Regione Emilia Romagna
Comune di Ferrara

IMPIANTO FOTOVOLTAICO E OPERE CONNESSE

Potenza Impianto 9,573 MWp

PROPONENTE

LIGHTSOURCE RENEWABLE ENERGY ITALY SPV 14 S.R.L.

VIA G. LEOPARDI, 7 - 20123 MILANO (MI) - P.IVA: 12593780963 – PEC: lightsourcespv_14@legalmail.it

PROGETTAZIONE

Ing. Antonello Ruttilio

Via R. Zandonai, 4 – 44124 – FERRARA IT - P.IVA: 00522150382 – PEC: incico@pec.it
Tel.: +39 0532 202613 – email: a.ruttilio@incico.com

antonello ruttilio
10.03.2023
17:21:29
GMT+01:00

COLLABORAZIONI

Ing. Lorenzo Stocchino

Via R. Zandonai, 4 – 44124 – FERRARA IT - P.IVA: 00522150382 – PEC: incico@pec.it
Tel.: +39 0532 202613 – email: l.stocchino@incico.com

COORDINAMENTO PROGETTUALE

SOLAR IT S.R.L.

VIA I. ALPI 4 – 46100 - MANTOVA IT - P.IVA: 02627240209 – PEC: solarit@lamiapec.it
Tel.: +390425 072 257– email: info@solaritglobal.com

TITOLO ELABORATO

CALCOLO DELLA PRODUCIBILITÀ

LIVELLO DI PROGETTAZIONE	CODICE ELABORATO	FILE NAME	DATA
DEFINITIVO	23-LS15787-IT-CONA-PI-R01	23-LS15787-IT-CONA-PI-R01_0	08/03/2023

REVISIONI

REV.	DATA	DESCRIZIONE	ESEGUITO	VERIFICATO	APPROVATO
0	08/03/2023	Emesso per filing	MCA	LST	ARU

CALCOLO DELLA

PRODUCIBILITÀ

Project: Cona LSBP 2023

Variant: Nuova variante di simulazione

PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Project summary

Geographical Site
Cona
Italia

Situation

Latitude	44.80 °N
Longitude	11.71 °E
Altitude	8 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Cona
Meteonorm 8.1 (1991-2012), Sat=100% - Sintetico

System summary

Grid-Connected System
Simulation for year no 10

Tracking system

PV Field Orientation

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

Tracking algorithm	
Astronomic calculation	

Near Shadings

Linear shadings	
Diffuse shading	Automatic

System information

PV Array		**Inverters**	
Nb. of modules	13676 units	Nb. of units	3 units
Pnom total	9573 kWp	Pnom total	10.31 MWac
		Pnom ratio	0.928

User's needs
Fixed constant load
20.00 kW
Global
175 MWh/Year

Results summary

Produced Energy	11807485 kWh/year	Specific production	1233 kWh/kWp/year	Perf. Ratio PR	68.49 %
Used Energy	175200 kWh/year			Solar Fraction SF	43.77 %

Table of contents

PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

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 526 units
Identical arrays

Sizes
Tracker Spacing 8.70 m
Collector width 4.79 m
Ground Cov. Ratio (GCR) 55.0 %
Phi min / max. -/+ 90.0 °

Shading limit angles
Phi limits for BT -/+ 56.5 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
Linear shadings
Diffuse shading Automatic

User's needs
Fixed constant load
20.00 kW
Global
175 MWh/Year

PV Array Characteristics

PV module
Manufacturer Risen Solar
Model RSM132-8-700BHDG
(Custom parameters definition)
Unit Nom. Power 700 Wp
Number of PV modules 13676 units
Nominal (STC) 9573 kWp
Modules 526 Strings x 26 In series
At operating cond. (50°C)
Pmpp 8762 kWp
U mpp 990 V
I mpp 8851 A

Inverter
Manufacturer Sungrow
Model SG3400-HV-20
(Custom parameters definition)
Unit Nom. Power 3437 kWac
Number of inverters 3 units
Total power 10311 kWac
Operating voltage 875-1300 V
Max. power (=>25°C) 3593 kWac
Pnom ratio (DC:AC) 0.93
Power sharing within this inverter

Total PV power
Nominal (STC) 9573 kWp
Total 13676 modules
Module area 42482 m²

Total inverter power
Total power 10311 kWac
Max. power 10779 kWac
Number of inverters 3 units
Pnom ratio 0.93

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. 1.9 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Array losses

Strings Mismatch loss
Loss Fraction 0.1 %

Module average degradation
Year no 10
Loss factor 0.4 %/year

Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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

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

System losses

Unavailability of the system
Time fraction 2.0 %
7.3 days,
3 periods

Auxiliaries loss
constant (fans) 20.0 kW
0.0 kW from Power thresh.
Proportionnal to Power 10.0 W/kW
0.0 kW from Power thresh.
Night aux. cons. 10.0 kW

AC wiring losses

Inv. output line up to MV transfo
Inverter voltage 600 Vac tri
Loss Fraction 0.00 % at STC
Inverter: SG3400-HV-20
Wire section (3 Inv.) Copper 3 x 3 x 2000 mm²
Average wires length 0 m

MV line up to Injection
MV Voltage 20 kV
Average each inverter
Wires Copper 3 x 120 mm²
Length 200 m
Loss Fraction 0.02 % at STC

AC losses in transformers

MV transfo
Medium voltage 20 kV

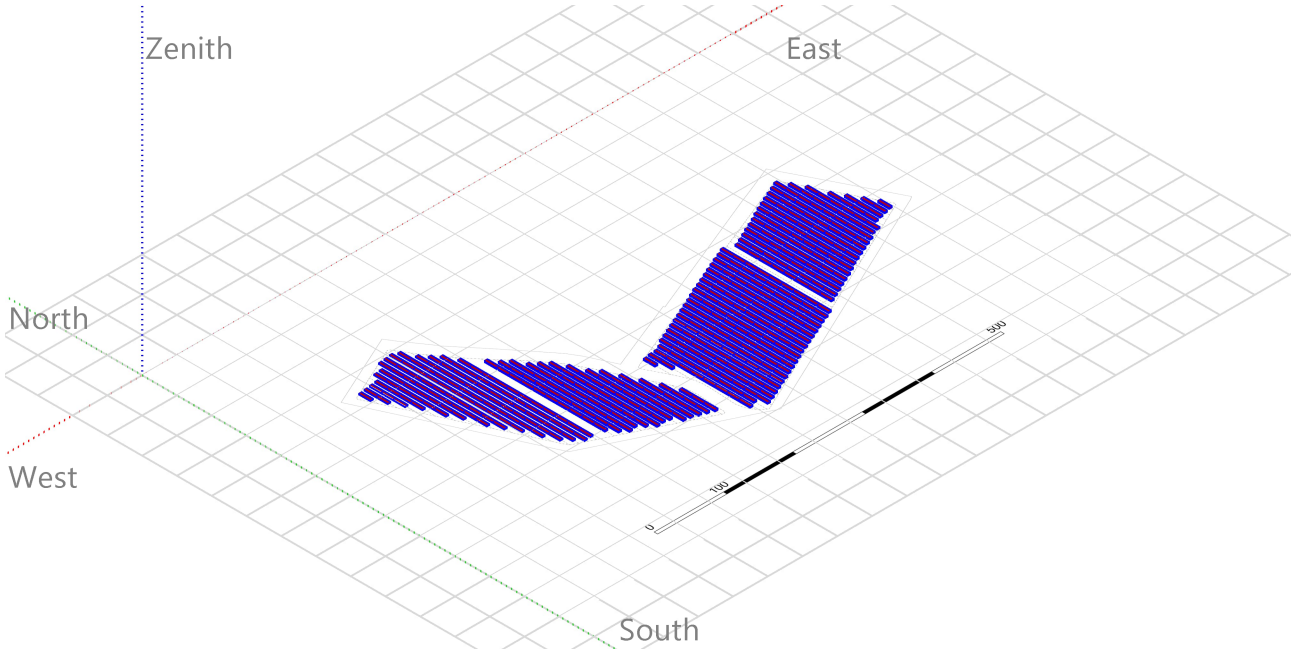
One transfo parameters
Nominal power at STC 3.16 MVA
Iron Loss (night disconnect) 3.44 kVA
Iron loss fraction 0.11 % at STC
Copper loss 29.03 kVA
Copper loss fraction 0.92 % at STC
Coils equivalent resistance 3 x 1.05 mΩ

Operating losses at STC (full system)
Nb. identical MV transfos 3
Nominal power at STC 9.48 MVA
Iron loss (night disconnect) 10.33 kVA
Copper loss 87.10 kVA

PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

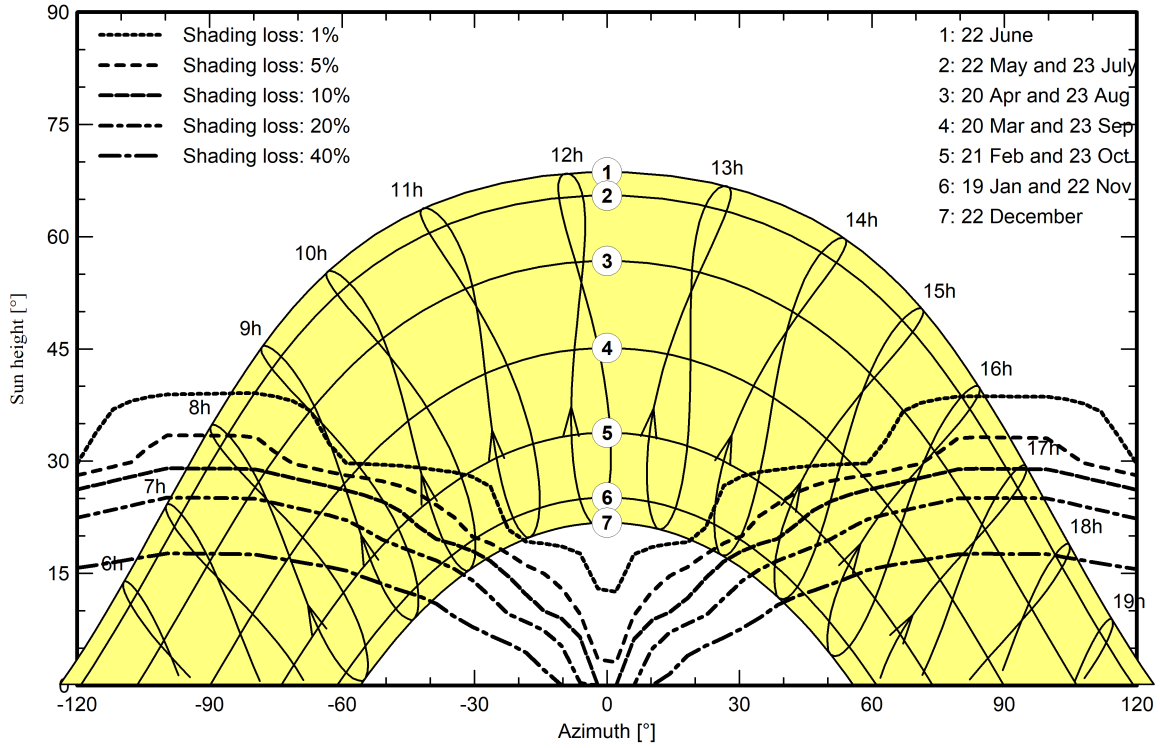
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1



Project: Cona LSBP 2023

Variant: Nuova variante di simulazione

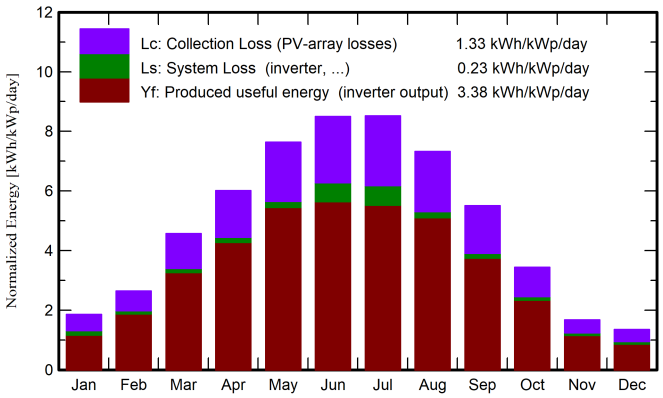
PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Main results

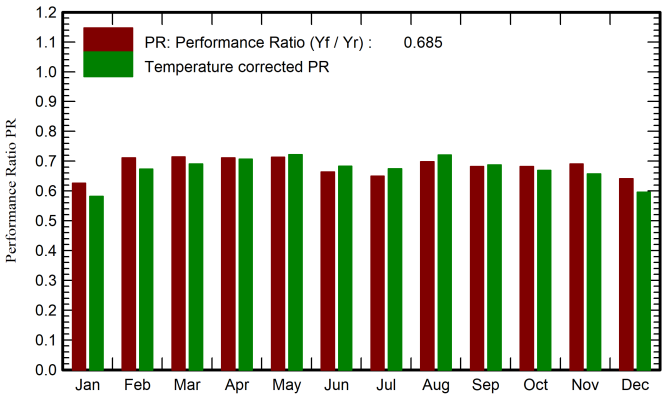
System Production

Produced Energy	11807485 kWh/year	Specific production	1233 kWh/kWp/year
Used Energy	175200 kWh/year	Performance Ratio PR	68.49 %
		Solar Fraction SF	43.77 %

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_User kWh	PR ratio	E_Grid kWh	EFrGrid kWh
January	41.3	25.33	3.03	57.6	44.0	390319	14880	0.626	340909	10352
February	54.9	29.81	5.06	74.1	60.8	532663	13440	0.711	500026	8733
March	105.5	56.66	10.08	141.8	117.7	1011801	14880	0.714	962503	8216
April	133.8	63.33	14.10	180.5	152.8	1279874	14400	0.711	1222042	7262
May	177.2	79.10	19.02	236.9	204.7	1679380	14880	0.713	1608346	6473
June	191.7	86.40	23.41	254.9	223.3	1804185	14400	0.664	1612663	6720
July	195.8	87.27	25.83	264.0	229.4	1835725	14880	0.650	1634104	7065
August	169.5	75.01	25.35	227.2	196.1	1575623	14880	0.698	1509396	7040
September	118.0	55.69	19.98	165.1	136.5	1123470	14400	0.682	1071339	7645
October	77.2	41.93	15.56	106.6	86.4	730340	14880	0.682	689523	9020
November	41.6	27.88	9.60	50.1	41.2	355923	14400	0.690	326517	9683
December	31.9	21.80	4.27	42.0	32.0	281526	14880	0.641	253436	10312
Year	1338.7	650.22	14.66	1800.9	1525.1	12600828	175200	0.685	11730804	98519

Legends

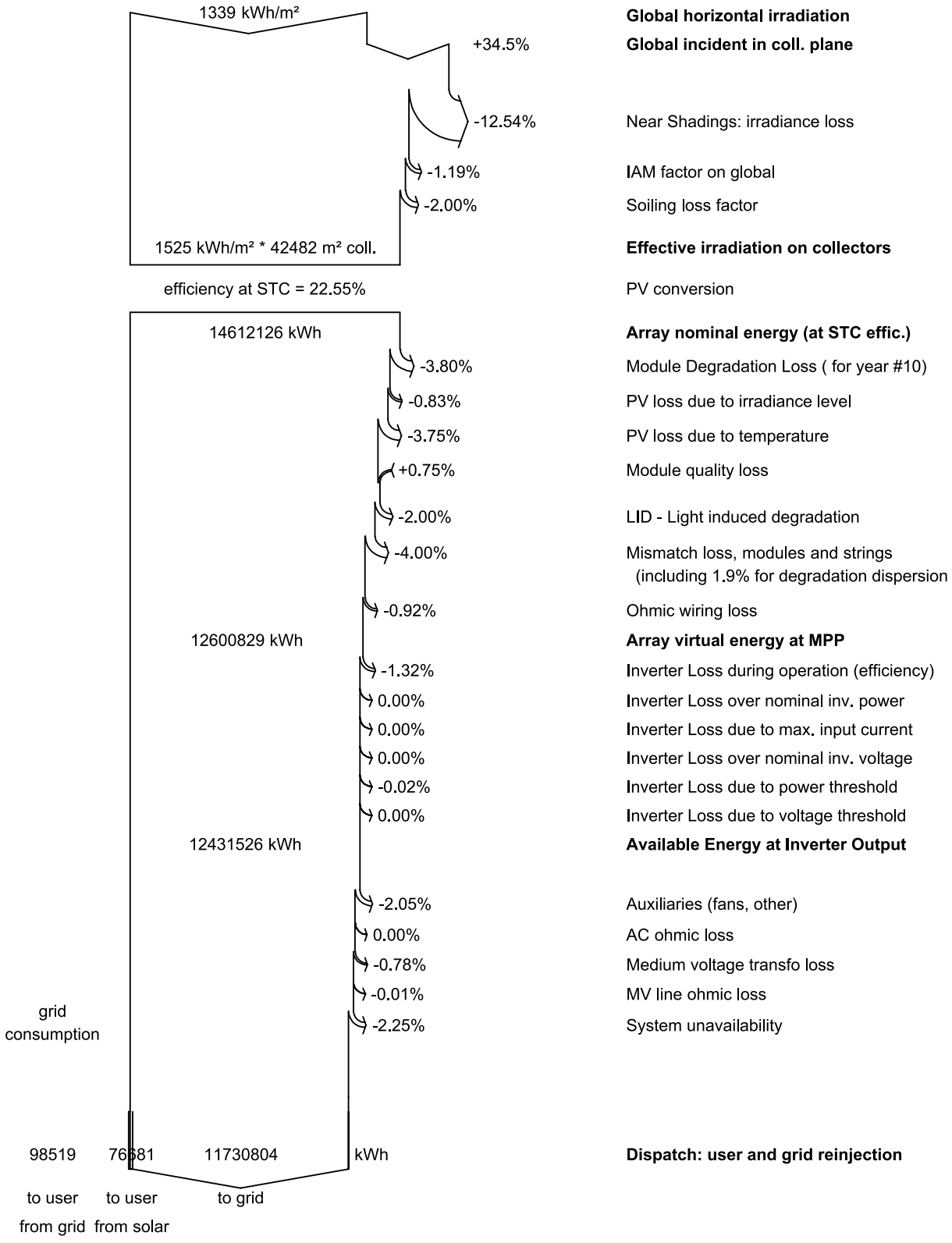
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective Global,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

Project: Cona LSBP 2023

Variant: Nuova variante di simulazione

PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

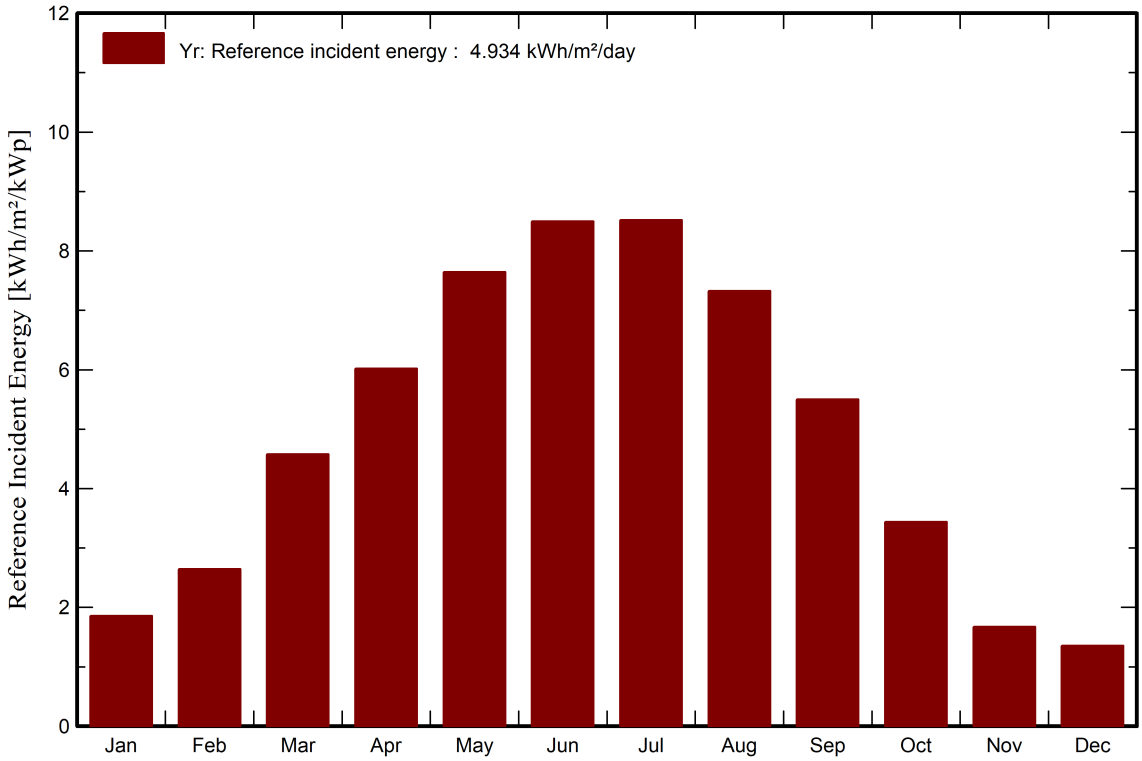
Loss diagram



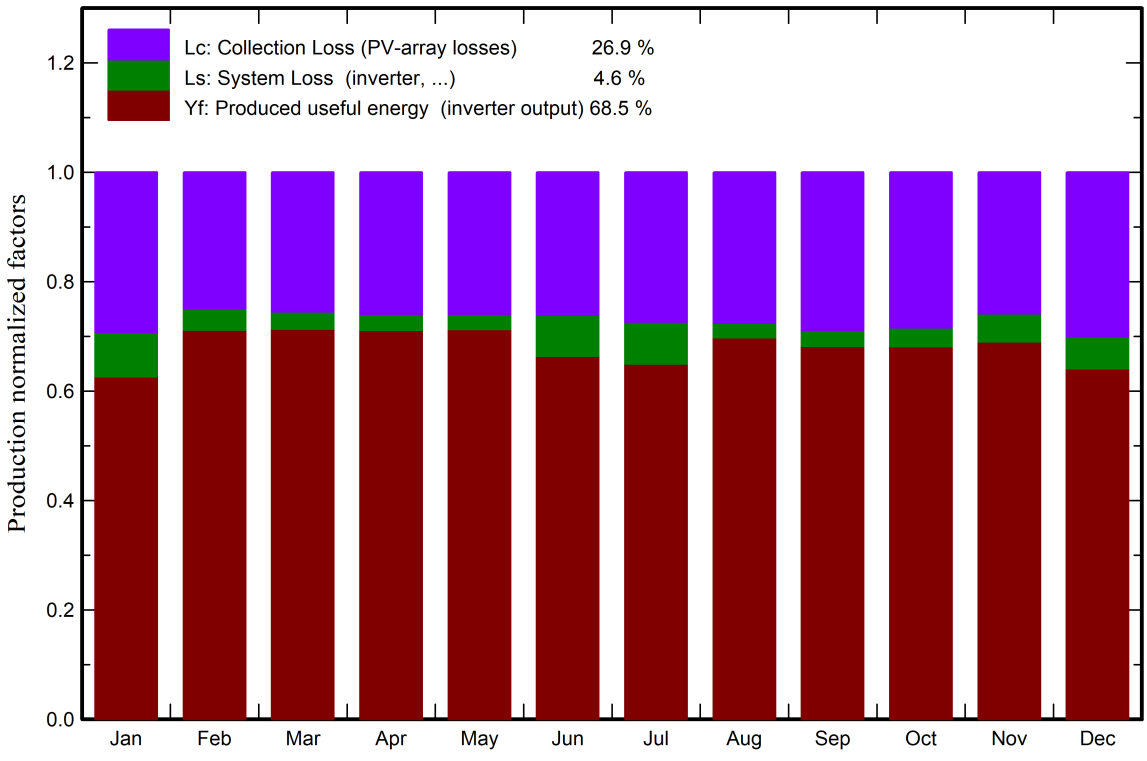
PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Predef. graphs

Energia incidente di riferimento su piano collettori



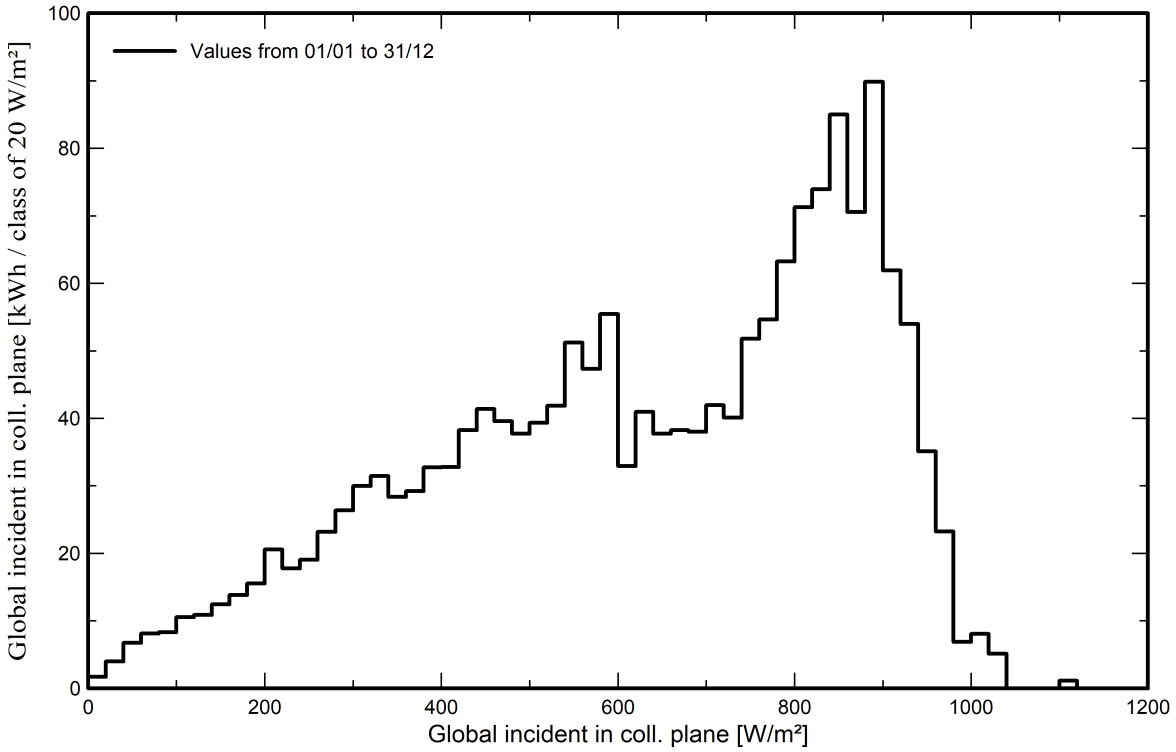
Fattori normalizzati di produzione e di perdita



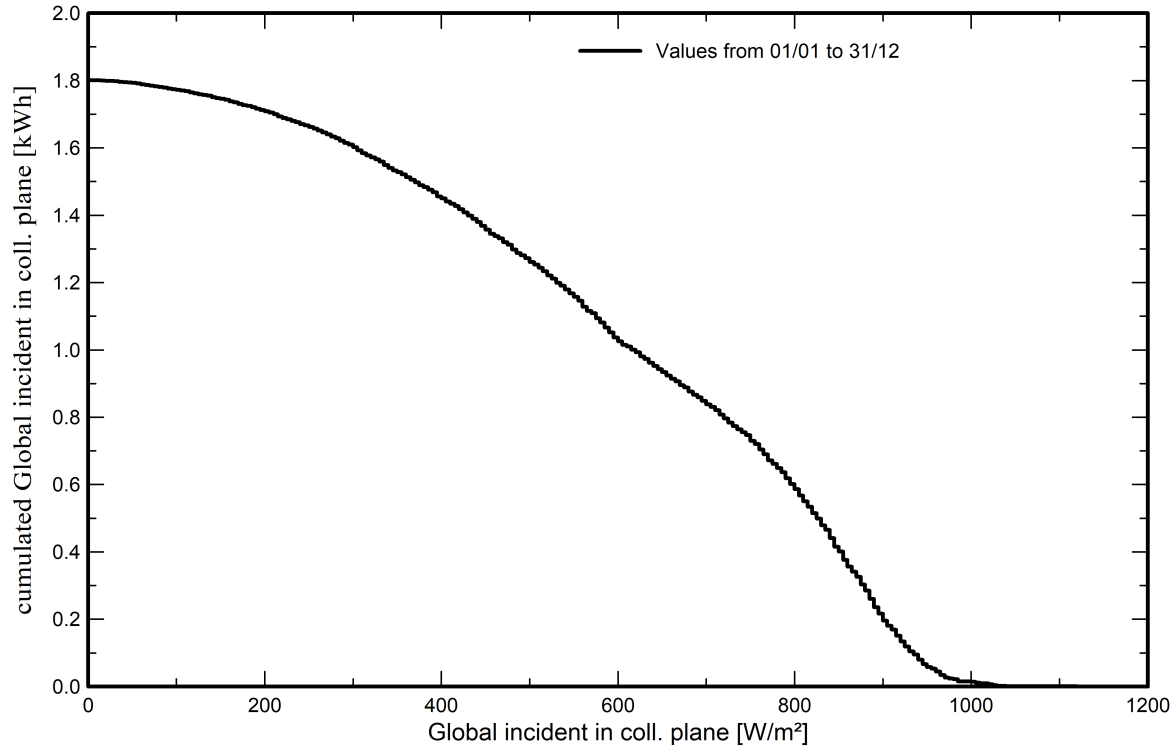
PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Predef. graphs

Distribuzione irraggiamento incidente



Coda della distribuzione di irradiazione incidente



PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Predef. graphs

Temperatura del campo vs.irradiazione efficace

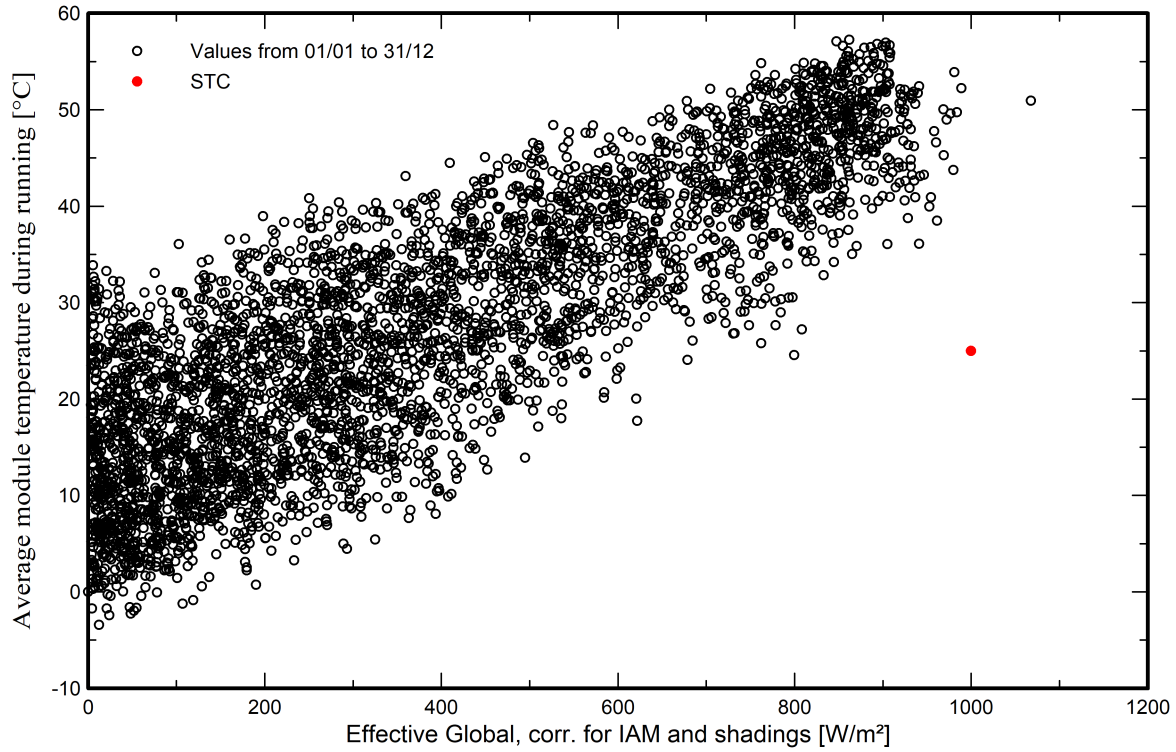
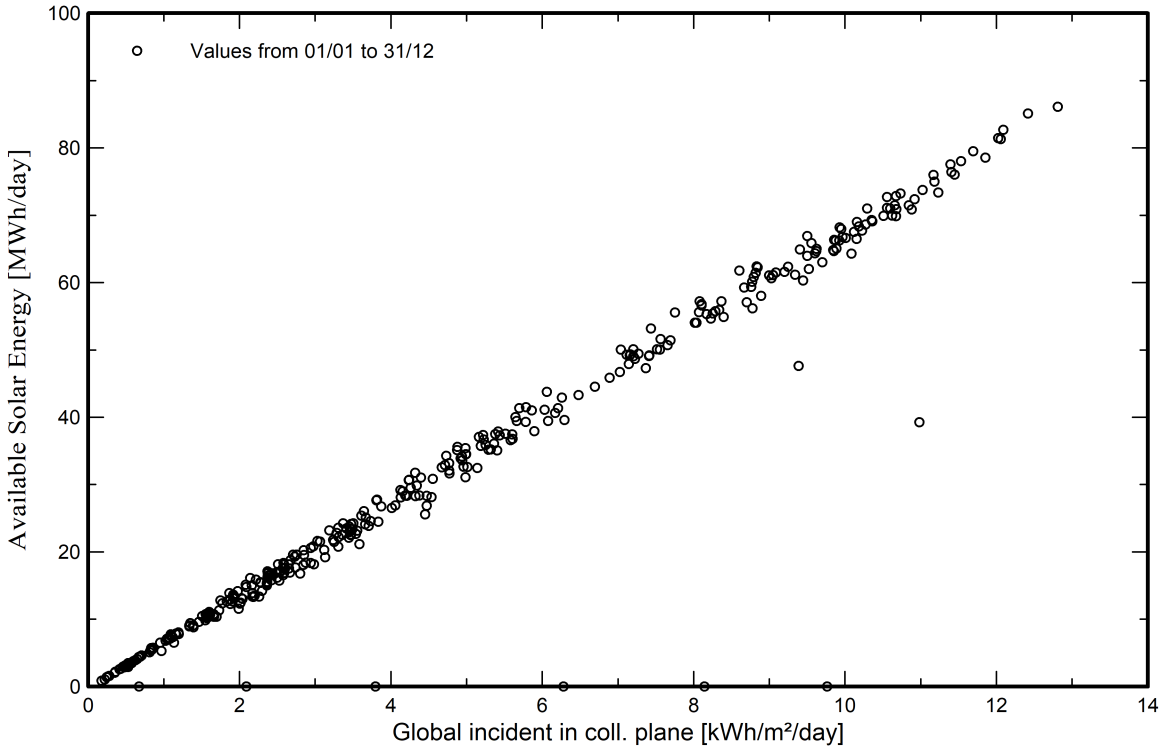


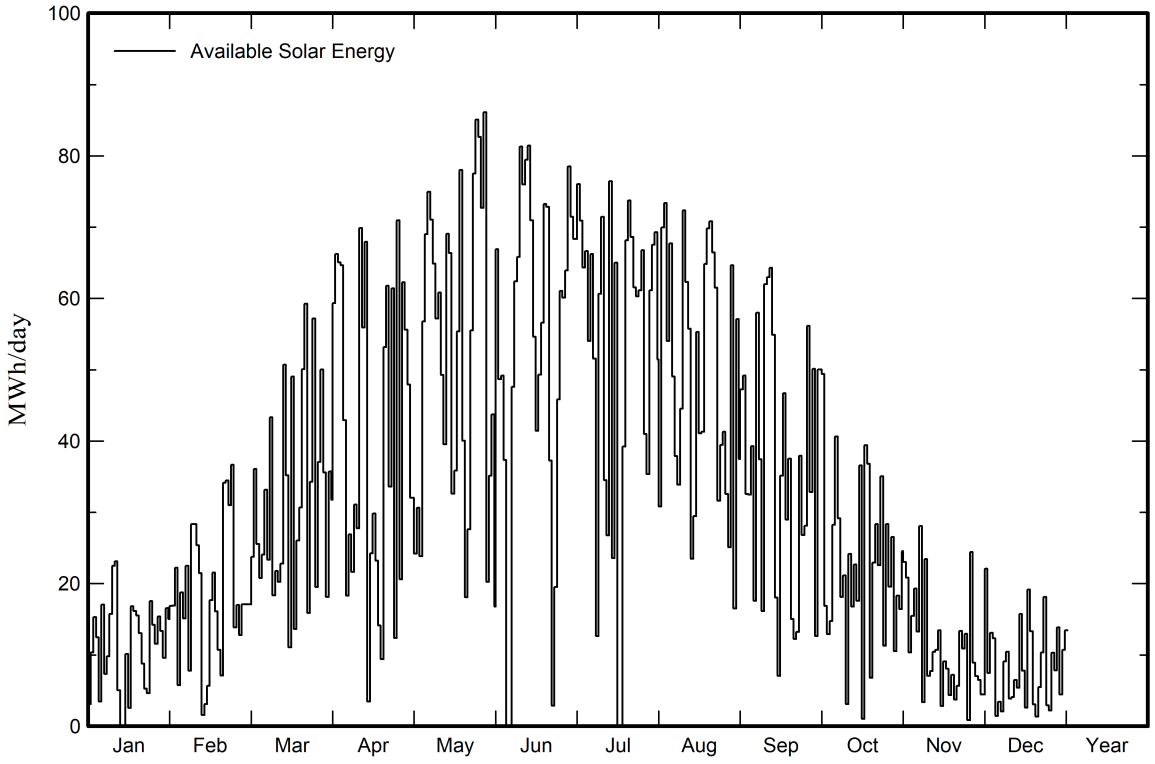
Diagramma giornaliero entrata/uscita



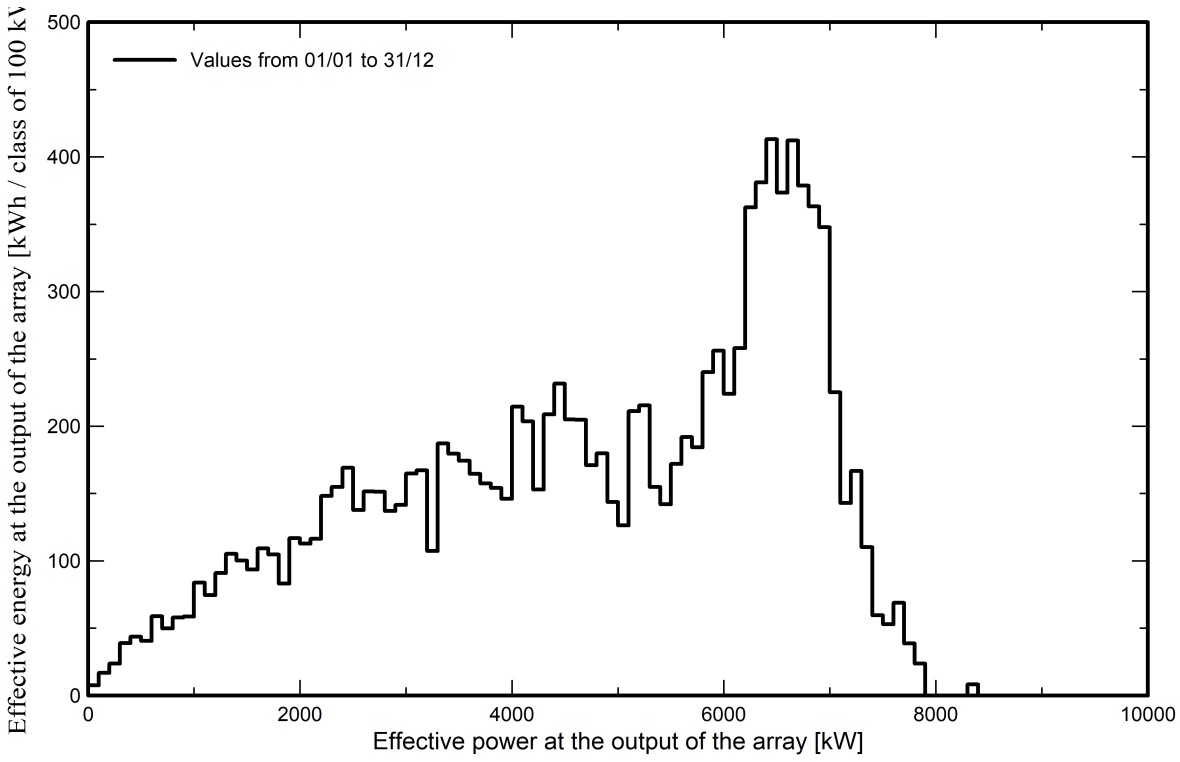
PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Predef. graphs

Energia giornaliera in uscita sistema



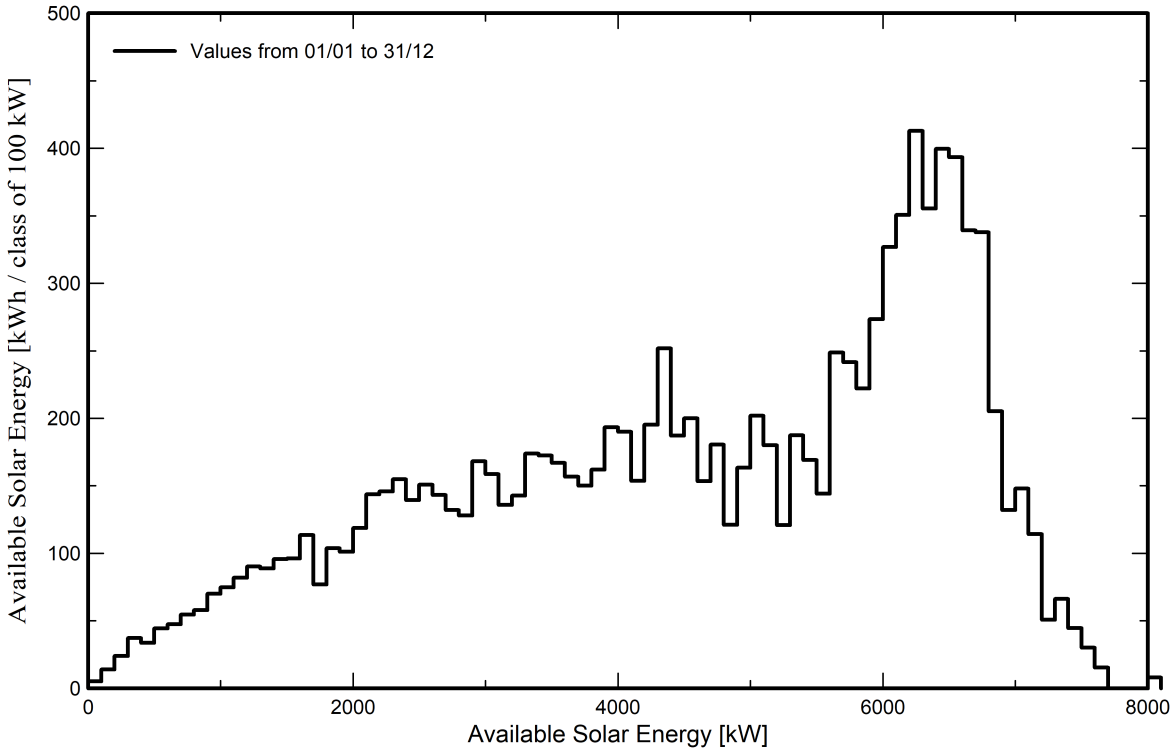
Distribuzione potenza dell'impianto



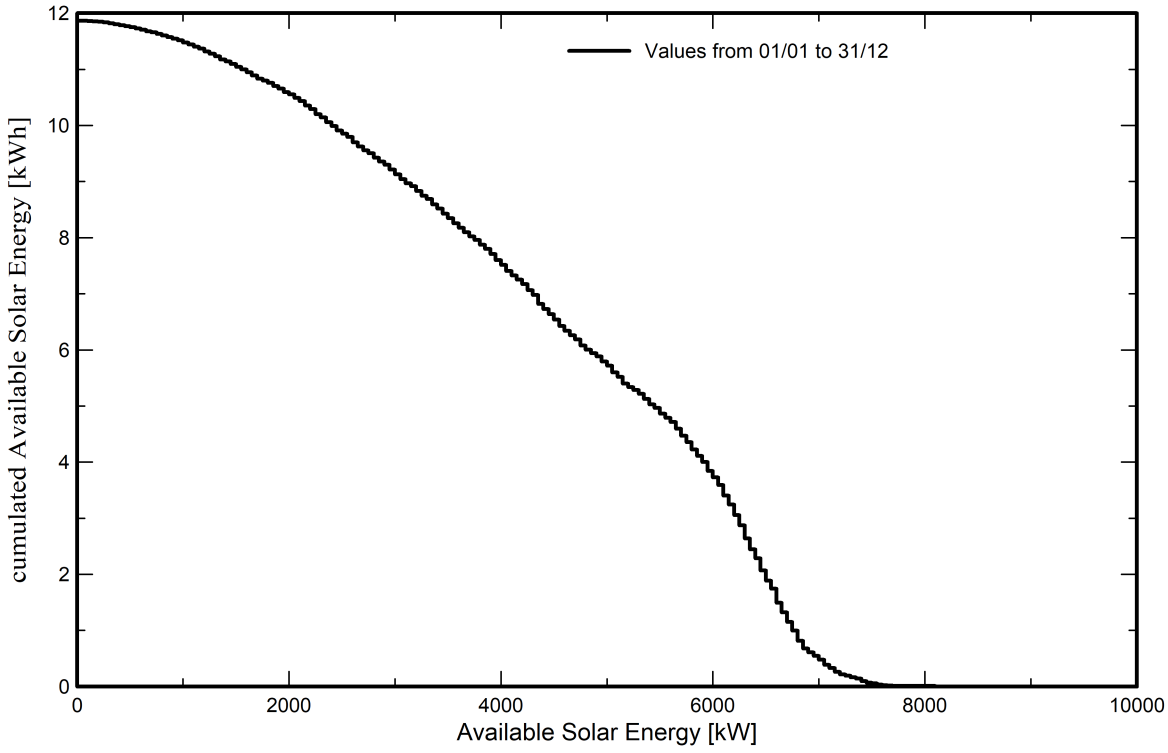
PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Predef. graphs

Distribuzione potenza in uscita sistema



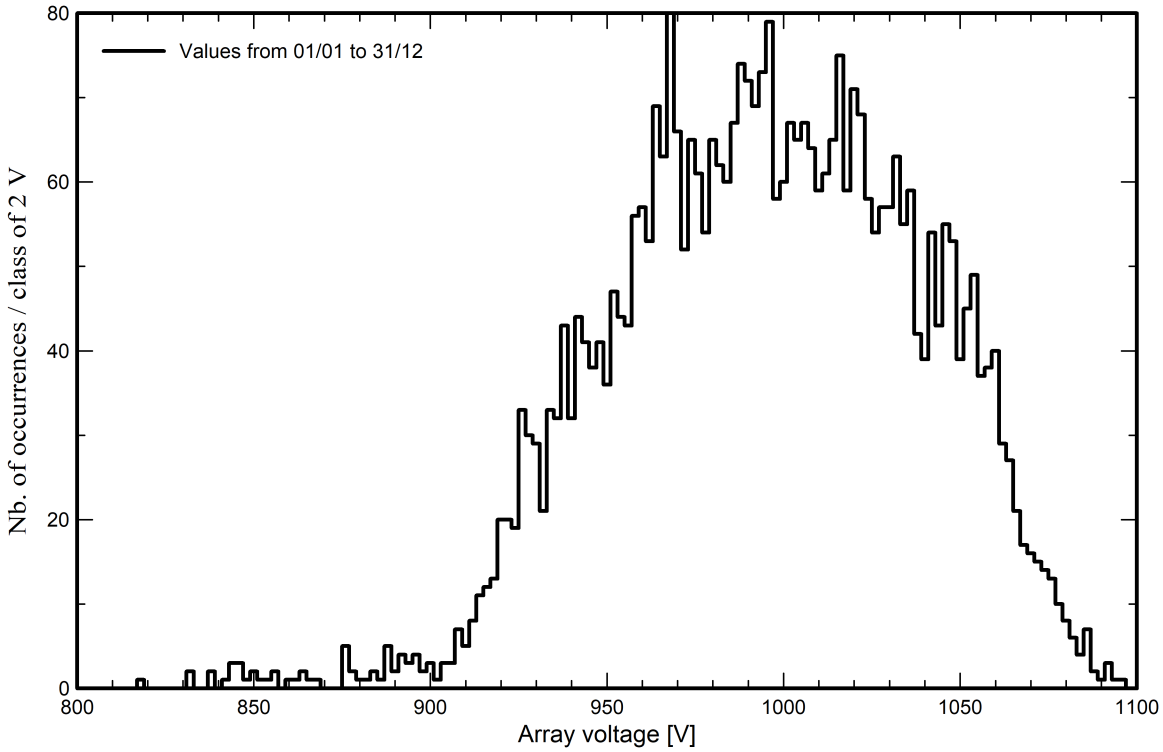
Coda della distribuzione della potenza in uscita



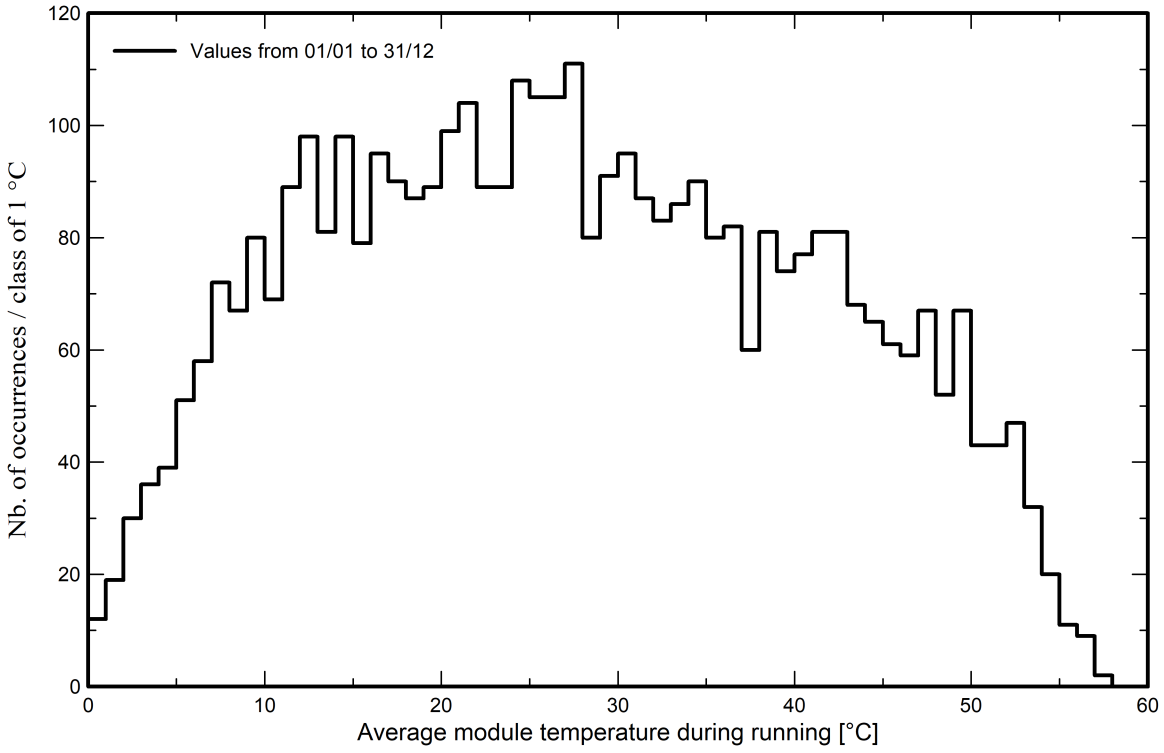
PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Predef. graphs

Distribuzione tensione impianto

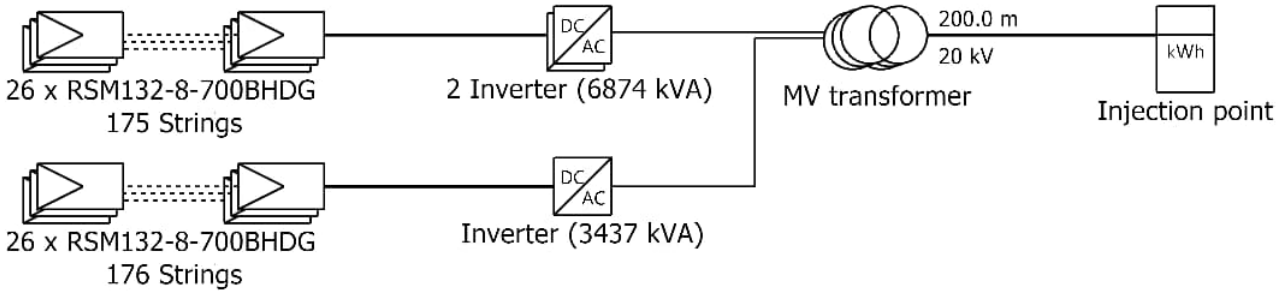


Distribuzione temperatura impianto



Single-line diagram

PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2



PV module	RSM132-8-700BHDG
Inverter	SG3400-HV-20
String	26 x RSM132-8-700BHDG

	Cona LSBP 2023	AREA TECNICA (Italy)
	VC6 : Nuova variante di simulazione	07/03/23

PVsyst V7.3.2
VC6, Simulato su
07/03/23 17:01
con v7.3.2

Nuova variante di simulazione
Coefficenti di rendimento normalizzati

	Yr kWh/m²/day	Lc kWh/kWp/day	Ya kWh/kWp/day	Ls kWh/kWp/day	Yf kWh/kWp/day	Lcr ratio	Lsr ratio	PR ratio
January	1.86	0.54	1.32	0.15	1.16	0.293	0.081	0.626
February	2.65	0.66	1.99	0.10	1.88	0.249	0.039	0.711
March	4.58	1.17	3.41	0.14	3.27	0.255	0.031	0.714
April	6.02	1.56	4.46	0.18	4.28	0.259	0.029	0.711
May	7.64	1.98	5.66	0.21	5.45	0.260	0.028	0.713
June	8.50	2.22	6.28	0.64	5.64	0.261	0.075	0.664
July	8.52	2.33	6.19	0.65	5.53	0.274	0.077	0.650
August	7.33	2.02	5.31	0.20	5.11	0.275	0.027	0.698
September	5.50	1.59	3.91	0.16	3.75	0.289	0.029	0.682
October	3.44	0.98	2.46	0.12	2.34	0.284	0.034	0.682
November	1.67	0.43	1.24	0.09	1.15	0.258	0.051	0.690
December	1.36	0.41	0.95	0.08	0.87	0.300	0.058	0.641
Year	4.93	1.33	3.61	0.23	3.38	0.269	0.046	0.685

Al fine di facilitare il confronto tra più impianti fotovoltaici, il JRC (Centro comune di ricerca europeo) ha introdotto il seguente Indice di prestazione , ora fissato nella norma IEC EN 61724.

Questi indicatori sono correlati all'energia incidente GlobInc nel piano del collettore e sono normalizzati da Pnom = Potenza nominale installata dell'array a STC , come fornito dal produttore del modulo fotovoltaico [kWp] .

Pertanto sono indipendenti dalla dimensione dell'array, dalla situazione geografica e dall'orientamento del campo.

In queste definizioni le energie di rendimento sono espresse come [kWh / KWp / giorno]. In altre parole, tali grandezze sono numericamente pari al Tempo di funzionamento equivalente con un irraggiamento costante di 1 kW/m², ovvero possono essere espresse anche come [Ore/ giorno] con funzionamento a 1 kW/m², oppure [kWh/ m²/giorno] (vedi nota sotto).

Definiamo le seguenti quantità:

- Yr = Sistema di riferimento Yield è l'array ideale Yield secondo Pnom come definito dal produttore, senza alcuna perdita . Si può capire come ogni kWh incidente dovrebbe idealmente produrre la potenza nominale dell'array Pnom durante un'ora. Yr è numericamente uguale all'energia incidente nel piano dell'array, espressa in [kWh/m²/giorno].

- Ya = Array Yield è l'energia prodotta giornalmente dall'array, riferita alla potenza nominale [kWh / KWp / giorno].

- Yf = Resa impianto è l'energia utile giornaliera dell'impianto, riferita alla potenza nominale [kWh / KWp / giorno].

- Lc = Collection Loss = Yr - Ya , sono le perdite dell'array , comprese le perdite termiche, di cablaggio, di qualità del modulo, mismatch e IAM, ombreggiamento, sporcizia, MPP, perdite di regolazione, nonché tutte le altre inefficienze.

- Ls = System Loss = Ya - Yf, include la perdita dell'inverter nei sistemi connessi alla rete o le inefficienze di batteria nei sistemi stand-alone.

- PR = Performance Ratio = Yf / Yr , è l'efficienza globale del sistema rispetto alla potenza nominale installata e all'energia incidente.

Per i sistemi stand-alone (o ogni sistema con carico limitato), introduciamo anche:

- Lu = Energia non utilizzata , l'energia potenzialmente disponibile all'uscita dell'array, che non può essere utilizzata perché il sistema è "saturato" (batteria carica o carico limitato nel sistema DC-grid).

Questo dovrebbe essere determinato durante la simulazione, e abbiamo: Ya = Yr - Lu - Lc.

In questo caso Lc è la perdita di raccolta, solo quando il sistema è in grado di utilizzare l'energia prodotta.

Project: Cona LSBP 2023

Variant: Nuova variante di simulazione

AREA TECNICA (Italy)

PVsyst V7.3.2
VC6, Simulation date:
07/03/23 17:01
with v7.3.2

Project summary

Geographical Site
Cona
Italia

Situation

Latitude	44.80 °N
Longitude	11.71 °E
Altitude	8 m
Time zone	UTC+1

Project settings

Albedo	0.20

Meteo data
Cona
Meteonorm 8.1 (1991-2012), Sat=100% - Sintetico

System summary

Grid-Connected System
Simulation for year no 10

Tracking system

PV Field Orientation

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

Tracking algorithm	
Astronomic calculation	

Near Shadings

Linear shadings	
Diffuse shading	Automatic

System information

PV Array		**Inverters**	
Nb. of modules	13676 units	Nb. of units	3 units
Pnom total	9573 kWp	Pnom total	10.31 MWac
		Pnom ratio	0.928

User's needs
Fixed constant load
20.00 kW
Global
175 MWh/Year

Results summary

Produced Energy	11807.5 MWh/year	Specific production	1233 kWh/kWp/year	Perf. Ratio PR	68.49 %
Used Energy	175.2 MWh/year			Solar Fraction SF	43.77 %

Table of contents