

# PVsyst - Simulation report

## Grid-Connected System

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Project: Black Rock Solar

Variant: Phase 3 – 80 MW Single Axis Tracking

Unlimited Trackers with backtracking

System power: 79.99 MWp

Clear Lake - United States

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| Author



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### PVsyst V7.1.5

VC3, Simulation date:  
03/03/21 20:32  
with v7.1.5

### Project summary

<b>Geographical Site</b>	<b>Situation</b>	<b>Project settings</b>
<b>Clear Lake</b>	Latitude 39.10 °N	Albedo 0.20
United States	Longitude -112.83 °W	
	Altitude 1405 m	
	Time zone UTC-7	
<b>Meteo data</b>		
Clear Lake		
NREL NSRDB Typ. Met. Year PSMv3_1998 to 2016 - TMY		

### System summary

<b>Grid-Connected System</b>	<b>Unlimited Trackers with backtracking</b>	
<b>PV Field Orientation</b>	<b>Tracking algorithm</b>	<b>Near Shadings</b>
<b>Orientation</b>	Astronomic calculation	No Shadings
Tracking horizontal axis	Backtracking activated	
<b>System information</b>		
<b>PV Array</b>	<b>Inverters</b>	
Nb. of modules 179764 units	Nb. of units 24 units	
Pnom total 79.99 MWp	Pnom total 82.49 MWac	
	Pnom ratio 0.970	
<b>User's needs</b>		
Unlimited load (grid)		

### Results summary

Produced Energy 156106 MWh/year	Specific production 1951 kWh/kWp/year	Perf. Ratio PR 84.99 %
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### General parameters

<b>Grid-Connected System</b>		<b>Unlimited Trackers with backtracking</b>	
<b>PV Field Orientation</b>		<b>Tracking algorithm</b>	
<b>Orientation</b>		Astronomic calculation	
Tracking horizontal axis		Backtracking activated	
		<b>Backtracking strategy</b>	
		Nb. of trackers 10 units	
		Unlimited trackers	
		<b>Sizes</b>	
		Tracker Spacing 5.64 m	
		Collector width 3.70 m	
		Ground Cov. Ratio (GCR) 65.6 %	
		Left inactive band 0.02 m	
		Right inactive band 0.02 m	
		Phi min / max -/+ 90.0 °	
		<b>Backtracking limit angle</b>	
		Phi limits +/- 48.3 °	
<b>Models used</b>			
Transposition	Perez		
Diffuse	Imported		
Circumsolar	separate		
<b>Horizon</b>		<b>Near Shadings</b>	
Free Horizon		No Shadings	
		<b>User's needs</b>	
		Unlimited load (grid)	

### PV Array Characteristics

<b>PV module</b>		<b>Inverter</b>	
Manufacturer	Suntech	Manufacturer	Sungrow
Model	STP-445-S-A72-Vnh	Model	SG3425-HV-20
(Custom parameters definition)		(Custom parameters definition)	
Unit Nom. Power	445 Wp	Unit Nom. Power	3437 kWac
Number of PV modules	179764 units	Number of inverters	24 units
Nominal (STC)	79.99 MWp	Total power	82488 kWac
Modules	6914 Strings x 26 In series	Operating voltage	875-1300 V
<b>At operating cond. (50°C)</b>		Max. power (=>25°C)	3593 kWac
Pmpp	72.66 MWp	Pnom ratio (DC:AC)	0.97
U mpp	962 V		
I mpp	75565 A		
<b>Total PV power</b>		<b>Total inverter power</b>	
Nominal (STC)	79995 kWp	Total power	82488 kWac
Total	179764 modules	Nb. of inverters	24 units
Module area	361688 m <sup>2</sup>	Pnom ratio	0.97
Cell area	320987 m <sup>2</sup>		

### Array losses

<b>Array Soiling Losses</b>											
Average loss Fraction	2.0 %										
Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
5.0%	5.0%	2.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	2.0%	3.0%



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### Array losses

#### Thermal Loss factor

Module temperature according to irradiance  
Uc (const) 29.0 W/m²K  
Uv (wind) 0.0 W/m²K/m/s

#### DC wiring losses

Global array res. 0.085 mΩ  
Loss Fraction 0.6 % at STC

#### LID - Light Induced Degradation

Loss Fraction 0.9 %

#### Module Quality Loss

Loss Fraction -0.1 %

#### Module mismatch losses

Loss Fraction 0.5 % at MPP

#### Strings Mismatch loss

Loss Fraction 0.1 %

#### IAM loss factor

Incidence effect (IAM): Fresnel smooth glass, n = 1.526

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.998	0.981	0.948	0.862	0.776	0.636	0.403	0.000

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**System losses**

**Auxiliaries loss**

**AC wiring losses**

**Inv. output line up to injection point**

Inverter voltage 600 Vac tri  
Loss Fraction 2.0 % at STC

**Inverter: SG3425-HV-20**

Wire section (24 Inv.) Copper 24 x 3 x 2000 mm<sup>2</sup>  
Average wires length 232 m

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### Main results

#### System Production

Produced Energy 156106 MWh/year

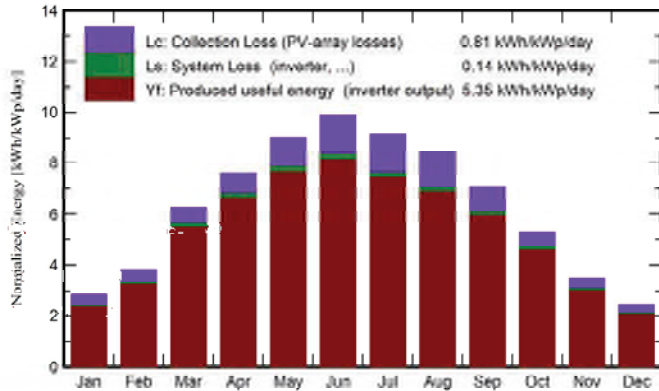
Specific production

1951 kWh/kWp/year

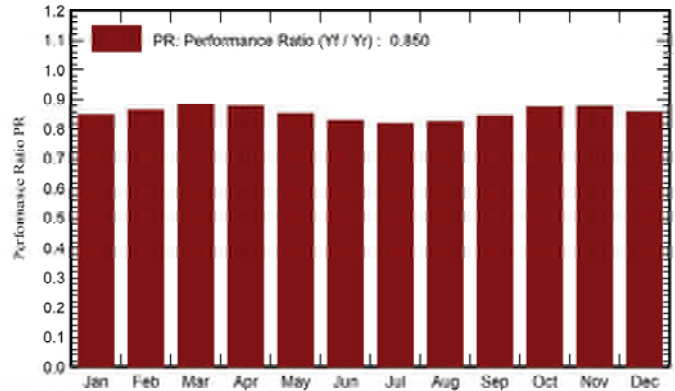
Performance Ratio PR

84.99 %

Normalized productions (per installed kWp)



Performance Ratio PR



### Balances and main results

	GlobHor kWh/m <sup>2</sup>	DiffHor kWh/m <sup>2</sup>	T_Amb °C	GlobInc kWh/m <sup>2</sup>	GlobEff kWh/m <sup>2</sup>	EArray MWh	E_Grid MWh	PR ratio
January	71.8	24.19	0.29	177.5	76.9	6094	5954	0.850
February	89.2	31.08	1.35	107.1	96.1	7580	7400	0.864
March	159.9	46.21	6.40	194.4	183.2	14061	13715	0.882
April	188.3	53.11	8.71	228.3	218.5	16458	16028	0.878
May	232.7	63.77	15.96	279.6	268.9	19607	19094	0.854
June	244.7	56.70	23.16	297.1	286.3	20212	19683	0.828
July	236.9	57.94	26.37	283.4	273.2	19073	18579	0.819
August	213.6	45.81	25.01	260.5	250.5	17608	17163	0.824
September	171.8	38.76	18.93	212.2	203.3	14724	14359	0.846
October	132.8	31.36	9.77	164.4	155.0	11773	11501	0.875
November	85.4	25.16	3.54	105.1	96.2	7542	7373	0.877
December	62.9	22.51	0.03	76.4	67.7	5378	5259	0.860
Year	1889.9	496.61	11.69	2296.0	2175.8	160111	156106	0.850

#### 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		



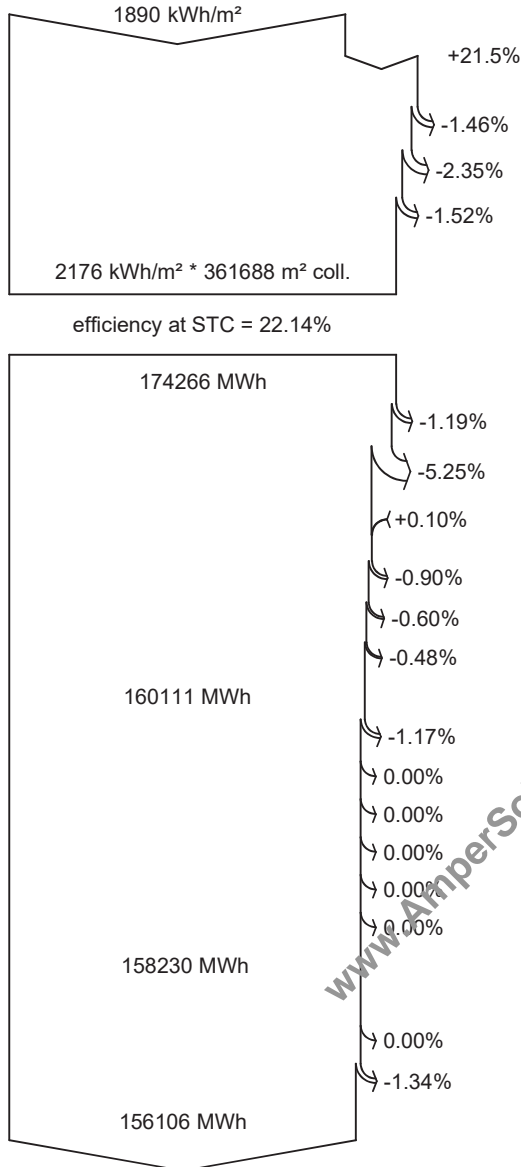
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### Loss diagram



#### 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

Module quality loss

LID - Light induced degradation

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

#### Available Energy at Inverter Output

Auxiliaries (fans, other)

AC ohmic loss

#### Energy injected into grid

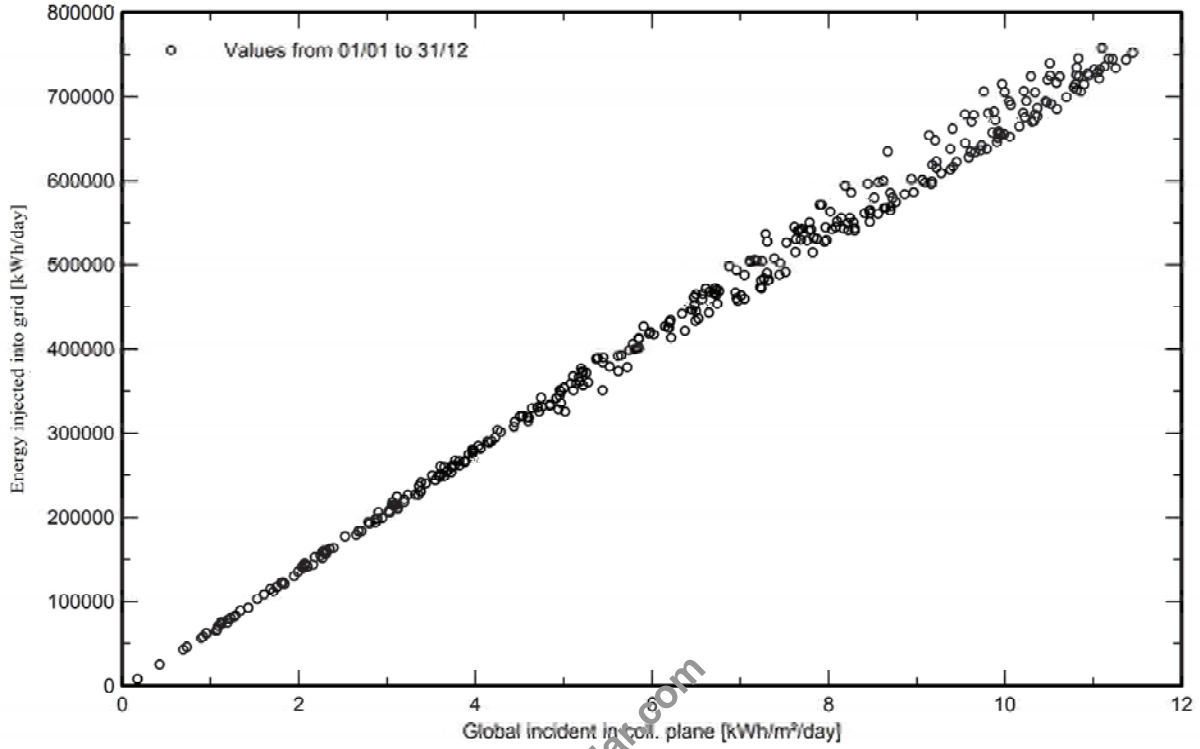


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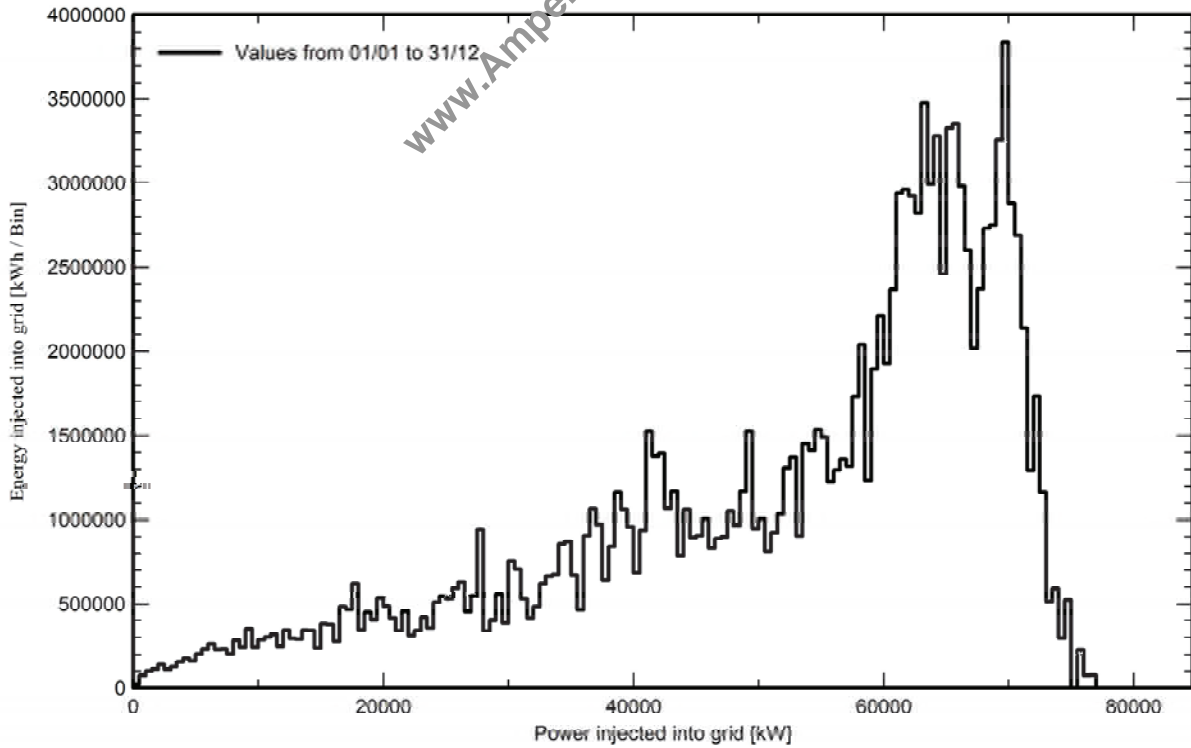
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**Special graphs**

**Daily Input/Output diagram**



**System Output Power Distribution**







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**P50 - P90 evaluation**

**Meteo data**

Reference Date: Met. Year PSMv3\_1998 to 2016  
Kind: TMY, multi-year  
Year-to-year variability(Variance): 0.5 %

**Specified Deviation**

Climate change: 0.0 %

**Global variability (meteo + system)**

Variability (Quadratic sum): 1.9 %

**Simulation and parameters uncertainties**

PV module modelling/parameters: 1.0 %  
Inverter efficiency uncertainty: 0.5 %  
Soiling and mismatch uncertainties: 1.0 %  
Degradation uncertainty: 1.0 %

**Annual production probability**

Variability: 2.92 GWh  
P50: 156.11 GWh  
P90: 152.36 GWh  
P95: 151.31 GWh

**Probability distribution**

