

REGIONE EMILIA-ROMAGNA  
PROVINCIA DI FERRARA  
COMUNE DI CODIGORO


PROGETTO DI UN IMPIANTO AGRIVOLTAICO CON PRODUZIONE AGRICOLA E DI ENERGIA ELETTRICA DA FONTE RINNOVABILE FOTVOLTAICA, DI POTENZA PARI A 24,9 MW E DELLE RELATIVE OPERE DI CONNESSIONE ALLA RTN DA UBICARSI NEL COMUNE DI CODIGORO (FE)

Timbri autorizzativi

**CALCOLO PRODUCIBILITA'**

IDENTIFICAZIONE ELABORATO

Livello prog.	Codice Pratica Terna	Tipo Elabor.	N.ro Elabor.	Project ID Cliente	Project ID Interno	NOME FILE	DATA	SCALA
PDef	202401788	Relazione	-	COD	COD	COD-DEV.PVS-1000	25/03/2026	
REVISIONI								
VERSIONE	DATA	DESCRIZIONE	ESEGUITO	VERIFICATO	APPROVATO			
Dft.00	25/03/2026	Prima Emissione	GT	DB	DB			

<p>IL PROPONENTE</p> 	<p>PROGETTO DI</p> 	<p>TECNICO INCARICATO</p>  <p>_____ Davide Bergamin Geometra</p>
<p><b>ELEMENTS CODIGORO SRL</b></p> <p>Sede in via Beato S. Valfrè n. 14, Torino (TO), 10121 CF e P.iva: 13328390011 Mail: elements.codigoro@legalmail.it</p>	<p><b>I-PERGOLA SRL SOCIETÀ BENEFIT</b></p> <p>Sede legale: Via Flero 28, Brescia (BS), 25125 P.Iva: 00747010197 PEC: i-pergolasrl@pec.it</p>	<p><b>Geom. Davide Bergamin</b></p> <p>Sede legale: via P. Savino Mombelli 36, Bassano Bresciano, 25020 P.IVA 03987410986 Mail: davide.bergamin@i-pergola.it</p>

**PREMESSA**

La presente analisi della producibilità è finalizzata a valutare la realizzabilità tecnica e operativa dell'impianto fotovoltaico che sarà realizzato a Codigoro (lat. 44.8507538; long. 12.0262581). L'analisi prende in considerazione le caratteristiche del sito di installazione, la configurazione dell'impianto, le tecnologie dei moduli e degli inverter, le strutture di supporto, le opere civili ed elettriche, nonché le fasi di montaggio, collegamento e messa in servizio.

COMMESSA: COD	CALCOLO PRODUCIBILITA'	REV.00	05/02/2026	PAGINA 2
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# PVsyst - Simulation report

## Grid-Connected System

Project: Codigoro Solar PV Plant – 24.9 MWp  
Variant: 24.9MWp\_22.1MW\_720Wp\_Tracker Tracking  
system

System power: 24.95 MWp

Pola - Italy



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Amrit Energy (India)

## Project summary

Geographical Site		Situation		Project settings	
Pola	Italy	Latitude	44.85 °(N)	Albedo	0.20
		Longitude	12.03 °(E)		
		Altitude	10 m		
		Time zone	UTC+1		
Weather data					
Pola					
Meteonorm 8.2 (1991-2012), Sat=100% - Synthetic					

## System summary

Grid-Connected System		Tracking system		User's needs	
<b>Orientation #1</b>		<b>Near Shadings</b>		Unlimited load (grid)	
Tracking plane, horizontal N-S axis		Linear shadings : Fast (table)			
Avg axis azim.	-14.8 °				
Phi min / max.	-/+ 55 °				
Diffuse shading	all trackers				
Tracking algorithm					
Astronomic calculation					
System information					
<b>PV Array</b>		<b>Inverters</b>			
Nb. of modules	34656 units	Nb. of units		63 units	
Pnom total	24.95 MWp	Total power		22176 kVA	
		Pnom ratio		1.13	

## Results summary

Produced Energy	40285 MWh/year	Specific production	1614 kWh/kWp/year	Perf. Ratio PR	89.26 %
Apparent energy	40328 MVAh/year			Bifacial perf. ratio	84.05 %

## Table of contents

Project and results summary	2
General parameters, PV Array Characteristics, System losses	3
Near shading definition - Iso-shadings diagram	6
Main results	7
Loss diagram	8
Predef. graphs	9
P50 - P90 evaluation	10
Single-line diagram	11



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**General parameters**

Grid-Connected System		Tracking system			
<b>Orientation #1</b>		<b>Trackers configuration</b>		<b>Sizes</b>	
Tracking plane, horizontal N-S axis		Nb. of trackers		Tracker Spacing	
Avg axis azim.		871 units		7.50 m	
Phi min / max.		Tracking plane, horizontal N-S axis		Sensitive width	
-14.8 °		-/+ 55 °		2.38 m	
Diffuse shading		Shading limit angles		GCR Shading	
all trackers		Phi limits		31.8 %	
<b>Tracking algorithm</b>		+/- 71.5 °			
Astronomic calculation					
<b>Models used</b>		<b>Horizon</b>		<b>Near Shadings</b>	
Transposition Perez		Free Horizon		Linear shadings : Fast (table)	
Diffuse Perez, Meteonorm					
Circumsolar separate					
<b>Bifacial system definition</b>				<b>User's needs</b>	
<b>Orientation #1</b>				Unlimited load (grid)	
<b>Bifacial system</b>					
Model Unlimited Trackers 2D model					
<b>Bifacial model geometry</b>					
Tracker Spacing		7.50 m			
Tracker width		2.38 m			
Axis height above ground		2.10 m			
Nb. of sheds		214 units			
<b>Bifacial model definitions</b>					
Ground albedo		0.20			
Bifaciality factor		80 %			
Rear shading factor		5.0 %			
Rear mismatch loss		10.0 %			
Shed transparent fraction		0.0 %			
<b>Grid injection point</b>					
<b>Power factor</b>					
Cos(phi) (lagging)		0.999			

**PV Array Characteristics**

PV module		Inverter	
Manufacturer Trina Solar		Manufacturer Azzurro ZCS	
Model TSM-720NEG21C.20		Model ZCS 3PH 350KTL-HV	
(Custom parameters definition)		(Custom parameters definition)	
TSM-720NEG21C.20-TR-V1.PAN		Unit Nom. Power	
Unit Nom. Power		352 kVA	
720 Wp		Number of inverters	
Number of PV modules		63 units	
34656 units		Total power	
Nominal (STC)		22176 kVA	
24.96 MWp		Operating voltage	
Modules		550-1300 V	
1444 string x 24 In series		Pnom ratio (DC:AC)	
<b>At operating cond. (50°C)</b>		1.13	
Pmpp		Leading limit Cos(phi) min	
23.16 MWp		1.000	
U mpp		Lagging limit Cos(phi) min	
909 V		1.000	
I mpp		Power sharing within this inverter	
25466 A			
<b>Total PV power</b>		<b>Total inverter power</b>	
Nominal (STC)		Inverter PNom limit defined as apparent power	
24952 kWp		Total power	
Total		22176 kVA	
34656 modules		Number of inverters	
Module area		63 units	
107654 m²		Pnom ratio	
Cell area		1.13	
100870 m²			



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**Array losses**

<b>Array Soiling Losses</b>		<b>Thermal Loss factor</b>		<b>DC wiring losses</b>				
Loss Fraction	2.0 %	Module temperature according to irradiance		Global array res.	0.39 mΩ			
		Uc (const)	29.0 W/m²K	Loss Fraction	1.00 % at STC			
		Uv (wind)	0.0 W/m²K/m/s					
<b>LID - Light Induced Degradation</b>		<b>Module Quality Loss</b>		<b>Module mismatch losses</b>				
Loss Fraction	1.00 %	Loss Fraction	0.00 %	Loss Fraction	0.80 % at MPP			
<b>Strings Mismatch loss</b>								
Loss Fraction	0.20 %							
<b>IAM loss factor</b>								
Incidence effect (IAM): User defined profile								
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	1.000	1.000	0.987	0.963	0.891	0.672	0.000
<b>Spectral correction</b>								
FirstSolar model								
Precipitable water estimated from relative humidity								
<b>Coefficient Set</b>	<b>C0</b>	<b>C1</b>	<b>C2</b>	<b>C3</b>	<b>C4</b>	<b>C5</b>		
Monocrystalline Si	0.85914	-0.02088	-0.0058853	0.12029	0.026814	-0.001781		

**System losses**

<b>Unavailability of the system</b>		<b>Auxiliary losses</b>	
Time fraction	0.5 %	Proportional to Power	3.0 W/kW
	1.8 days, 3 periods	0.0 kW from Power thresh.	

**AC wiring losses**

<b>Inv. output line up to MV transfo</b>	
Inverter voltage	800 Vac tri
Loss Fraction	2.00 % at STC
<b>Inverter: ZCS 3PH 350KTL-HV</b>	
Wire section (63 Inv.)	Copper 63 x 3 x 150 mm²
Average wires length	261 m
<b>MV line up to Injection</b>	
MV Voltage	20 kV
Wires	Copper 3 x 500 mm²
Length	5000 m
Loss Fraction	1.16 % at STC

**AC losses in transformers**

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#### AC losses in transformers

<b>MV transfo</b>	
Medium voltage	20 kV
<b>Transformer from Datasheets</b>	
Nominal power	25000 kVA
Iron Loss (24/24 Connexion)	20.00 kVA
Iron loss fraction	0.08 % of PNom
Copper loss	150.00 kVA
Copper loss fraction	0.60 % at PNom
Coils equivalent resistance	3 x 0.15 mΩ



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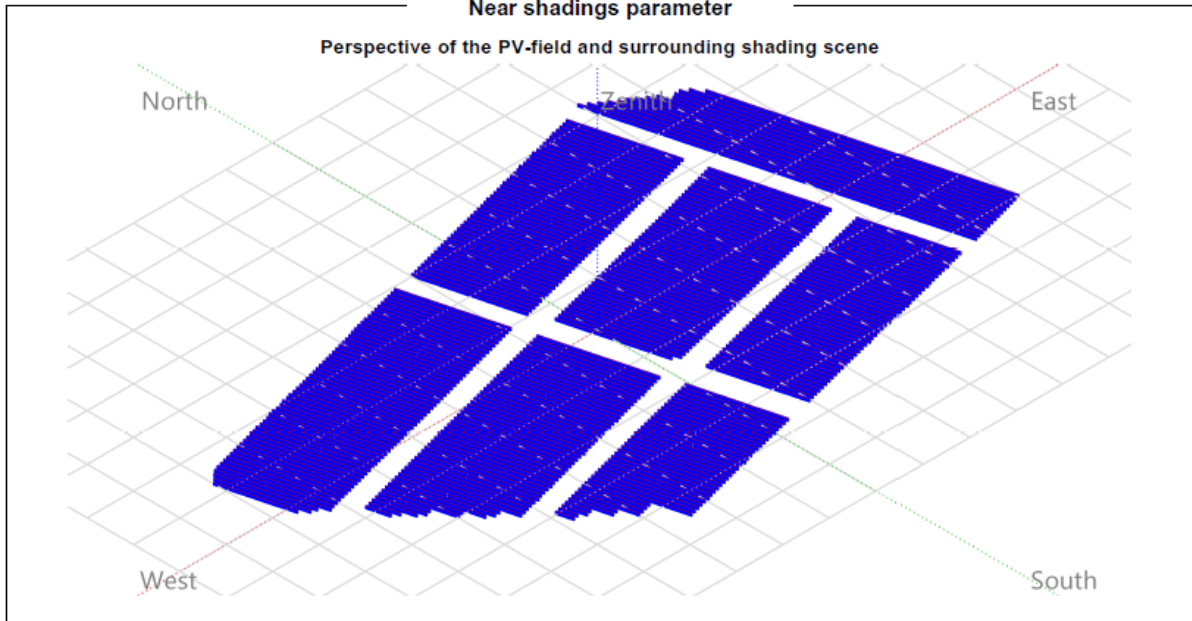
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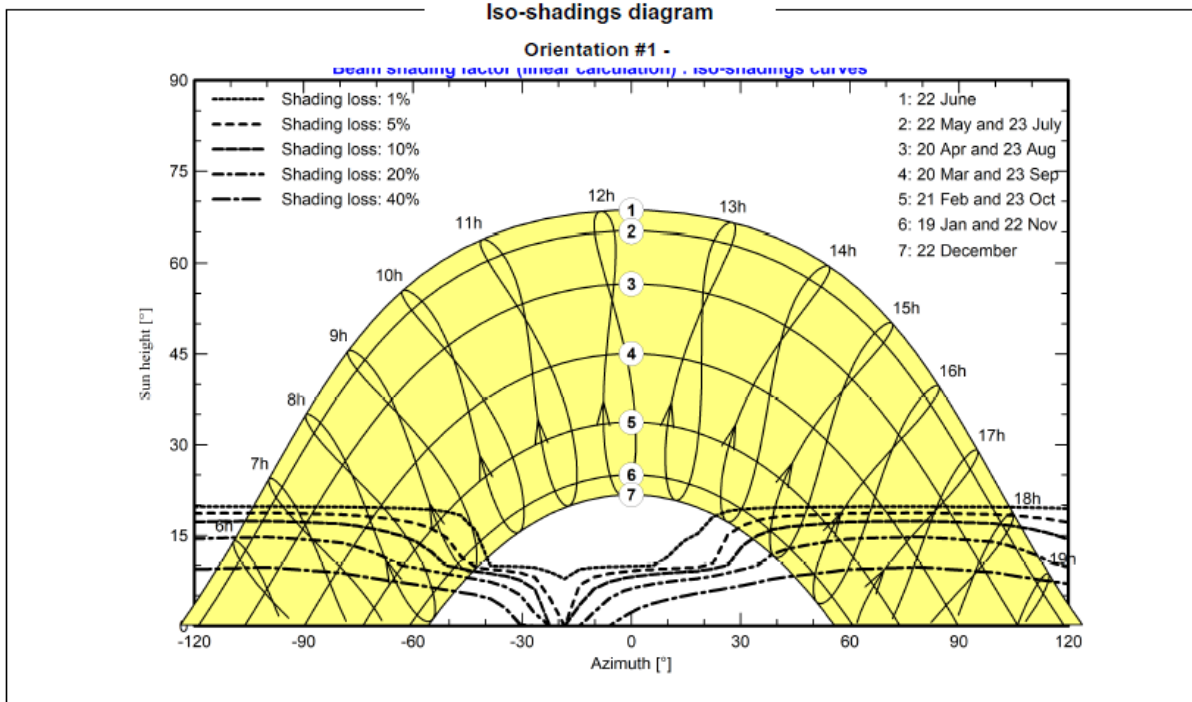


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Near shadings parameter



Iso-shadings diagram





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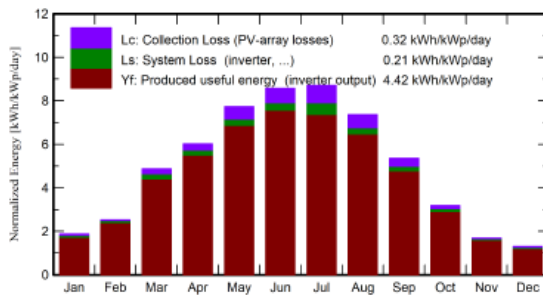
Main results

System Production

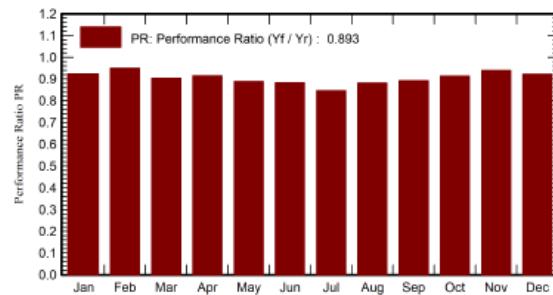
Produced Energy 40285 MWh/year  
Apparent energy 40328 MVAh/year

Specific production 1614 kWh/kWp/year  
Perf. Ratio PR 89.26 %  
Bifacial perf. ratio 84.05 %

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 MWh	E_Grid MWh	PR ratio	PRBifi ratio
January	39.4	20.70	3.07	58.5	51.5	1405	1349	0.924	0.872
February	53.7	32.25	5.24	71.0	65.0	1751	1684	0.951	0.891
March	109.1	51.01	10.06	151.3	138.6	3599	3416	0.905	0.853
April	138.5	67.39	14.40	180.6	169.0	4298	4124	0.915	0.860
May	179.6	79.92	19.49	239.7	224.0	5551	5320	0.890	0.838
June	195.4	78.63	24.11	257.4	243.1	5926	5675	0.884	0.833
July	200.4	77.87	26.30	270.2	253.2	6121	5712	0.847	0.800
August	171.4	74.53	25.72	228.2	213.9	5234	5021	0.882	0.831
September	118.0	55.44	20.13	161.0	148.7	3739	3590	0.894	0.842
October	74.9	43.63	15.58	99.0	90.6	2361	2260	0.914	0.857
November	39.6	25.75	9.83	51.1	46.2	1248	1197	0.939	0.877
December	29.6	19.33	4.44	40.8	35.7	981	938	0.922	0.862
Year	1349.6	626.46	14.92	1808.8	1679.4	42214	40285	0.893	0.840

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	PRBifi	Bifacial Performance Ratio
GlobEff	Effective Global, corr. for IAM and shadings		



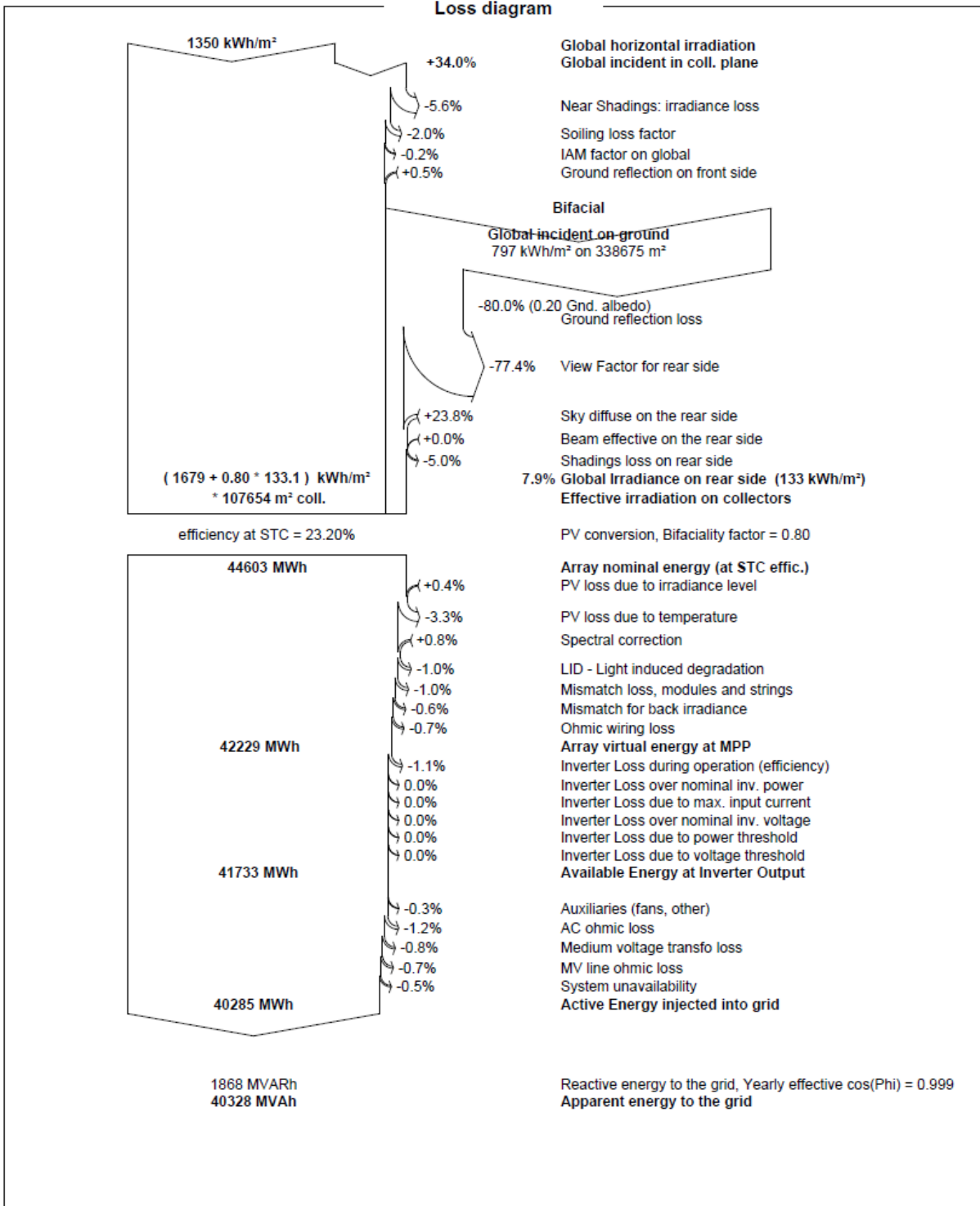
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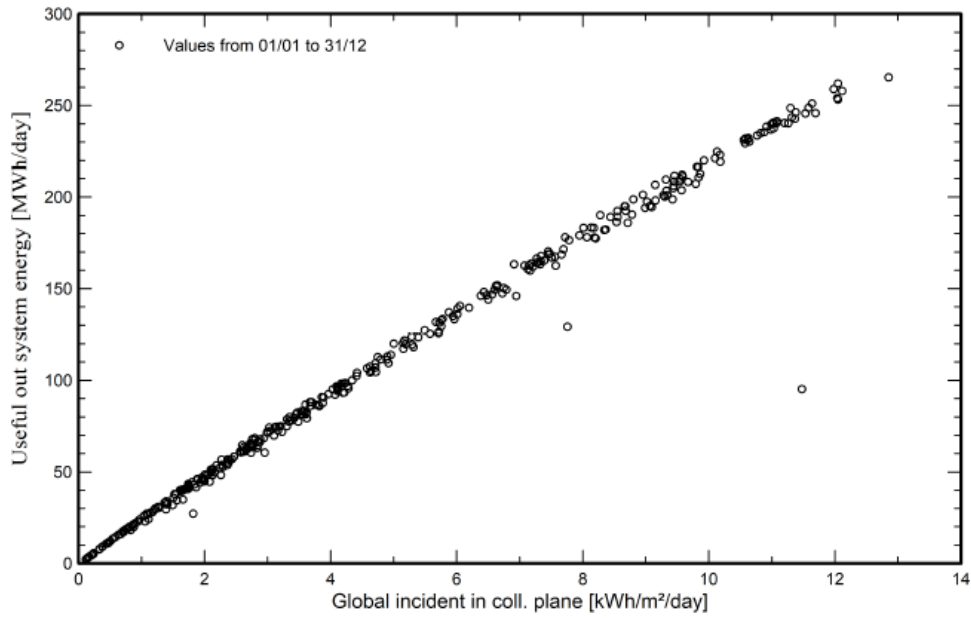
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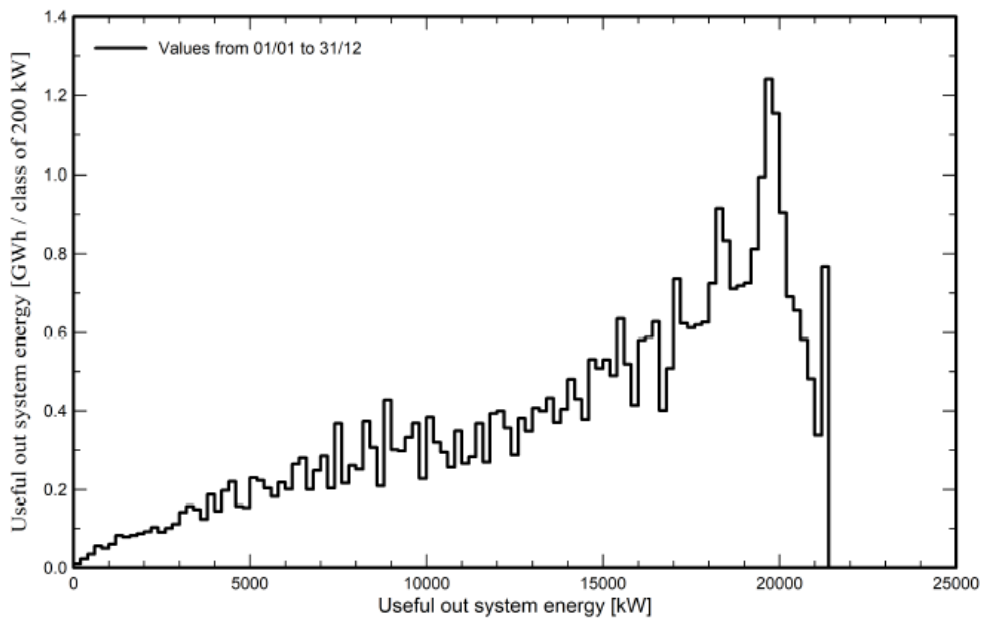
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Predef. graphs

Daily Input/Output diagram



System Output Power Distribution





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P50 - P90 evaluation

Weather data

Source Meteororm 8.2 (1991-2012), Sat=100%  
Kind TMY, multi-year  
Year-to-year variability(Variance) 5.0 %  
Specified Deviation  
Climate change 0.0 %

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 %

Global variability (weather data + system)

Variability (Quadratic sum) 5.3 %

Annual production probability

Variability 2.14 GWh  
P50 40.28 GWh  
P75 38.84 GWh  
P90 37.54 GWh

Probability distribution

