

**ISTANZA VIA**  
**Presentata al**  
**Ministero della Transizione Ecologica**  
**e al Ministero della Cultura**  
**(art. 23 del D. Lgs 152/2006 e ss. mm. ii)**

**PROGETTO**

**IMPIANTO FOTOVOLTAICO A TERRA (AGRIVOLTAICO)**  
**COLLEGATO ALLA RTN**  
**POTENZA NOMINALE 18,31 MW<sub>p</sub> – POTENZA IN IMMISSIONE 15 MW**  
***Comune di Belmonte Piceno e Servigliano (FM)***

**CALCOLO DI PRODUCIBILITA'**  
**21-00014-IT-BELMONTE\_PI-R02\_Rev0**


**PROPONENTE:**

**TEP RENEWABLES (BELMONTE PV) S.R.L.**  
**Viale SHAKESPEARE, 71 – 00144 Roma**  
**P. IVA e C.F. 16376251001 – REA RM - 1653235**

**PROGETTISTA:**


**ING. GIULIA GIOMBINI**  
**Iscritta all'Ordine degli Ingegneri della Provincia di Viterbo al n. A-1009**

<b>Data</b>	<b>Rev.</b>	<b>Tipo revisione</b>	<b>Redatto</b>	<b>Verificato</b>	<b>Approvato</b>
06/2022	0	Prima emissione	MV	GG	G. Calzolari

	<b>IMPIANTO FOTOVOLTAICO A TERRA (AGRIVOLTAICO)</b> <b>COLLEGATO ALLA RTN</b> <b>POTENZA NOMINALE 18,31 MWp</b> <b>POTENZA IN IMMISSIONE 15 MW</b> <b>Comune di Belmonte Piceno e Servigliano (FM)</b>	<b>Rev.</b>	<b>0</b>
	<b>21-00014-IT-BELMONTE_PI-R02</b> <b>CALCOLO DI PRODUCIBILITA'</b>	<b>Pag.</b>	<b>2 di 3</b>

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## 1 CALCOLO DI PRODUCIBILITA'

# PVsyst - Simulation report

## Grid-Connected System

Project: Terreni Menatta Belmonte 545Wp (10m pitch)

Variant: Terreni Menatta Belmonte 545Wp (10m pitch)

Unlimited Trackers with backtracking

System power: 18.31 MWp

Servigliano - Italy

**M.Valentini**

TEP Renewables (Italia) S.r.l (Italy)



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**Project summary**

<b>Geographical Site</b> Servigliano Italy	<b>Situation</b> Latitude 43.08 °N Longitude 13.52 °E Altitude 195 m Time zone UTC+1	<b>Project settings</b> Albedo 0.20
<b>Meteo data</b> Servigliano Meteonorm 8.0 (1991-2002), Sat=100% - Synthetic		

**System summary**

<b>Grid-Connected System</b>	<b>Unlimited Trackers with backtracking</b>		
<b>PV Field Orientation</b> Orientation Tracking horizontal axis	<b>Tracking algorithm</b> Irradiance optimization Backtracking activated	<b>Near Shadings</b> No Shadings	
<b>System information</b>			
<b>PV Array</b> Nb. of modules Pnom total	33600 units 18.31 MWp	<b>Inverters</b> Nb. of units Pnom total Pnom ratio	75 units 15.00 MWac 1.221
<b>User's needs</b> Unlimited load (grid)			

**Results summary**

Produced Energy	29951 MWh/year	Specific production	1636 kWh/kWp/year	Perf. Ratio PR	88.60 %
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**General parameters**

<b>Grid-Connected System</b>		<b>Unlimited Trackers with backtracking</b>	
<b>PV Field Orientation</b>			
<b>Orientation</b>		<b>Tracking algorithm</b>	<b>Backtracking strategy</b>
Tracking horizontal axis		Irradiance optimization	Nb. of trackers 10 units
		Backtracking activated	Unlimited trackers
			<b>Sizes</b>
			Tracker Spacing 10.00 m
			Collector width 4.53 m
			Ground Cov. Ratio (GCR) 45.3 %
			Phi min / max. +/- 55.0 °
			<b>Backtracking limit angle</b>
			Phi limits +/- 63.0 °
<b>Models used</b>			
Transposition	Perez		
Diffuse	Perez, Meteonorm		
Circumsolar	separate		
<b>Horizon</b>		<b>Near Shadings</b>	
Free Horizon		No Shadings	<b>User's needs</b>
			Unlimited load (grid)
<b>Bifacial system</b>			
Model	2D Calculation		
	unlimited trackers		
<b>Bifacial model geometry</b>		<b>Bifacial model definitions</b>	
Tracker Spacing	10.00 m	Ground albedo	0.30
Tracker width	4.53 m	Bifaciality factor	70 %
GCR	45.3 %	Rear shading factor	15.0 %
Axis height above ground	2.10 m	Rear mismatch loss	3.5 %
		Shed transparent fraction	0.0 %

**PV Array Characteristics**

<b>PV module</b>		<b>Inverter</b>	
Manufacturer	Longi Solar	Manufacturer	Huawei Technologies
Model	LR5-72 HBD 545 M Bifacial1	Model	SUN2000-215KTL-H0
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	545 Wp	Unit Nom. Power	200 kWac
Number of PV modules	33600 units	Number of inverters	75 units
Nominal (STC)	18.31 MWp	Total power	15000 kWac
<b>Array #1 - PV Array</b>			
Number of PV modules	4424 units	Number of inverters	10 units
Nominal (STC)	2411 kWp	Total power	2000 kWac
Modules	158 Strings x 28 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	2209 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	2099 A	Pnom ratio (DC:AC)	1.21
<b>Array #2 - Sub-array #2</b>			
Number of PV modules	4424 units	Number of inverters	10 units
Nominal (STC)	2411 kWp	Total power	2000 kWac
Modules	158 Strings x 28 In series		



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**PV Array Characteristics**

<b>Array #2 - Sub-array #2</b>			
<b>At operating cond. (50°C)</b>			
Pmpp	2209 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	2099 A	Pnom ratio (DC:AC)	1.21
<b>Array #3 - Sub-array #3</b>			
Number of PV modules	4424 units	Number of inverters	10 units
Nominal (STC)	2411 kWp	Total power	2000 kWac
Modules	158 Strings x 28 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	2209 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	2099 A	Pnom ratio (DC:AC)	1.21
<b>Array #4 - Sub-array #4</b>			
Number of PV modules	4424 units	Number of inverters	10 units
Nominal (STC)	2411 kWp	Total power	2000 kWac
Modules	158 Strings x 28 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	2209 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	2099 A	Pnom ratio (DC:AC)	1.21
<b>Array #5 - Sub-array #5</b>			
Number of PV modules	4424 units	Number of inverters	10 units
Nominal (STC)	2411 kWp	Total power	2000 kWac
Modules	158 Strings x 28 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	2209 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	2099 A	Pnom ratio (DC:AC)	1.21
<b>Array #6 - Sub-array #6</b>			
Number of PV modules	1960 units	Number of inverters	4 units
Nominal (STC)	1068 kWp	Total power	800 kWac
Modules	70 Strings x 28 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	979 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	930 A	Pnom ratio (DC:AC)	1.34
<b>Array #7 - Sub-array #7</b>			
Number of PV modules	2520 units	Number of inverters	5 units
Nominal (STC)	1373 kWp	Total power	1000 kWac
Modules	90 Strings x 28 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	1258 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	1196 A	Pnom ratio (DC:AC)	1.37
<b>Array #8 - Sub-array #8</b>			
Number of PV modules	3500 units	Number of inverters	8 units
Nominal (STC)	1908 kWp	Total power	1600 kWac
Modules	125 Strings x 28 In series		



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**PV Array Characteristics**

<b>Array #8 - Sub-array #8</b>			
<b>At operating cond. (50°C)</b>			
Pmpp	1747 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	1661 A	Pnom ratio (DC:AC)	1.19
<b>Array #9 - Sub-array #9</b>			
Number of PV modules	3500 units	Number of inverters	8 units
Nominal (STC)	1908 kWp	Total power	1600 kWac
Modules	125 Strings x 28 In series		
<b>At operating cond. (50°C)</b>			
Pmpp	1747 kWp	Operating voltage	500-1500 V
U mpp	1052 V	Max. power (=>33°C)	215 kWac
I mpp	1661 A	Pnom ratio (DC:AC)	1.19
<b>Total PV power</b>		<b>Total inverter power</b>	
Nominal (STC)	18312 kWp	Total power	15000 kWac
Total	33600 modules	Number of inverters	75 units
Module area	85883 m <sup>2</sup>	Pnom ratio	1.22
Cell area	79882 m <sup>2</sup>		

**Array losses**

<b>Array Soiling Losses</b>		<b>Thermal Loss factor</b>		<b>Serie Diode Loss</b>				
Loss Fraction	3.0 %	Module temperature according to irradiance		Voltage drop	0.7 V			
		Uc (const)	29.0 W/m <sup>2</sup> K	Loss Fraction	0.1 % at STC			
		Uv (wind)	0.0 W/m <sup>2</sup> K/m/s					
<b>LID - Light Induced Degradation</b>		<b>Module Quality Loss</b>		<b>Module mismatch losses</b>				
Loss Fraction	0.3 %	Loss Fraction	-0.8 %	Loss Fraction	2.0 % at MPP			
<b>Strings Mismatch loss</b>								
Loss Fraction	0.1 %							
<b>IAM loss factor</b>								
Incidence effect (IAM): User defined profile								
0°	25°	45°	60°	65°	70°	75°	80°	90°
1.000	1.000	0.995	0.962	0.936	0.903	0.851	0.754	0.000

**DC wiring losses**

Global wiring resistance	1.1 mΩ		
Loss Fraction	1.5 % at STC		
<b>Array #1 - PV Array</b>		<b>Array #2 - Sub-array #2</b>	
Global array res.	8.3 mΩ	Global array res.	8.3 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
<b>Array #3 - Sub-array #3</b>		<b>Array #4 - Sub-array #4</b>	
Global array res.	8.3 mΩ	Global array res.	8.3 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
<b>Array #5 - Sub-array #5</b>		<b>Array #6 - Sub-array #6</b>	
Global array res.	8.3 mΩ	Global array res.	19 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC
<b>Array #7 - Sub-array #7</b>		<b>Array #8 - Sub-array #8</b>	
Global array res.	15 mΩ	Global array res.	10 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC





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**DC wiring losses**

**Array #9 - Sub-array #9**

Global array res.	10 mΩ
Loss Fraction	1.5 % at STC

**System losses**

**Auxiliaries loss**

constant (fans)	70.0 kW
100.0 kW from Power thresh.	
Proportionnal to Power	5.0 W/kW
0.0 kW from Power thresh.	
Night aux. cons.	13.0 kW



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**Main results**

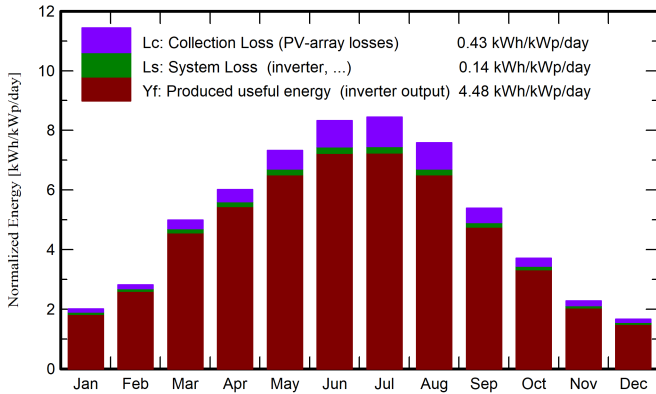
**System Production**

Produced Energy 29951 MWh/year

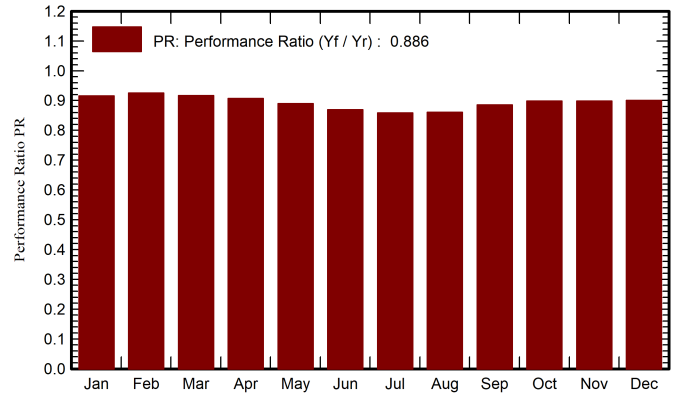
Specific production  
Performance Ratio PR

1636 kWh/kWp/year  
88.60 %

**Normalized productions (per installed kWp)**



**Performance Ratio PR**



**Balances and main results**

	<b>GlobHor</b> kWh/m <sup>2</sup>	<b>DiffHor</b> kWh/m <sup>2</sup>	<b>T_Amb</b> °C	<b>GlobInc</b> kWh/m <sup>2</sup>	<b>GlobEff</b> kWh/m <sup>2</sup>	<b>EArray</b> MWh	<b>E_Grid</b> MWh	<b>PR</b> ratio
<b>January</b>	48.5	27.17	5.51	62.2	57.2	1086	1042	0.916
<b>February</b>	62.6	34.23	6.70	78.8	73.7	1385	1337	0.926
<b>March</b>	120.0	51.35	10.31	154.7	146.0	2676	2596	0.917
<b>April</b>	143.9	71.16	13.63	180.2	170.4	3084	2994	0.907
<b>May</b>	179.3	85.95	18.15	227.2	215.1	3812	3702	0.890
<b>June</b>	197.3	83.15	22.80	249.7	237.1	4094	3978	0.870
<b>July</b>	204.5	82.00	25.67	261.7	248.3	4236	4114	0.859
<b>August</b>	179.2	70.30	25.38	234.9	222.9	3812	3701	0.860
<b>September</b>	125.4	53.57	20.01	161.6	152.7	2702	2619	0.885
<b>October</b>	89.4	42.70	16.02	115.1	108.1	1957	1893	0.898
<b>November</b>	52.7	25.41	10.58	68.3	63.2	1170	1124	0.899
<b>December</b>	39.4	22.18	6.53	51.5	47.1	889	850	0.901
<b>Year</b>	1442.2	649.17	15.16	1846.1	1741.7	30902	29951	0.886

**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

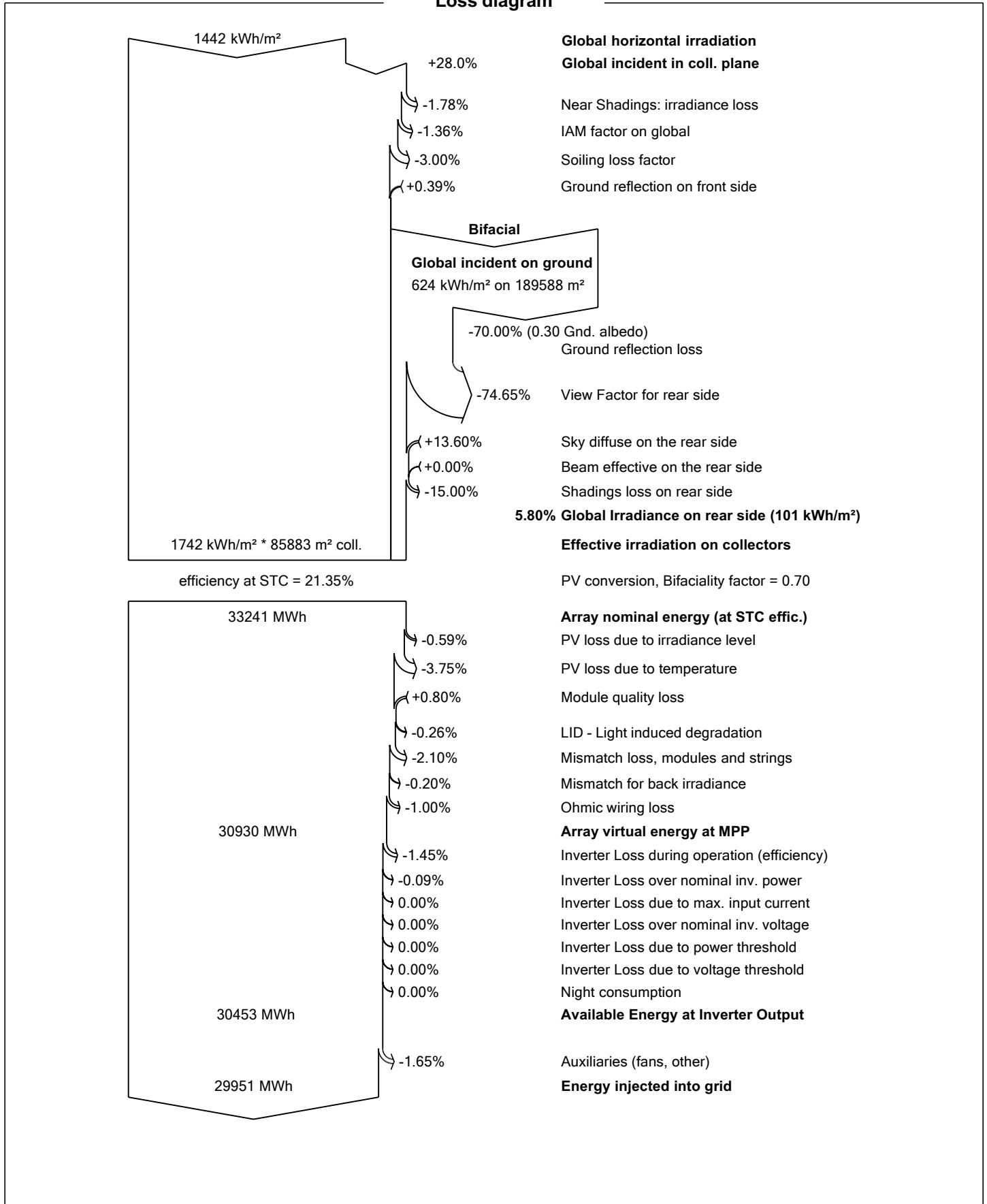


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### Loss diagram





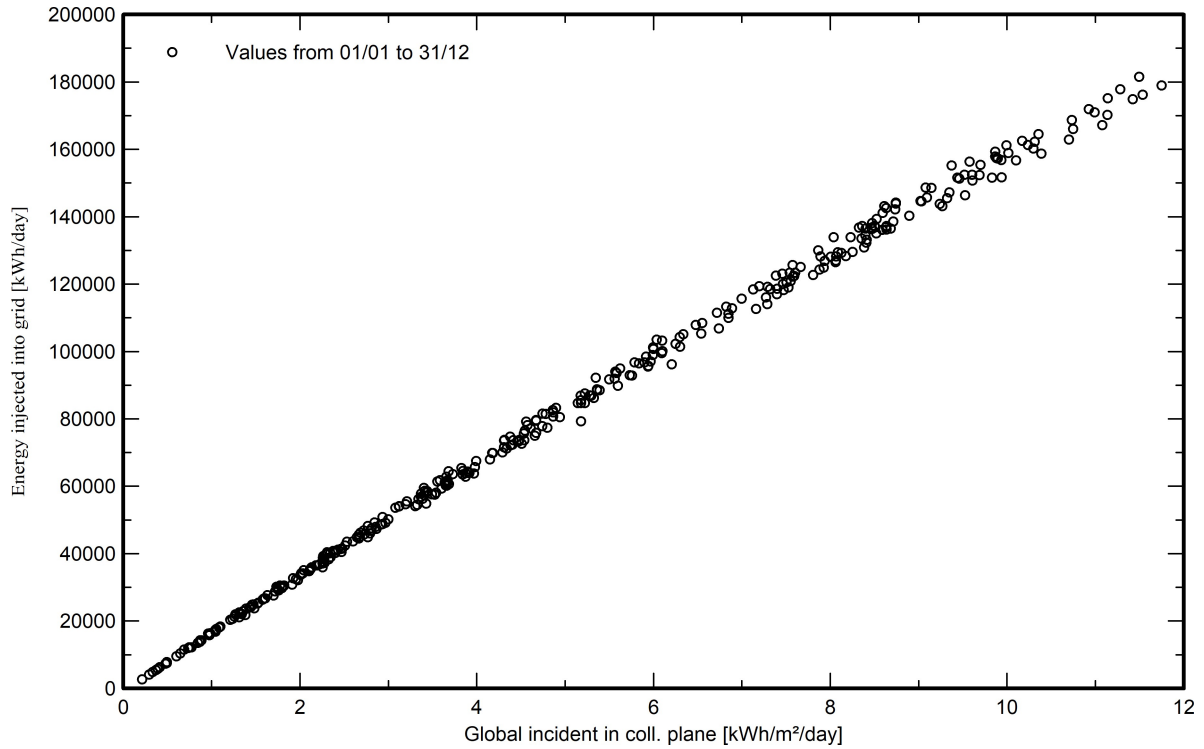
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### Special graphs

#### Daily Input/Output diagram



#### System Output Power Distribution

