PVsyst

PHOTOVOLTAIC SOFTWARE

PVsyst - Simulation report

Grid-Connected System

Project: Patricia Solar v3

Variant: PVsyst Report (Verano Energy) 2022.03.16
Tracking system with backtracking
System power: 10.99 MWp
Patricia Solar (h) - Chile

Verano Energy

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Las Condes

Santiago

Chile

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Project summary

Geographical Site	**Situation**		**Meteo data**
Patricia Solar (h)	Latitude	-33.70 °S	Patricia Solar (h)
Chile	Longitude	-70.95 °W	SolarGISv2.2.9 - TMY
	Altitude	305 m	
	Time zone	UTC-4	

Monthly albedo values

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Albedo	0.16	0.16	0.15	0.14	0.13	0.12	0.12	0.13	0.14	0.15	0.16	0.16

System summary

Grid-Connected System   **Tracking system with backtracking**

PV Field Orientation

Tracking plane, horizontal N-S axis

Axis azimuth   0 °

Near Shadings	**User's needs**
Linear shadings	Unlimited load (grid)

System information

PV Array		**Inverters**	
Nb. of modules	20358 units	Nb. of units	39 units
Pnom total	10.99 MWp	Pnom total	8775 kWac
		Grid power limit	9000 kWac
		Grid lim. Pnom ratio	1.221

Results summary

Produced Energy	23 GWh/year	Specific production	2100 kWh/kWp/year	Perf. Ratio PR	82.21 %
Apparent energy	23081 MVAh				

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General parameters

Grid-Connected System   **Tracking system with backtracking**

PV Field Orientation

Orientation		**Backtracking strategy**		**Models used**	
Tracking plane, horizontal N-S axis		Nb. of trackers	344 units	Transposition	Perez
Axis azimuth	0 °	**Sizes**		Diffuse	Imported
		Tracker Spacing	5.30 m	Circumsolar	separate
		Collector width	2.28 m		
		Ground Cov. Ratio (GCR)	43.0 %		
		Phi min / max.	-/+ 55.0 °		
		Backtracking limit angle			
		Phi limits	+/- 64.4 °		

Horizon		**Near Shadings**	**User's needs**
Average Height	2.6 °	Linear shadings	Unlimited load (grid)

Bifacial system

Model   2D Calculation
                               unlimited trackers

Bifacial model geometry		**Bifacial model definitions**	
Tracker Spacing	5.30 m	Ground albedo average	0.14
Tracker width	2.28 m	Bifaciality factor	70 %
GCR	43.0 %	Rear shading factor	15.0 %
Axis height above ground	1.50 m	Rear mismatch loss	5.0 %
		Shed transparent fraction	0.0 %

Monthly ground albedo values

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
0.16	0.16	0.15	0.14	0.13	0.12	0.12	0.13	0.14	0.15	0.16	0.16	0.14

Grid injection point

Grid power limitation		**Power factor**	
Active Power	9000 kWac	Cos(phi) (leading)	1.000
Pnom ratio	1.221		

PV Array Characteristics

PV module		**Inverter**	
Manufacturer	JA Solar	Manufacturer	Sungrow
Model	JAM72D30-540/MB	Model	SG250HX
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	540 Wp	Unit Nom. Power	225 kVA
Number of PV modules	20358 units	Number of inverters	39 units
Nominal (STC)	10.99 MWp	Total power	8775 kVA
Modules	702 Strings x 29 In series	Operating voltage	600-1500 V
At operating cond. (25°C)		Max. power (=>30°C)	250 kVA
Pmpp	11.00 MWp	Pnom ratio (DC:AC)	1.25
U mpp	1194 V		
I mpp	9215 A		

Total PV power		**Total inverter power**	
Nominal (STC)	10993 kWp	Total power	8775 kVA
Total	20358 modules	Number of inverters	39 units
Module area	52590 m²	Pnom ratio	1.25
Cell area	48429 m²		

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Array losses

Array Soiling Losses

Loss Fraction   2.0 %

Thermal Loss factor

Module temperature according to irradiance

Uc (const)   25.0 W/m²K

Uv (wind)   1.2 W/m²K/m/s

DC wiring losses

Global array res.   0.97 mΩ

Loss Fraction   0.8 % at STC

Serie Diode Loss

Voltage drop   0.7 V

Loss Fraction   0.1 % at STC

LID - Light Induced Degradation

Loss Fraction   1.6 %

Module Quality Loss

Loss Fraction   -0.2 %

Module mismatch losses

Loss Fraction   0.8 % at MPP

Strings Mismatch loss

Loss Fraction   0.1 %

IAM loss factor

Incidence effect (IAM): User defined profile

0°	40°	50°	60°	70°	75°	80°	85°	90°
1.000	1.000	0.996	0.992	0.958	0.917	0.847	0.710	0.000

System losses

Auxiliaries loss

Proportionnal to Power   5.0 W/kW

0.0 kW from Power thresh.

AC wiring losses

Inv. output line up to MV transfo

Inverter voltage   800 Vac tri

Loss Fraction   1.50 % at STC

Inverter: SG250HX

Wire section (39 Inv.)   Alu 39 x 3 x 150 mm²

Average wires length   165 m

MV line up to Injection

MV Voltage   23 kV

Average each inverter

Wires   Alu 3 x 120 mm²

Length   1750 m

Loss Fraction   0.31 % at STC

AC losses in transformers

MV transfo

Grid voltage   23 kV

Operating losses at STC

Nominal power at STC   10831 kVA

Iron loss (night disconnect)   3.25 kW/Inv.

Loss Fraction   0.09 % at STC

Coils equivalent resistance   3 x 1.60 mΩ/inv.

Loss Fraction   0.90 % at STC

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Horizon definition
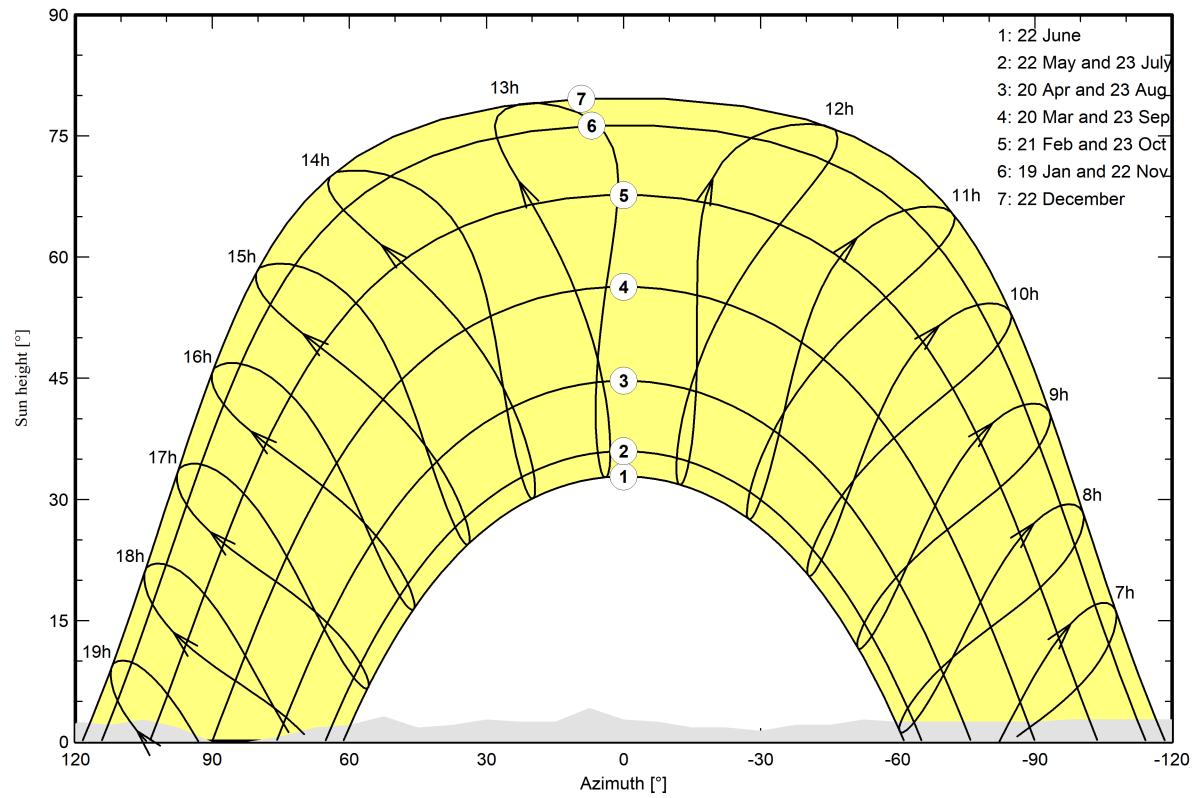
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Average Height	2.6 °	Albedo Factor	0.90
Diffuse Factor	0.97	Albedo Fraction	100 %

Horizon profile

Azimuth [°]	-173	-165	-158	-150	-143	-135	-128	-120	-113	-105	-98	-90
Height [°]	3.2	3.2	3.2	2.5	1.8	1.8	2.5	2.8	2.8	2.8	2.8	2.5
Azimuth [°]	-83	-75	-68	-60	-53	-45	-38	-30	-23	-15	-8	0
Height [°]	2.5	2.5	2.5	2.5	2.8	2.1	2.1	1.4	1.8	1.8	2.5	2.8
Azimuth [°]	8	15	23	30	38	45	53	60	68	75	83	90
Height [°]	4.2	2.5	2.5	2.8	2.1	1.8	3.2	2.1	1.8	0.7	0.0	0.0
Azimuth [°]	98	105	113	120	128	135	143	150	158	165	173	180
Height [°]	1.8	2.8	2.1	2.5	2.5	2.8	2.8	4.2	6.4	5.6	3.9	3.9
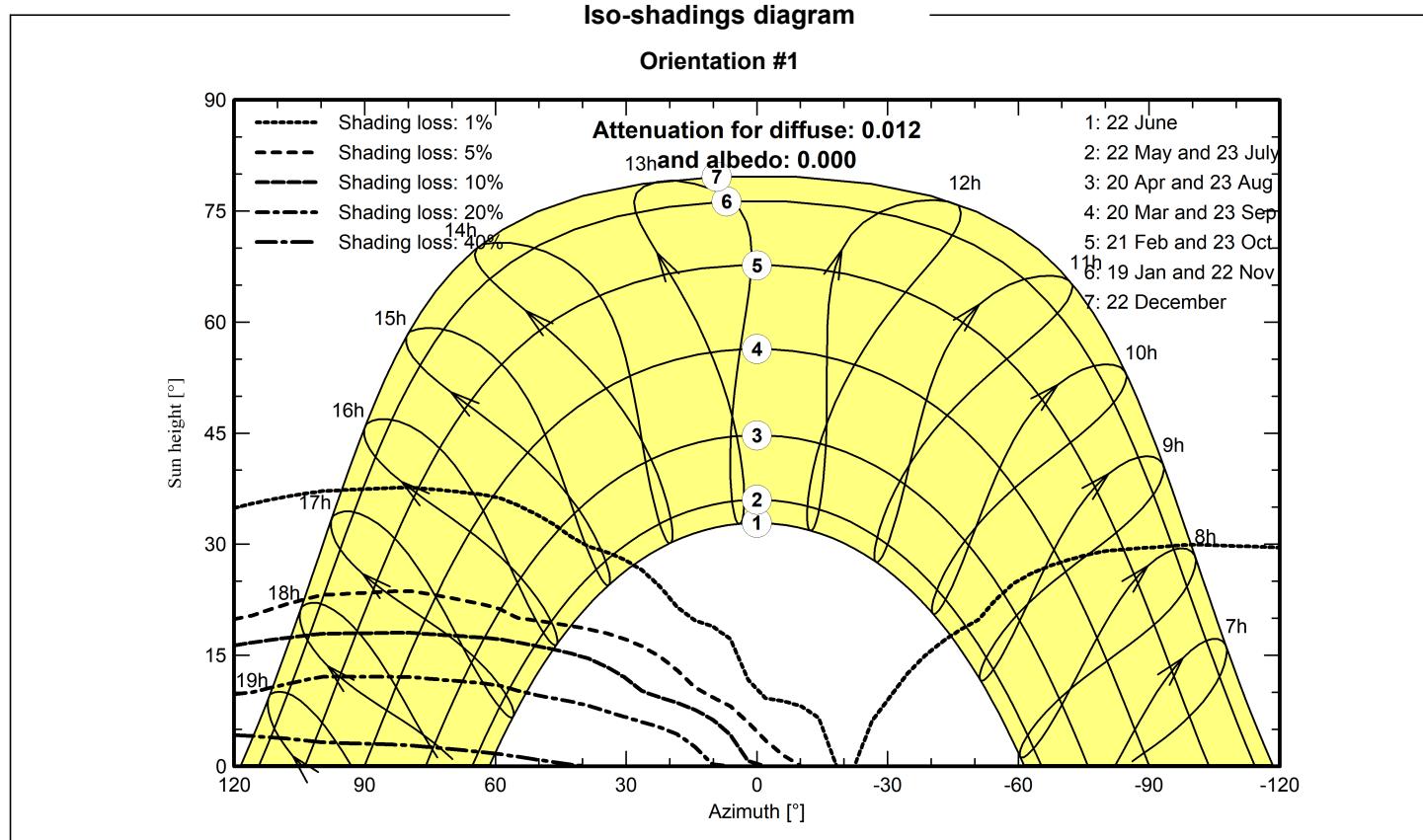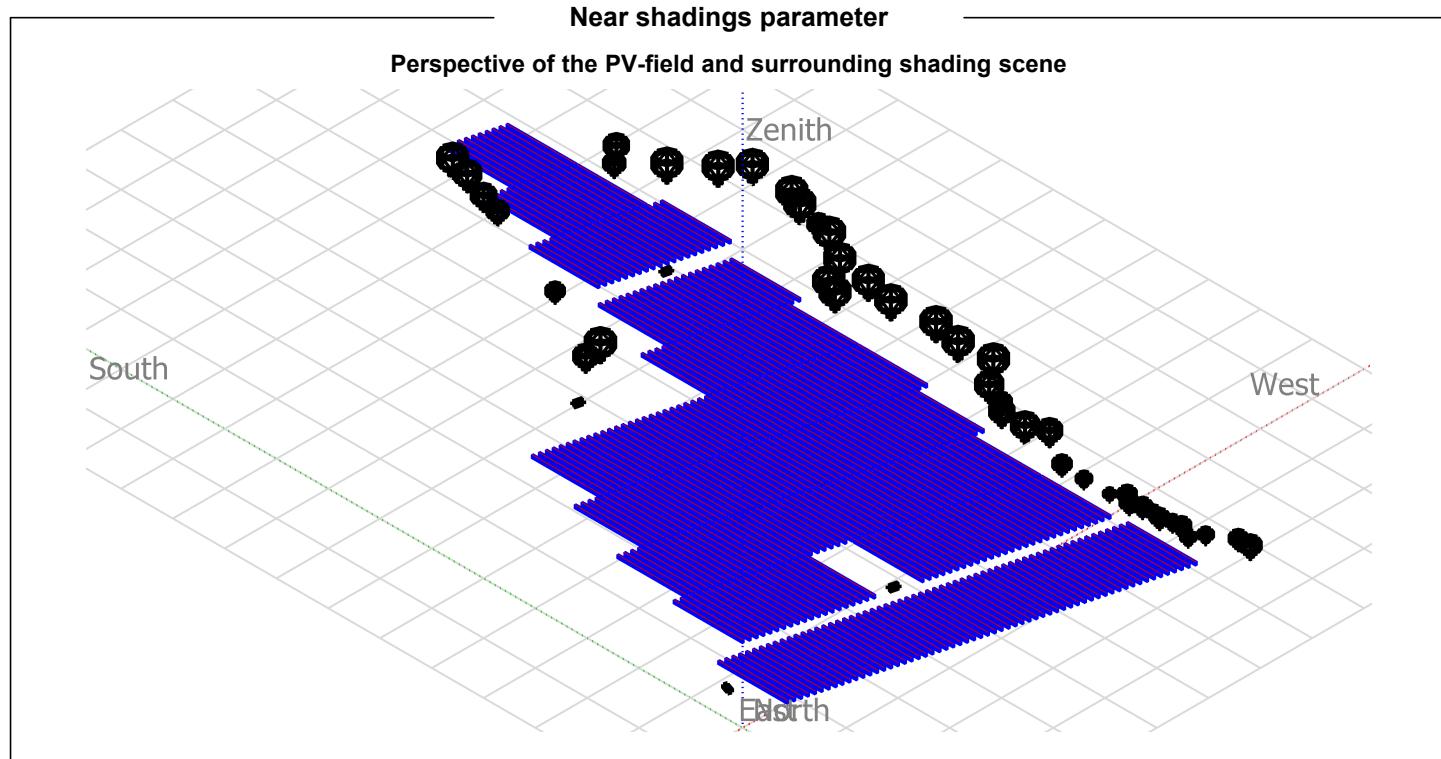
Sun Paths (Height / Azimuth diagram)

1: 22 June
2: 22 May and 23 July
3: 20 Apr and 23 Aug.
4: 20 Mar and 23 Sep
5: 21 Feb and 23 Oct
6: 19 Jan and 22 Nov.
7: 22 December

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Near shadings parameter

Perspective of the PV-field and surrounding shading scene

Iso-shadings diagram

Orientation #1

Attenuation for diffuse: 0.012 and albedo: 0.000

Shading loss: 1%
Shading loss: 5%
Shading loss: 10%
Shading loss: 20%
Shading loss: 40%

1: 22 June
2: 22 May and 23 July
3: 20 Apr and 23 Aug
4: 20 Mar and 23 Sep
5: 21 Feb and 23 Oct.
6: 19 Jan and 22 Nov
7: 22 December

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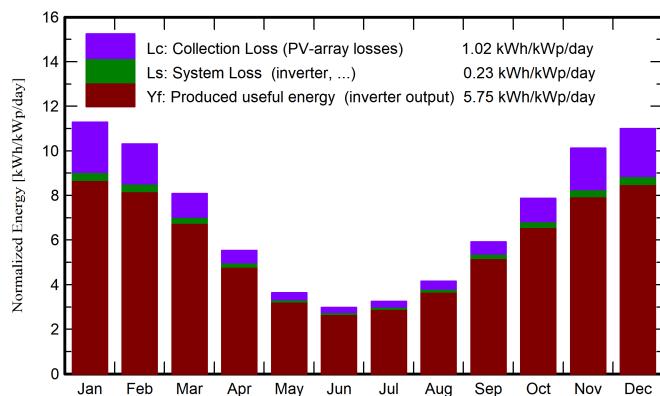
Main results

System Production
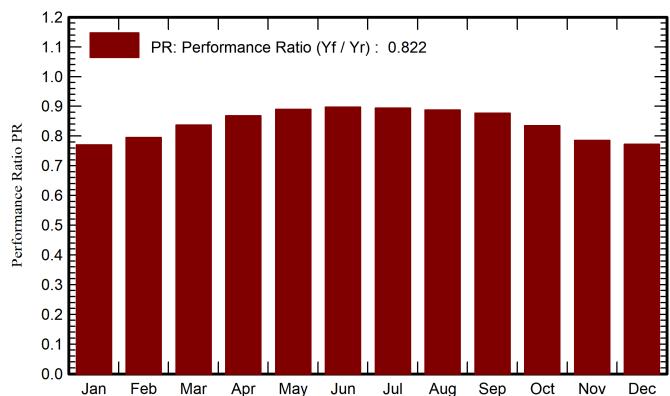
Produced Energy	23 GWh/year	Specific production	2100 kWh/kWp/year
Apparent energy	23081 MVAh	Performance Ratio PR	82.21 %

Normalized productions (per installed kWp)

Lc: Collection Loss (PV-array losses)   1.02 kWh/kWp/day
Ls: System Loss (inverter, ...)   0.23 kWh/kWp/day
Yf: Produced useful energy (inverter output)   5.75 kWh/kWp/day

Performance Ratio PR

PR: Performance Ratio (Yf / Yr) :   0.822

Balances and main results

|	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_Grid	PR
	kWh/m²	kWh/m²	°C	kWh/m²	kWh/m²	GWh	GWh	ratio
January	270.0	63.58	21.96	349.8	333.3	3.086	2.963	0.771
February	220.6	52.80	21.17	288.7	274.8	2.627	2.522	0.795
March	187.7	43.05	19.87	250.8	238.0	2.399	2.306	0.836
April	125.9	39.14	14.82	166.2	156.7	1.646	1.586	0.868
May	87.3	37.50	11.92	112.7	105.4	1.139	1.101	0.889
June	69.6	30.38	9.81	89.6	83.5	0.913	0.883	0.897
July	77.8	29.24	9.66	100.9	94.2	1.024	0.991	0.894
August	99.9	39.53	10.16	128.6	120.8	1.301	1.256	0.888
September	139.8	55.86	12.84	177.5	167.7	1.776	1.710	0.876
October	192.0	65.12	14.73	244.0	231.6	2.331	2.241	0.835
November	236.0	62.95	17.38	304.0	289.9	2.731	2.623	0.785
December	267.4	61.97	20.67	341.2	325.6	3.019	2.898	0.773
Year	1974.0	581.12	15.39	2553.8	2421.4	23.992	23.081	0.822

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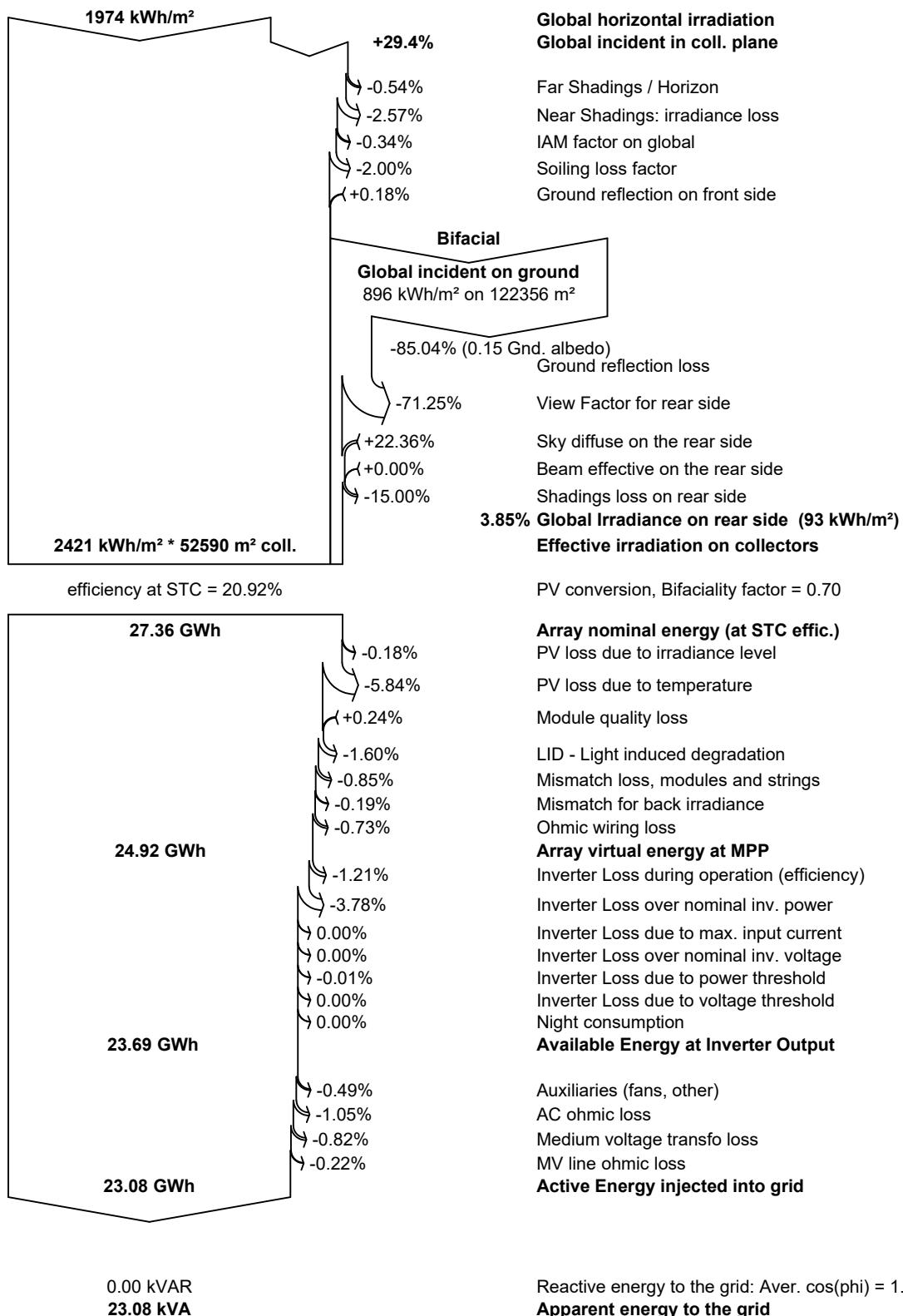
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

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Loss diagram

1974 kWh/m²	**Global horizontal irradiation**
+29.4%	**Global incident in coll. plane**
-0.54%	Far Shadings / Horizon
-2.57%	Near Shadings: irradiance loss
-0.34%	IAM factor on global
-2.00%	Soiling loss factor
+0.18%	Ground reflection on front side

Bifacial

Global incident on ground
896 kWh/m² on 122356 m²

-85.04% (0.15 Gnd. albedo)	Ground reflection loss
-71.25%	View Factor for rear side
+22.36%	Sky diffuse on the rear side
+0.00%	Beam effective on the rear side
-15.00%	Shadings loss on rear side
3.85%	**Global Irradiance on rear side (93 kWh/m²)**

2421 kWh/m² * 52590 m² coll.   **Effective irradiation on collectors**

efficiency at STC = 20.92%   PV conversion, Bifaciality factor = 0.70

27.36 GWh	**Array nominal energy (at STC effic.)**
-0.18%	PV loss due to irradiance level
-5.84%	PV loss due to temperature
+0.24%	Module quality loss
-1.60%	LID - Light induced degradation
-0.85%	Mismatch loss, modules and strings
-0.19%	Mismatch for back irradiance
-0.73%	Ohmic wiring loss
24.92 GWh	**Array virtual energy at MPP**
-1.21%	Inverter Loss during operation (efficiency)
-3.78%	Inverter Loss over nominal inv. power
0.00%	Inverter Loss due to max. input current
0.00%	Inverter Loss over nominal inv. voltage
-0.01%	Inverter Loss due to power threshold
0.00%	Inverter Loss due to voltage threshold
0.00%	Night consumption
23.69 GWh	**Available Energy at Inverter Output**
-0.49%	Auxiliaries (fans, other)
-1.05%	AC ohmic loss
-0.82%	Medium voltage transfo loss
-0.22%	MV line ohmic loss
23.08 GWh	**Active Energy injected into grid**

0.00 kVAR	Reactive energy to the grid: Aver. cos(phi) = 1.000
23.08 kVA	**Apparent energy to the grid**

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Special graphs

Daily Input/Output diagram

System Output Power Distribution