Version 7.3.2

PVsyst - Simulation report

Grid-Connected System

Project: Santa Barbara AC

Variant: New simulation variant

Tables on a building

System power: 1540 kWp

Santa Barbara/La Patera - 美国

作者

University of Edinburgh (United kingdom)

PVsyst V7.3.2
VC1, Simulation date:
03/20/23 11:47
with v7.3.2

Project summary

Geographical Site
Santa Barbara/La Patera
美国

Situation
Latitude	34.43 °N
Longitude	-119.84 °W
Altitude	2 m
Time zone	UTC-8

Project settings
Albedo	0.20

Meteo data
Santa Barbara/La Patera
MeteoNorm 8.1 station - 合成的

System summary

Grid-Connected System
Simulation for year no 10

Tables on a building

PV Field Orientation
Fixed plane
Tilt/Azimuth 13 / 0 °

Near Shadings
Linear shadings

User's needs
Ext. defined as file
EV_load.CSV

System information
PV Array
Nb. of modules	3460 units
Pnom total	1540 kWp

Inverters
Nb. of units	21 units
Pnom total	1386 kWac
Pnom ratio	1.111

Results summary

Produced Energy	2520659 kWh/year	Specific production	1637 kWh/kWp/year	Perf. Ratio PR	81.30 %
Used Energy	971465 kWh/year			Solar Fraction SF	60.13 %

Table of contents

PVsyst V7.3.2
VC1, Simulation date:
03/20/23 11:47
with v7.3.2

General parameters

Grid-Connected System

Tables on a building

PV Field Orientation

Orientation
Fixed plane
Tilt/Azimuth 13 / 0 °

Sheds configuration
Nb. of sheds 54 units

Sizes
Sheds spacing 19.0 m
Collector width 13.7 m
Ground Cov. Ratio (GCR) 72.0 %

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Average Height 2.6 °

Near Shadings
Linear shadings

User's needs
Ext. defined as file
EV_load.CSV

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Year	
82508	74524	82508	79847	82508	79847	82508	82508	79847	82508	79847	82508	971467	kWh

PV Array Characteristics

PV module
Manufacturer Generic
Model SPR-X20-445-COM
(Original PVsyst database)
Unit Nom. Power 445 Wp
Number of PV modules 3460 units
Nominal (STC) 1540 kWp
Modules 346 Strings x 10 In series

At operating cond. (50° C)
Pmpp 1433 kWp
U mpp 694 V
I mpp 2066 A

Inverter
Manufacturer Generic
Model CSI-66KTL-GS
(Original PVsyst database)
Unit Nom. Power 66.0 kWac
Number of inverters 84 * MPPT 25% 21 units
Total power 1386 kWac
Operating voltage 200-850 V
Pnom ratio (DC:AC) 1.11
No power sharing between MPPTs

Total PV power
Nominal (STC) 1540 kWp
Total 3460 modules
Module area 7481 m²
Cell area 6776 m²

Total inverter power
Total power 1386 kWac
Number of inverters 21 units
Pnom ratio 1.11

Array losses

Array Soiling Losses
Average loss Fraction 3.1 %

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
2.0%	2.0%	2.0%	2.0%	4.3%	4.3%	4.3%	4.3%	4.3%	4.3%	2.0%	2.0%

Thermal Loss factor
Module temperature according to irradiance
Uc (const) 29.0 W/m² K
Uv (wind) 0.0 W/m² K/m/s

DC wiring losses
Global array res. 5.5 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.8 %

Array losses

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.1 %

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

IAM loss factor

Incidence effect (IAM): Fresnel, AR coating, n(glass)=1.526, n(AR)=1.290

0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

System losses

Unavailability of the system

Time fraction 1.0 %

3.7 days,

3 periods

Horizon definition

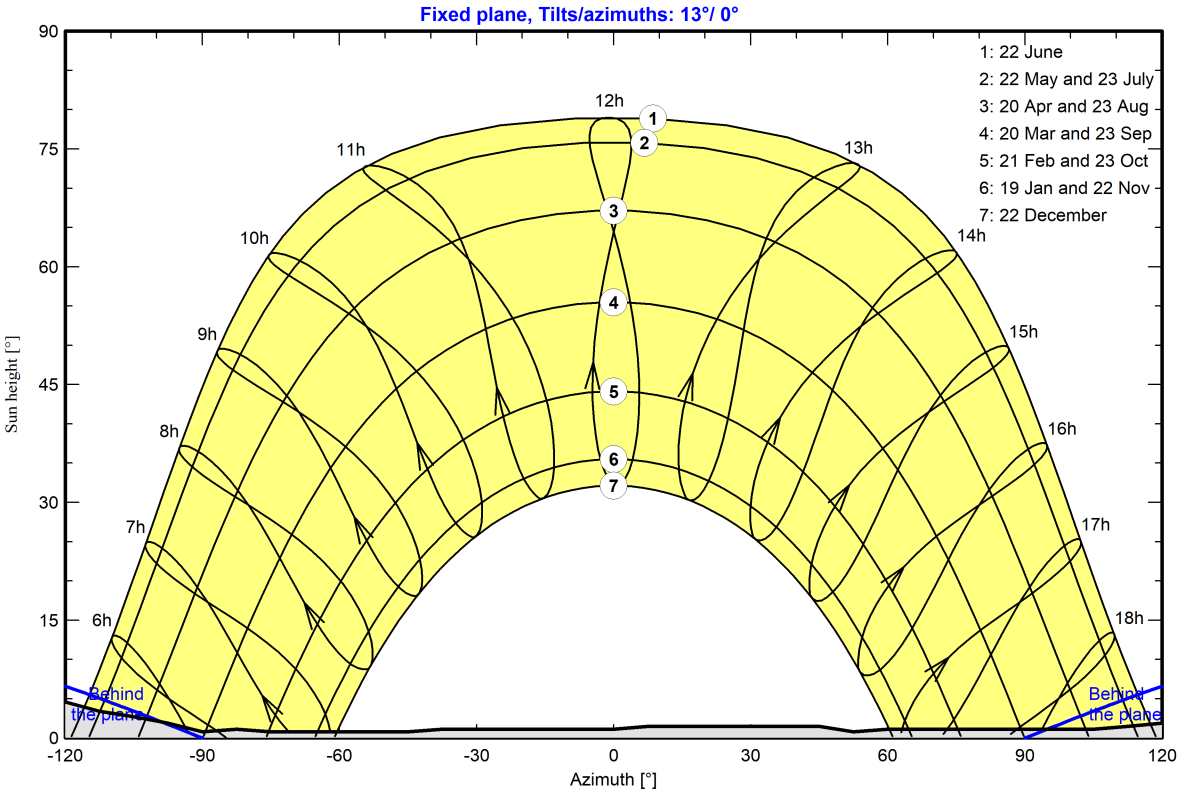
Horizon from PVGIS website API, Lat=34° 25"48', Long=-119° 50"24', Alt=2m

Average Height	2.6 °	Albedo Factor	0.94
Diffuse Factor	1.00	Albedo Fraction	100 %

Horizon profile

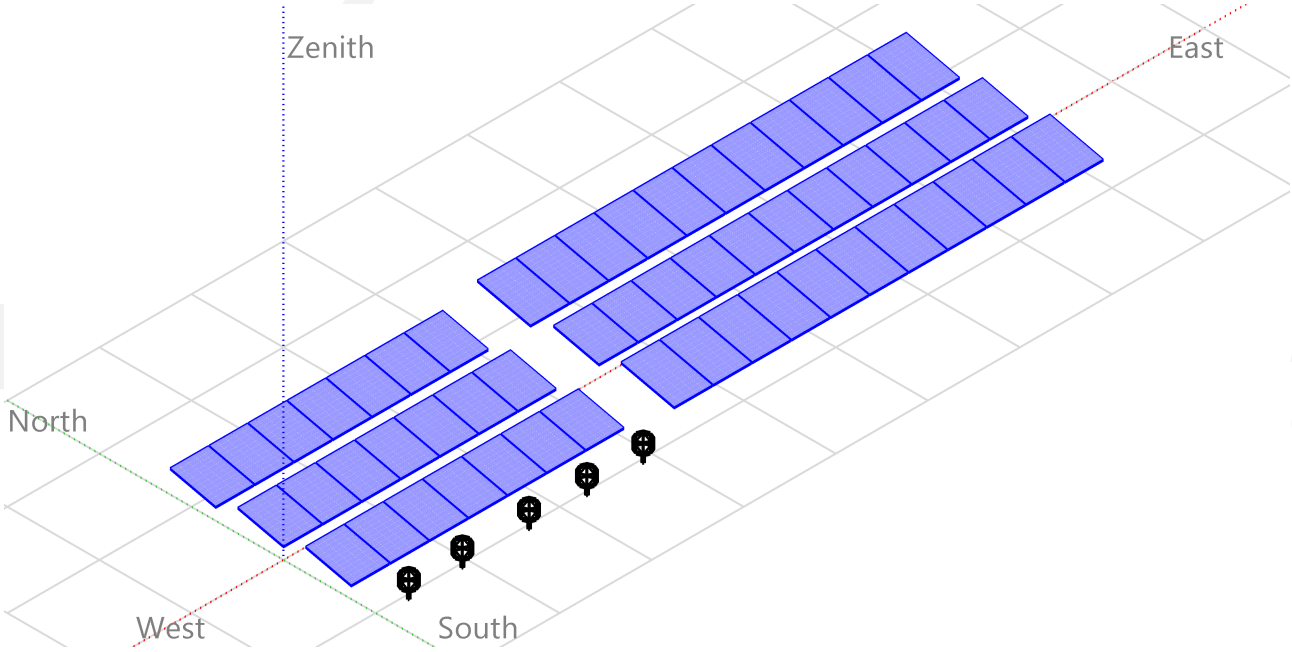
Azimuth [°]	-180	-173	-165	-150	-143	-135	-128	-120	-113	-105	-98
Height [°]	5.7	5.3	5.0	5.0	5.7	4.6	5.0	4.6	3.4	2.7	1.9
Azimuth [°]	-90	-83	-75	-45	-38	0	8	45	53	60	105
Height [°]	0.8	1.1	0.8	0.8	1.1	1.1	1.5	1.5	0.8	1.1	1.1
Azimuth [°]	113	120	128	135	150	158	165	173	180		
Height [°]	1.5	1.9	3.8	4.6	4.6	5.7	6.1	6.1	5.7		

Sun Paths (Height / Azimuth diagram)



Near shadings parameter

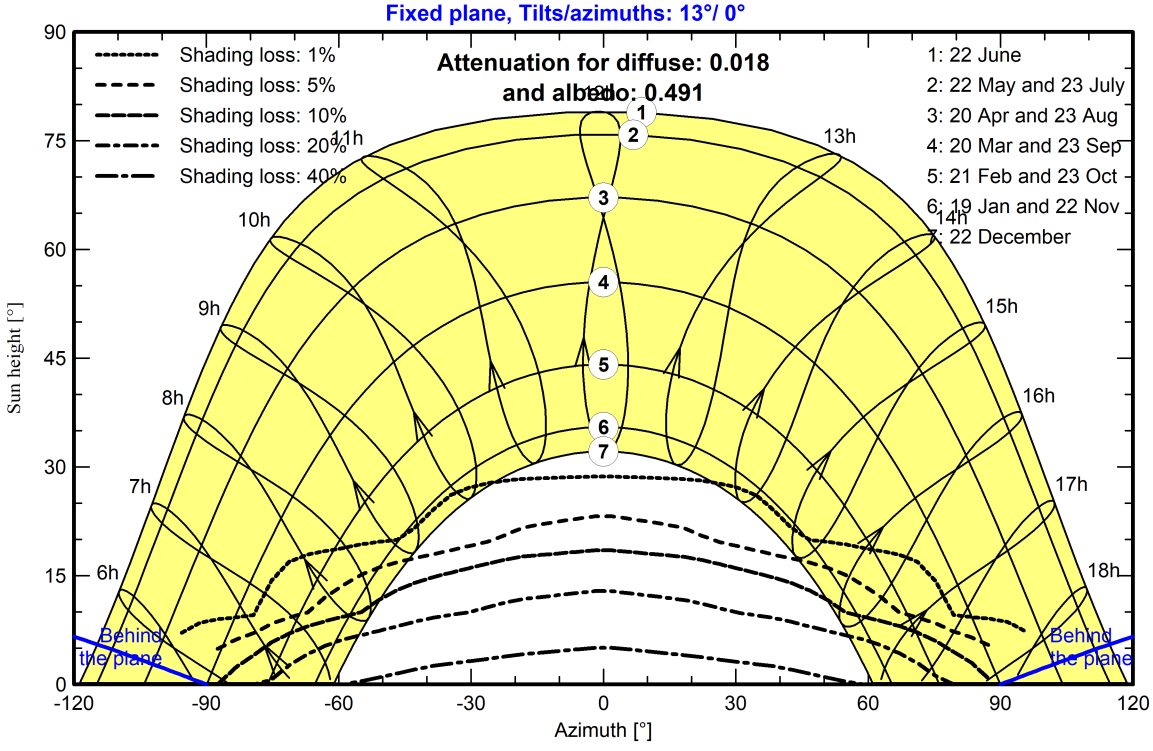
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Orientation #1

Fixed plane, Tilts/azimuths: 13° / 0°



PVsyst V7.3.2
VC1, Simulation date:
03/20/23 11:47
with v7.3.2

Main results

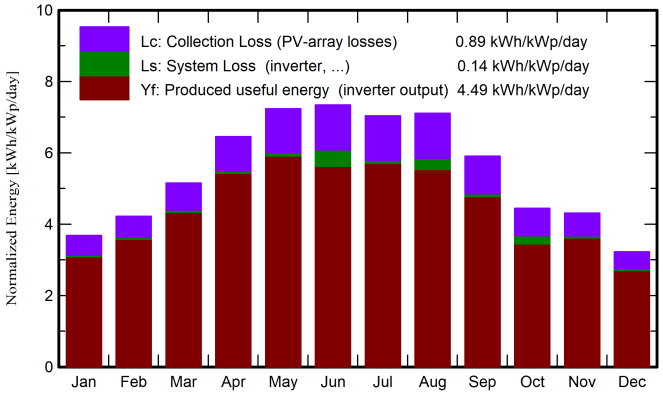
System Production

Produced Energy	2520659 kWh/year	Specific production	1637 kWh/kWp/year
Used Energy	971465 kWh/year	Performance Ratio PR	81.30 %
		Solar Fraction SF	60.13 %

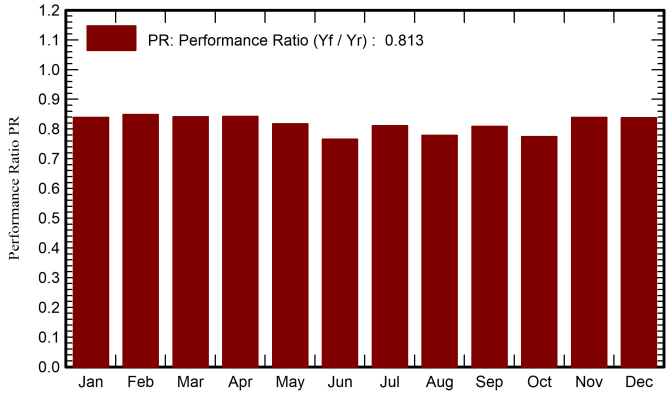
Economic evaluation

Investment		Yearly cost		LCOE	
Global	4,693,236.82 USD	Annuities	0.00 USD/yr	Energy cost	0.10 USD/kWh
Specific	3.05 USD/Wp	Run. costs	54,063.50 USD/yr		
		Payback period	7.5 years		

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray kWh	E_User kWh	E_Solar kWh	E_Grid kWh	EFrGrid kWh
January	89.9	32.10	12.00	114.2	107.0	149984	82508	44007	103646	38501
February	99.3	38.50	11.80	118.3	112.0	157036	74523	43014	111645	31509
March	144.9	57.80	13.40	159.8	151.9	210195	82508	50879	156046	31629
April	183.1	64.70	14.10	193.5	184.4	254679	79846	53098	197773	26749
May	222.4	64.00	15.70	224.3	209.3	286940	82508	56377	225997	26130
June	223.6	70.40	16.80	220.3	205.2	281229	79846	53757	206117	26089
July	218.9	82.10	18.60	218.1	203.1	276858	82508	58009	214451	24499
August	212.6	60.30	18.80	220.5	205.8	279533	82508	53233	211092	29275
September	163.0	58.10	18.30	177.3	164.8	224300	79846	47992	172829	31854
October	119.6	48.30	16.80	137.9	127.7	175988	82508	43264	121207	39244
November	102.4	28.40	13.70	129.4	122.1	169761	79846	40394	126774	39453
December	77.2	28.40	10.90	100.0	93.2	131178	82508	40125	88932	42383
Year	1856.9	633.10	15.09	2013.7	1886.6	2597682	971465	584150	1936509	387315

Legends

GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective Global, corr. for IAM and shadings	EFrGrid	Energy from the grid

PVsyst V7.3.2
VC1, Simulation date:
03/20/23 11:47
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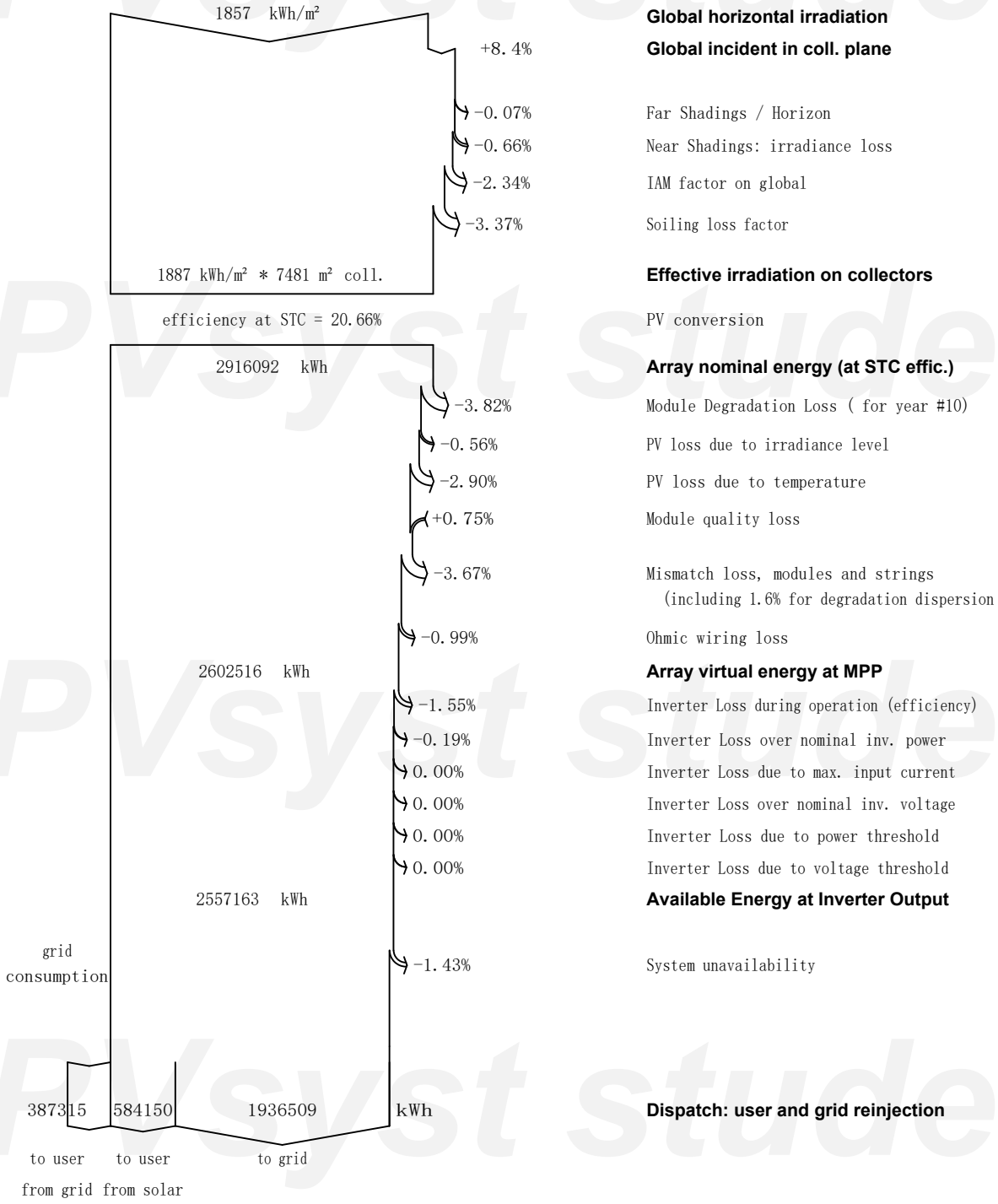
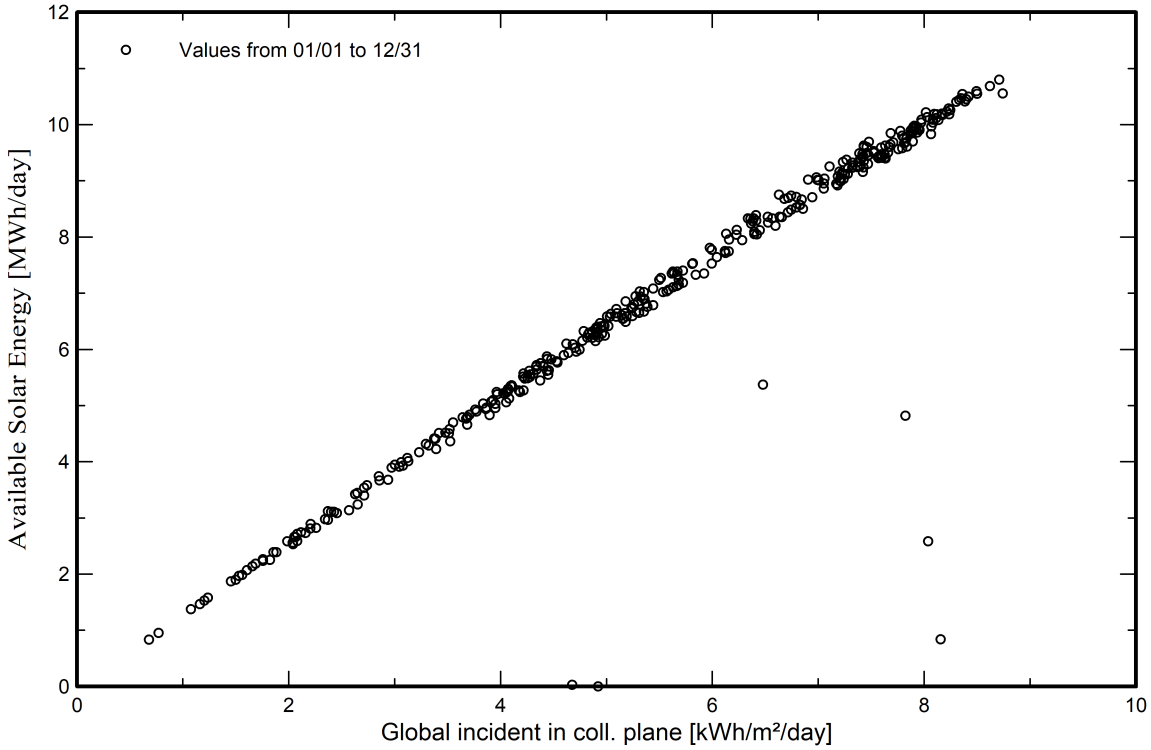
Loss diagram

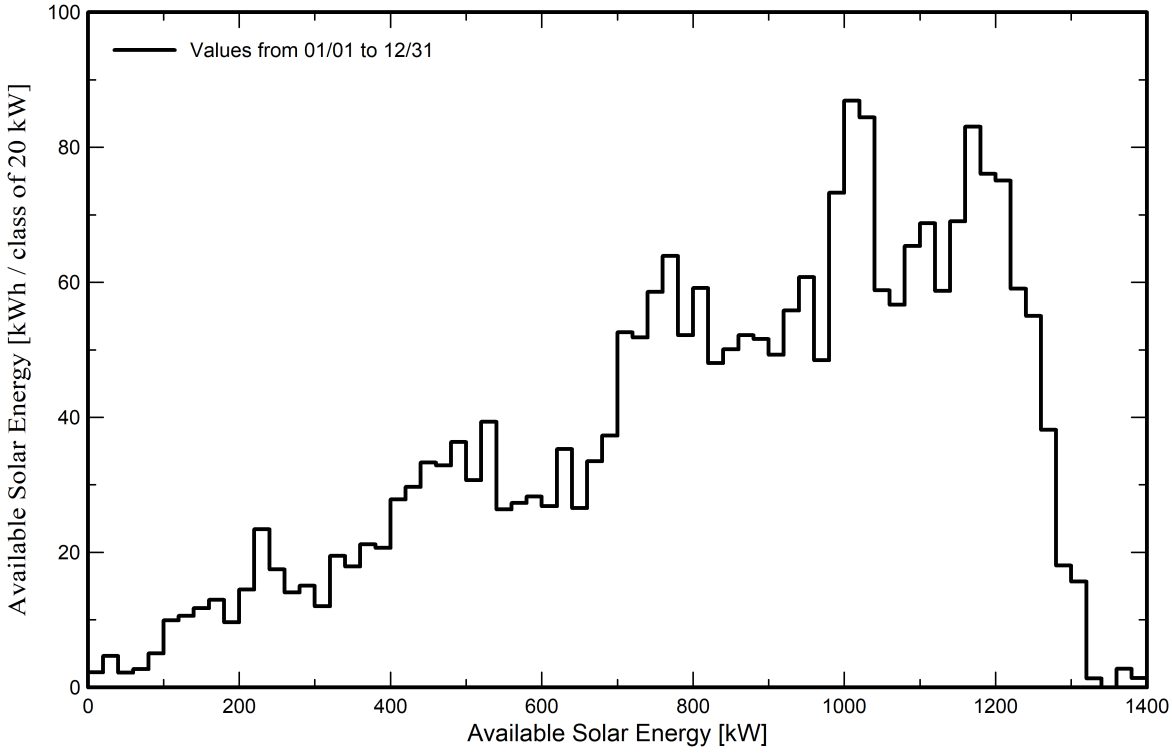


Predef. graphs

每日的 输入/输出 能量图



系统输出功率的分布



P50 - P90 evaluation

Meteo data

Source	MeteoNorm 8.1 station
Kind	Monthly averages
合成的 - Multi-year average	
Year-to-year variability(Variance)	2.5 %

Specified Deviation

Climate change	0.0 %

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 %

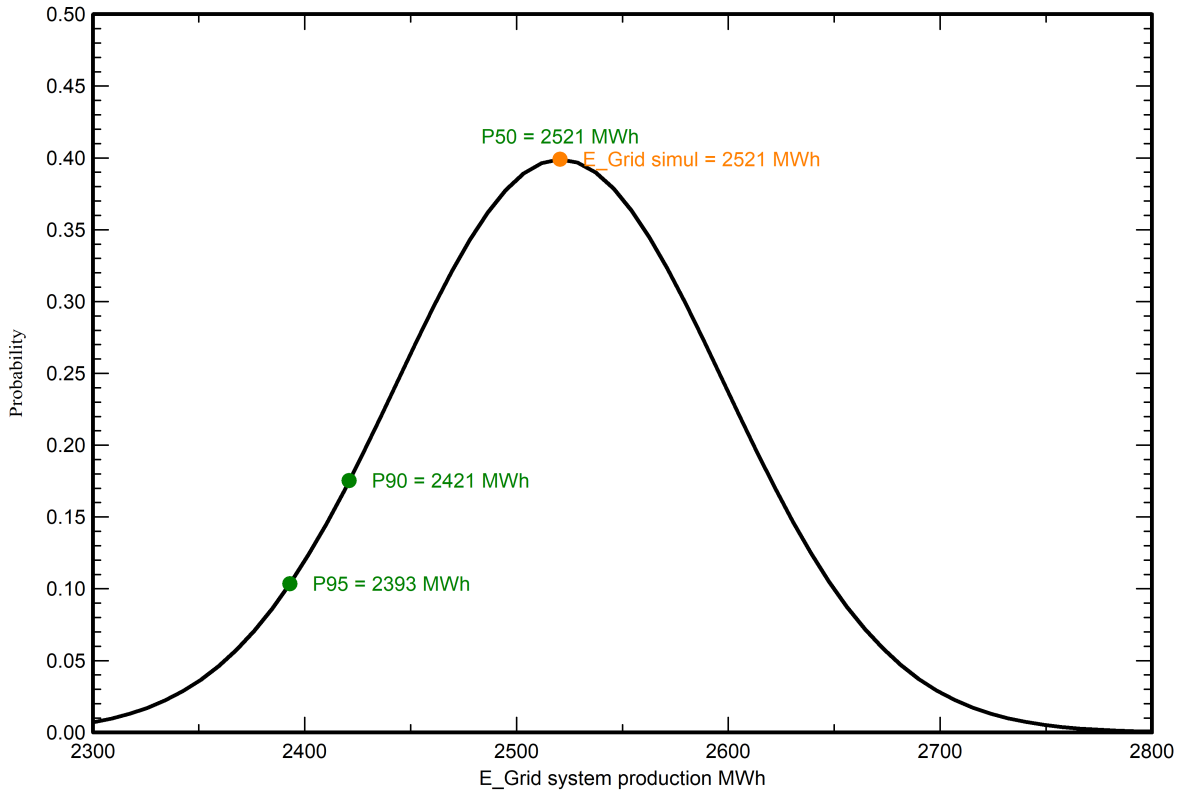
Global variability (meteo + system)

Variability (Quadratic sum)	3.1 %

Annual production probability

Variability	78 MWh
P50	2521 MWh
P90	2421 MWh
P95	2393 MWh

Probability distribution



Cost of the system

Installation costs

Item	Quantity units	Cost USD	Total USD
PV modules			
SPR-X20-445-COM	3460	500.00	1,730,000.00
Supports for modules	3460	70.00	242,200.00
Inverters			
CSI-66KTL-GS	21	3,870.00	81,270.00
Other components			
Accessories, fasteners	6	50,000.00	300,000.00
Wiring	1	80,000.00	80,000.00
Combiner box	2	3,500.00	7,000.00
Monitoring system, display screen	1	10,000.00	10,000.00
Measurement system, pyranometer	1	10,000.00	10,000.00
Surge arrester	6	2,000.00	12,000.00
Studies and analysis			
Engineering	1	30,000.00	30,000.00
Permitting and other admin. Fees	1	15,000.00	15,000.00
Environmental studies	1	15,000.00	15,000.00
Economic analysis	1	15,000.00	15,000.00
Installation			
Global installation cost per module	3460	70.00	242,200.00
Global installation cost per inverter	21	500.00	10,500.00
Transport	1	20,000.00	20,000.00
Settings	1	20,000.00	20,000.00
Grid connection	1	150,000.00	150,000.00
Insurance			
Building insurance	1	25,000.00	25,000.00
Transport insurance	1	10,000.00	10,000.00
Liability insurance	1	15,000.00	15,000.00
Land costs			
Land purchase	1	1,500,000.00	1,500,000.00
Taxes			
VAT	1	0.00	93,857.93
Federal taxes	1	0.00	43,870.89
State taxes	1	0.00	12,690.00
Local taxes	1	0.00	2,119.00
Other taxes	1	0.00	529.00
		Total	4,693,236.82
		Depreciable asset	2,353,470.00

Operating costs

Item	Total USD/year
Maintenance	
Provision for inverter replacement	4,063.50
Cleaning	50,000.00
Total (OPEX)	54,063.50

Cost of the system

System summary

Total installation cost	4,693,236.82 USD
Operating costs	54,063.50 USD/year
Unused energy	584 MWh/year
Energy sold to the grid	1937 MWh/year
Cost of produced energy (LCOE)	0.096 USD/kWh

Financial analysis

Simulation period

Project lifetime	25 years	Start year	2024

Income variation over time

Inflation	0.00 %/year
Production variation (aging)	0.00 %/year
Discount rate	0.00 %/year

Income dependent expenses

Income tax rate	0.00 %/year
Other income tax	0.00 %/year
Dividends	0.00 %/year

Depreciable assets

Asset	Depreciation method	Depreciation period (years)	Salvage value (USD)	Depreciable (USD)
PV modules				
SPR-X20-445-COM	Straight-line	25	0.00	1,730,000.00
Supports for modules	Straight-line	25	0.00	242,200.00
Inverters				
CSI-66KTL-GS	Straight-line	25	0.00	81,270.00
Accessories, fasteners	Straight-line	20	0.00	300,000.00
		Total	0.00	2,353,470.00

Financing

Own funds	4,693,236.82 USD

Electricity sale

Feed-in tariff	0.2325 USD/kWh
Duration of tariff warranty	20 years
Annual connection tax	0.00 USD/kWh
Annual tariff variation	0.0 %/year
Feed-in tariff decrease after warranty	0.00 %

Self-consumption

Consumption tariff	0.4000 USD/kWh
Tariff evolution	0.0 %/year

Return on investment

Payback period	7.5 years
Net present value (NPV)	11,052,773.82 USD
Internal rate of return (IRR)	12.76 %
Return on investment (ROI)	235.5 %

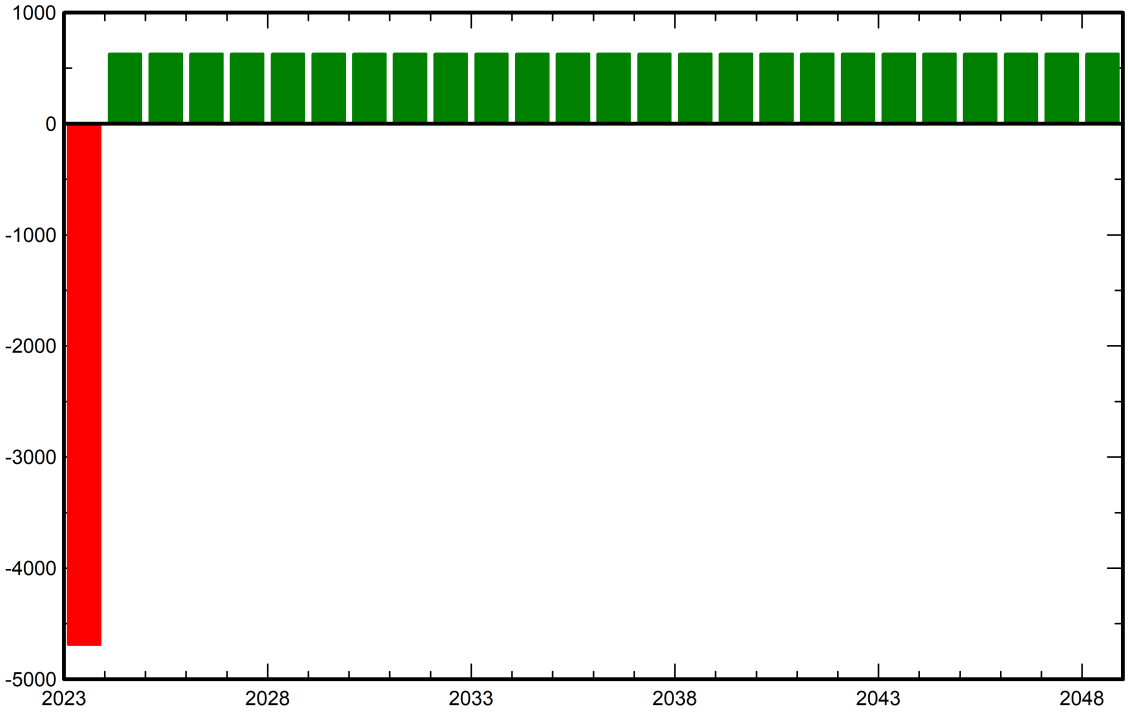
Financial analysis

Detailed economic results (USD)

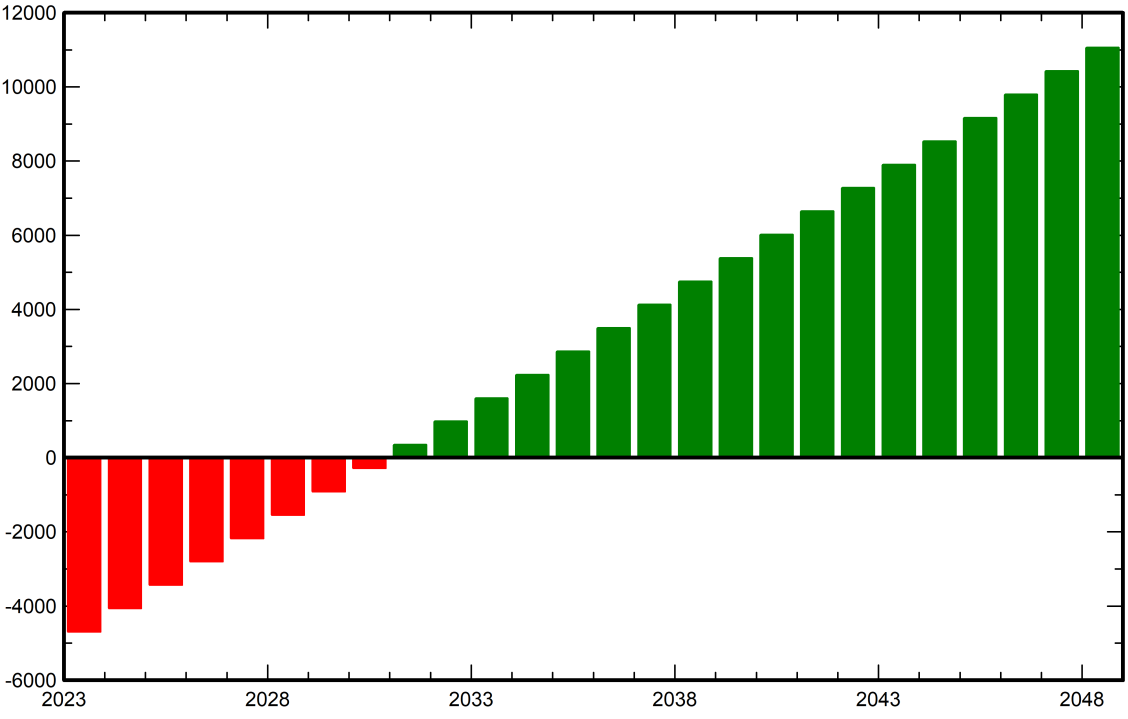
Year	Electricity sale	Own funds	Run. costs	Deprec. allow.	Taxable income	Taxes	After-tax profit	Self-cons. saving	Cumul. profit	% amorti.
0	0	4,693,237	0	0	0	0	0	0	-4,693,237	0.0%
1	450,243	0	54,064	97,139	299,041	0	396,180	233,661	-4,063,396	13.4%
2	450,243	0	54,064	97,139	299,041	0	396,180	233,661	-3,433,556	26.8%
3	450,243	0	54,064	97,139	299,041	0	396,180	233,661	-2,803,716	40.3%
4	450,243	0	54,064	97,139	299,041	0	396,180	233,661	-2,173,875	53.7%
5	450,243	0	54,064	97,139	299,041	0	396,180	233,661	-1,544,035	67.1%
6	450,243	0	54,064	97,139	299,041	0	396,180	233,661	-914,194	80.5%
7	450,243	0	54,064	97,139	299,041	0	396,180	233,661	-284,354	93.9%
8	450,243	0	54,064	97,139	299,041	0	396,180	233,661	345,487	107.4%
9	450,243	0	54,064	97,139	299,041	0	396,180	233,661	975,327	120.8%
10	450,243	0	54,064	97,139	299,041	0	396,180	233,661	1,605,167	134.2%
11	450,243	0	54,064	97,139	299,041	0	396,180	233,661	2,235,008	147.6%
12	450,243	0	54,064	97,139	299,041	0	396,180	233,661	2,864,848	161.0%
13	450,243	0	54,064	97,139	299,041	0	396,180	233,661	3,494,689	174.5%
14	450,243	0	54,064	97,139	299,041	0	396,180	233,661	4,124,529	187.9%
15	450,243	0	54,064	97,139	299,041	0	396,180	233,661	4,754,370	201.3%
16	450,243	0	54,064	97,139	299,041	0	396,180	233,661	5,384,210	214.7%
17	450,243	0	54,064	97,139	299,041	0	396,180	233,661	6,014,050	228.1%
18	450,243	0	54,064	97,139	299,041	0	396,180	233,661	6,643,891	241.6%
19	450,243	0	54,064	97,139	299,041	0	396,180	233,661	7,273,731	255.0%
20	450,243	0	54,064	97,139	299,041	0	396,180	233,661	7,903,572	268.4%
21	450,243	0	54,064	82,139	314,041	0	396,180	233,661	8,533,412	281.8%
22	450,243	0	54,064	82,139	314,041	0	396,180	233,661	9,163,253	295.2%
23	450,243	0	54,064	82,139	314,041	0	396,180	233,661	9,793,093	308.7%
24	450,243	0	54,064	82,139	314,041	0	396,180	233,661	10,422,933	322.1%
25	450,243	0	54,064	82,139	314,041	0	396,180	233,661	11,052,774	335.5%
Total	**11,256,080**	**4,693,237**	**1,351,588**	**2,353,470**	**7,551,023**	**0**	**9,904,493**	**5,841,518**	**11,052,774**	**335.5%**

Financial analysis

Yearly net profit (kUSD)



Cumulative cashflow (kUSD)



CO_2 Emission Balance

Total: -3196.7 tCO_2

Generated emissions

Total: 3196.66 tCO_2

Source: Detailed calculation from table below

Replaced Emissions

Total: 0.0 tCO_2

System production: 2520.66 MWh/yr

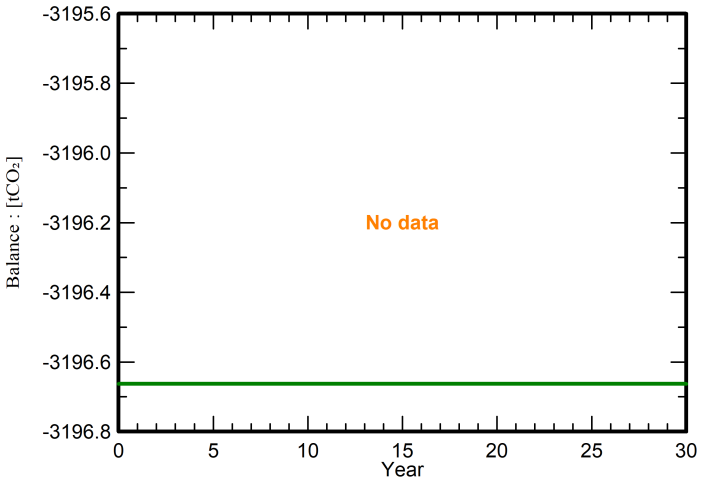
Grid Lifecycle Emissions: 0 gCO_2/kWh

Source: Custom value supplied by user

Lifetime: 30 years

Annual degradation: 1.0 %

Saved CO_2 Emission vs. Time



System Lifecycle Emissions Details

Item	LCE	Quantity	Subtotal
			[$kgCO_2$]
Modules	1559 kgCO2/kWp	2051 kWp	3196347
Supports	0.01 kgCO2/kg	46080 kg	307
Inverters	0.66 kgCO2/units	13.0 units	8.59