

Grid-Connected System: Simulation parameters

Project : **Solidago_SA_V3_4**

Geographical Site **Solidago_SA_V3_4_GHI** Country **United States**

Situation Latitude 36.85° N Longitude -76.75° W
 Time defined as Legal Time Time zone UT-5 Altitude 28 m
 Albedo 0.20

Meteo data: **Solidago_SA_V3_4_GHI** NREL NSRD : TMY3 - TMY

Simulation variant : **1790_Strings_Hanwha_580_BF_equiv_6xSG3600_5.9m_100'_trees_monthly_albedo_CO-2022**

Simulation date 18/05/22 16h14

Simulation parameters System type **Tracking system with backtracking**

Tracking plane, tilted axis Axis Tilt 0° Axis azimuth 0°
 Rotation Limitations Minimum Phi -52° Maximum Phi 52°
 Tracking algorithm Astronomic calculation

Backtracking strategy Nb. of trackers 633 Identical arrays
 Tracker Spacing 5.90 m Collector width 2.42 m
 Backtracking limit angle Phi limits +/- 65.7° Ground Cov. Ratio (GCR) 40.9%

Models used Transposition Perez Diffuse Imported
 Circumsolar separate

Horizon Free Horizon

Near Shadings According to module strings Electrical effect 100 %

Bifacial system Model , unlimited trackers 2D Calculation
 Tracker Spacing 5.90 m Tracker width 2.46 m
 Backtracking limit angle 65.2° GCR 41.6 %
 Ground albedo average 0.16 Axis height above ground 1.60 m
 Module bifaciality factor 75 % Rear shading factor 12.3 %
 Module transparency 2.1 % Rear mismatch loss 10.0 %

Monthly ground albedo values

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year
0.15	0.15	0.16	0.16	0.17	0.18	0.17	0.17	0.16	0.15	0.15	0.14	0.16

User's needs : Unlimited load (grid)

Grid power limitation Active Power 20.0 MW Pnom ratio 1.298
 Power factor Cos(phi) 0.950 leading Phi 18.2°

PV Arrays Characteristics (6 kinds of array defined)

PV module Si-mono Model Q.PEAK DUO XL-G11.3 580/BFG
 Custom parameters definition Manufacturer Hanwha Q Cells
 Sub-arrays

#1 - Sub-array #1

Number of PV modules In series 25 modules In parallel 298 strings
 Total number of PV modules nb. modules 7450 Unit Nom. Power 580 Wp
 Array global power Nominal (STC) 4321 kWp At operating cond. 3953 kWp (50°C)
 Array operating characteristics (50°C) U mpp 1026 V I mpp 3851 A

Grid-Connected System: Simulation parameters

#2 - Sub-array #2

Number of PV modules	In series	25 modules	In parallel	298 strings
Total number of PV modules	nb. modules	7450	Unit Nom. Power	580 Wp
Array global power	Nominal (STC)	4321 kWp	At operating cond.	3953 kWp (50°C)
Array operating characteristics (50°C)	U mpp	1026 V	I mpp	3851 A

#3 - Sub-array #3

Number of PV modules	In series	25 modules	In parallel	298 strings
Total number of PV modules	nb. modules	7450	Unit Nom. Power	580 Wp
Array global power	Nominal (STC)	4321 kWp	At operating cond.	3953 kWp (50°C)
Array operating characteristics (50°C)	U mpp	1026 V	I mpp	3851 A

#4 - Sub-array #4

Number of PV modules	In series	25 modules	In parallel	298 strings
Total number of PV modules	nb. modules	7450	Unit Nom. Power	580 Wp
Array global power	Nominal (STC)	4321 kWp	At operating cond.	3953 kWp (50°C)
Array operating characteristics (50°C)	U mpp	1026 V	I mpp	3851 A

#5 - Sub-array #5

Number of PV modules	In series	25 modules	In parallel	299 strings
Total number of PV modules	nb. modules	7475	Unit Nom. Power	580 Wp
Array global power	Nominal (STC)	4336 kWp	At operating cond.	3966 kWp (50°C)
Array operating characteristics (50°C)	U mpp	1026 V	I mpp	3864 A

#6 - Sub-array #6

Number of PV modules	In series	25 modules	In parallel	299 strings
Total number of PV modules	nb. modules	7475	Unit Nom. Power	580 Wp
Array global power	Nominal (STC)	4336 kWp	At operating cond.	3966 kWp (50°C)
Array operating characteristics (50°C)	U mpp	1026 V	I mpp	3864 A

Total Arrays global power	Nominal (STC)	25955 kWp	Total	44750 modules
	Module area	122604 m²	Cell area	113092 m ²

Inverter

Custom parameters definition	Model	SG3600UD		
Characteristics	Manufacturer	Sungrow		
	Unit Nom. Power	3600 kWac	Oper. Voltage	915-1300 V

Sub-arrays

#1 - Sub-array #1	Total power	3600 kWac	Pnom ratio	1.20
	Nb. of inverters	1 units		
#2 - Sub-array #2	Total power	3600 kWac	Pnom ratio	1.20
	Nb. of inverters	1 units		
#3 - Sub-array #3	Total power	3600 kWac	Pnom ratio	1.20
	Nb. of inverters	1 units		
#4 - Sub-array #4	Total power	3600 kWac	Pnom ratio	1.20
	Nb. of inverters	1 units		
#5 - Sub-array #5	Total power	3600 kWac	Pnom ratio	1.20
	Nb. of inverters	1 units		
#6 - Sub-array #6	Total power	3600 kWac	Pnom ratio	1.20
	Nb. of inverters	1 units		

PV Array loss factors

Array Soiling Losses			Loss Fraction	1.0 %
Thermal Loss factor	Uc (const)	29.0 W/m ² K	Uv (wind)	0.0 W/m ² K / m/s

Grid-Connected System: Simulation parameters

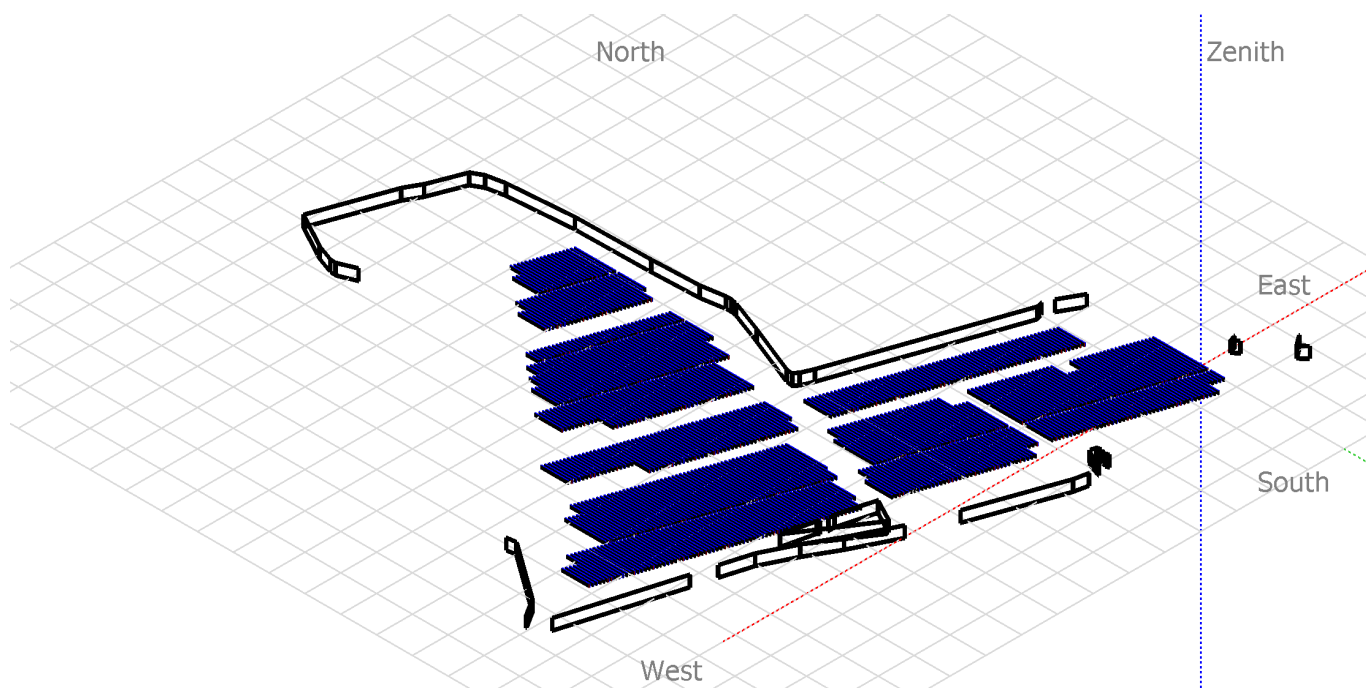
Wiring Ohmic Loss	Array #1	4.4 m	Loss Fraction	1.5 % at STC
	Array #2	4.4 m	Loss Fraction	1.5 % at STC
	Array #3	4.4 m	Loss Fraction	1.5 % at STC
	Array #4	4.4 m	Loss Fraction	1.5 % at STC
	Array #5	4.4 m	Loss Fraction	1.5 % at STC
	Array #6	4.4 m	Loss Fraction	1.5 % at STC
	Global		Loss Fraction	1.5 % at STC
LID - Light Induced Degradation			Loss Fraction	2.5 %
Module Quality Loss			Loss Fraction	0.3 %
Module mismatch losses			Loss Fraction	0.5 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
#1 - Sub-array #1				
Incidence effect, ASHRAE parametrization	IAM =	$1 - bo (1/\cos i - 1)$	bo Param.	0.04
#2 - Sub-array #2				
Incidence effect, ASHRAE parametrization	IAM =	$1 - bo (1/\cos i - 1)$	bo Param.	0.04
#3 - Sub-array #3				
Incidence effect, ASHRAE parametrization	IAM =	$1 - bo (1/\cos i - 1)$	bo Param.	0.04
#4 - Sub-array #4				
Incidence effect, ASHRAE parametrization	IAM =	$1 - bo (1/\cos i - 1)$	bo Param.	0.04
#5 - Sub-array #5				
Incidence effect, ASHRAE parametrization	IAM =	$1 - bo (1/\cos i - 1)$	bo Param.	0.04
#6 - Sub-array #6				
Incidence effect, ASHRAE parametrization	IAM =	$1 - bo (1/\cos i - 1)$	bo Param.	0.04
System loss factors				
AC wire loss inverter to transfo	Inverter voltage	630 Vac tri		
Whole system	Wires: 3 x 20000 mm ²	149 m	Loss Fraction	1.0 % at STC
MV transfo				
	Grid Voltage	20 kV		
One MV transfo				
Operating losses at STC	Iron loss (night disconnect)	50.94 kW	Loss Fraction	0.2 % at STC
	Copper (resistive) loss	3 x 0.14 m	Loss Fraction	0.9 % at STC
Auxiliaries loss	constant (fans)	20.0 kW	... from Power thresh.	0.0 kW

Grid-Connected System: Near shading definition

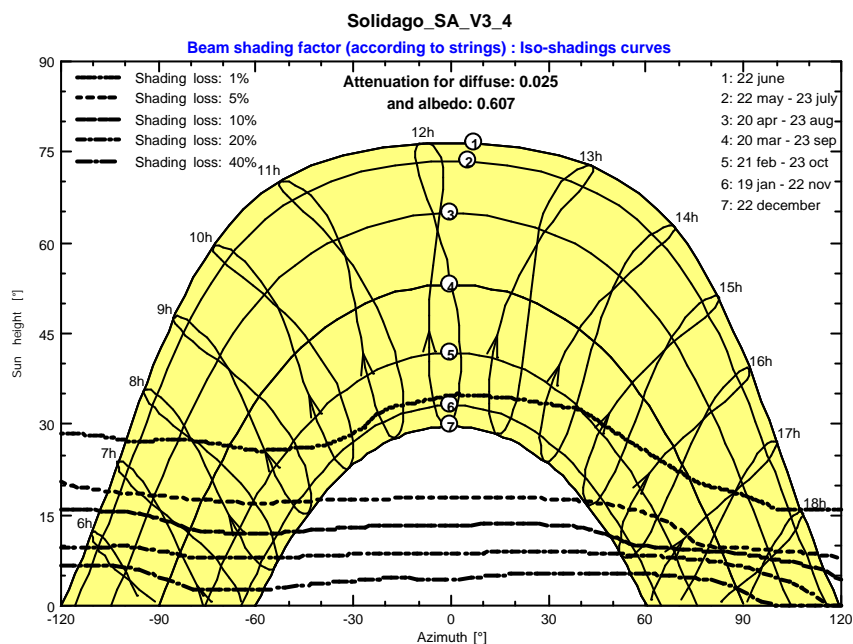
Project : Solidago_SA_V3_4
Simulation variant : 1790_Strings_Hanwha_580_BF_equiv_6xSG3600_5.9m_100'_trees_monthly_albedo_CO-2022

Main system parameters	System type	Tracking system with backtracking	
Near Shadings	According to module strings	Electrical effect	100 %
PV Field Orientation	tracking, tilted axis, Axis Tilt	Axis azimuth	0°
PV modules	Model	Q.PEAK DUO XL-G11.3 580/BFG	580 Wp
PV Array	Nb. of modules	44750	Pnom total 25955 kWp
Inverter	Model	SG3600UD	Pnom 3600 kW ac
Inverter pack	Nb. of units	6.0	Pnom total 21600 kW ac
User's needs	Unlimited load (grid)	Cos(phi)	0.950 leading

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Main results

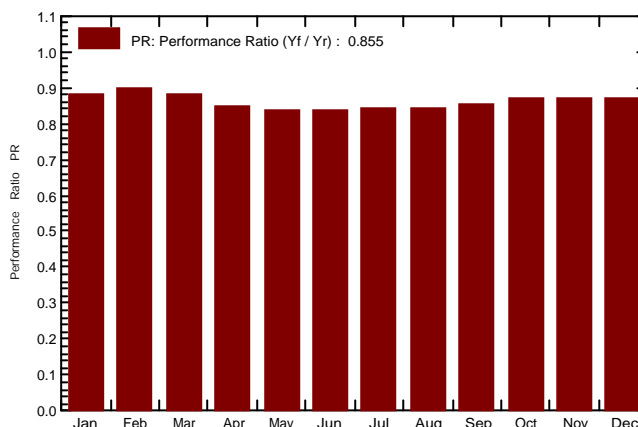
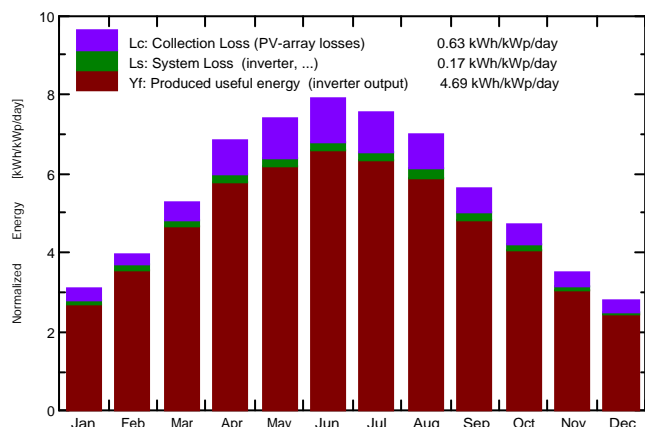
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Main simulation results		Produced Energy	44395 MWh/year	Specific prod.	1710 kWh/kWp/year
System Production	Apparent energy	46860 MVAh	Perf. Ratio PR	85.48 %	

Normalized productions (per installed kWp): Nominal power 25955 kWp

Performance Ratio PR



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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	73.3	30.05	6.97	96.0	89.3	2271	2192	0.880
February	86.6	36.45	4.89	111.6	105.3	2700	2605	0.899
March	128.4	51.40	9.56	163.7	156.1	3891	3754	0.883
April	161.8	64.58	14.49	205.1	196.9	4668	4503	0.846
May	185.5	78.44	19.40	229.1	220.3	5159	4978	0.837
June	192.1	74.70	24.11	236.4	228.2	5300	5115	0.834
July	189.9	78.44	25.42	233.8	225.3	5283	5101	0.841
August	171.5	68.62	24.80	217.1	208.7	4922	4753	0.844
September	132.9	55.35	21.76	169.7	162.1	3894	3763	0.854
October	111.1	40.07	15.44	146.0	138.6	3404	3287	0.868
November	79.9	28.40	11.52	106.0	98.9	2472	2389	0.869
December	65.0	25.17	7.79	86.5	79.9	2028	1955	0.871
Year	1578.0	631.68	15.57	2000.9	1909.6	45993	44395	0.855

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

Grid-Connected System: Special graphs

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Main system parameters

System type **Tracking system with backtracking**

Near Shadings

According to module strings

Electrical effect 100 %

PV Field Orientation

tracking, tilted axis, Axis Tilt

Axis azimuth 0°

PV modules

Model Q.PEAK DUO XL-G11.3 580/BFG

580 Wp

PV Array

Nb. of modules 44750

Pnom total **25955 kWp**

Inverter

Model SG3600UD

Pnom 3600 kW ac

Inverter pack

Nb. of units 6.0

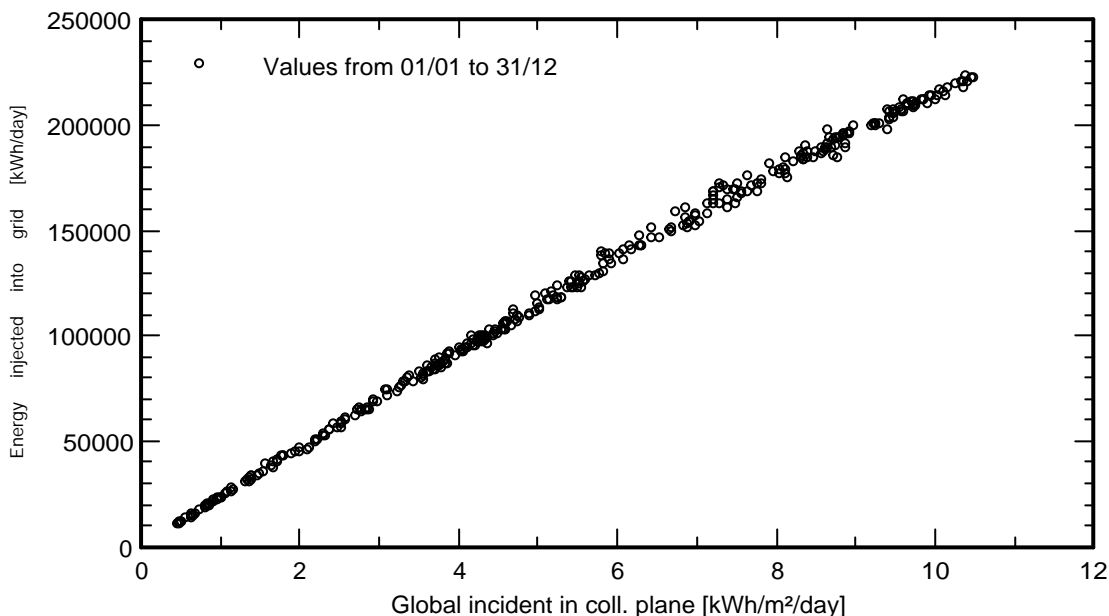
Pnom total **21600 kW ac**

User's needs

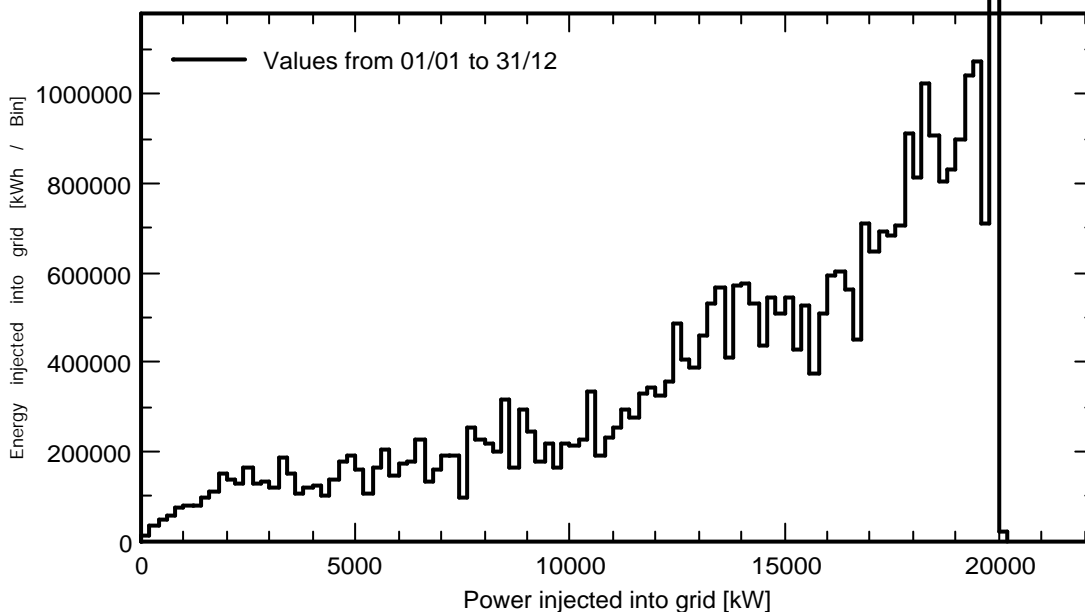
Unlimited load (grid)

Cos(phi) 0.950 leading

Daily Input/Output diagram



System Output Power Distribution



Grid-Connected System: Loss diagram

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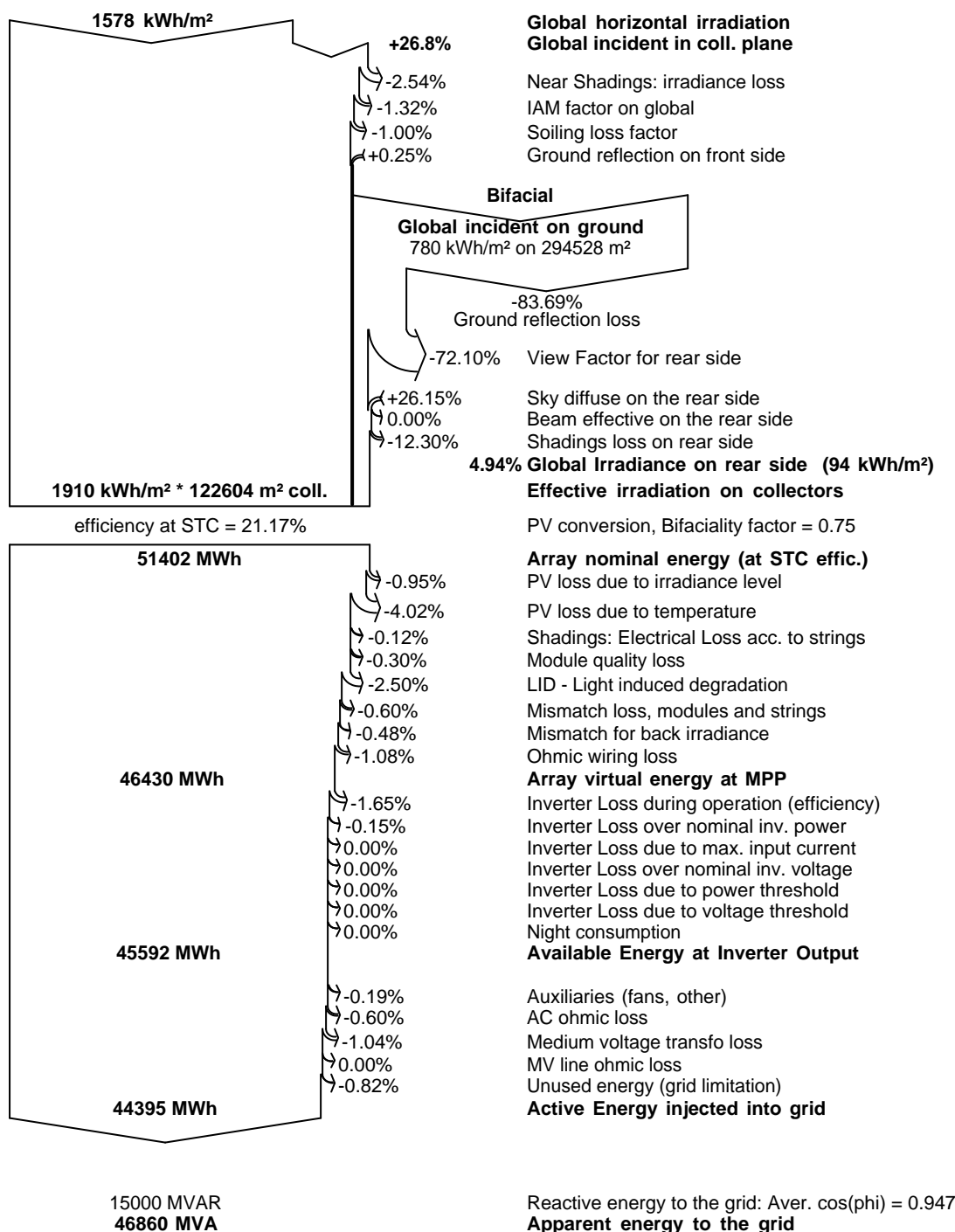
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Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

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Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

Meteo data source	NREL NSRD : TMY3
Meteo data	Kind TMY, multi-year
Specified Deviation	Climate change 0.0 %
Year-to-year variability	Variance 3.3 %

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	3.8 %	(quadratic sum)

Annual production probability	Variability 1685 MWh
	P50 44395 MWh
	P90 42235 MWh
	P95 41627 MWh

Probability distribution

