

Grid-Connected System: Simulation parameters

Project : **10MW Grid Connected**

Geographical Site **King Abdul Aziz University** Country **Saudi Arabia**

Situation Latitude 21.69° N Longitude 39.19° E
 Time defined as Legal Time Time zone UT+3 Altitude 29 m
 Albedo 0.20

Meteo data: **King Abdul Aziz University** Meteonorm 7.2 (1998-2002) - Synthetic

Simulation variant : **New simulation variant**

Simulation date 07/06/22 18h02
Simulation for the 10th year of operation

Simulation parameters System type **Sheds on ground**

Collector Plane Orientation Tilt 25° Azimuth 0°

Sheds configuration Nb. of sheds 1440 Identical arrays
 Sheds spacing 5.00 m Collector width 3.16 m
 Shading limit angle Limit profile angle 32.0° Ground cov. Ratio (GCR) 63.2 %

Models used Transposition Perez Diffuse Perez, Meteonorm

Horizon Free Horizon

Near Shadings Linear shadings

User's needs : Unlimited load (grid)

PV Array Characteristics

PV module Si-mono Model **SPR-315E-WHT-D**

Original PVsyst database Manufacturer SunPower
 Number of PV modules In series 10 modules In parallel 2886 strings
 Total number of PV modules Nb. modules 28860 Unit Nom. Power 315 Wp
 Array global power Nominal (STC) **9091 kWp** At operating cond. 8241 kWp (50°C)
 Array operating characteristics (50°C) U mpp 485 V I mpp 17001 A
 Total area Module area **47062 m²** Cell area 42473 m²

Inverter Model **SG500MX**

Original PVsyst database Manufacturer Sungrow
 Characteristics Operating Voltage 460-850 V Unit Nom. Power 500 kWac
 Inverter pack Nb. of inverters 16 units Total Power 8000 kWac
 Pnom ratio 1.14

PV Array loss factors

Array Soiling Losses Loss Fraction 2.0 %
 Thermal Loss factor U_c (const) 29.0 W/m²K U_v (wind) 0.0 W/m²K / m/s
 Wiring Ohmic Loss Global array res. 0.48 mOhm Loss Fraction 1.5 % at STC
 Module Quality Loss Loss Fraction 2.5 %
 Module Mismatch Losses Loss Fraction 1.0 % at MPP
 Strings Mismatch loss Loss Fraction 0.10 %
 Module average degradation Year no 10 Loss factor 0.4 %/year
 Mismatch due to degradation Imp RMS dispersion 0.4 %/year Vmp RMS dispersion 0.4 %/year
 Incidence effect, ASHRAE parametrization IAM = 1 - bo (1/cos i - 1) bo Param. 0.05

Auxiliaries loss constant (fans) 0 W ... from Power thresh. 0.0 kW

Grid-Connected System: Near shading definition

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Main system parameters

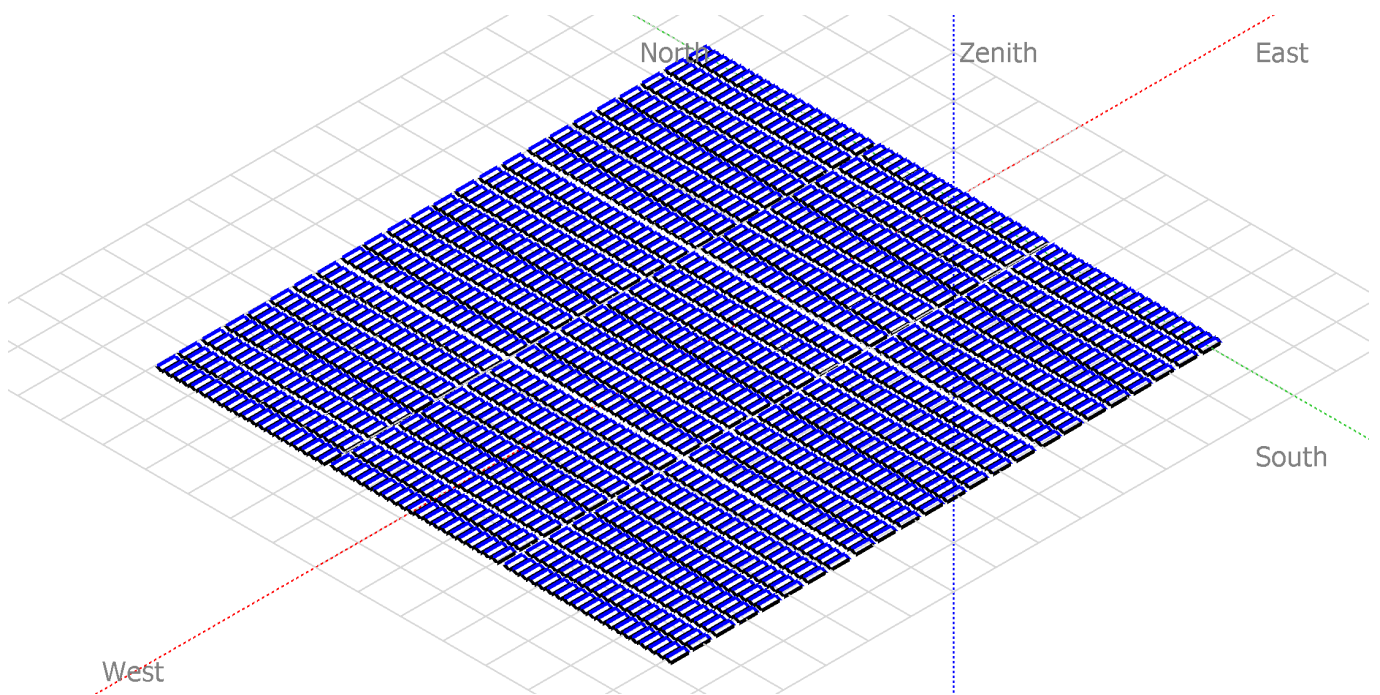
Near Shadings

PV Field Orientation
 PV modules
 PV Array
 Inverter
 Inverter pack
 User's needs

System type	Sheds on ground
Linear shadings	
tilt	25°
Model	SPR-315E-WHT-D
Nb. of modules	28860
Model	SG500MX
Nb. of units	16.0
Unlimited load (grid)	

azimuth	0°
Pnom	315 Wp
Pnom total	9091 kWp
Pnom	500 kW ac
Pnom total	8000 kW ac

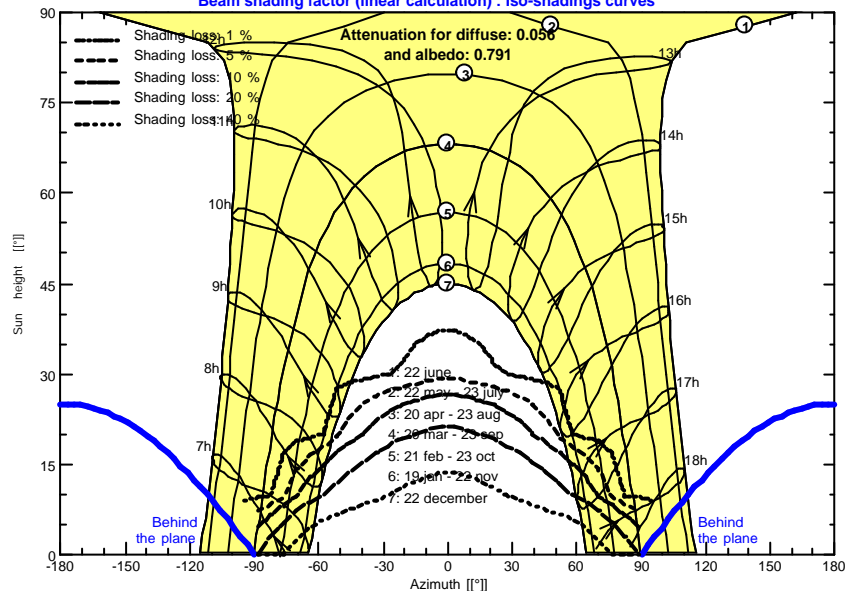
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

10MW Grid Connected

Beam shading factor (linear calculation) : Iso-shadings curves



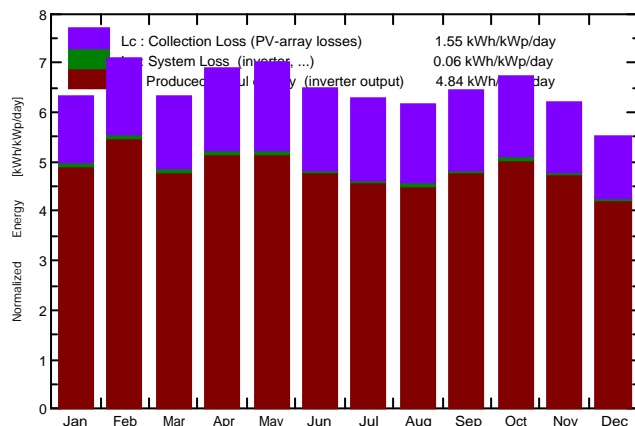
Grid-Connected System: Main results

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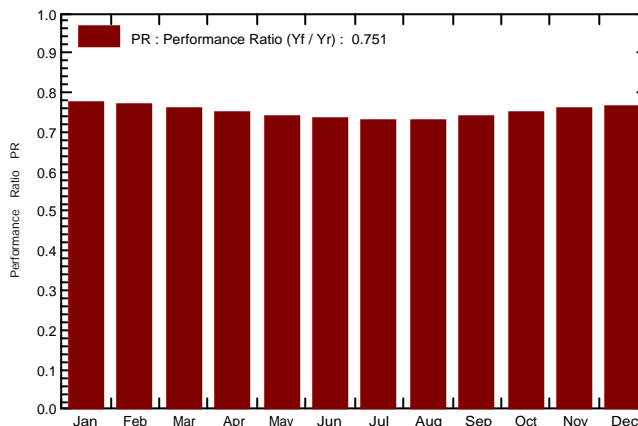
Main system parameters	System type	Sheds on ground	
Near Shadings	Linear shadings		
PV Field Orientation	tilt	25°	azimuth 0°
PV modules	Model	SPR-315E-WHT-D	Pnom 315 Wp
PV Array	Nb. of modules	28860	Pnom total 9091 kWp
Inverter	Model	SG500MX	Pnom 500 kW ac
Inverter pack	Nb. of units	16.0	Pnom total 8000 kW ac
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Main simulation results
 System Production **Produced Energy 16065 MWh/year** Specific prod. 1767 kWh/kWp/year
 Performance Ratio PR **75.07 %**

Normalized productions (per installed kWp): Nominal power 9091 kWp



Performance Ratio PR



New simulation variant
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
January	148.5	37.45	22.06	196.3	184.1	1403	1386	0.776
February	161.7	37.05	23.21	198.6	186.9	1409	1393	0.771
March	180.4	72.35	25.48	196.1	181.9	1370	1354	0.760
April	208.2	68.84	28.40	206.8	192.1	1424	1406	0.748
May	238.2	65.46	31.16	216.8	201.4	1473	1456	0.739
June	221.6	78.95	32.00	195.0	179.6	1319	1304	0.736
July	216.7	88.37	33.55	194.3	178.6	1307	1291	0.731
August	198.5	92.22	33.35	191.3	176.1	1289	1273	0.732
September	183.9	71.01	30.90	193.1	179.2	1318	1302	0.742
October	177.8	55.14	29.33	208.5	195.0	1436	1418	0.748
November	144.6	44.72	26.44	186.4	173.8	1305	1291	0.762
December	128.3	45.45	23.90	170.7	158.3	1205	1191	0.767
Year	2208.4	757.01	28.35	2354.1	2186.9	16258	16065	0.751

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

Grid-Connected System: Special graphs

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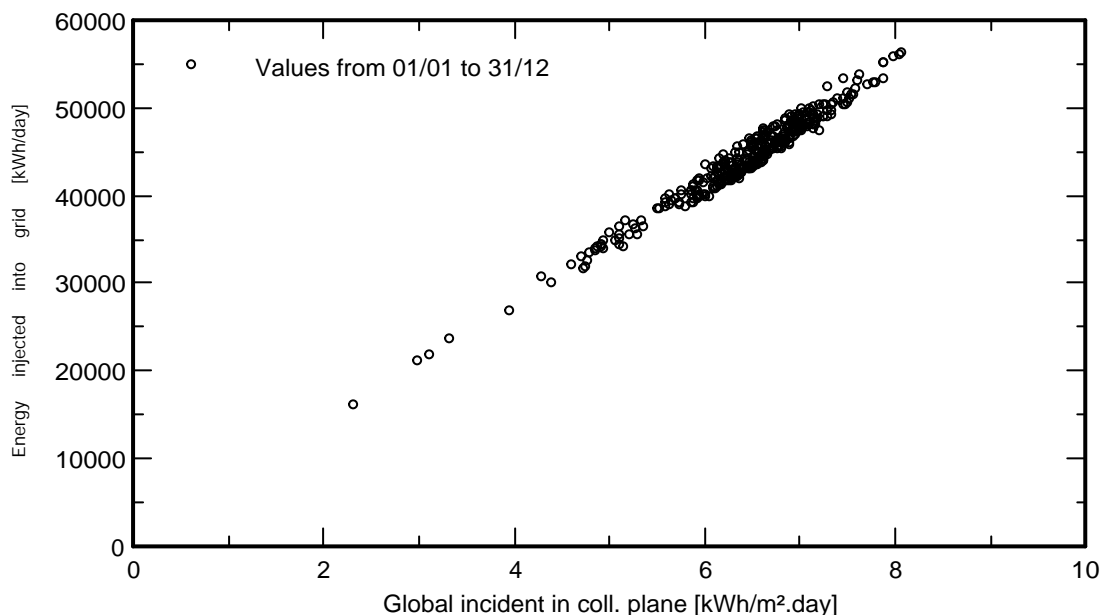
System type **Sheds on ground**

Near Shadings

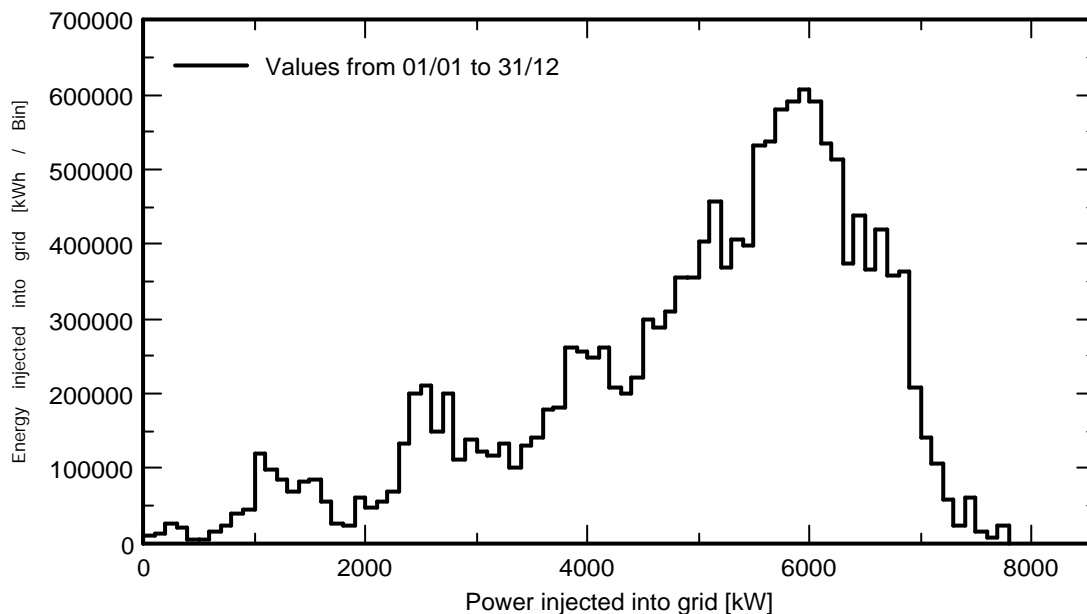
Linear shadings

PV Field Orientation	tilt	25°	azimuth	0°
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PV Array	Nb. of modules	28860	Pnom total	9091 kWp
Inverter	Model	SG500MX	Pnom	500 kW ac
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Daily Input/Output diagram



System Output Power Distribution



Grid-Connected System: Loss diagram

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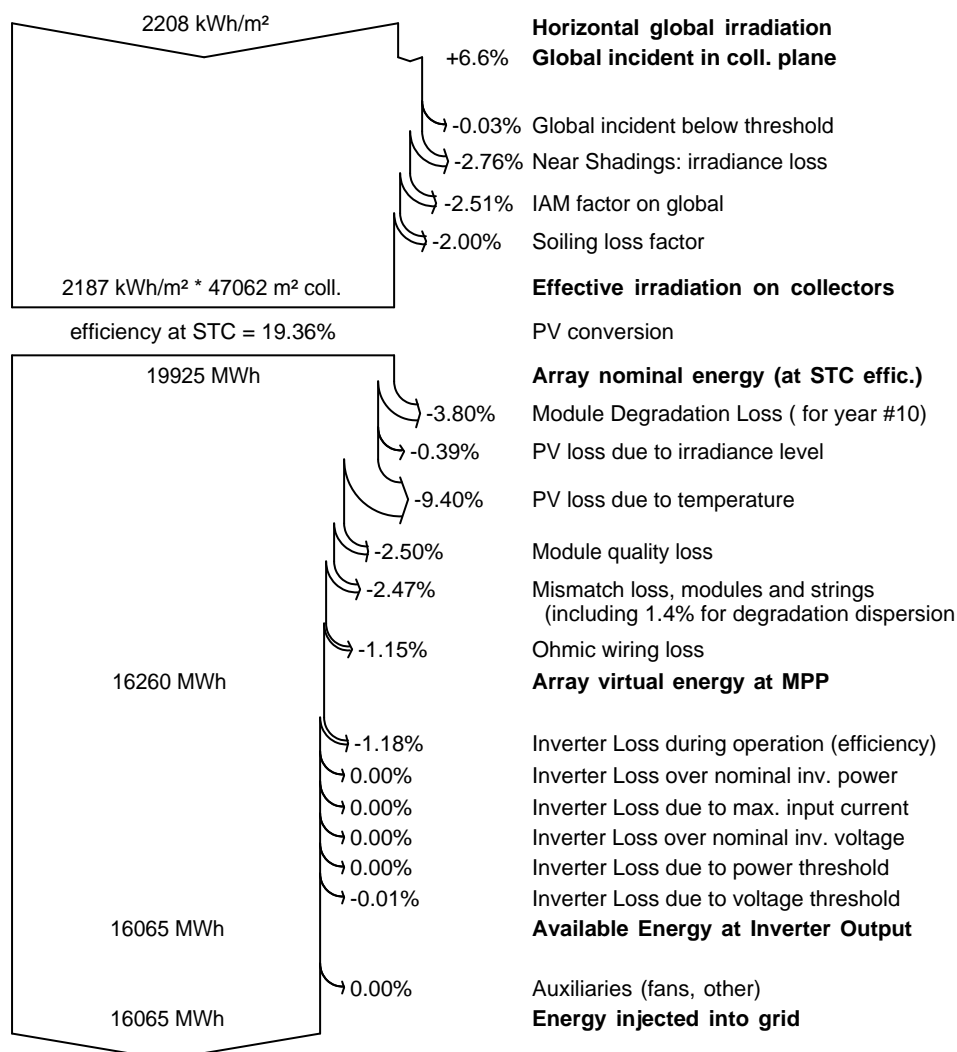
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Near Shadings

Linear shadings

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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	Meteonorm 7.2 (1998-2002)		
Meteo data	Kind	Not defined	Year 1995
Specified Deviation	Year deviation from aver.	3 %	
Year-to-year variability	Variance	0.5 %	

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	1.9 %	(quadratic sum)

Annual production probability	Variability	301 MWh
	P50	16065 MWh
	P90	15679 MWh
	P95	15571 MWh

Probability distribution

