

ERG Solar Holding S.r.l.

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Realizzazione di un impianto agrivoltaico di potenza nominale DC pari a 60,58 MWp, da realizzarsi nel comune di Poggio Imperiale (FG) in località Zancardi e delle relative opere di connessione anche nel comune di Apricena (FG).



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PREMESSA

Il presente documento di analisi di producibilità è redatto da ERG Solar Holding S.r.l. che se ne assume ogni responsabilità circa i contenuti, per cui la società BFP S.r.l. declina ogni responsabilità circa i contenuti dello studio che rappresenta lo stato iniziale di sviluppo progettuale.

In base ai dati storici riportati dal software PVGIS, l'irraggiamento globale incidente sul piano dei collettori è quella riportata nella seguente tabella.

Gen	Feb	Mar	Apr	Mag	Giu	Lug	Ago	Set	Ott	Nov	Dic
79.1	99.2	162.5	201.7	258.2	277.8	302.2	267.6	188.4	127.6	77.9	65.5

Tabella 1: Dati di radiazione per la città di Poggio Imperiale su superficie inclinata (elaborazione su PVGIS).
Radiazione globale annua sulla superficie inclinata: 2107.7 kWh/m²

L'impianto agrivoltaico per la produzione di energia elettrica per il quale è stato redatto il report di producibilità avrà le seguenti caratteristiche:

- potenza installata lato DC: circa 60,58 MWp;
- potenza dei singoli moduli: 670 Wp;
- numero dei moduli: 90.420;
- potenza dell'inverter: 2933 kW in c.a.;
- lunghezza del cavo MT di collegamento con la sottostazione elettrica: circa 8 km.

Per determinare la producibilità del sistema fotovoltaico sono stati adottati i seguenti parametri:

- perdite per Sporco: 1,0%;
- perdite di qualità del modulo: -0,4%;
- perdite di disadattamento del modulo: 2,0%;
- perdite di disadattamento delle strighe: 0,1%.

Quale risultato il software ha generato una previsione di energia prodotta pari a **106.953,60 MWh/anno**, pari a circa **1765 ore equivalenti annue (kWh/kWp)**.

In coda alla presente relazione è allegato il report di output del programma.

PVsyst - Simulation report

Grid-Connected System

Project: POGGIO IMPERIALE

LAYOUT VIA

Tracking system with backtracking

System power: 60.58 MWp

Poggio imperiale FG - Italy



PVsyst V7.3.2

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ERG (Italy)

Project summary

Geographical Site Poggio imperiale FG Italy	Situation Latitude 41.81 °N Longitude 15.34 °E Altitude 104 m Time zone UTC+1	Project settings Albedo 0.20
Meteo data Poggio imperiale FG SolarGISv2.2.23 - TMY		

System summary

Grid-Connected System	Tracking system with backtracking		
PV Field Orientation Orientation Tracking plane, tilted axis Avg axis tilt -0.9 ° 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 90420 units Pnom total 60.58 MWp	Inverters Nb. of units 19 units Pnom total 55.73 MWac Pnom ratio 1.087		
User's needs Unlimited load (grid)			

Results summary

Produced Energy 106953.60 MWh/year	Specific production 1765 kWh/kWp/year	Perf. Ratio PR 83.76 %
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General parameters

Grid-Connected System		Tracking system with backtracking	
PV Field Orientation		Tracking algorithm	Backtracking array
Orientation		Astronomic calculation	Nb. of trackers 3210 units
Tracking plane, tilted axis		Backtracking activated	Identical arrays
Avg axis tilt	-0.9 °		Sizes
Avg axis azim.	0 °		Tracker Spacing 9.00 m
			Collector width 2.38 m
			Ground Cov. Ratio (GCR) 26.5 %
			Phi min / max. -/+ 55.0 °
			Backtracking strategy
			Phi limits for BT -/+ 74.5 °
			Backtracking pitch 8.83 m
			Backtracking width 2.38 m
Models used		Near Shadings	User's needs
Transposition	Perez	According to strings	Unlimited load (grid)
Diffuse	Imported	Electrical effect 100 %	
Circumsolar	separate	Diffuse shading Automatic	
Horizon			
Free Horizon			

PV Array Characteristics

PV module		Inverter	
Manufacturer	Trina Solar	Manufacturer	SMA
Model	TSM-670DE21	Model	Sunny Central 2930 UP
(Custom parameters definition)		(Original PVsyst database)	
Unit Nom. Power	670 Wp	Unit Nom. Power	2933 kWac
Number of PV modules	90420 units	Number of inverters	19 units
Nominal (STC)	60.58 MWp	Total power	55727 kWac
Array #1 - AREA 1		Array #1 - AREA 1	
Number of PV modules	20940 units	Number of inverters	4 units
Nominal (STC)	14.03 MWp	Total power	11732 kWac
Modules	698 Strings x 30 In series	Operating voltage	962-1325 V
At operating cond. (50°C)		Pnom ratio (DC:AC)	1.20
Pmpp	12.84 MWp		
U mpp	1041 V		
I mpp	12334 A		
Array #2 - AREA 2		Array #2 - AREA 2	
Number of PV modules	37200 units	Number of inverters	8 units
Nominal (STC)	24.92 MWp	Total power	23464 kWac
Modules	1240 Strings x 30 In series	Operating voltage	962-1325 V
At operating cond. (50°C)		Pnom ratio (DC:AC)	1.06
Pmpp	22.81 MWp		
U mpp	1041 V		
I mpp	21912 A		



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PV Array Characteristics

Array #3 - AREA 3			
Number of PV modules	18510 units	Number of inverters	4 units
Nominal (STC)	12.40 MWp	Total power	11732 kWac
Modules	617 Strings x 30 In series		
At operating cond. (50°C)			
Pmpp	11.35 MWp	Operating voltage	962-1325 V
U mpp	1041 V	Pnom ratio (DC:AC)	1.06
I mpp	10903 A		
Array #4 - AREA 4			
Number of PV modules	13770 units	Number of inverters	3 units
Nominal (STC)	9226 kWp	Total power	8799 kWac
Modules	459 Strings x 30 In series		
At operating cond. (50°C)			
Pmpp	8444 kWp	Operating voltage	962-1325 V
U mpp	1041 V	Pnom ratio (DC:AC)	1.05
I mpp	8111 A		
Total PV power		Total inverter power	
Nominal (STC)	60581 kWp	Total power	55727 kWac
Total	90420 modules	Number of inverters	19 units
Module area	280876 m ²	Pnom ratio	1.09
Cell area	144419 m ²		

Array losses

Array Soiling Losses		Thermal Loss factor		Module Quality Loss				
Loss Fraction	1.0 %	Module temperature according to irradiance		Loss Fraction	-0.4 %			
		Uc (const)	29.0 W/m ² K					
		Uv (wind)	0.0 W/m ² K/m/s					
Module mismatch losses		Strings Mismatch loss						
Loss Fraction	2.0 % at MPP	Loss Fraction	0.1 %					
IAM loss factor								
Incidence effect (IAM): User defined profile								
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

DC wiring losses

Global wiring resistance	0.32 mΩ		
Loss Fraction	1.5 % at STC		
Array #1 - AREA 1		Array #2 - AREA 2	
Global array res.	1.4 mΩ	Global array res.	0.78 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
Array #3 - AREA 3		Array #4 - AREA 4	
Global array res.	1.6 mΩ	Global array res.	2.1 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC



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AC wiring losses

Inv. output line up to MV transfo

Inverter voltage 660 Vac tri
Loss Fraction 0.25 % at STC

Inverter: Sunny Central 2930 UP

Wire section (19 Inv.) Alu 19 x 3 x 2500 mm²
Average wires length 28 m

MV line up to Injection

MV Voltage 33 kV
Wires Alu 3 x 1200 mm²
Length 8350 m
Loss Fraction 1.20 % at STC

AC losses in transformers

MV transfo

Medium voltage 33 kV

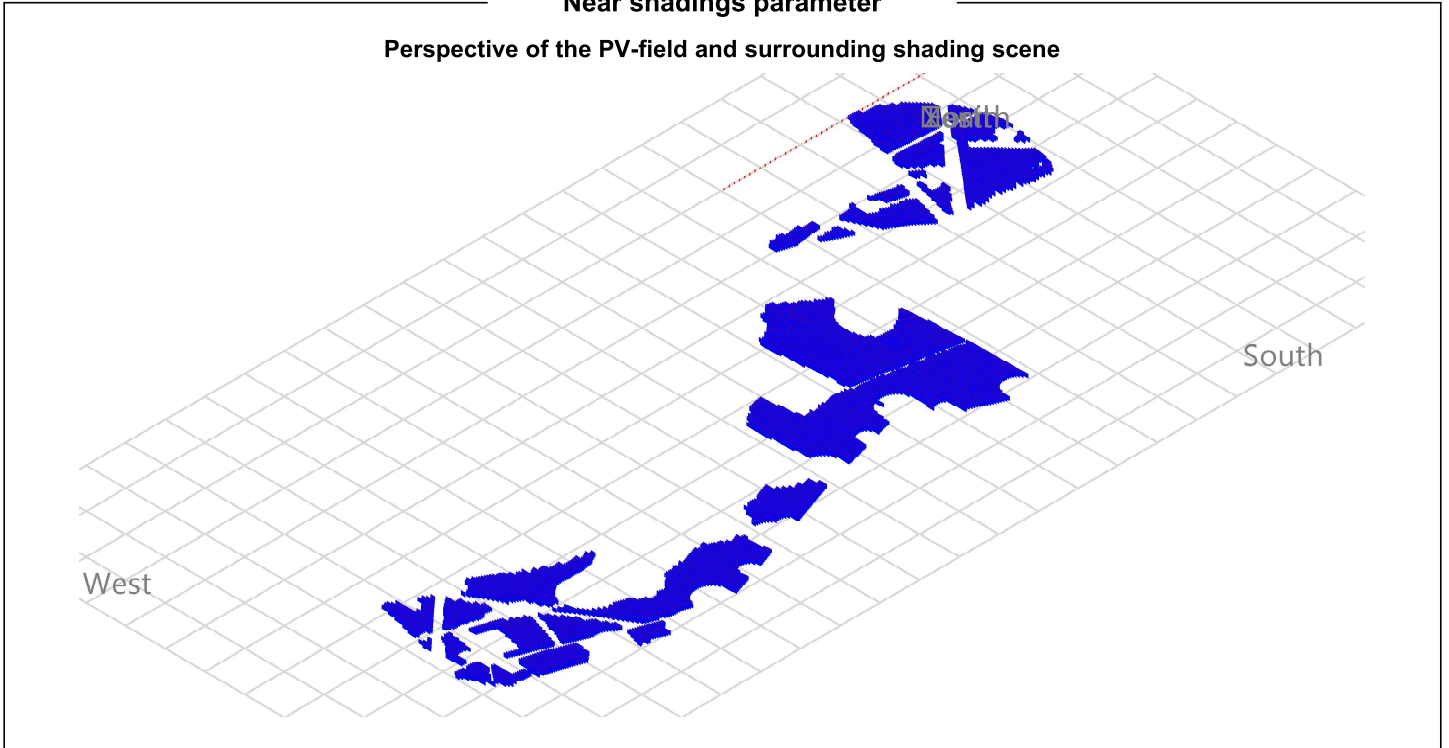
Transformer parameters

Nominal power at STC 59.52 MVA
Iron Loss (24/24 Connexion) 55.73 kVA
Iron loss fraction 0.09 % at STC
Copper loss 714.27 kVA
Copper loss fraction 1.20 % at STC
Coils equivalent resistance 3 x 0.09 mΩ



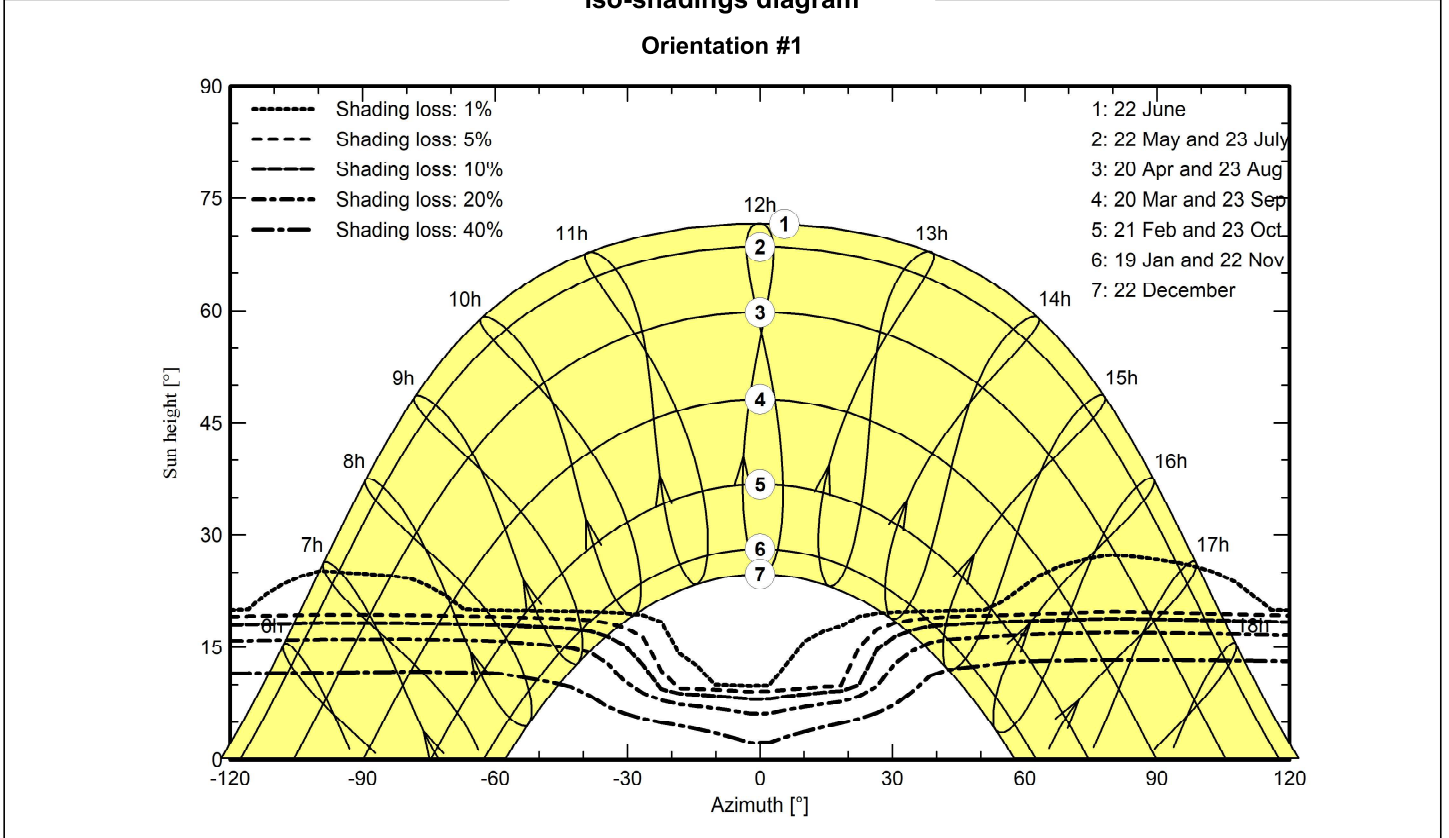
Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1





Main results

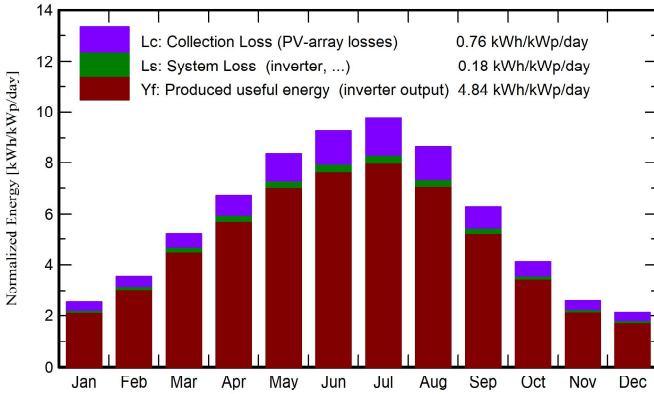
System Production

Produced Energy 106953.60 MWh/year

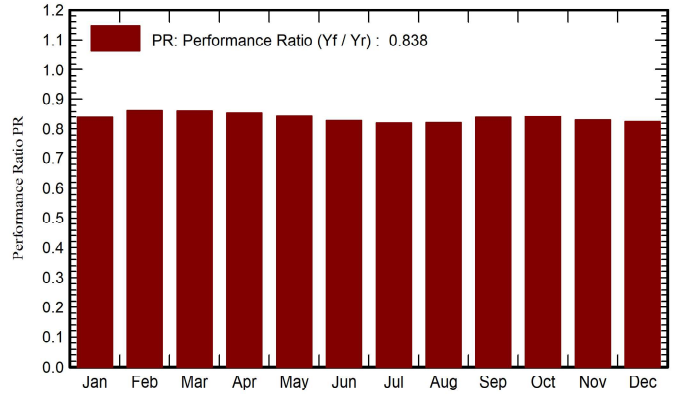
Specific production
Performance Ratio PR

1765 kWh/kWp/year
83.76 %

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 MWh	E_Grid MWh	PR ratio
January	58.6	29.79	9.76	79.1	73.9	4171	4024	0.839
February	72.3	32.39	8.76	99.2	94.0	5370	5184	0.862
March	120.6	47.58	11.40	162.5	155.7	8806	8486	0.862
April	156.0	65.56	15.11	201.7	194.8	10844	10446	0.855
May	198.6	77.85	19.25	258.2	250.0	13724	13225	0.845
June	212.6	76.45	24.27	277.8	269.7	14465	13943	0.828
July	226.3	66.01	26.74	302.2	293.7	15585	15019	0.820
August	201.0	69.47	26.42	267.6	259.1	13819	13330	0.822
September	139.8	59.39	22.21	188.4	181.3	9924	9585	0.840
October	96.3	43.76	18.34	127.6	121.5	6741	6514	0.843
November	58.4	29.01	14.50	77.9	73.1	4064	3920	0.831
December	46.5	22.91	9.54	65.5	60.5	3405	3277	0.826
Year	1587.1	620.17	17.24	2107.7	2027.2	110919	106954	0.838

Legends

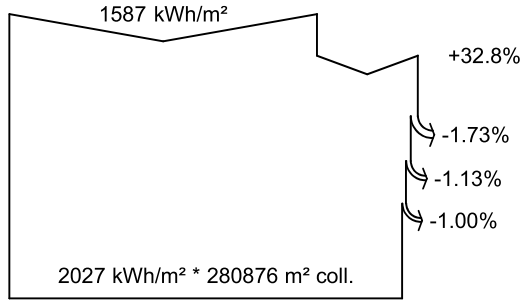
- GlobHor Global horizontal irradiation
- DiffHor Horizontal diffuse irradiation
- T_Amb Ambient Temperature
- GlobInc Global incident in coll. plane
- GlobEff Effective Global, corr. for IAM and shadings
- EArray Effective energy at the output of the array
- E_Grid Energy injected into grid
- PR Performance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



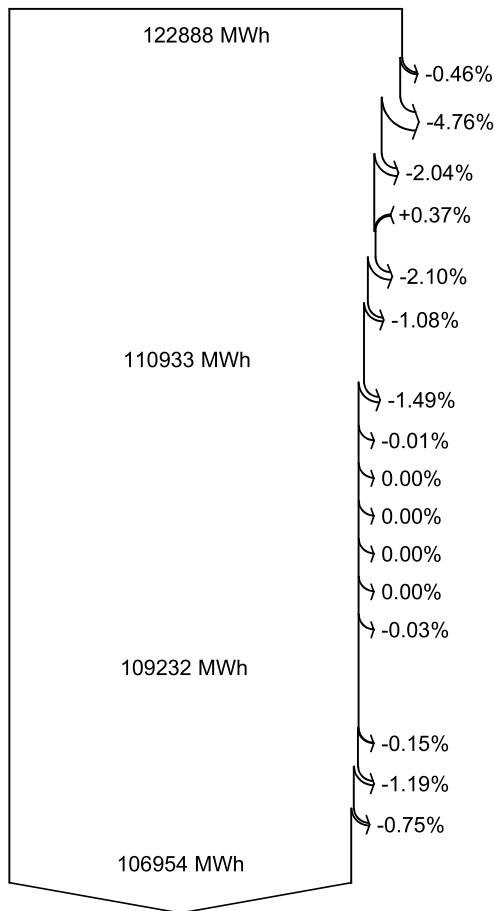
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Loss diagram



efficiency at STC = 21.58%



Global horizontal irradiation
Global incident in coll. plane

- Near Shadings: irradiance loss
- IAM factor on global
- Soiling loss factor

Effective irradiation on collectors

- PV conversion

Array nominal energy (at STC effic.)

- PV loss due to irradiance level
- PV loss due to temperature
- Shadings: Electrical Loss acc. to strings
- Module quality loss

- Mismatch loss, modules and strings

- Ohmic wiring loss

Array virtual energy at MPP

- Inverter Loss during operation (efficiency)
- Inverter Loss over nominal inv. power
- Inverter Loss due to max. input current
- Inverter Loss over nominal inv. voltage
- Inverter Loss due to power threshold
- Inverter Loss due to voltage threshold
- Night consumption

Available Energy at Inverter Output

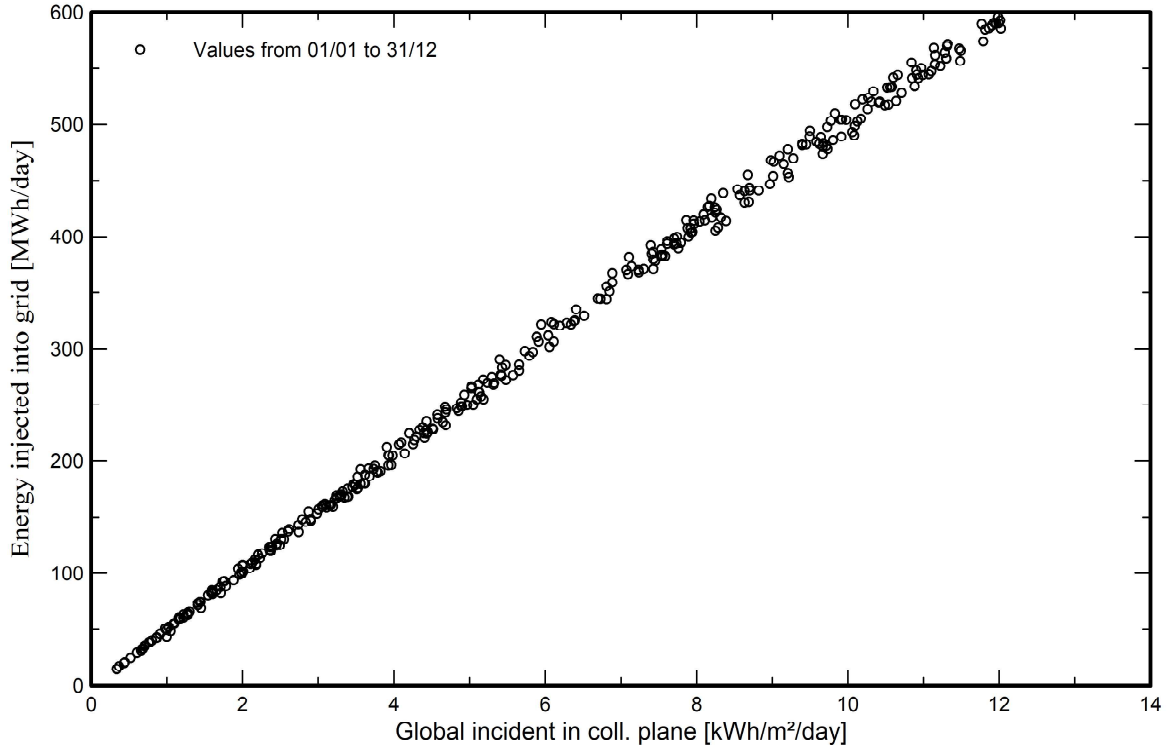
- AC ohmic loss
- Medium voltage transfo loss
- MV line ohmic loss

Energy injected into grid



Predef. graphs

Daily Input/Output diagram



System Output Power Distribution

