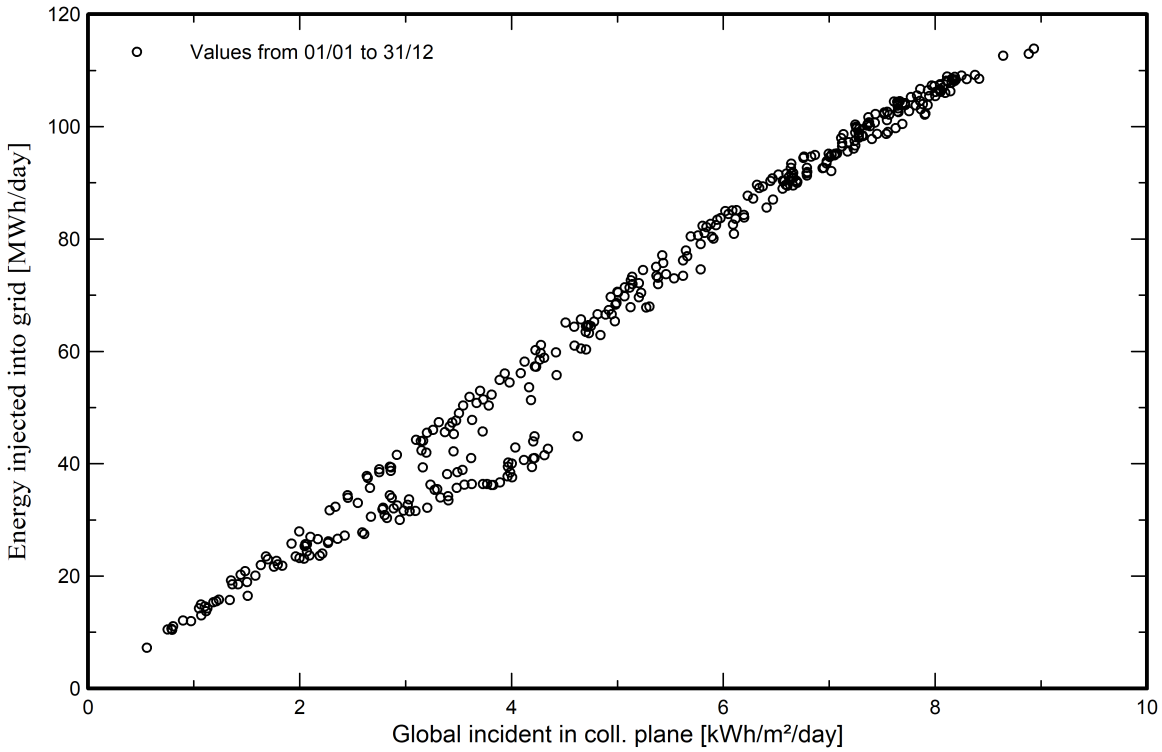
GlobHor	Global horizontal irradiation
DiffHor	Horizontal diffuse irradiation
T_Amb	Ambient Temperature
GlobInc	Global incident in coll. plane
GlobEff	Effective Global, corr. for IAM and shadings
EArray	Effective energy at the output of the array
E_Grid	Energy injected into grid
PR	Performance Ratio

Loss diagram

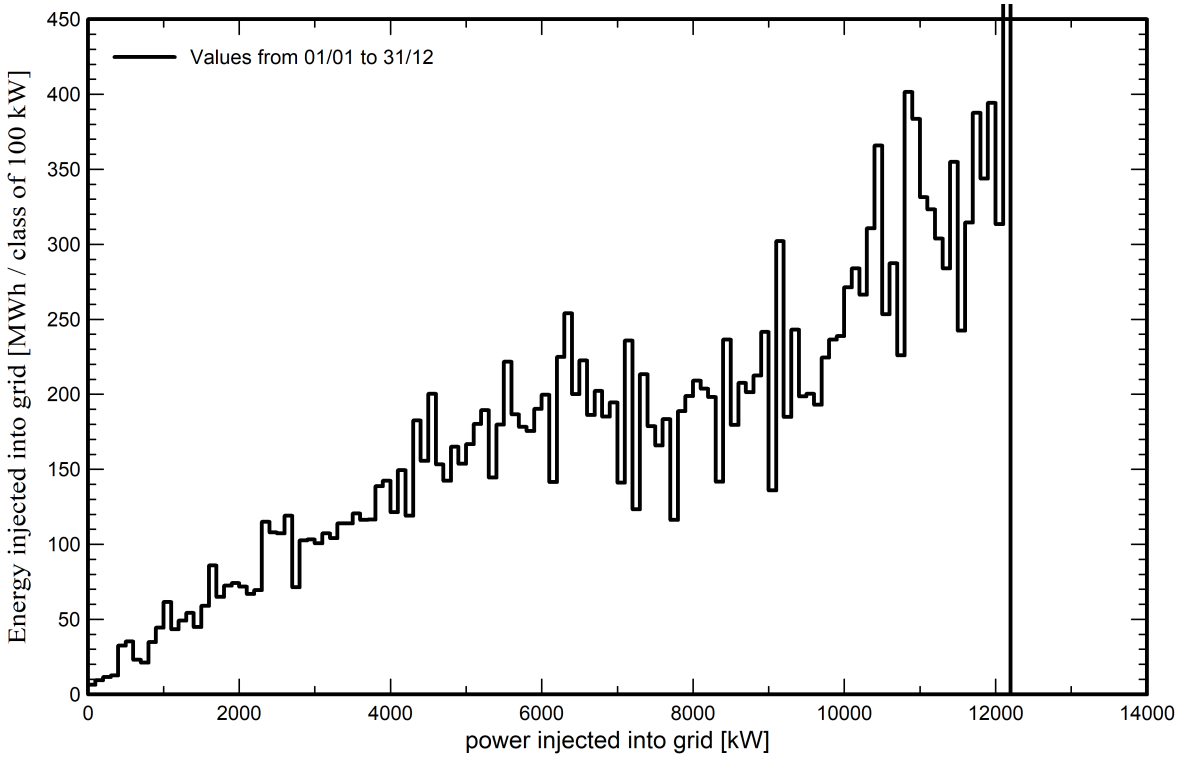


Special graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	SolarGIS Monthly aver. , period not spec.
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	3.7 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	4.1 %

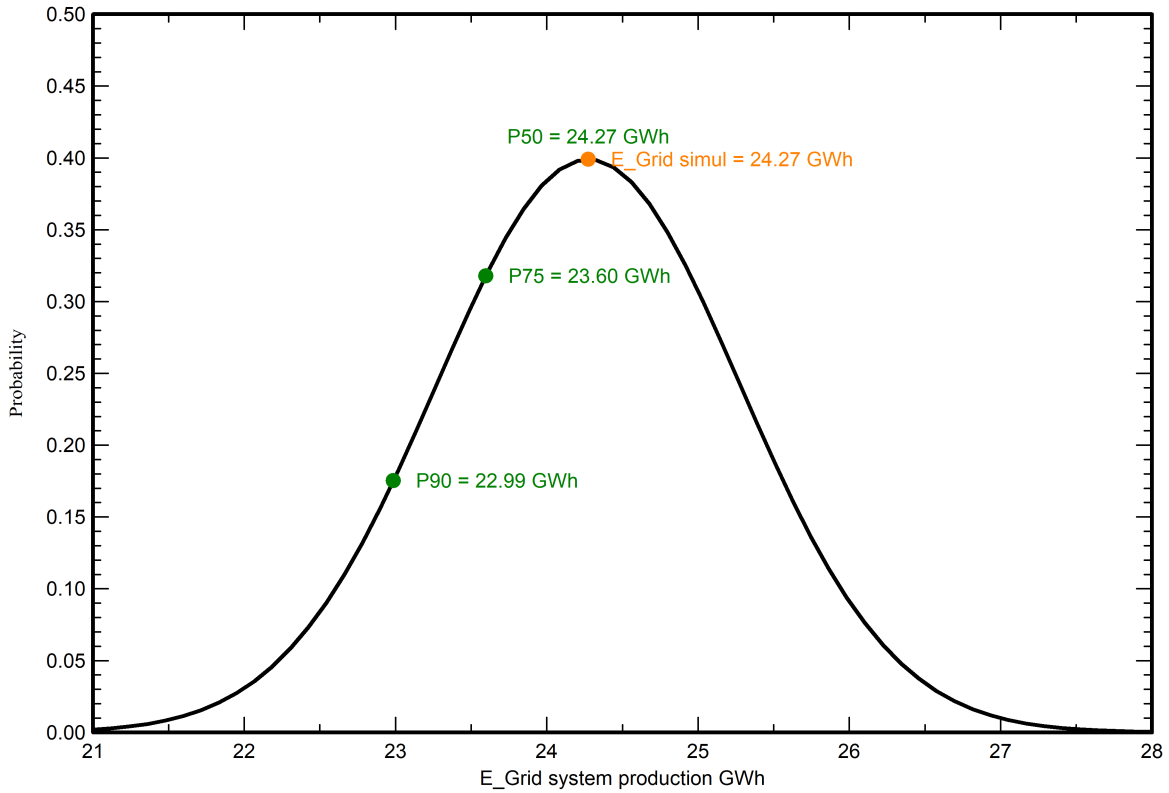
Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

Annual production probability

Variability	1.00 GWh
P50	24.27 GWh
P75	23.60 GWh
P90	22.99 GWh

Probability distribution



Version 7.2.18

PVsyst - Simulation report

Grid-Connected System

Project: Campi di Merlo

Variant: Campi di Merlo (TR2V, 9m) (FT2V 20º, var.pitch) Canad N 690 - 24.57504MWp TR part 1792_31.08.22

Tracking system with backtracking
System power: 9042 kWp
Campi di Merlo 09102020 - Italy

Author
Enfinity Iberia SLU (Spain)

Project: Campi di Merlo

Variant: Campi di Merlo (TR2V, 9m) (FT2V 20º, var.pitch) Canad N 690 - 24.57504MWp TR part 1792_31.08.22

Enfinity Iberia SLU (Spain)

Project summary

Geographical Site
Campi di Merlo 09102020
Italy

Situation

Latitude	41.82 °N
Longitude	12.37 °E
Altitude	12 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Campi di Merlo 09102020
SolarGIS Monthly aver. , period not spec. - Synthetic

System summary

Grid-Connected System

Tracking system with backtracking

PV Field Orientation

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

Tracking algorithm
Astronomic calculation
Backtracking activated

Near Shadings
Linear shadings

System information

PV Array

Nb. of modules	13104 units
Pnom total	9042 kWp

Inverters

Nb. of units	3 units
Pnom total	10.64 MWac
Grid power limit	7350 kWac
Grid lim. Pnom ratio	1.230

User's needs
Unlimited load (grid)

Results summary

Produced Energy	16 GWh/year	Specific production	1792 kWh/kWp/year	Perf. Ratio PR	87.58 %
Apparent energy	16200 MVAh				

Table of contents

General parameters

Grid-Connected System

Tracking system with backtracking

PV Field Orientation

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

Tracking algorithm
Astronomic calculation
Backtracking activated

Backtracking array
Nb. of trackers 215 units

Sizes
Tracker Spacing 9.00 m
Collector width 4.92 m
Ground Cov. Ratio (GCR) 54.6 %
Phi min / max. -/+ 60.0 °

Backtracking strategy
Phi limits +/- 56.8 °
Backtracking pitch 9.00 m
Backtracking width 4.92 m

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

Bifacial system
Model 2D Calculation
unlimited trackers

Bifacial model geometry
Tracker Spacing 9.00 m
Tracker width 4.92 m
GCR 54.6 %
Axis height above ground 2.10 m

Bifacial model definitions
Ground albedo average 0.17
Bifaciality factor 80 %
Rear shading factor 4.0 %
Rear mismatch loss 3.5 %
Shed transparent fraction 4.0 %

Monthly ground albedo values

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

Grid injection point

Grid power limitation
Active Power 7350 kWac
Pnom ratio 1.230

Power factor
Cos(phi) (lagging) 1.000

PV Array Characteristics

PV module
Manufacturer CSI Solar Co., Ltd.
Model CS7N-690TB-AG 1500V
(Custom parameters definition)
Unit Nom. Power 690 Wp
Number of PV modules 13104 units
Nominal (STC) 9042 kWp
Modules 468 Strings x 28 In series
At operating cond. (50°C)
Pmpp 8367 kWp
U mpp 1016 V
I mpp 8233 A

Inverter
Manufacturer Ingeteam
Model IS_3Power_3825TL_C640_IP65 [2021-12-03_up to 50°C]
(Custom parameters definition)
Unit Nom. Power 3547 kWac
Number of inverters 3 units
Total power 10641 kWac
Operating voltage 909-1300 V
Pnom ratio (DC:AC) 0.85

PV Array Characteristics

Total PV power

Nominal (STC)	9042 kWp
Total	13104 modules
Module area	40706 m²

Total inverter power

Total power	10641 kWac
Number of inverters	3 units
Pnom ratio	0.85

Array losses

Array Soiling Losses
Loss Fraction 1.5 %

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 30.0 W/m²K
Uv (wind) 1.2 W/m²K/m/s

DC wiring losses
Global array res. 1.9 mΩ
Loss Fraction 1.4 % at STC

Serie Diode Loss
Voltage drop 0.7 V
Loss Fraction 0.1 % at STC

LID - Light Induced Degradation
Loss Fraction 0.5 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

IAM loss factor
Incidence effect (IAM): User defined profile

20°	40°	60°	65°	70°	75°	80°	85°	90°
1.000	1.000	1.000	0.990	0.960	0.920	0.840	0.720	0.000

System losses

Auxiliaries loss
Proportionnal to Power 4.0 W/kW
20.0 kW from Power thresh.
Night aux. cons. 5.00 kW

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 640 Vac tri
Loss Fraction 0.85 % at STC
Inverter: IS_3Power_3825TL_C640_IP65 [2021-12-03_up to 50°C]
Wire section (3 Inv.) Copper 3 x 3 x 2000 mm²
Average wires length 125 m

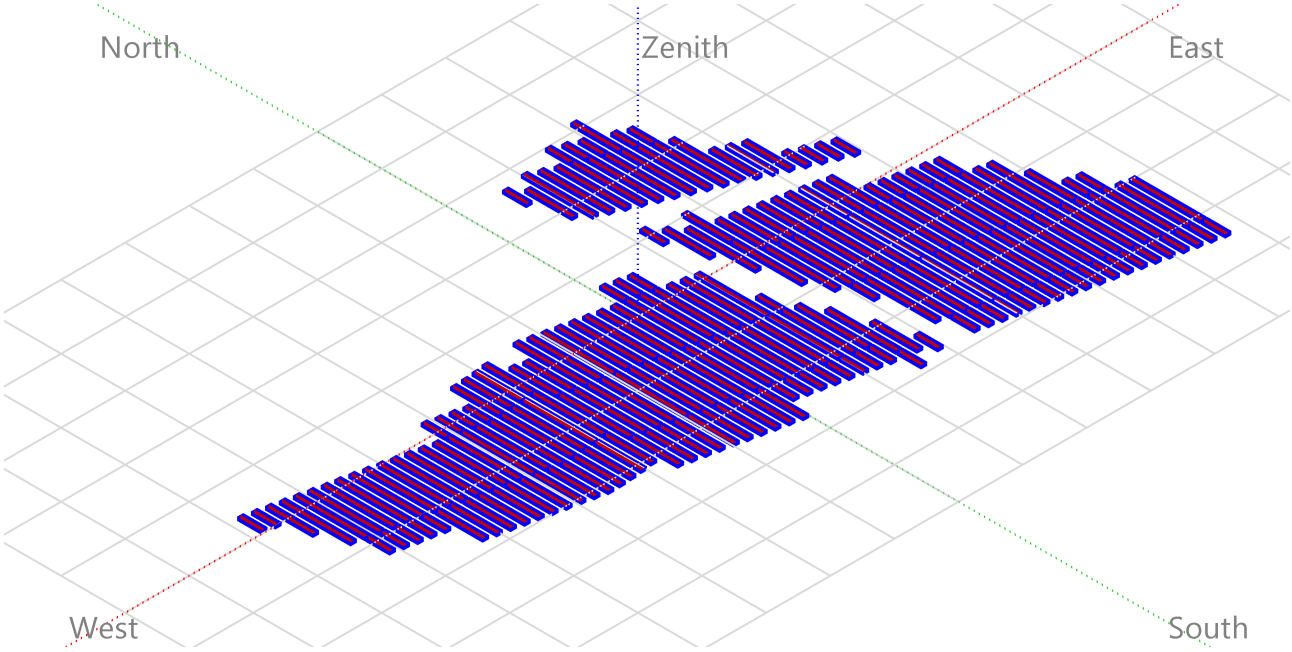
MV line up to Injection
MV Voltage 30 kV
Wires Alu 3 x 400 mm²
Length 21850 m
Loss Fraction 1.70 % at STC

AC losses in transformers

MV transfo
Grid voltage 30 kV
Operating losses at STC
Nominal power at STC 8893 kVA
Iron loss (night disconnect) 8.89 kW
Loss Fraction 0.10 % at STC
Coils equivalent resistance 3 x 0.51 mΩ
Loss Fraction 1.10 % at STC

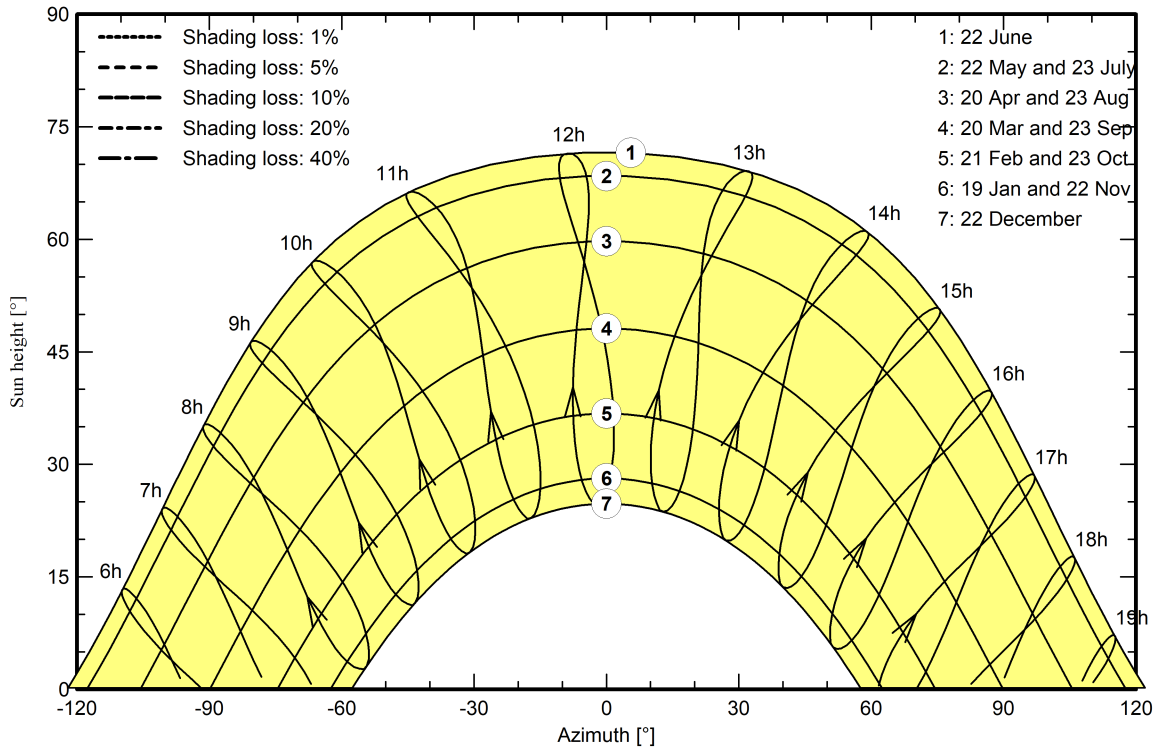
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

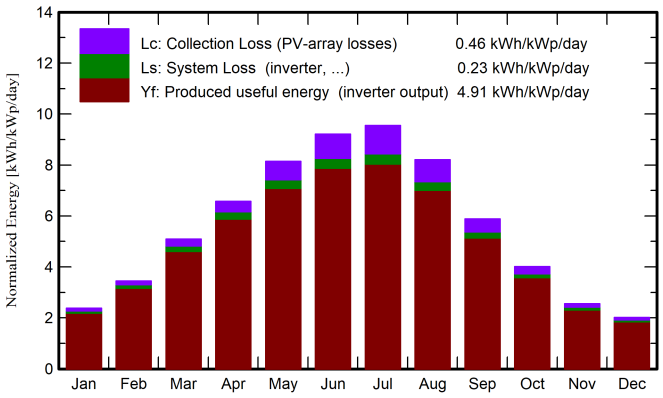


Main results

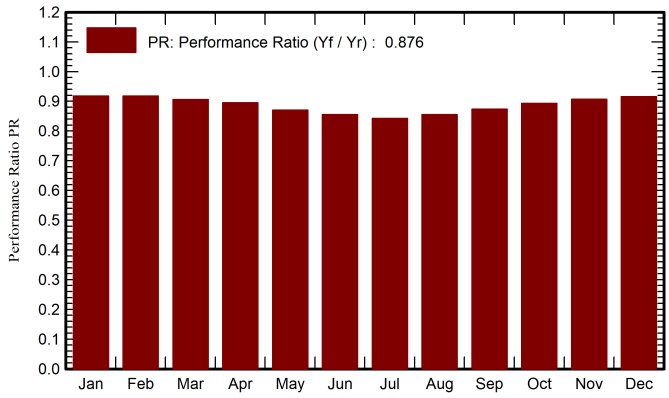
System Production

Produced Energy (P50)	16 GWh/year	Specific production (P50)	1792 kWh/kWp/year	Performance Ratio PR	87.58 %
Produced Energy (P75)	15.98 GWh/year	Specific production (P75)	1767 kWh/kWp/year		
Produced Energy (P90)	15.77 GWh/year	Specific production (P90)	1744 kWh/kWp/year		
Apparent energy	16200 MVAh				

Normalized productions (per installed kWp)



Performance Ratio PR



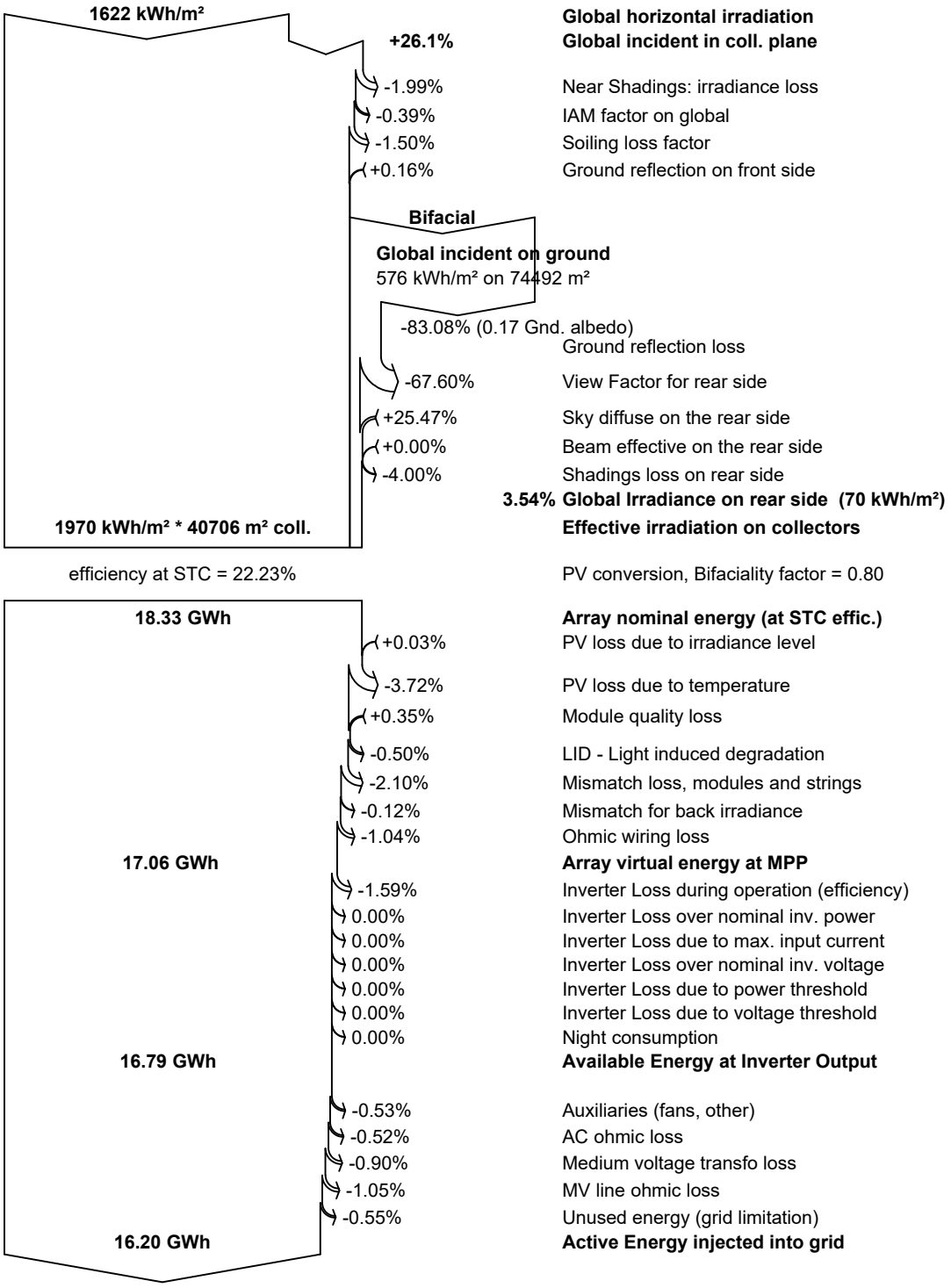
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray GWh	E_Grid GWh	PR ratio
January	58.0	26.00	10.40	73.9	70.5	0.640	0.613	0.918
February	77.0	32.00	10.30	96.6	92.9	0.838	0.802	0.917
March	126.0	52.00	12.10	157.9	151.6	1.354	1.294	0.906
April	157.0	64.00	14.50	197.4	190.0	1.673	1.598	0.895
May	201.0	76.00	18.20	252.5	243.7	2.084	1.987	0.870
June	219.0	75.00	22.10	276.5	267.1	2.243	2.138	0.855
July	232.0	69.00	24.60	296.1	286.5	2.366	2.254	0.842
August	200.0	66.00	25.10	254.3	245.8	2.063	1.967	0.856
September	141.0	56.00	21.90	176.7	170.0	1.460	1.396	0.874
October	100.0	45.00	18.80	124.4	119.3	1.048	1.004	0.893
November	61.0	29.00	14.80	76.8	73.3	0.658	0.630	0.907
December	50.0	23.00	11.39	62.6	59.6	0.541	0.518	0.915
Year	1622.0	613.00	17.06	2045.7	1970.3	16.968	16.200	0.876

Legends

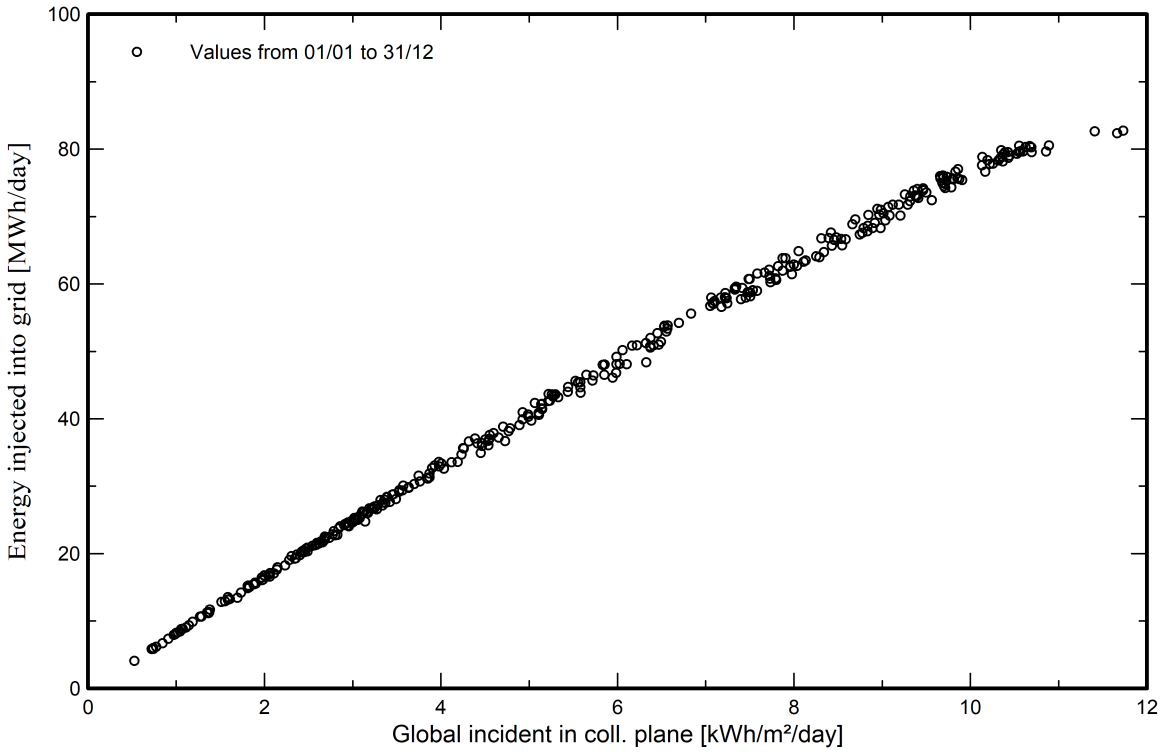
GlobHor	Global horizontal irradiation
DiffHor	Horizontal diffuse irradiation
T_Amb	Ambient Temperature
GlobInc	Global incident in coll. plane
GlobEff	Effective Global, corr. for IAM and shadings
EArray	Effective energy at the output of the array
E_Grid	Energy injected into grid
PR	Performance Ratio

Loss diagram

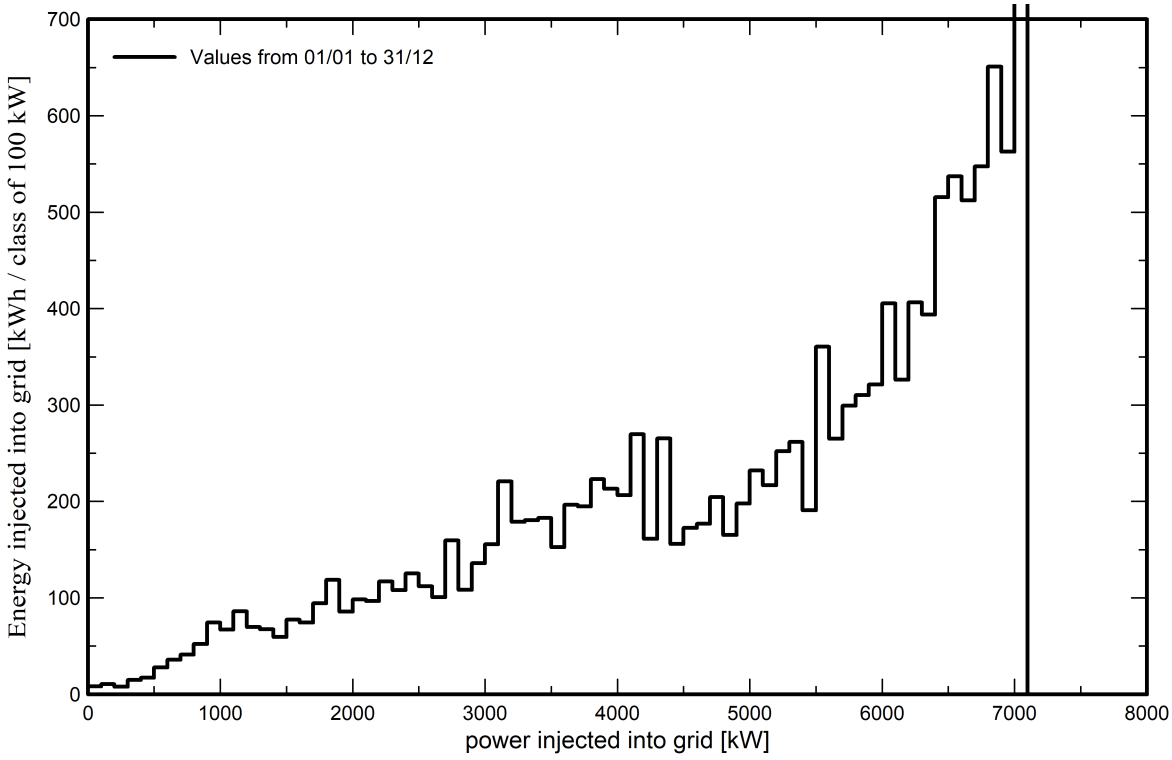


Special graphs

Daily Input/Output diagram



System Output Power Distribution



P50 - P90 evaluation

Meteo data

Source	SolarGIS Monthly aver. , period not spec.
Kind	Monthly averages
Synthetic - Multi-year average	
Year-to-year variability(Variance)	-1.0 %

Specified Deviation

Climate change	0.0 %

Global variability (meteo + system)

Variability (Quadratic sum)	2.1 %

Simulation and parameters uncertainties

PV module modelling/parameters	1.0 %
Inverter efficiency uncertainty	0.5 %
Soiling and mismatch uncertainties	1.0 %
Degradation uncertainty	1.0 %

Annual production probability

Variability	334 MWh
P50	16200 MWh
P75	15975 MWh
P90	15772 MWh

Probability distribution