

GIPUZKOAKO INGENIARITZA ESKOLA

ESCUELA DE INGENIERÍA DE GIPUZKOA

EIBAR

Instalación fotovoltaica conectada a red en Pereira de Montes

DOCUMENTO Nº6: ANEXO Nº1 ESTUDIOS PVSYST

Grado: Ingeniería de Energías Renovables

Curso: 2022-2023

Autor: Pérez Castro, Iker

Director: Aguirre Porturas, Iñigo

PVsyst - Simulation report

Grid-Connected System

Project: Pereira

Variant: Opción 1 Pereira (Cubierta A 4kW)

Tables on a building

System power: 4200 Wp

Pereira de Montes (A Merca) - Spain

| Author



Project: Pereira

Variant: Opción 1 Pereira (Cubierta A 4kW)

PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

Project summary

Geographical Site
Pereira de Montes (A Merca)
Spain

Situation
Latitude 42.23 °N
Longitude -7.95 °W
Altitude 384 m
Time zone UTC+1

Project settings
Albedo 0.20

Meteo data

Pereira
Meteonorm 7.3 (1999-2010), Sat=100% - Sintético

System summary

Grid-Connected System

Simulation for year no 1

PV Field Orientation

Fixed plane
Tilt/Azimuth 45 / -40 °

System information

PV Array

Nb. of modules 12 units
Pnom total 4200 Wp

Tables on a building

Near Shadings

Linear shadings

Inverters

Nb. of units 1 unit
Pnom total 4000 W
Grid power limit 3500 W
Grid lim. Pnom ratio 1.200

User's needs

Ext. defined as file
Consumo final.csv

Battery pack

Storage strategy: Self-consumption
Nb. of units 2 units
Voltage 48 V
Capacity 108 Ah

Results summary

| | | | | | |
|-----------------|---------------|---------------------|-------------------|-------------------|---------|
| Produced Energy | 5.49 MWh/year | Specific production | 1307 kWh/kWp/year | Perf. Ratio PR | 77.62 % |
| Used Energy | 4.78 MWh/year | | | Solar Fraction SF | 61.73 % |
| Apparent energy | 2.54 MVAh | | | | |

Table of contents

| | |
|---|----|
| Project and results summary | 2 |
| General parameters, PV Array Characteristics, System losses | 3 |
| Horizon definition | 5 |
| Near shading definition - Iso-shadings diagram | 6 |
| Main results | 7 |
| Loss diagram | 8 |
| Special graphs | 9 |
| P50 - P90 evaluation | 10 |
| Cost of the system | 11 |
| Financial analysis | 12 |
| CO ₂ Emission Balance | 15 |



PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

General parameters

Grid-Connected System

PV Field Orientation

Orientation

Fixed plane
Tilt/Azimuth 45 / -40 °

Horizon

Average Height 5.1 °

Storage

Kind Self-consumption

Charging strategy

When excess solar power is available

Tables on a building

Sheds configuration

Near Shadings

Linear shadings

Models used

Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

User's needs

Ext. defined as file
Consumo final.csv

| Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Year | |
|------|------|------|------|-----|------|------|------|------|------|------|------|------|-----|
| 389 | 405 | 636 | 405 | 480 | 313 | 305 | 403 | 323 | 328 | 330 | 467 | 4784 | kWh |

Grid injection point

Grid power limitation

Active Power 3500 W
Pnom ratio 1.200

Power factor

Cos(phi) (lagging) 1.000

PV Array Characteristics

PV module

Manufacturer Generic
Model AS-M1203-H-350

(Original PVsyst database)

Unit Nom. Power 350 Wp
Number of PV modules 12 units
Nominal (STC) 4200 Wp
Modules 2 Strings x 6 In series

At operating cond. (50°C)

Pmpp 3843 Wp
U mpp 193 V
I mpp 20 A

Total PV power

Nominal (STC) 4.20 kWp
Total 12 modules
Module area 20.3 m²

Battery Storage

Battery

Manufacturer Generic
Model DCB102Z

Battery pack

Nb. of units 2 in parallel
Discharging min. SOC 20.0 %
Stored energy 4.2 kWh

Inverter

Manufacturer Generic
Model SUN2000-4KTL-L1

(Original PVsyst database)

Unit Nom. Power 4.00 kWac
Number of inverters 2 * MPPT 50% 1 unit
Total power 4.0 kWac
Operating voltage 80-600 V
Max. power (=>50°C) 4.40 kWac
Pnom ratio (DC:AC) 1.05

Total inverter power

Total power 4 kWac
Number of inverters 1 unit
Pnom ratio 1.05

Battery Pack Characteristics

Voltage 48 V
Nominal Capacity 108 Ah (C10)
Temperature Fixed 20 °C

**PVsyst V7.2.21**

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

PV Array Characteristics**Battery Storage****Battery input charger**

Model Generic
Max. charg. power 3.3 kWdc
Max./Euro effic. 97.0/95.0 %

Battery to Grid inverter

Model Generic
Max. disch. power 5.0 kWac
Max./Euro effic. 97.0/95.0 %

Array losses**Array Soiling Losses**

Loss Fraction 3.0 %

Thermal Loss factor

Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses

Global array res. 159 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss

Loss Fraction -1.0 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.1 %

Module average degradation

Year no 1
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 |

AC wiring losses**Inv. output line up to injection point**

Inverter voltage 230 Vac mono
Loss Fraction 1.38 % at STC

Inverter: SUN2000-4KTL-L1

Wire section (1 Inv.) Copper 1 x 2 x 3 mm²
Wires length 12 m



PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

Horizon definition

Horizon from PVGIS website API, Lat=42°14'5", Long=-7°57'9", Alt=384m

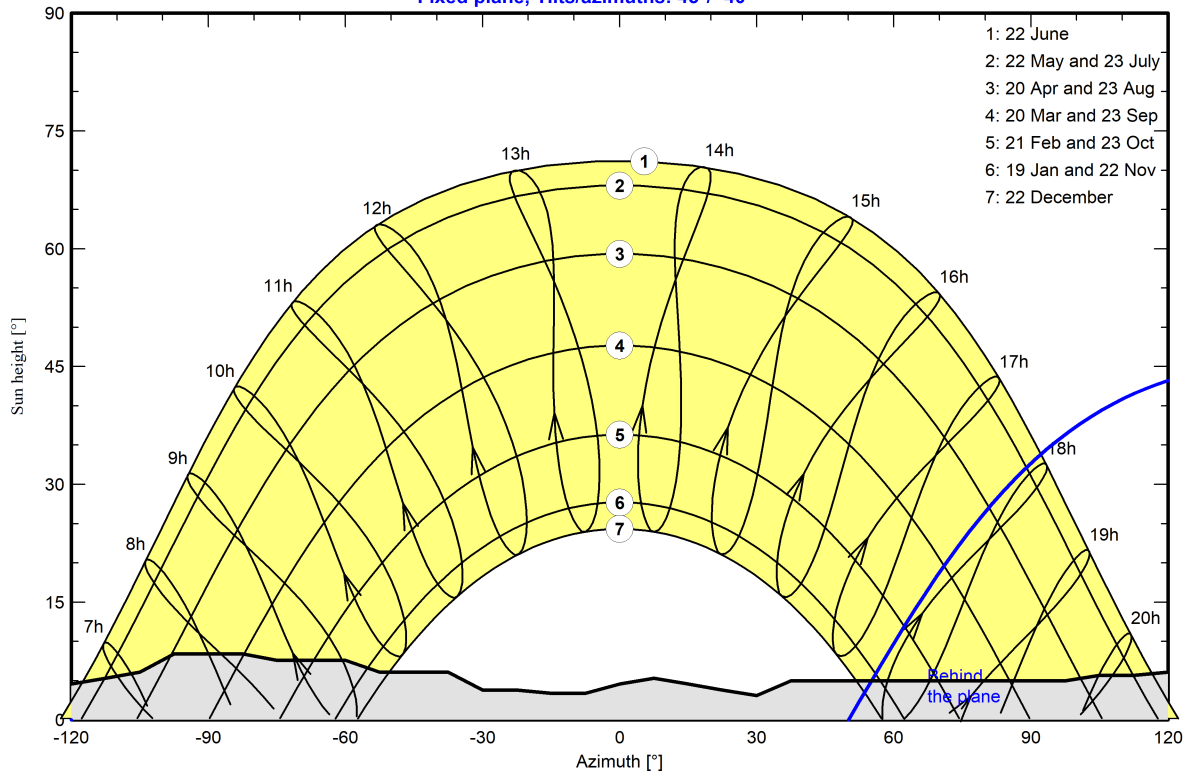
| | | | |
|----------------|-------|-----------------|-------|
| Average Height | 5.1 ° | Albedo Factor | 0.72 |
| Diffuse Factor | 0.94 | Albedo Fraction | 100 % |

Horizon profile

| | | | | | | | | | | | | | |
|-------------|------|------|------|------|------|------|------|------|------|------|-----|-----|-----|
| Azimuth [°] | -180 | -173 | -165 | -158 | -143 | -135 | -128 | -120 | -113 | -105 | -98 | -83 | -75 |
| Height [°] | 3.4 | 3.4 | 3.8 | 3.8 | 3.1 | 3.1 | 3.8 | 4.6 | 5.3 | 6.1 | 8.4 | 8.4 | 7.6 |
| Azimuth [°] | -60 | -53 | -38 | -30 | -23 | -15 | -8 | 0 | 8 | 15 | 23 | 30 | 38 |
| Height [°] | 7.6 | 6.1 | 6.1 | 3.8 | 3.8 | 3.4 | 3.4 | 4.6 | 5.3 | 4.6 | 3.8 | 3.1 | 5.0 |
| Azimuth [°] | 98 | 105 | 113 | 120 | 128 | 135 | 143 | 150 | 158 | 173 | 180 | | |
| Height [°] | 5.0 | 5.7 | 5.7 | 6.1 | 6.1 | 5.7 | 5.7 | 5.0 | 5.0 | 3.4 | 3.4 | | |

Sun Paths (Height / Azimuth diagram)

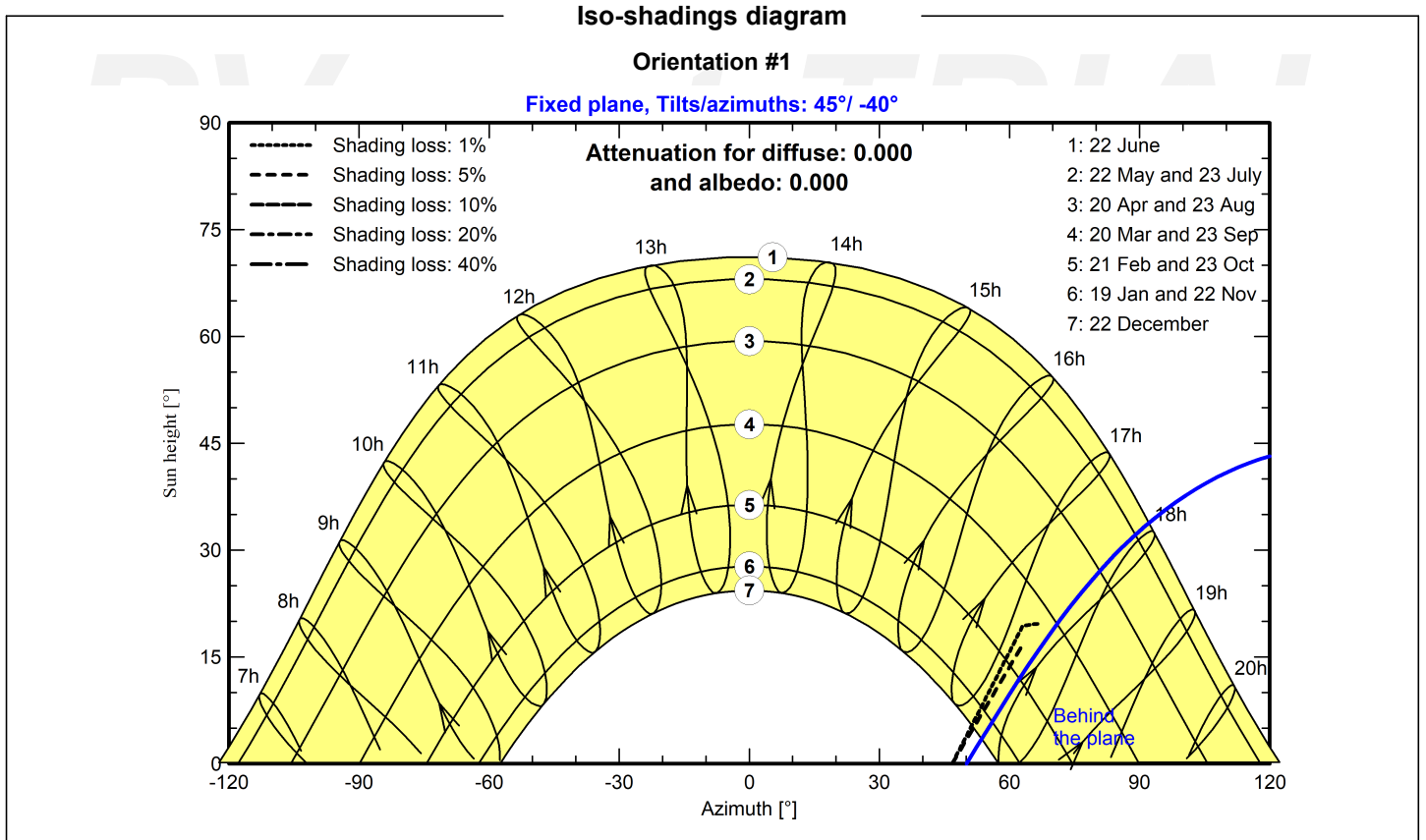
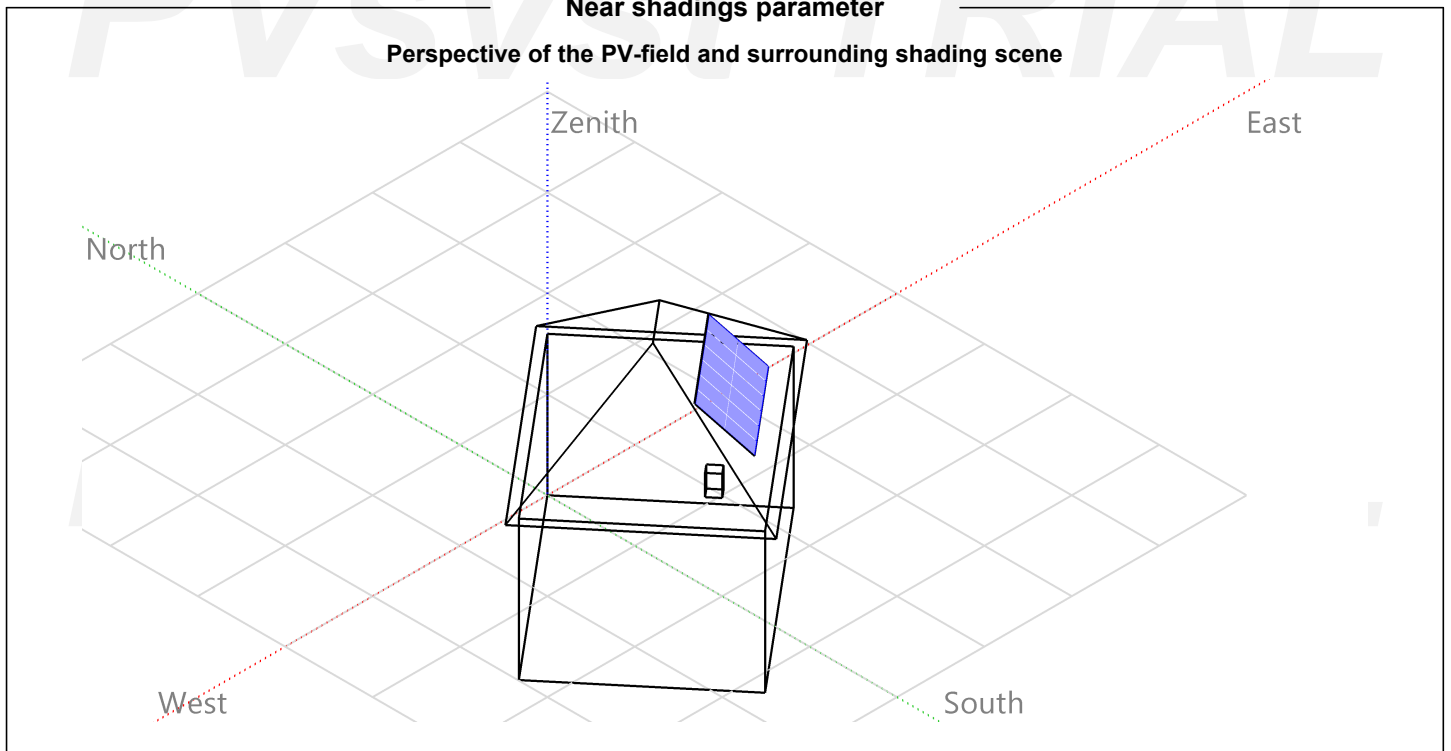
Fixed plane, Tilts/azimuths: 45° / -40°





PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21





PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

Main results

System Production

| | | | |
|-----------------|---------------|----------------------|-------------------|
| Produced Energy | 5.49 MWh/year | Specific production | 1307 kWh/kWp/year |
| Used Energy | 4.78 MWh/year | Performance Ratio PR | 77.62 % |
| Apparent energy | 2.54 MVAh | Solar Fraction SF | 61.73 % |

Battery aging (State of Wear)

| | |
|------------------|-----------|
| Cycles SOW | 70.8 % |
| Static SOW | 90.0 % |
| Battery lifetime | 3.4 years |

Economic evaluation

Investment

| | |
|----------|-------------|
| Global | 7495.56 EUR |
| Specific | 1.78 EUR/Wp |

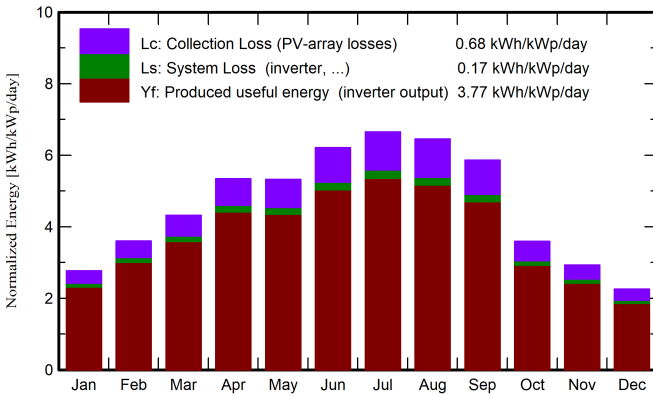
Yearly cost

| | |
|----------------|---------------|
| Annuities | 0.00 EUR/yr |
| Run. costs | 216.45 EUR/yr |
| Payback period | 4.0 years |

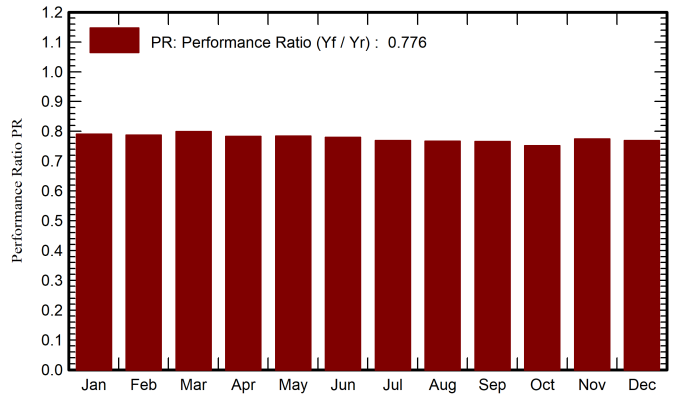
LCOE

| | |
|-------------|--------------|
| Energy cost | 0.06 EUR/kWh |
|-------------|--------------|

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

| | GlobHor | DiffHor | T_Amb | GlobInc | GlobEff | EArray | E_User | E_Solar | E_Grid | EFrGrid |
|-------------|--------------------|--------------------|--------------|--------------------|--------------------|--------------|--------------|--------------|--------------|--------------|
| | kWh/m ² | kWh/m ² | °C | kWh/m ² | kWh/m ² | MWh | MWh | MWh | MWh | MWh |
| January | 54.3 | 24.01 | 7.75 | 85.9 | 78.9 | 0.316 | 0.389 | 0.208 | 0.077 | 0.181 |
| February | 73.5 | 32.84 | 8.58 | 101.0 | 92.9 | 0.370 | 0.405 | 0.245 | 0.089 | 0.161 |
| March | 113.2 | 57.12 | 10.60 | 134.0 | 123.4 | 0.488 | 0.636 | 0.305 | 0.145 | 0.331 |
| April | 150.0 | 68.53 | 11.13 | 160.2 | 148.2 | 0.581 | 0.405 | 0.302 | 0.225 | 0.103 |
| May | 178.7 | 79.05 | 13.88 | 165.0 | 152.4 | 0.592 | 0.480 | 0.325 | 0.218 | 0.155 |
| June | 204.0 | 71.82 | 17.37 | 186.3 | 173.0 | 0.662 | 0.313 | 0.162 | 0.448 | 0.151 |
| July | 223.8 | 68.67 | 18.25 | 206.2 | 191.9 | 0.728 | 0.305 | 0.273 | 0.394 | 0.032 |
| August | 195.2 | 65.07 | 19.06 | 200.2 | 185.3 | 0.702 | 0.403 | 0.321 | 0.324 | 0.082 |
| September | 148.2 | 41.40 | 17.10 | 175.8 | 164.2 | 0.619 | 0.323 | 0.246 | 0.320 | 0.078 |
| October | 90.7 | 44.67 | 14.11 | 111.4 | 101.8 | 0.398 | 0.328 | 0.202 | 0.150 | 0.126 |
| November | 59.0 | 27.71 | 9.89 | 87.8 | 80.6 | 0.320 | 0.330 | 0.188 | 0.098 | 0.142 |
| December | 43.8 | 23.90 | 8.07 | 69.8 | 63.1 | 0.254 | 0.467 | 0.177 | 0.049 | 0.290 |
| Year | 1534.4 | 604.78 | 13.01 | 1683.6 | 1555.6 | 6.030 | 4.784 | 2.953 | 2.535 | 1.831 |

Legends

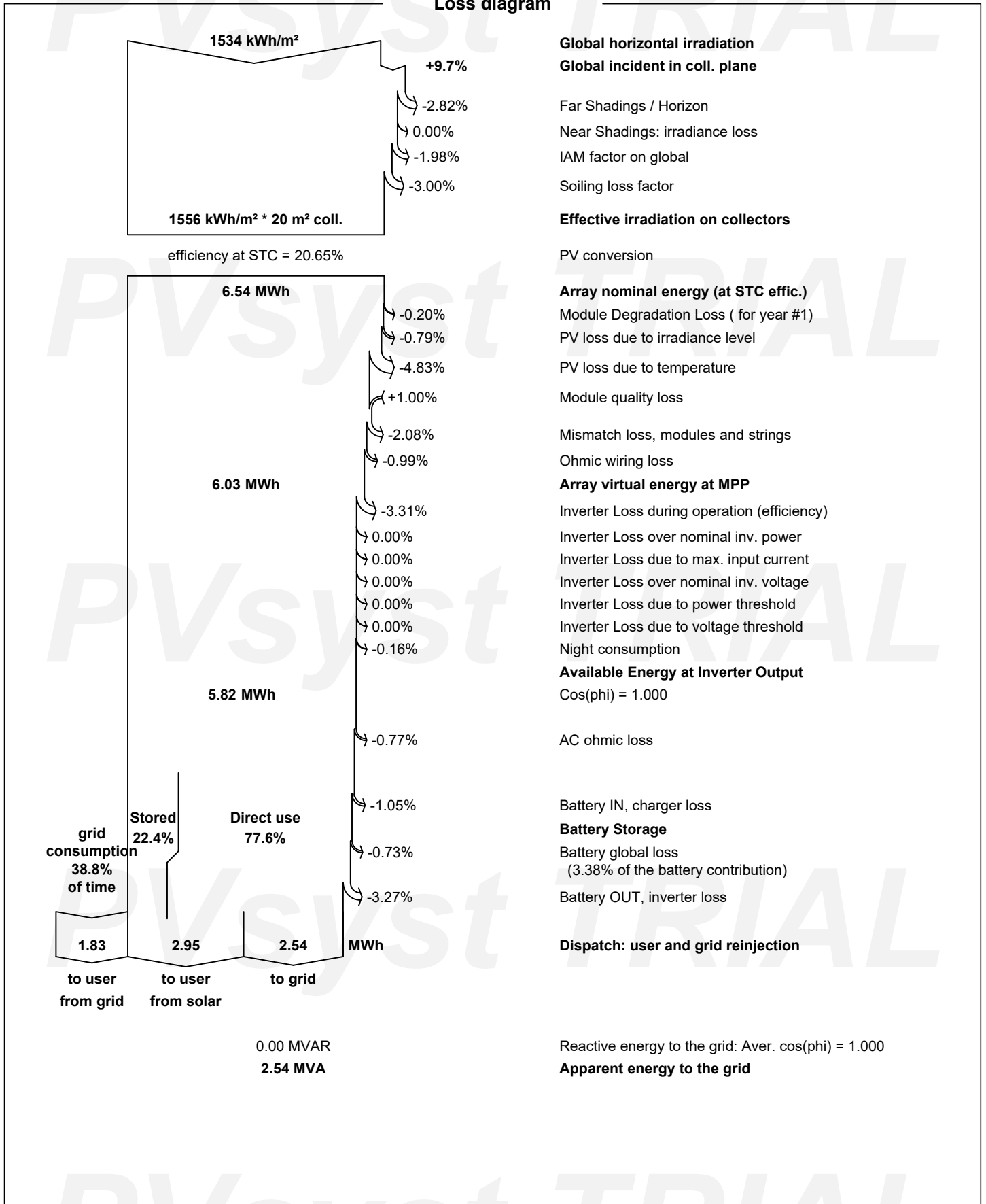
| | | | |
|---------|--|---------|---|
| GlobHor | Global horizontal irradiation | EArray | Effective energy at the output of the array |
| DiffHor | Horizontal diffuse irradiation | E_User | Energy supplied to the user |
| T_Amb | Ambient Temperature | E_Solar | Energy from the sun |
| GlobInc | Global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



PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

Loss diagram



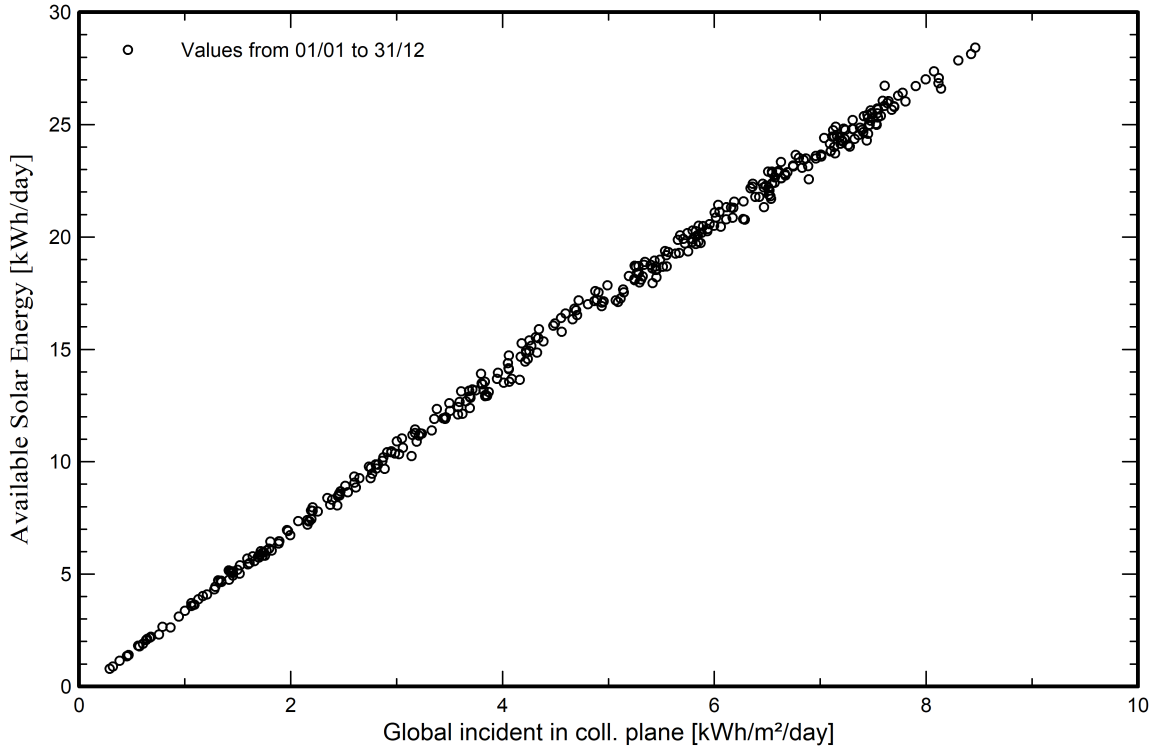


PVsyst V7.2.21

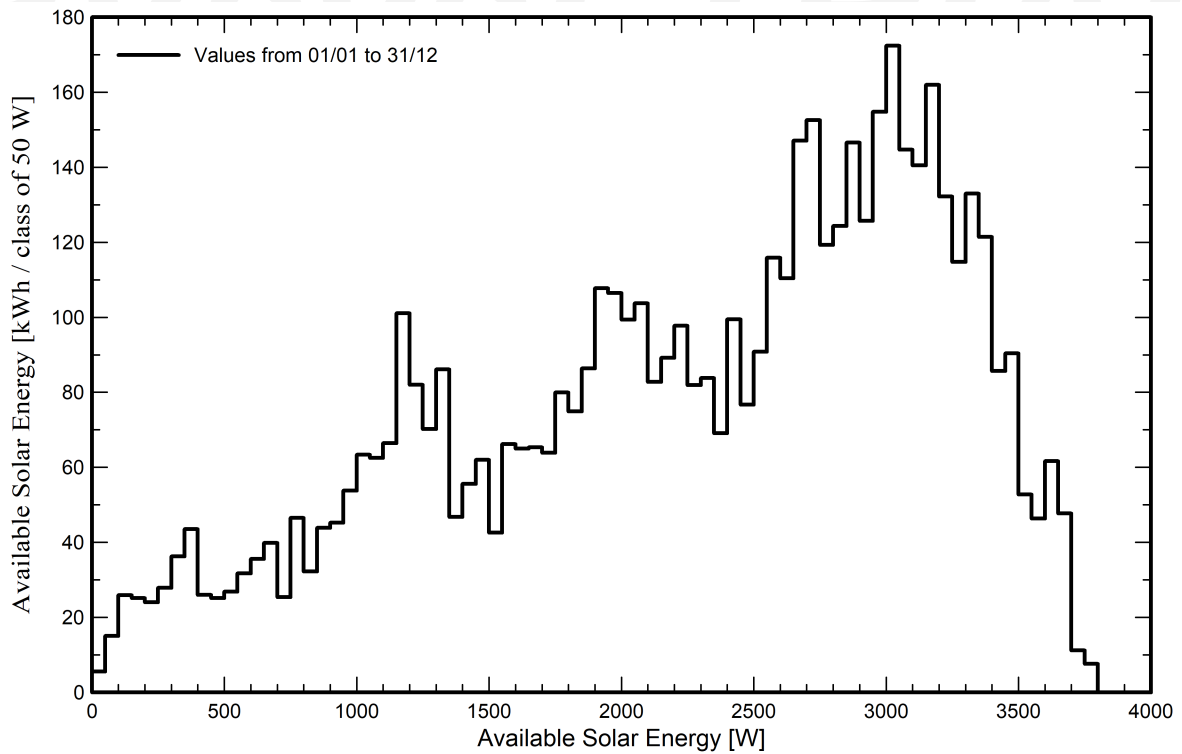
VC1, Simulation date:
28/11/22 16:08
with v7.2.21

Special graphs

Diagrama entrada/salida diaria



Distribución de potencia de salida del sistema





PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

P50 - P90 evaluation

Meteo data

Source Meteonorm 7.3 (1999-2010), Sat=100%
Kind Monthly averages
Sintético - Multi-year average
Year-to-year variability(Variance) 3.2 %

Specified Deviation

Climate change 0.0 %

Global variability (meteo + system)

Variability (Quadratic sum) 3.6 %

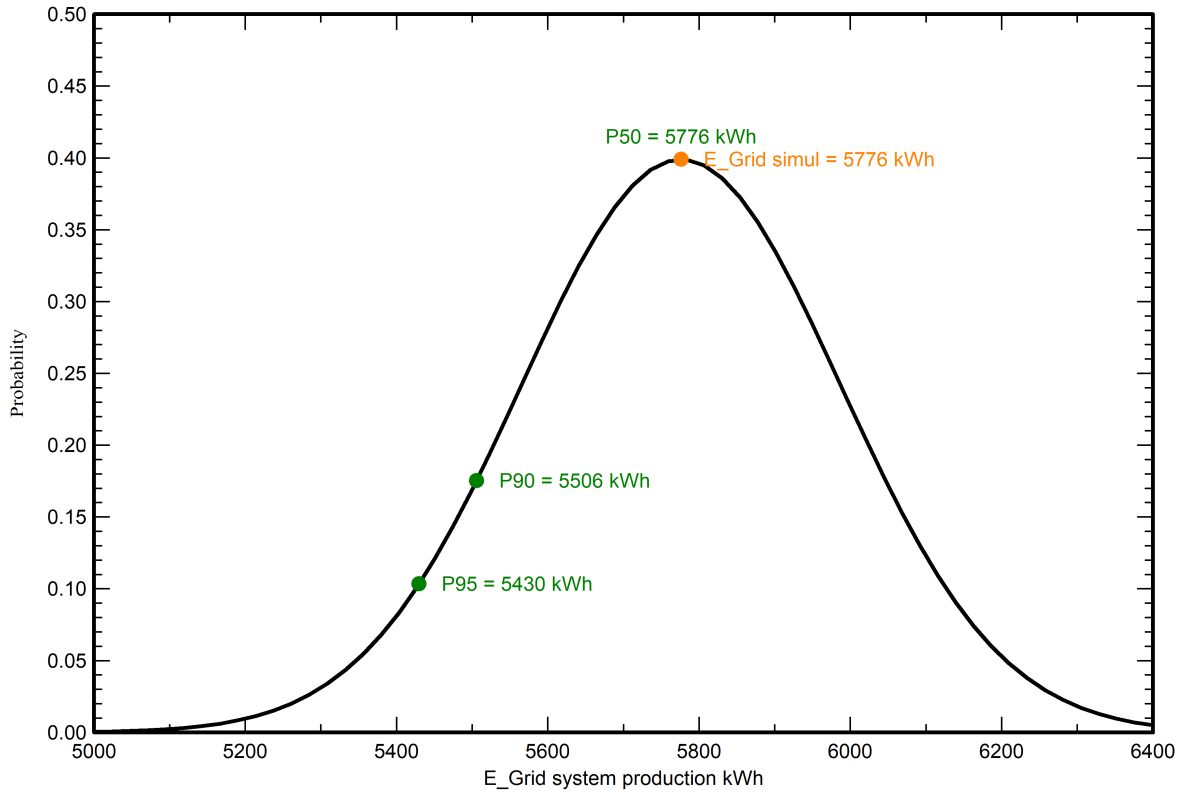
Simulation and parameters uncertainties

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 211 kWh
P50 5776 kWh
P90 5506 kWh
P95 5430 kWh

Probability distribution





PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

Cost of the system

Installation costs

| Item | Quantity units | Cost EUR | Total EUR |
|----------------------|-------------------|-------------|----------------|
| PV modules | | | |
| AS-M1203-H-350 | 12 | 114.00 | 1368.00 |
| Supports for modules | 12 | 48.11 | 577.32 |
| Inverters | | | |
| SUN2000-4KTL-L1 | 1 | 1187.20 | 1187.20 |
| Batteries | 2 | 801.52 | 1603.04 |
| Studies and analysis | | | |
| Engineering | 1 | 960.00 | 960.00 |
| Installation | | | |
| Mano de obra | 1 | 1800.00 | 1800.00 |
| Total | | | 7495.56 |
| Depreciable asset | | | 4735.56 |

Operating costs

| Item | Total EUR/year |
|-----------------------------|-------------------|
| Maintenance | |
| Repairs | 180.00 |
| Total (OPEX) | 180.00 |
| Including inflation (1.50%) | 216.45 |

System summary

| | |
|--|-----------------|
| Total installation cost | 7495.56 EUR |
| Operating costs (incl. inflation 1.50%/year) | 216.45 EUR/year |
| Unused energy | 2953 kWh/year |
| Energy sold to the grid | 2535 kWh/year |
| Cost of produced energy (LCOE) | 0.064 EUR/kWh |

**PVsyst V7.2.21**VC1, Simulation date:
28/11/22 16:08
with v7.2.21**Financial analysis****Simulation period**

Project lifetime 25 years Start year 2023

Income variation over timeInflation 1.50 %/year
Production variation (aging) -0.50 %/year
Discount rate 1.00 %/year**Income dependent expenses**Income tax rate 10.00 %/year
Other income tax 10.00 %/year
Dividends 15.00 %/year**Tax depreciation**Depreciable assets 4735.56 EUR
Salvage value 3000.00 EUR
Total redeemable 1735.56 EUR
Depreciation period 20 years**Financing**Own funds 2623.56 EUR
Subsidies 4872.00 EUR**Electricity sale**Feed-in tariff Peak tariff 0.3173 EUR/kWh
Off-peak tariff 0.2241 EUR/kWh 20:00-07:00
Duration of tariff warranty 20 years
Annual connection tax 0.00 EUR/kWh
Annual tariff variation 0.0 %/year
Feed-in tariff decrease after warranty 0.00 %**Self-consumption**Consumption tariff Peak tariff 0.0600 EUR/kWh
Off-peak tariff 0.0500 EUR/kWh 20:00-07:00
Tariff evolution 0.0 %/year**Return on investment**Payback period 4.0 years
Net present value (NPV) 10854.61 EUR
Return on investment (ROI) 413.7 %
Paid dividends 1675.61 EUR



PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

Financial analysis

Detailed economic results (EUR)

| | Electricity sale | Run. costs | Deprec. allow. | Taxable income | Taxes | After-tax profit | Divid. 15.00% | Self-cons. saving | Cumul. profit | % amorti. |
|--------------|---------------------|---------------|-------------------|-------------------|-------------|---------------------|------------------|----------------------|------------------|---------------|
| 2023 | 804 | 180 | 87 | 537 | 107 | 517 | 77 | 171 | -1942 | 26.0% |
| 2024 | 800 | 183 | 87 | 531 | 106 | 511 | 77 | 171 | -1274 | 51.4% |
| 2025 | 796 | 185 | 87 | 524 | 105 | 506 | 76 | 170 | -618 | 76.4% |
| 2026 | 792 | 188 | 87 | 517 | 103 | 500 | 75 | 169 | 25 | 100.9% |
| 2027 | 788 | 191 | 87 | 510 | 102 | 495 | 74 | 168 | 656 | 125.0% |
| 2028 | 784 | 194 | 87 | 503 | 101 | 490 | 73 | 167 | 1274 | 148.6% |
| 2029 | 780 | 197 | 87 | 497 | 99 | 484 | 73 | 166 | 1881 | 171.7% |
| 2030 | 776 | 200 | 87 | 490 | 98 | 479 | 72 | 166 | 2476 | 194.4% |
| 2031 | 772 | 203 | 87 | 483 | 97 | 473 | 71 | 165 | 3059 | 216.6% |
| 2032 | 769 | 206 | 87 | 476 | 95 | 468 | 70 | 164 | 3631 | 238.4% |
| 2033 | 765 | 209 | 87 | 469 | 94 | 462 | 69 | 163 | 4191 | 259.7% |
| 2034 | 761 | 212 | 87 | 462 | 92 | 456 | 68 | 162 | 4740 | 280.7% |
| 2035 | 757 | 215 | 87 | 455 | 91 | 451 | 68 | 161 | 5278 | 301.2% |
| 2036 | 753 | 218 | 87 | 448 | 90 | 445 | 67 | 161 | 5805 | 321.3% |
| 2037 | 750 | 222 | 87 | 441 | 88 | 440 | 66 | 160 | 6322 | 341.0% |
| 2038 | 746 | 225 | 87 | 434 | 87 | 434 | 65 | 159 | 6827 | 360.2% |
| 2039 | 742 | 228 | 87 | 427 | 85 | 428 | 64 | 158 | 7323 | 379.1% |
| 2040 | 738 | 232 | 87 | 420 | 84 | 423 | 63 | 157 | 7807 | 397.6% |
| 2041 | 735 | 235 | 87 | 413 | 83 | 417 | 63 | 157 | 8282 | 415.7% |
| 2042 | 731 | 239 | 87 | 405 | 81 | 411 | 62 | 156 | 8747 | 433.4% |
| 2043 | 727 | 242 | 0 | 485 | 97 | 388 | 58 | 155 | 9187 | 450.2% |
| 2044 | 724 | 246 | 0 | 478 | 96 | 382 | 57 | 154 | 9618 | 466.6% |
| 2045 | 720 | 250 | 0 | 470 | 94 | 376 | 56 | 154 | 10040 | 482.7% |
| 2046 | 717 | 254 | 0 | 463 | 93 | 370 | 56 | 153 | 10452 | 498.4% |
| 2047 | 713 | 257 | 0 | 456 | 91 | 365 | 55 | 152 | 10855 | 513.7% |
| Total | 18941 | 5411 | 1736 | 11794 | 2359 | 11171 | 1676 | 4038 | 10855 | 513.7% |

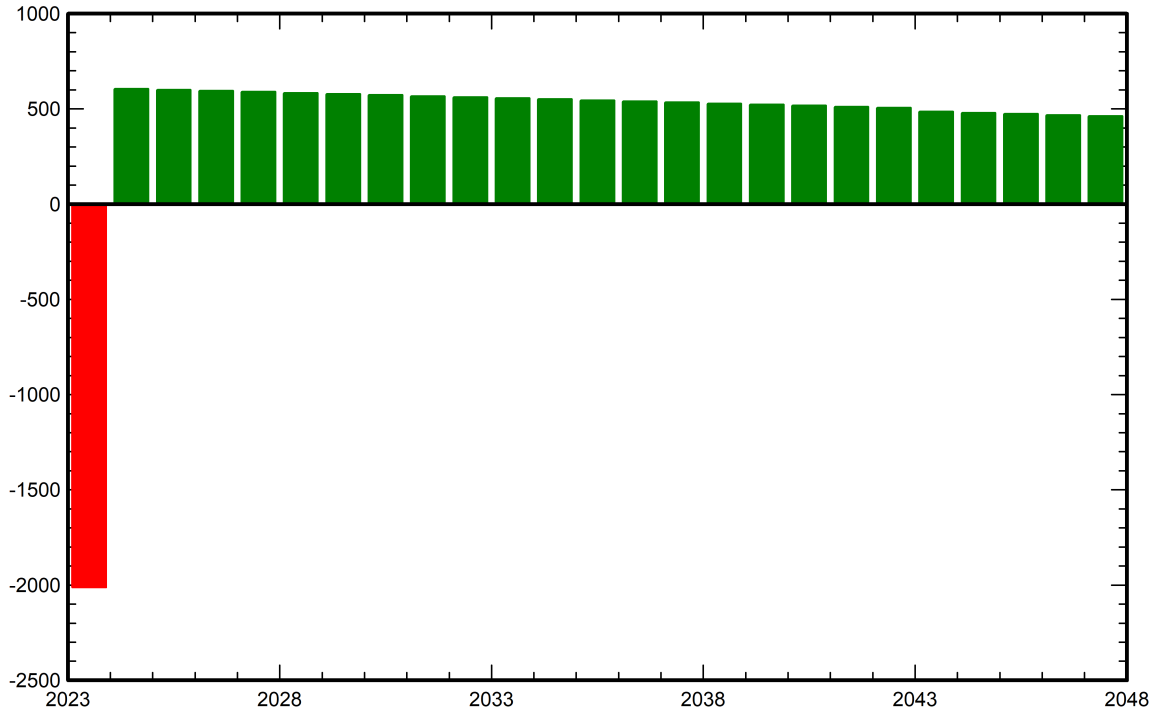


PVsyst V7.2.21

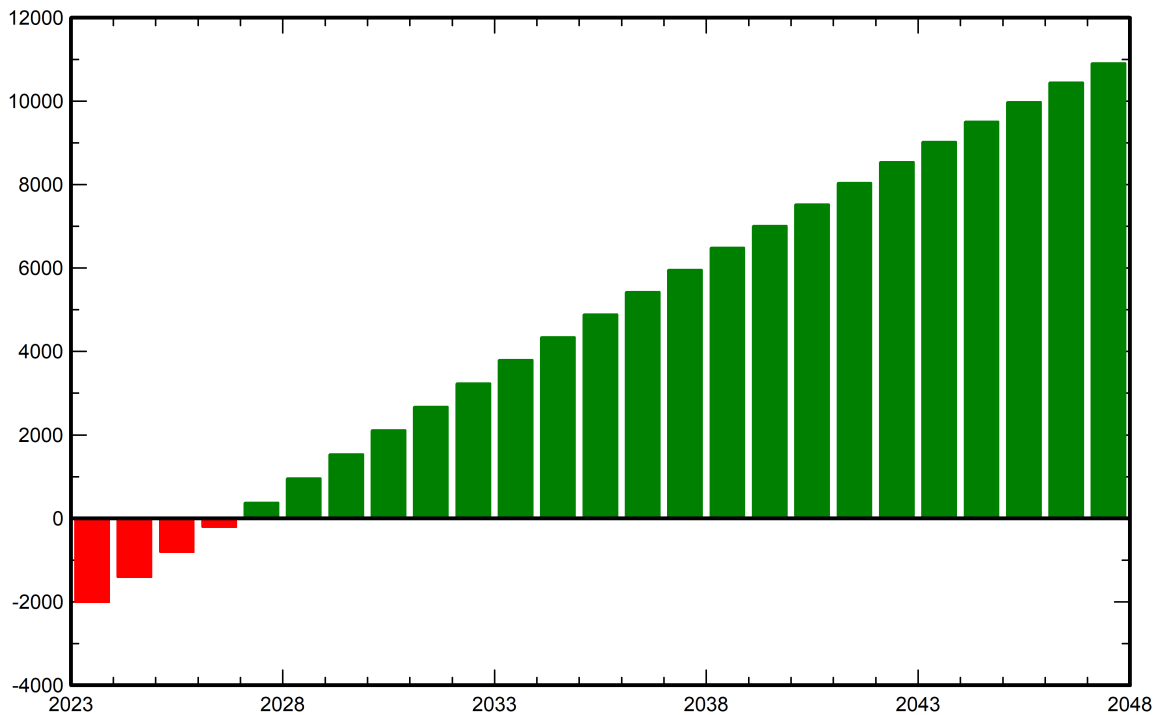
VC1, Simulation date:
28/11/22 16:08
with v7.2.21

Financial analysis

Yearly net profit (EUR)



Cumulative cashflow (EUR)





PVsyst V7.2.21

VC1, Simulation date:
28/11/22 16:08
with v7.2.21

CO₂ Emission Balance

Total: 29.2 tCO₂

Generated emissions

Total: 7.61 tCO₂

Source: Detailed calculation from table below:

Replaced Emissions

Total: 41.4 tCO₂

System production: 5776.24 kWh/yr

Grid Lifecycle Emissions: 287 gCO₂/kWh

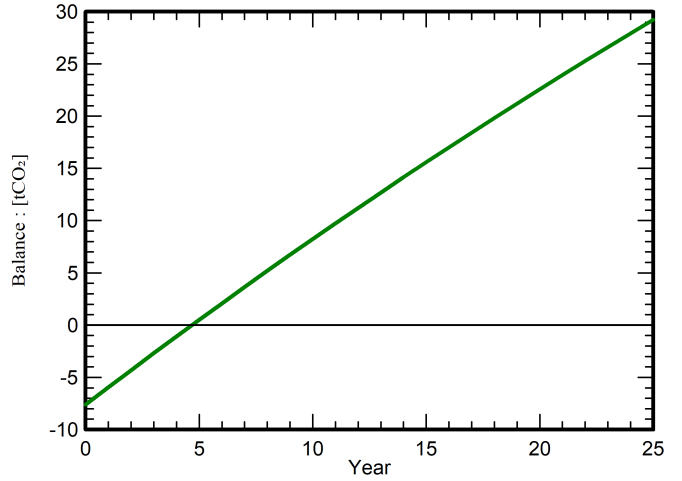
Source: IEA List

Country: Spain

Lifetime: 25 years

Annual degradation: 1.0 %

Saved CO₂ Emission vs. Time



System Lifecycle Emissions Details

| Item | LCE | Quantity | Subtotal |
|-----------|------------------------------|------------|----------------------|
| | | | [kgCO ₂] |
| Modules | 1713 kgCO ₂ /kWp | 4.20 kWp | 7193 |
| Supports | 1.91 kgCO ₂ /kg | 120 kg | 230 |
| Inverters | 190 kgCO ₂ /units | 1.00 units | 190 |

PVsyst - Simulation report

Grid-Connected System

Project: Pereira

Variant: Opción 2 Pereira (Cubierta A y B 4kW)

Tables on a building

System power: 4200 Wp

Pereira de Montes (A Merca) - Spain



Project: Pereira

Variant: Opción 2 Pereira (Cubierta A y B 4kW)

PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Project summary

Geographical Site
Pereira de Montes (A Merca)
Spain

Situation
Latitude 42.23 °N
Longitude -7.95 °W
Altitude 384 m
Time zone UTC+1

Project settings
Albedo 0.20

Meteo data

Pereira
Meteonorm 7.3 (1999-2010), Sat=100% - Sintético

System summary

Grid-Connected System

Simulation for year no 1

PV Field Orientation

Fixed planes 2 orientations
Tilts/azimuths 45 / -40 °
45 / 50 °

System information

PV Array

Nb. of modules 12 units
Pnom total 4200 Wp

Tables on a building

Near Shadings

Linear shadings

Inverters

Nb. of units 1 unit
Pnom total 4000 W
Grid power limit 3500 W
Grid lim. Pnom ratio 1.200

User's needs

Ext. defined as file
Consumo final.csv

Battery pack

Storage strategy: Self-consumption
Nb. of units 2 units
Voltage 48 V
Capacity 108 Ah

Results summary

| | | | | | |
|-----------------|---------------|---------------------|-------------------|-------------------|---------|
| Produced Energy | 5.29 MWh/year | Specific production | 1259 kWh/kWp/year | Perf. Ratio PR | 76.63 % |
| Used Energy | 4.78 MWh/year | | | Solar Fraction SF | 63.77 % |

Table of contents

| | |
|---|----|
| Project and results summary | 2 |
| General parameters, PV Array Characteristics, System losses | 3 |
| Horizon definition | 5 |
| Near shading definition - Iso-shadings diagram | 6 |
| Main results | 8 |
| Loss diagram | 9 |
| Special graphs | 10 |
| Cost of the system | 11 |
| Financial analysis | 12 |
| CO ₂ Emission Balance | 15 |



PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

General parameters

Grid-Connected System

PV Field Orientation

Orientation

Fixed planes 2 orientations
Tilts/azimuths 45 / -40 °
45 / 50 °

Horizon

Average Height 5.1 °

Storage

Kind Self-consumption

Charging strategy

When excess solar power is available

Tables on a building

Sheds configuration

Near Shadings

Linear shadings

Models used

Transposition Perez
Diffuse Perez, Meteororm
Circumsolar separate

User's needs

Ext. defined as file
Consumo final.csv

Grid power limitation

Active Power 3500 W
Pnom ratio 1.200

Discharging strategy

As soon as power is needed

| Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Year | |
|------|------|------|------|-----|------|------|------|------|------|------|------|------|-----|
| 389 | 405 | 636 | 405 | 480 | 313 | 305 | 403 | 323 | 328 | 330 | 467 | 4784 | kWh |

PV Array Characteristics

PV module

Manufacturer Generic
Model TSM-PE15H-350
(Original PVsyst database)

Unit Nom. Power 350 Wp
Number of PV modules 12 units
Nominal (STC) 4200 Wp
Modules 2 Strings x 6 In series

At operating cond. (50°C)

Pmpp 3801 Wp
U mpp 207 V
I mpp 18 A

Total PV power

Nominal (STC) 4.20 kWp
Total 12 modules
Module area 24.4 m²
Cell area 20.9 m²

Battery Storage

Battery

Manufacturer Generic
Model DCB102Z

Battery pack

Nb. of units 2 in parallel
Discharging min. SOC 20.0 %
Stored energy 4.2 kWh

Inverter

Manufacturer Generic
Model SUN2000-4KTL-L1
(Original PVsyst database)

Unit Nom. Power 4.00 kWac
Number of inverters 2 * MPPT 50% 1 unit
Total power 4.0 kWac
Operating voltage 80-600 V
Max. power (=>50°C) 4.40 kWac
Pnom ratio (DC:AC) 1.05

Total inverter power

Total power 4 kWac
Number of inverters 1 unit
Pnom ratio 1.05

Battery Pack Characteristics

Voltage 48 V
Nominal Capacity 108 Ah (C10)
Temperature Fixed 20 °C



PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

PV Array Characteristics

Battery Storage

Battery input charger

Model Generic
Max. charg. power 3.3 kWdc
Max./Euro effic. 97.0/95.0 %

Battery to Grid inverter

Model Generic
Max. disch. power 5.0 kWac
Max./Euro effic. 97.0/95.0 %

Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Thermal Loss factor

Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses

Global array res. 188 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss

Loss Fraction -1.0 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.1 %

Module average degradation

Year no 1
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 |

AC wiring losses

Inv. output line up to injection point

Inverter voltage 230 Vac mono
Loss Fraction 1.38 % at STC

Inverter: SUN2000-4KTL-L1

Wire section (1 Inv.) Copper 1 x 2 x 3 mm²
Wires length 12 m



PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Horizon definition

Horizon from PVGIS website API, Lat=42°14'5", Long=-7°57'9", Alt=384m

| | | | |
|----------------|-------|-----------------|-------|
| Average Height | 5.1 ° | Albedo Factor | 0.76 |
| Diffuse Factor | 0.95 | Albedo Fraction | 100 % |

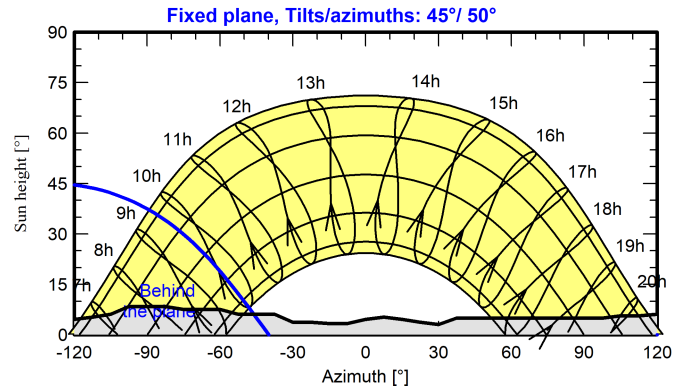
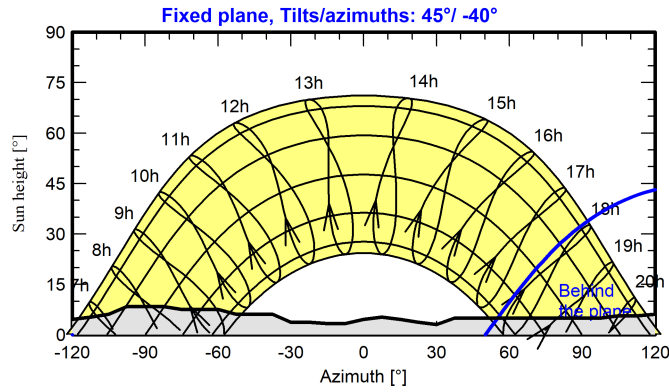
Horizon profile

| | | | | | | | | | | | | | |
|-------------|------|------|------|------|------|------|------|------|------|------|-----|-----|-----|
| Azimuth [°] | -180 | -173 | -165 | -158 | -143 | -135 | -128 | -120 | -113 | -105 | -98 | -83 | -75 |
| Height [°] | 3.4 | 3.4 | 3.8 | 3.8 | 3.1 | 3.1 | 3.8 | 4.6 | 5.3 | 6.1 | 8.4 | 8.4 | 7.6 |
| Azimuth [°] | -60 | -53 | -38 | -30 | -23 | -15 | -8 | 0 | 8 | 15 | 23 | 30 | 38 |
| Height [°] | 7.6 | 6.1 | 6.1 | 3.8 | 3.8 | 3.4 | 3.4 | 4.6 | 5.3 | 4.6 | 3.8 | 3.1 | 5.0 |
| Azimuth [°] | 98 | 105 | 113 | 120 | 128 | 135 | 143 | 150 | 158 | 173 | 180 | | |
| Height [°] | 5.0 | 5.7 | 5.7 | 6.1 | 6.1 | 5.7 | 5.7 | 5.0 | 5.0 | 3.4 | 3.4 | | |

Sun Paths (Height / Azimuth diagram)

Orientation #1

Orientation #2



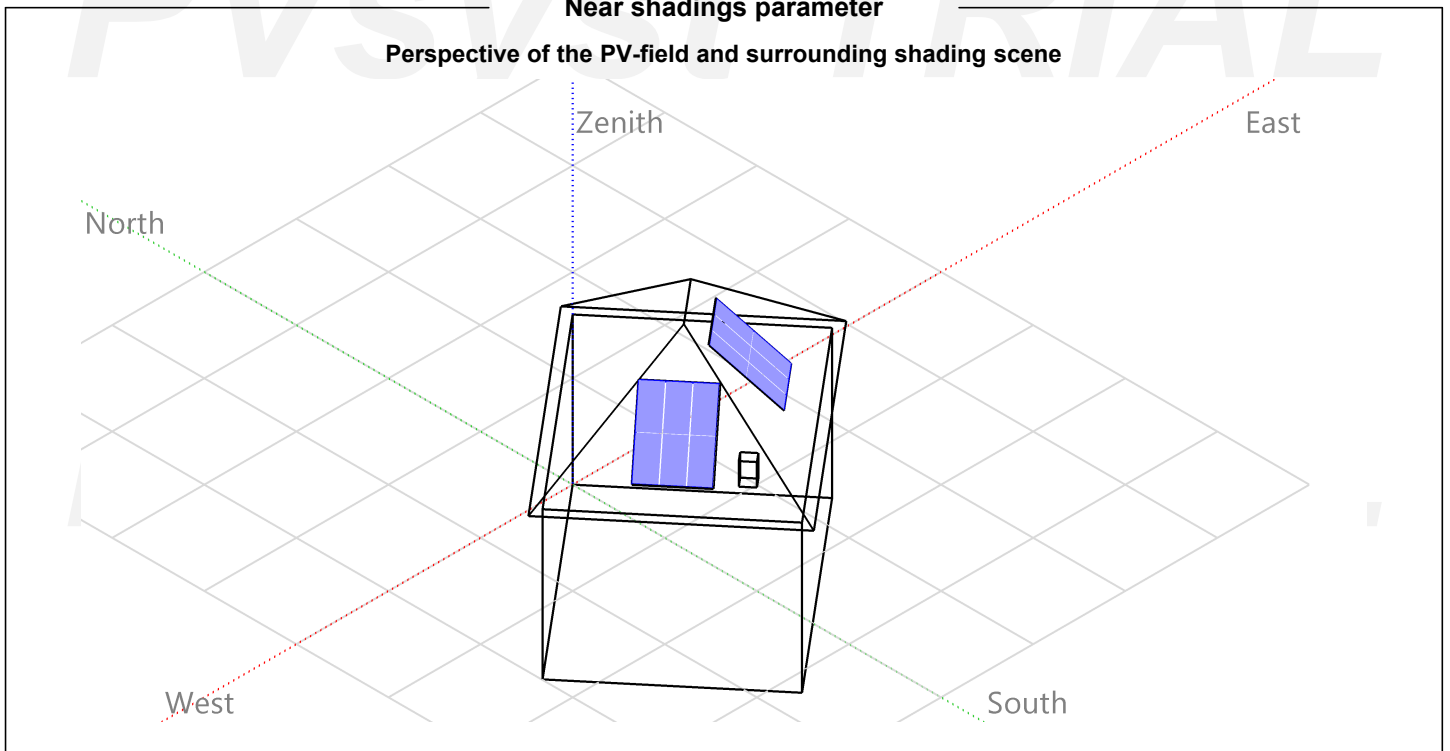


PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Near shadings parameter

Perspective of the PV-field and surrounding shading scene





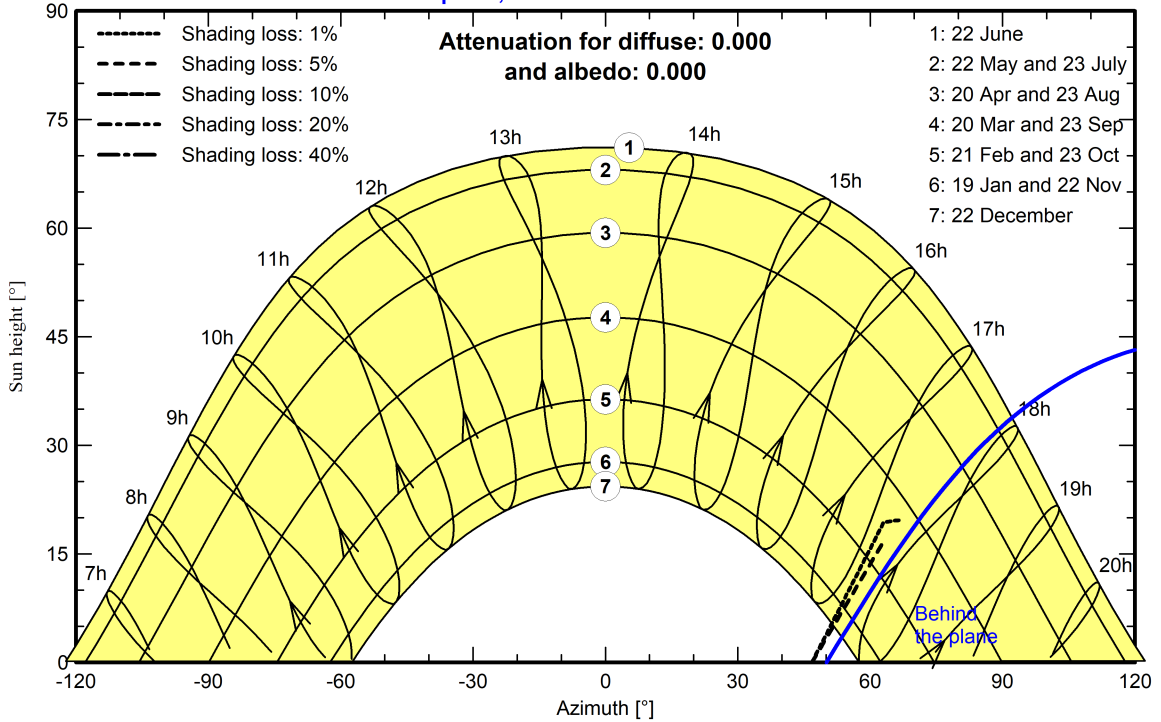
PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Iso-shadings diagram

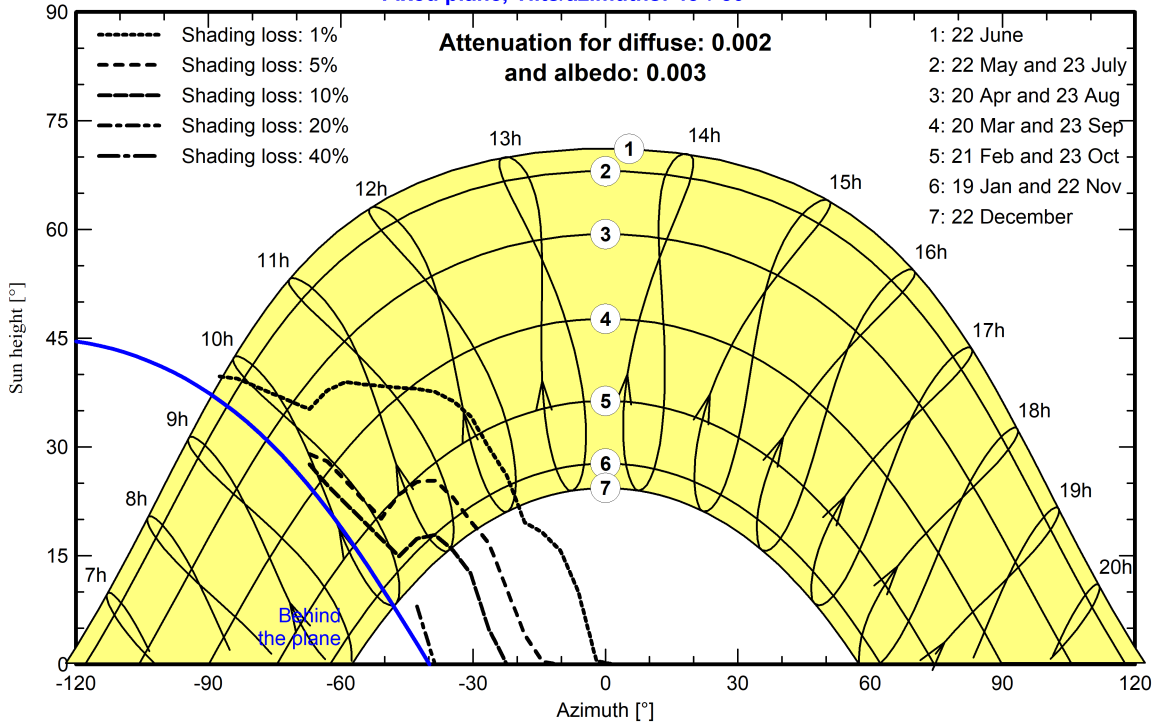
Orientation #1

Fixed plane, Tilts/azimuths: 45° / -40°



Orientation #2

Fixed plane, Tilts/azimuths: 45° / 50°





PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Main results

System Production

| | | | |
|-----------------|---------------|----------------------|-------------------|
| Produced Energy | 5.29 MWh/year | Specific production | 1259 kWh/kWp/year |
| Used Energy | 4.78 MWh/year | Performance Ratio PR | 76.63 % |
| | | Solar Fraction SF | 63.77 % |

Battery aging (State of Wear)

| | |
|------------------|-----------|
| Cycles SOW | 71.1 % |
| Static SOW | 90.0 % |
| Battery lifetime | 3.5 years |

Economic evaluation

Investment

| | |
|----------|-------------|
| Global | 7495.56 EUR |
| Specific | 1.78 EUR/Wp |

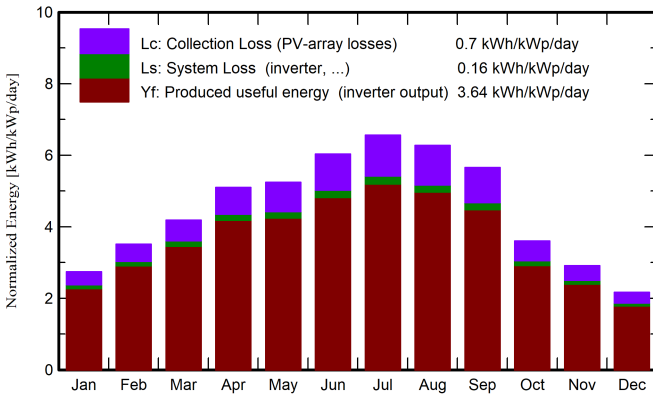
Yearly cost

| | |
|----------------|---------------|
| Annuities | 0.00 EUR/yr |
| Run. costs | 216.45 EUR/yr |
| Payback period | 4.5 years |

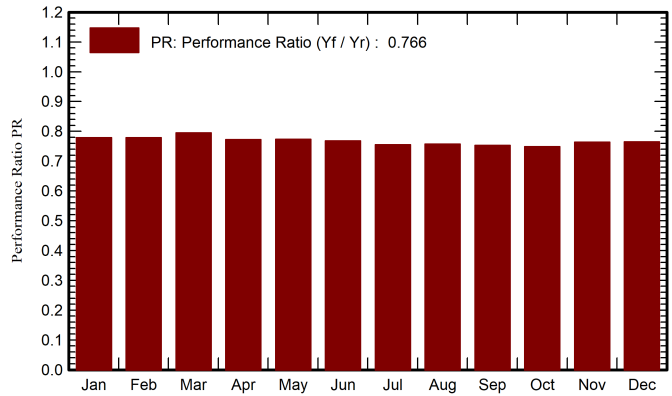
LCOE

| | |
|-------------|--------------|
| Energy cost | 0.07 EUR/kWh |
|-------------|--------------|

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

| | GlobHor | DiffHor | T_Amb | GlobInc | GlobEff | EArray | E_User | E_Solar | E_Grid | EFrGrid |
|-----------|--------------------|--------------------|-------|--------------------|--------------------|--------|--------|---------|--------|---------|
| | kWh/m ² | kWh/m ² | °C | kWh/m ² | kWh/m ² | MWh | MWh | MWh | MWh | MWh |
| January | 54.3 | 24.01 | 7.75 | 84.9 | 77.7 | 0.310 | 0.389 | 0.213 | 0.065 | 0.176 |
| February | 73.5 | 32.84 | 8.58 | 98.2 | 90.5 | 0.357 | 0.405 | 0.249 | 0.072 | 0.156 |
| March | 113.2 | 57.12 | 10.60 | 129.6 | 119.7 | 0.470 | 0.636 | 0.309 | 0.124 | 0.327 |
| April | 150.0 | 68.53 | 11.13 | 152.9 | 141.3 | 0.549 | 0.405 | 0.307 | 0.188 | 0.098 |
| May | 178.7 | 79.05 | 13.88 | 162.5 | 150.4 | 0.577 | 0.480 | 0.342 | 0.186 | 0.138 |
| June | 204.0 | 71.82 | 17.37 | 181.0 | 167.8 | 0.633 | 0.313 | 0.161 | 0.422 | 0.151 |
| July | 223.8 | 68.67 | 18.25 | 203.3 | 189.1 | 0.706 | 0.305 | 0.282 | 0.363 | 0.023 |
| August | 195.2 | 65.07 | 19.06 | 194.6 | 180.7 | 0.674 | 0.403 | 0.340 | 0.279 | 0.064 |
| September | 148.2 | 41.40 | 17.10 | 169.8 | 158.7 | 0.589 | 0.323 | 0.258 | 0.279 | 0.065 |
| October | 90.7 | 44.67 | 14.11 | 111.7 | 102.8 | 0.397 | 0.328 | 0.211 | 0.140 | 0.117 |
| November | 59.0 | 27.71 | 9.89 | 87.3 | 79.9 | 0.316 | 0.330 | 0.200 | 0.080 | 0.129 |
| December | 43.8 | 23.90 | 8.07 | 67.1 | 60.9 | 0.244 | 0.467 | 0.177 | 0.038 | 0.290 |
| Year | 1534.4 | 604.78 | 13.01 | 1642.8 | 1519.3 | 5.821 | 4.784 | 3.051 | 2.237 | 1.733 |

Legends

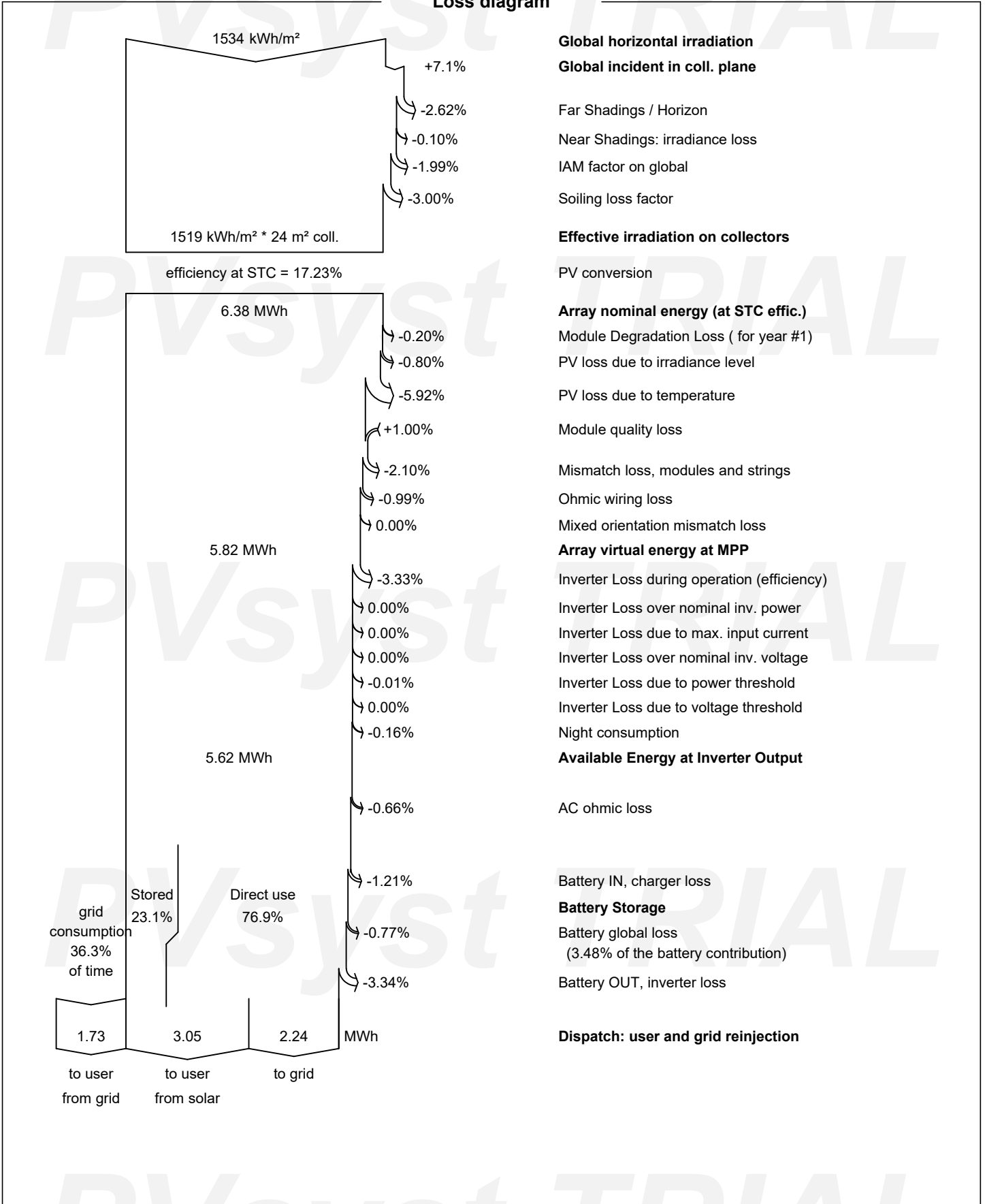
| | | | |
|---------|--|---------|---|
| GlobHor | Global horizontal irradiation | EArray | Effective energy at the output of the array |
| DiffHor | Horizontal diffuse irradiation | E_User | Energy supplied to the user |
| T_Amb | Ambient Temperature | E_Solar | Energy from the sun |
| GlobInc | Global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



PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Loss diagram



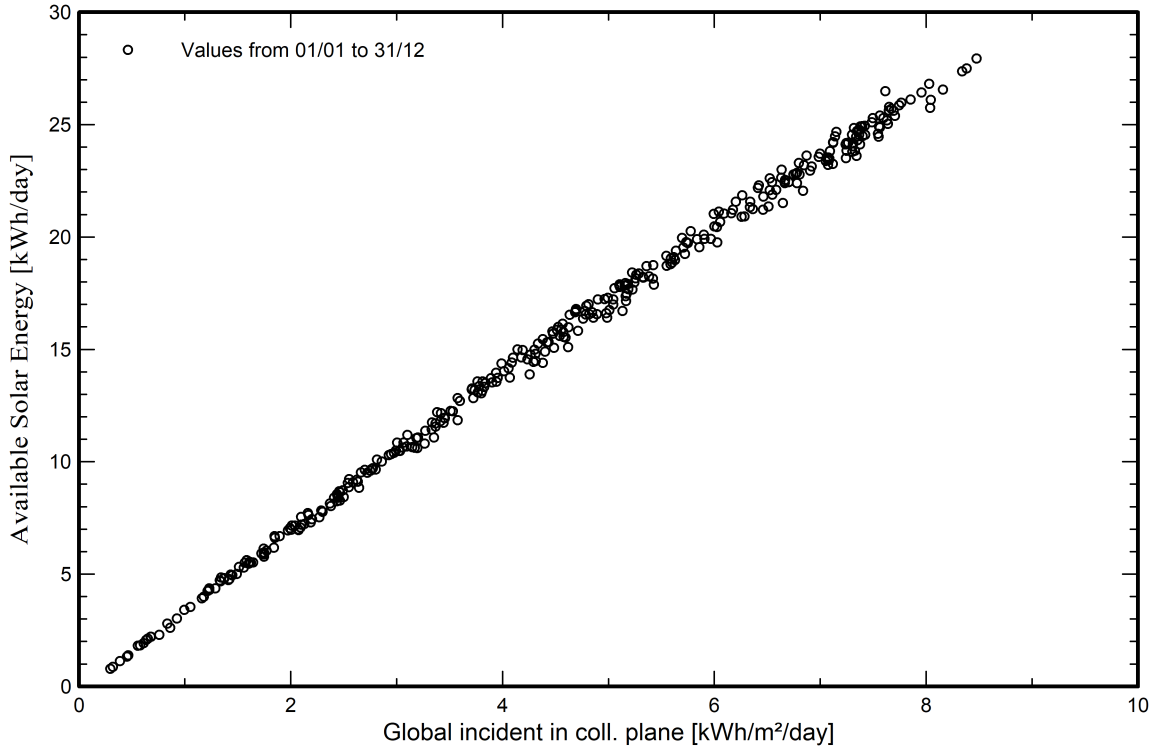


PVsyst V7.2.21

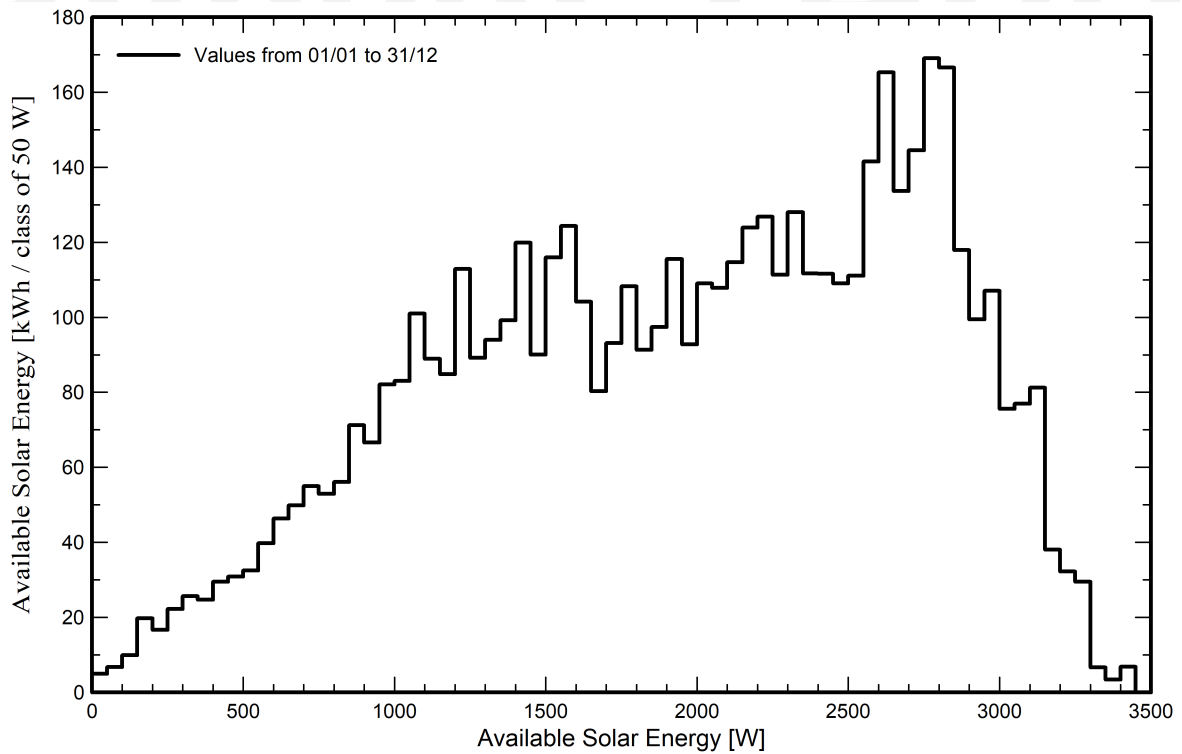
VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Special graphs

Diagrama entrada/salida diaria



Distribución de potencia de salida del sistema





PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Cost of the system

Installation costs

| Item | Quantity units | Cost EUR | Total EUR |
|----------------------|-------------------|-------------|----------------|
| PV modules | | | |
| TSM-PE15H-350 | 12 | 114.00 | 1368.00 |
| Supports for modules | 12 | 48.11 | 577.32 |
| Inverters | | | |
| SUN2000-4KTL-L1 | 1 | 1187.20 | 1187.20 |
| Batteries | 2 | 801.52 | 1603.04 |
| Studies and analysis | | | |
| Engineering | 1 | 960.00 | 960.00 |
| Installation | | | |
| Mano de obra | 1 | 1800.00 | 1800.00 |
| Total | | | 7495.56 |
| Depreciable asset | | | 4735.56 |

Operating costs

| Item | Total EUR/year |
|-----------------------------|-------------------|
| Maintenance | |
| Repairs | 180.00 |
| Total (OPEX) | 180.00 |
| Including inflation (1.50%) | 216.45 |

System summary

| | |
|--|-----------------|
| Total installation cost | 7495.56 EUR |
| Operating costs (incl. inflation 1.50%/year) | 216.45 EUR/year |
| Unused energy | 3051 kWh/year |
| Energy sold to the grid | 2237 kWh/year |
| Cost of produced energy (LCOE) | 0.067 EUR/kWh |



PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Financial analysis

Simulation period

Project lifetime 25 years Start year 2023

Income variation over time

Inflation 1.50 %/year
Production variation (aging) -0.50 %/year
Discount rate 1.00 %/year

Income dependent expenses

Income tax rate 10.00 %/year
Other income tax 10.00 %/year
Dividends 15.00 %/year

Tax depreciation

Depreciable assets 4735.56 EUR
Salvage value 3000.00 EUR
Total redeemable 1735.56 EUR
Depreciation period 20 years

Financing

Own funds 2623.56 EUR
Subsidies 4872.00 EUR

Electricity sale

Feed-in tariff Peak tariff 0.3173 EUR/kWh
Off-peak tariff 0.2241 EUR/kWh 20:00-07:00
Duration of tariff warranty 20 years
Annual connection tax 0.00 EUR/kWh
Annual tariff variation 0.0 %/year
Feed-in tariff decrease after warranty 0.00 %

Self-consumption

Consumption tariff Peak tariff 0.0600 EUR/kWh
Off-peak tariff 0.0500 EUR/kWh 20:00-07:00
Tariff evolution 0.0 %/year

Return on investment

Payback period 4.5 years
Net present value (NPV) 9329.63 EUR
Return on investment (ROI) 355.6 %
Paid dividends 1400.62 EUR



PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Financial analysis

Detailed economic results (EUR)

| | Electricity sale | Run. costs | Deprec. allow. | Taxable income | Taxes | After-tax profit | Divid. 15.00% | Self-cons. saving | Cumul. profit | % amorti. |
|--------------|---------------------|---------------|-------------------|-------------------|-------------|---------------------|------------------|----------------------|------------------|---------------|
| 2023 | 707 | 180 | 87 | 440 | 88 | 439 | 66 | 176 | -2015 | 23.2% |
| 2024 | 703 | 183 | 87 | 434 | 87 | 434 | 65 | 175 | -1418 | 46.0% |
| 2025 | 700 | 185 | 87 | 428 | 86 | 429 | 64 | 174 | -833 | 68.3% |
| 2026 | 696 | 188 | 87 | 421 | 84 | 424 | 64 | 173 | -259 | 90.1% |
| 2027 | 693 | 191 | 87 | 415 | 83 | 419 | 63 | 172 | 304 | 111.6% |
| 2028 | 689 | 194 | 87 | 409 | 82 | 414 | 62 | 172 | 855 | 132.6% |
| 2029 | 686 | 197 | 87 | 402 | 80 | 409 | 61 | 171 | 1395 | 153.2% |
| 2030 | 682 | 200 | 87 | 396 | 79 | 403 | 61 | 170 | 1925 | 173.4% |
| 2031 | 679 | 203 | 87 | 389 | 78 | 398 | 60 | 169 | 2443 | 193.1% |
| 2032 | 676 | 206 | 87 | 383 | 77 | 393 | 59 | 168 | 2952 | 212.5% |
| 2033 | 672 | 209 | 87 | 377 | 75 | 388 | 58 | 167 | 3449 | 231.5% |
| 2034 | 669 | 212 | 87 | 370 | 74 | 383 | 57 | 167 | 3937 | 250.1% |
| 2035 | 666 | 215 | 87 | 364 | 73 | 378 | 57 | 166 | 4414 | 268.3% |
| 2036 | 662 | 218 | 87 | 357 | 71 | 372 | 56 | 165 | 4882 | 286.1% |
| 2037 | 659 | 222 | 87 | 350 | 70 | 367 | 55 | 164 | 5339 | 303.5% |
| 2038 | 656 | 225 | 87 | 344 | 69 | 362 | 54 | 163 | 5787 | 320.6% |
| 2039 | 652 | 228 | 87 | 337 | 67 | 356 | 53 | 162 | 6225 | 337.3% |
| 2040 | 649 | 232 | 87 | 330 | 66 | 351 | 53 | 162 | 6654 | 353.6% |
| 2041 | 646 | 235 | 87 | 324 | 65 | 346 | 52 | 161 | 7073 | 369.6% |
| 2042 | 643 | 239 | 87 | 317 | 63 | 340 | 51 | 160 | 7483 | 385.2% |
| 2043 | 639 | 242 | 0 | 397 | 79 | 318 | 48 | 159 | 7870 | 400.0% |
| 2044 | 636 | 246 | 0 | 390 | 78 | 312 | 47 | 158 | 8248 | 414.4% |
| 2045 | 633 | 250 | 0 | 383 | 77 | 307 | 46 | 158 | 8617 | 428.4% |
| 2046 | 630 | 254 | 0 | 376 | 75 | 301 | 45 | 157 | 8978 | 442.2% |
| 2047 | 627 | 257 | 0 | 369 | 74 | 295 | 44 | 156 | 9330 | 455.6% |
| Total | 16649 | 5411 | 1736 | 9502 | 1900 | 9337 | 1401 | 4145 | 9330 | 455.6% |

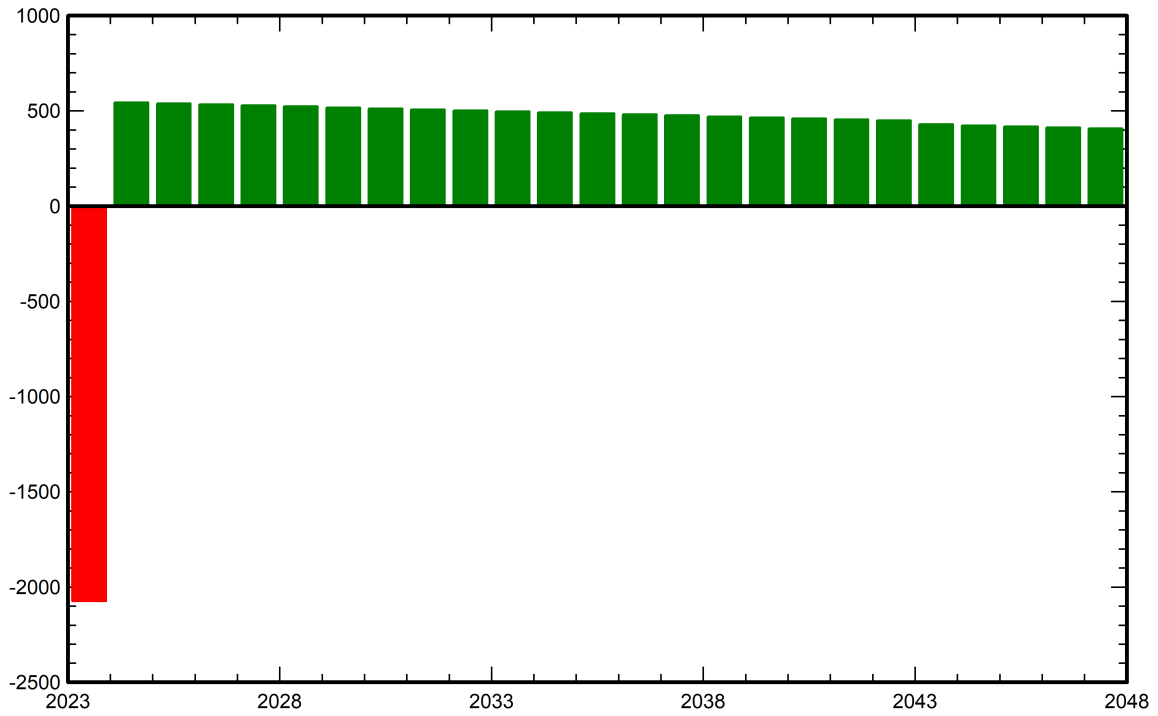


PVsyst V7.2.21

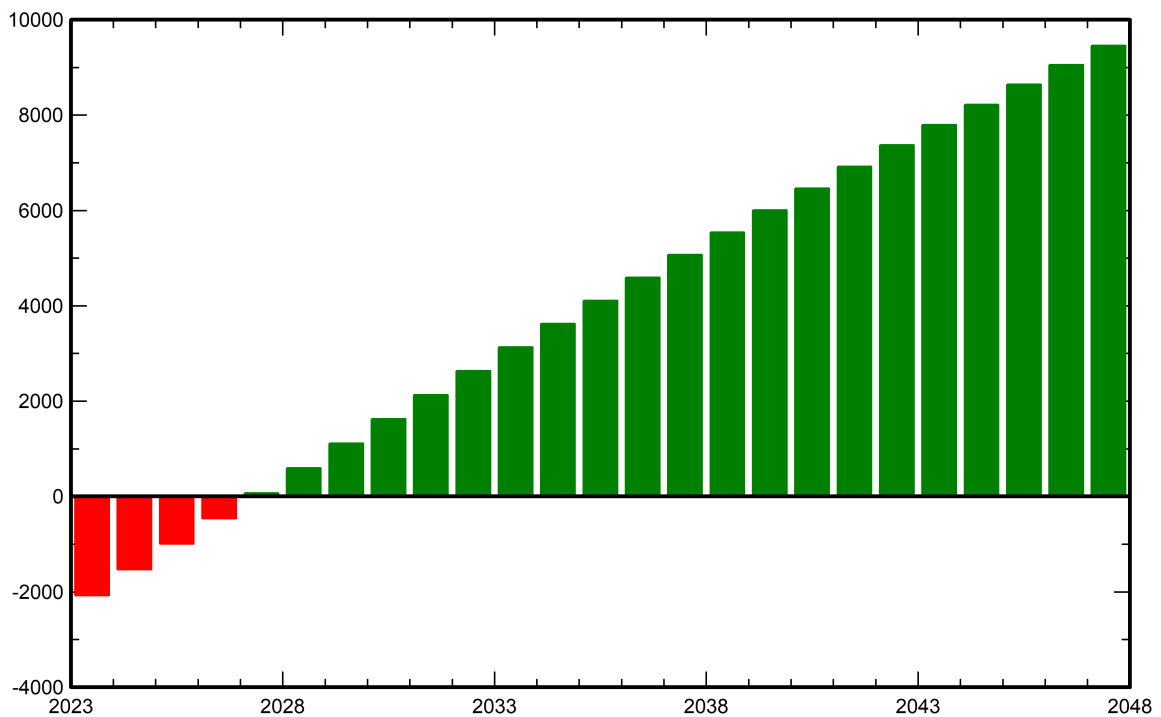
VC5, Simulation date:
03/12/22 18:47
with v7.2.21

Financial analysis

Yearly net profit (EUR)



Cumulative cashflow (EUR)





PVsyst V7.2.21

VC5, Simulation date:
03/12/22 18:47
with v7.2.21

CO₂ Emission Balance

Total: 34.1 tCO₂

Generated emissions

Total: 7.61 tCO₂

Source: Detailed calculation from table below:

Replaced Emissions

Total: 48.0 tCO₂

System production: 5580.59 kWh/yr

Grid Lifecycle Emissions: 287 gCO₂/kWh

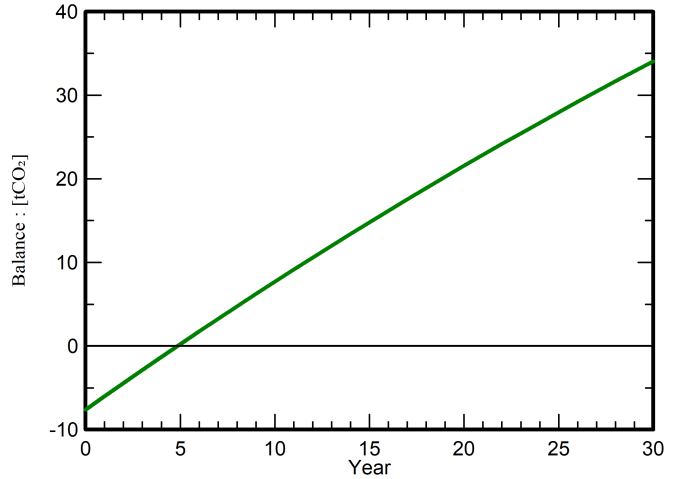
Source: IEA List

Country: Spain

Lifetime: 30 years

Annual degradation: 1.0 %

Saved CO₂ Emission vs. Time



System Lifecycle Emissions Details

| Item | LCE | Quantity | Subtotal |
|-----------|------------------------------|------------|----------------------|
| | | | [kgCO ₂] |
| Modules | 1713 kgCO ₂ /kWp | 4.20 kWp | 7193 |
| Supports | 1.91 kgCO ₂ /kg | 120 kg | 230 |
| Inverters | 190 kgCO ₂ /units | 1.00 units | 190 |

PVsyst - Simulation report

Grid-Connected System

Project: Pereira

Variant: Opción 3 Pereira (Cubierta A 3kW)

Tables on a building

System power: 3500 Wp

Pereira de Montes (A Merca) - España



Project: Pereira

Variant: Opción 3 Pereira (Cubierta A 3kW)

PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Project summary

Geographical Site
Pereira de Montes (A Merca)
España

Situation
Latitude 42.23 °N
Longitude -7.95 °W
Altitude 384 m
Time zone UTC+1

Project settings
Albedo 0.20

Meteo data

Pereira
Meteonorm 7.3 (1999-2010), Sat=100% - Sintético

System summary

Grid-Connected System

Simulation for year no 1

PV Field Orientation

Fixed plane
Tilt/Azimuth 45 / -40 °

System information

PV Array

Nb. of modules 10 units
Pnom total 3500 Wp

Tables on a building

Near Shadings

Linear shadings

Inverters

Nb. of units 1 unit
Pnom total 3000 W
Grid power limit 2700 W
Grid lim. Pnom ratio 1.296

User's needs

Ext. defined as file
Consumo final.csv

Battery pack

Storage strategy: Self-consumption
Nb. of units 2 units
Voltage 48 V
Capacity 108 Ah

Results summary

| | | | | | |
|-----------------|---------------|---------------------|-------------------|-------------------|---------|
| Produced Energy | 4529 kWh/year | Specific production | 1294 kWh/kWp/year | Perf. Ratio PR | 76.87 % |
| Used Energy | 4784 kWh/year | | | Solar Fraction SF | 58.27 % |

Table of contents

| | |
|---|----|
| Project and results summary | 2 |
| General parameters, PV Array Characteristics, System losses | 3 |
| Horizon definition | 5 |
| Near shading definition - Iso-shadings diagram | 6 |
| Main results | 7 |
| Loss diagram | 8 |
| Special graphs | 9 |
| Cost of the system | 10 |
| Financial analysis | 11 |
| CO ₂ Emission Balance | 14 |



PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

General parameters

Grid-Connected System

PV Field Orientation

Orientation

Fixed plane
Tilt/Azimuth 45 / -40 °

Horizon

Average Height 5.1 °

Storage

Kind Self-consumption

Charging strategy

When excess solar power is available

Tables on a building

Sheds configuration

Nb. of sheds 2 units

Sizes

Sheds spacing 1.36 m
Collector width 1.69 m
Ground Cov. Ratio (GCR) 124.0 %

Shading limit angle

Limit profile angle 82.4 °

Near Shadings

Linear shadings

Models used

Transposition Perez
Diffuse Perez, Meteororm
Circumsolar separate

User's needs

Ext. defined as file
Consumo final.csv

Grid power limitation

Active Power 2700 W
Pnom ratio 1.296

| Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Year | |
|------|------|------|------|-----|------|------|------|------|------|------|------|------|-----|
| 389 | 405 | 636 | 405 | 480 | 313 | 305 | 403 | 323 | 328 | 330 | 467 | 4784 | kWh |

PV Array Characteristics

PV module

Manufacturer Generic
Model AS-M1203-H-350
(Original PVsyst database)

Unit Nom. Power 350 Wp
Number of PV modules 10 units
Nominal (STC) 3500 Wp
Modules 2 Strings x 5 In series

At operating cond. (50°C)

Pmpp 3202 Wp
U mpp 161 V
I mpp 20 A

Total PV power

Nominal (STC) 3.50 kWp
Total 10 modules
Module area 17.0 m²

Battery Storage

Battery

Manufacturer Generic
Model DCB102Z

Battery pack

Nb. of units 2 in parallel
Discharging min. SOC 20.0 %
Stored energy 4.2 kWh

Inverter

Manufacturer Generic
Model SUN2000-3KTL-L1
(Original PVsyst database)

Unit Nom. Power 3.00 kWac
Number of inverters 2 * MPPT 50% 1 unit
Total power 3.0 kWac
Operating voltage 80-600 V
Pnom ratio (DC:AC) 1.17

Total inverter power

Total power 3 kWac
Number of inverters 1 unit
Pnom ratio 1.17

Battery Pack Characteristics

Voltage 48 V
Nominal Capacity 108 Ah (C10)
Temperature Fixed 20 °C



PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

PV Array Characteristics

Battery Storage

Battery input charger

Model Generic
Max. charg. power 3.1 kWdc
Max./Euro effic. 97.0/95.0 %

Battery to Grid inverter

Model Generic
Max. disch. power 5.0 kWac
Max./Euro effic. 97.0/95.0 %

Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Thermal Loss factor

Module temperature according to irradiance
Uc (const) 20.0 W/m²K
Uv (wind) 0.0 W/m²K/m/s

DC wiring losses

Global array res. 133 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss

Loss Fraction -1.0 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.1 %

Module average degradation

Year no 1
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 |

AC wiring losses

Inv. output line up to injection point

Inverter voltage 230 Vac mono
Loss Fraction 1.15 % at STC

Inverter: SUN2000-3KTL-L1

Wire section (1 Inv.) Copper 1 x 2 x 3 mm²
Wires length 12 m



PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Horizon definition

Horizon from PVGIS website API, Lat=42°14'5", Long=-7°57'9", Alt=384m

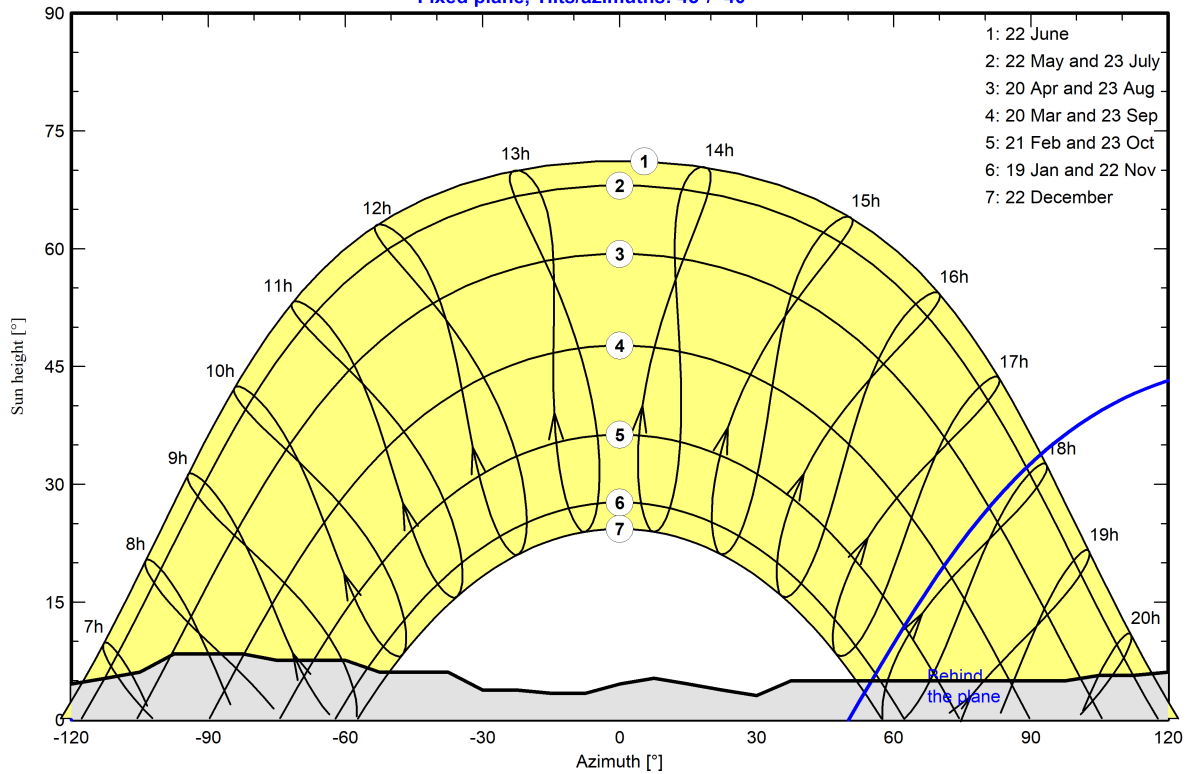
| | | | |
|----------------|-------|-----------------|-------|
| Average Height | 5.1 ° | Albedo Factor | 0.71 |
| Diffuse Factor | 0.94 | Albedo Fraction | 100 % |

Horizon profile

| | | | | | | | | | | | | | |
|-------------|------|------|------|------|------|------|------|------|------|------|-----|-----|-----|
| Azimuth [°] | -180 | -173 | -165 | -158 | -143 | -135 | -128 | -120 | -113 | -105 | -98 | -83 | -75 |
| Height [°] | 3.4 | 3.4 | 3.8 | 3.8 | 3.1 | 3.1 | 3.8 | 4.6 | 5.3 | 6.1 | 8.4 | 8.4 | 7.6 |
| Azimuth [°] | -60 | -53 | -38 | -30 | -23 | -15 | -8 | 0 | 8 | 15 | 23 | 30 | 38 |
| Height [°] | 7.6 | 6.1 | 6.1 | 3.8 | 3.8 | 3.4 | 3.4 | 4.6 | 5.3 | 4.6 | 3.8 | 3.1 | 5.0 |
| Azimuth [°] | 98 | 105 | 113 | 120 | 128 | 135 | 143 | 150 | 158 | 173 | 180 | | |
| Height [°] | 5.0 | 5.7 | 5.7 | 6.1 | 6.1 | 5.7 | 5.7 | 5.0 | 5.0 | 3.4 | 3.4 | | |

Sun Paths (Height / Azimuth diagram)

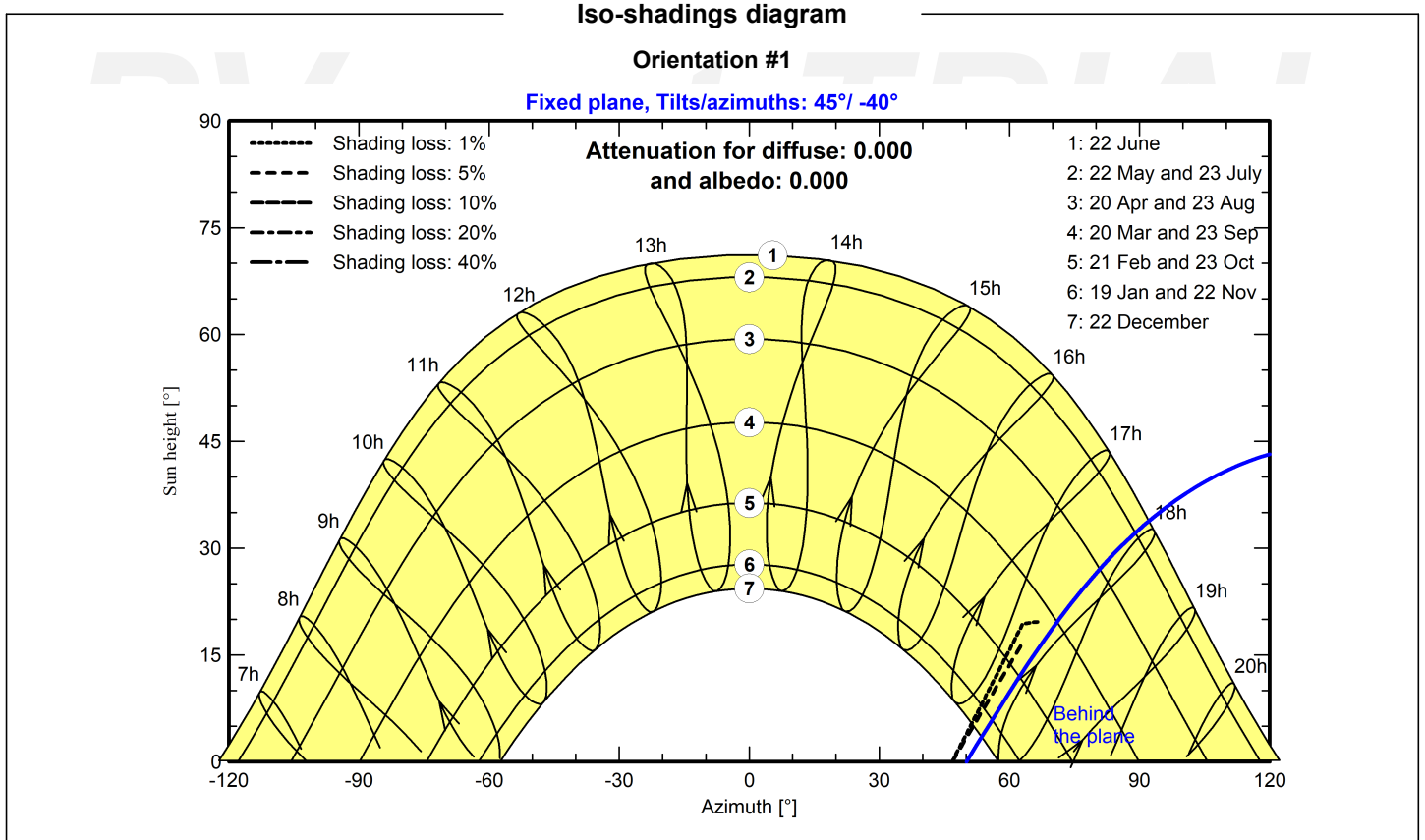
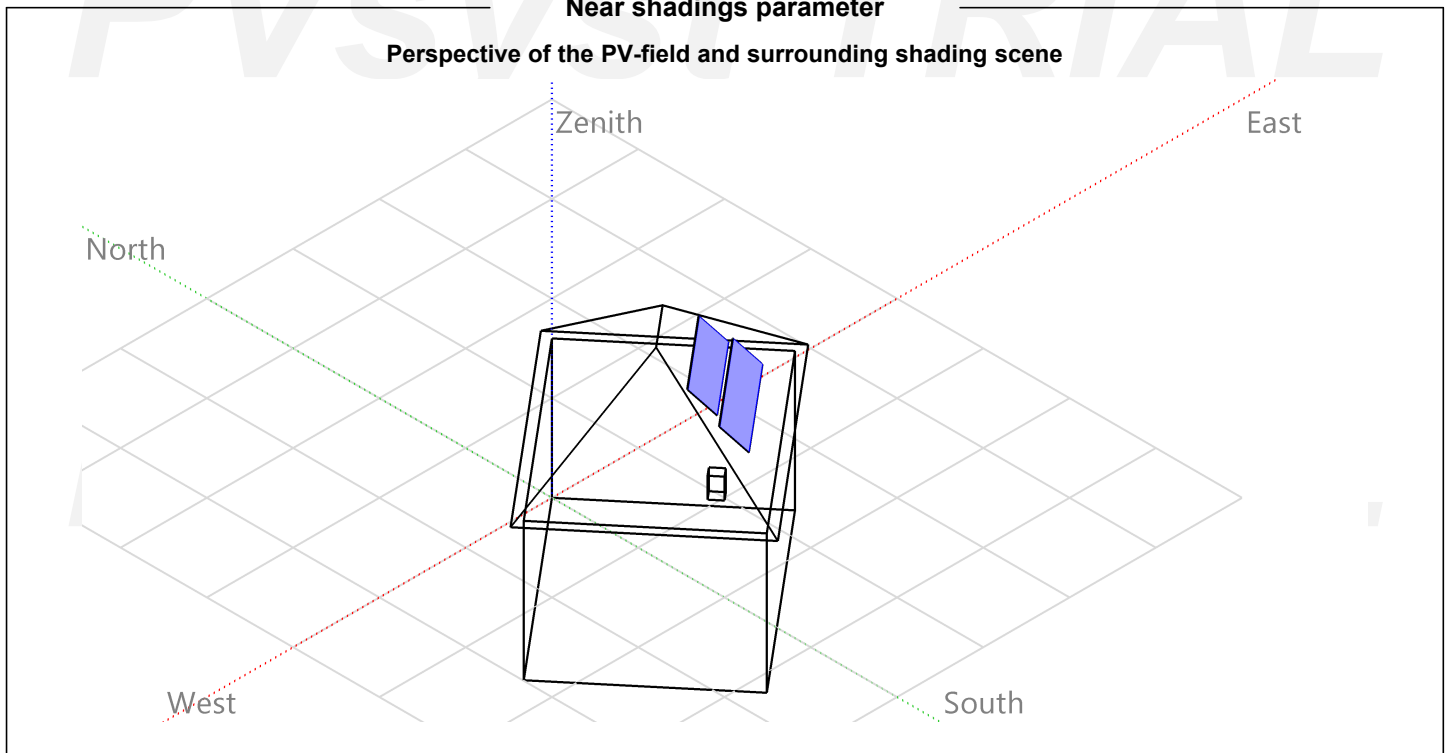
Fixed plane, Tilts/azimuths: 45° / -40°





PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21





PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Main results

System Production

| | | | |
|-----------------|---------------|----------------------|-------------------|
| Produced Energy | 4529 kWh/year | Specific production | 1294 kWh/kWp/year |
| Used Energy | 4784 kWh/year | Performance Ratio PR | 76.87 % |
| | | Solar Fraction SF | 58.27 % |

Battery aging (State of Wear)

| | |
|------------------|-----------|
| Cycles SOW | 72.7 % |
| Static SOW | 90.0 % |
| Battery lifetime | 3.7 years |

Economic evaluation

Investment

| | |
|----------|-------------|
| Global | 6878.69 EUR |
| Specific | 1.97 EUR/Wp |

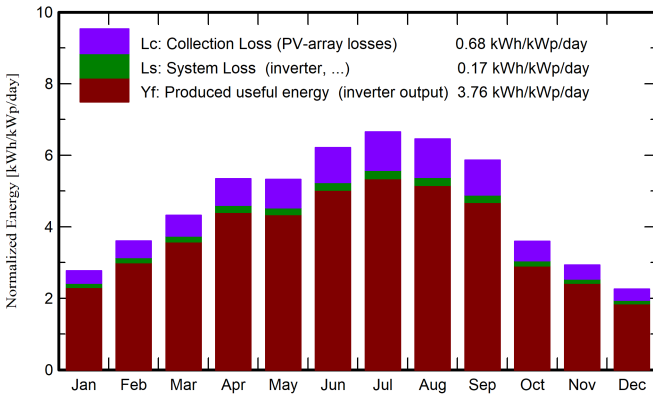
Yearly cost

| | |
|----------------|---------------|
| Annuities | 0.00 EUR/yr |
| Run. costs | 216.45 EUR/yr |
| Payback period | 5.6 years |

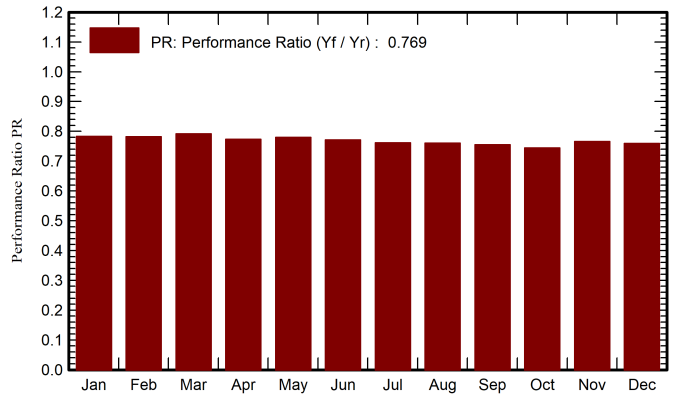
LCOE

| | |
|-------------|--------------|
| Energy cost | 0.08 EUR/kWh |
|-------------|--------------|

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

| | GlobHor | DiffHor | T_Amb | GlobInc | GlobEff | EArray | E_User | E_Solar | E_Grid | EFrGrid |
|-------------|--------------------|--------------------|--------------|--------------------|--------------------|---------------|---------------|---------------|---------------|---------------|
| | kWh/m ² | kWh/m ² | °C | kWh/m ² | kWh/m ² | kWh | kWh | kWh | kWh | kWh |
| January | 54.3 | 24.00 | 7.75 | 85.9 | 78.9 | 263.5 | 388.7 | 193.4 | 42.1 | 195.3 |
| February | 73.5 | 32.84 | 8.58 | 101.0 | 92.9 | 307.9 | 405.3 | 228.1 | 48.5 | 177.2 |
| March | 113.2 | 57.12 | 10.60 | 134.0 | 123.4 | 406.1 | 636.0 | 281.8 | 89.8 | 354.2 |
| April | 150.0 | 68.53 | 11.13 | 160.2 | 148.2 | 483.2 | 404.7 | 290.0 | 144.0 | 114.7 |
| May | 178.7 | 79.05 | 13.88 | 165.0 | 152.4 | 492.5 | 479.6 | 304.1 | 146.4 | 175.6 |
| June | 204.0 | 71.82 | 17.37 | 186.3 | 173.0 | 550.8 | 312.8 | 146.0 | 357.1 | 166.8 |
| July | 223.8 | 68.66 | 18.25 | 206.2 | 191.9 | 605.6 | 304.9 | 266.3 | 283.3 | 38.6 |
| August | 195.2 | 65.07 | 19.06 | 200.2 | 185.3 | 584.4 | 403.4 | 314.5 | 218.3 | 89.0 |
| September | 148.2 | 41.40 | 17.10 | 175.8 | 164.2 | 513.8 | 323.2 | 241.2 | 223.7 | 82.0 |
| October | 90.7 | 44.67 | 14.11 | 111.4 | 101.8 | 331.2 | 327.9 | 187.8 | 102.6 | 140.2 |
| November | 59.0 | 27.70 | 9.89 | 87.8 | 80.6 | 266.8 | 329.7 | 173.7 | 61.6 | 156.0 |
| December | 43.8 | 23.90 | 8.07 | 69.8 | 63.1 | 211.9 | 467.5 | 160.8 | 24.7 | 306.7 |
| Year | 1534.4 | 604.78 | 13.01 | 1683.6 | 1555.6 | 5017.9 | 4783.7 | 2787.5 | 1742.0 | 1996.2 |

Legends

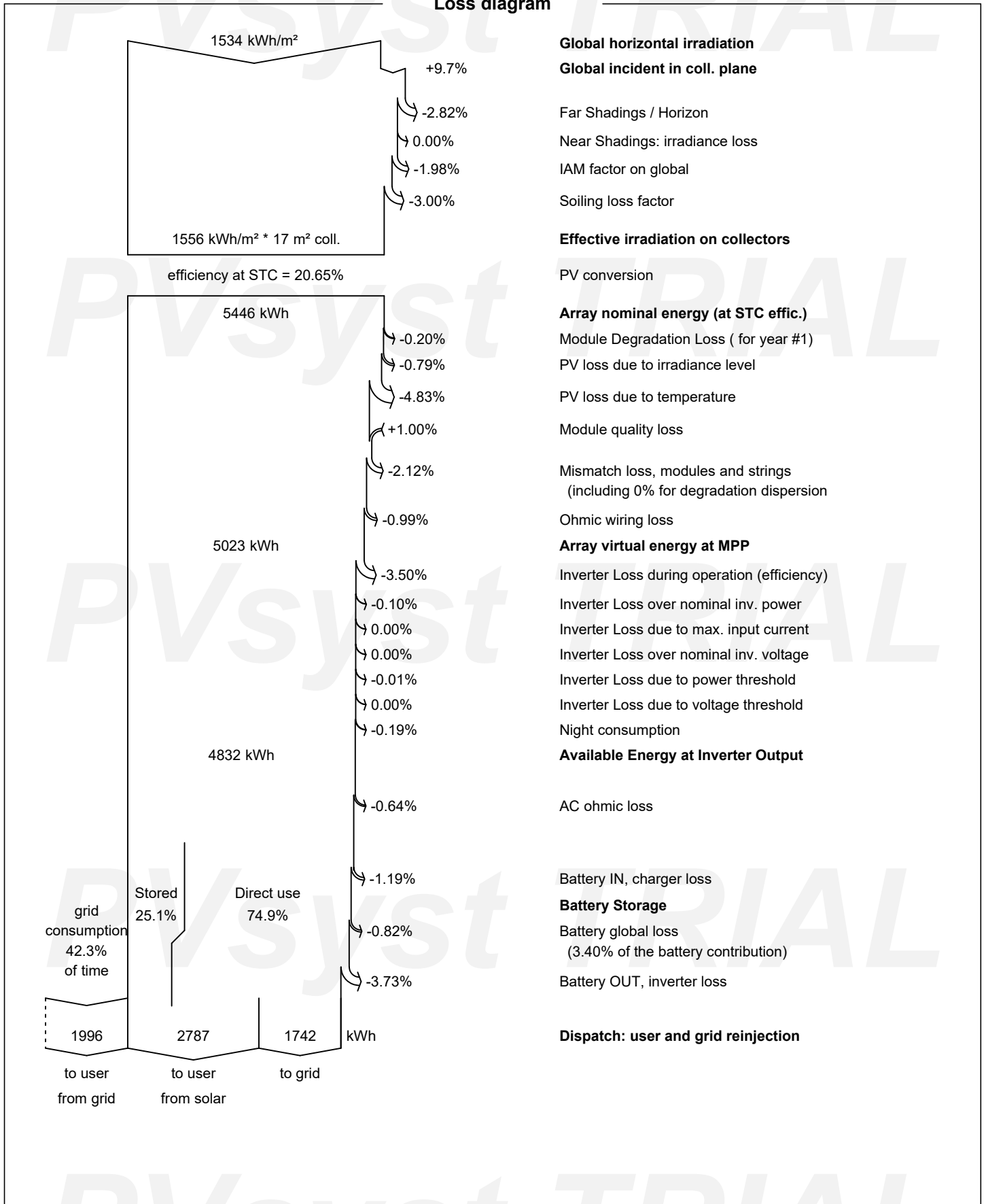
| | | | |
|---------|--|---------|---|
| GlobHor | Global horizontal irradiation | EArray | Effective energy at the output of the array |
| DiffHor | Horizontal diffuse irradiation | E_User | Energy supplied to the user |
| T_Amb | Ambient Temperature | E_Solar | Energy from the sun |
| GlobInc | Global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



PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Loss diagram



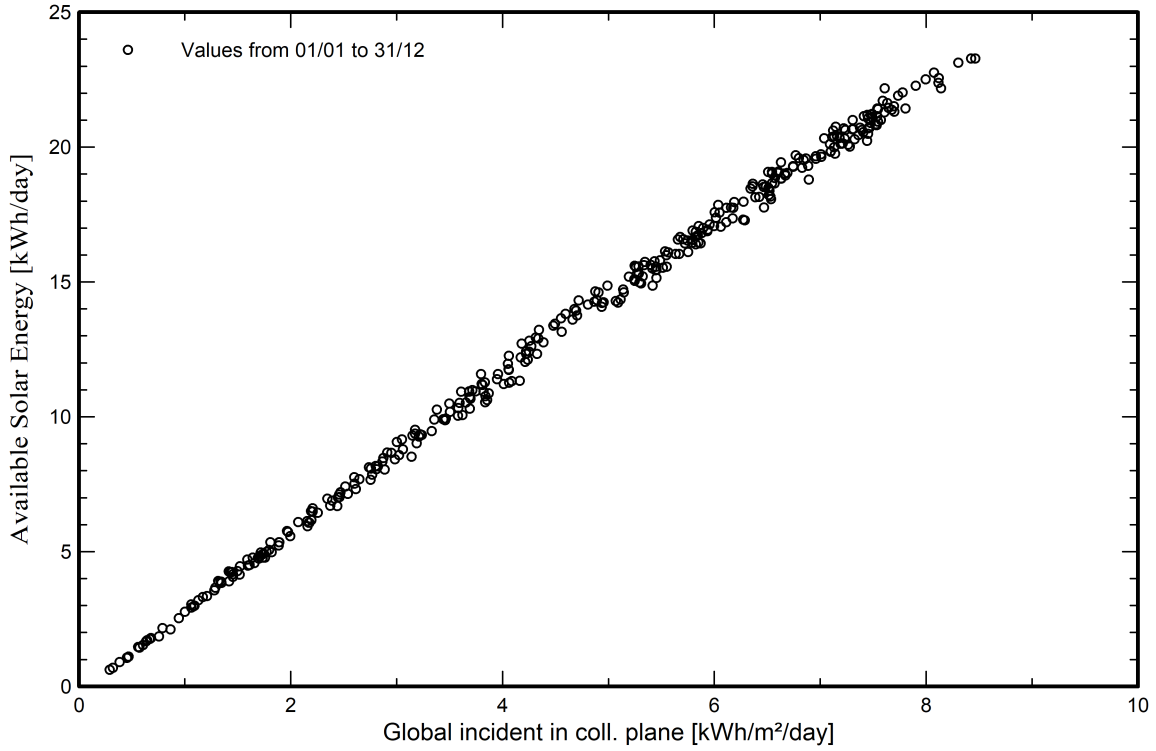


PVsyst V7.2.21

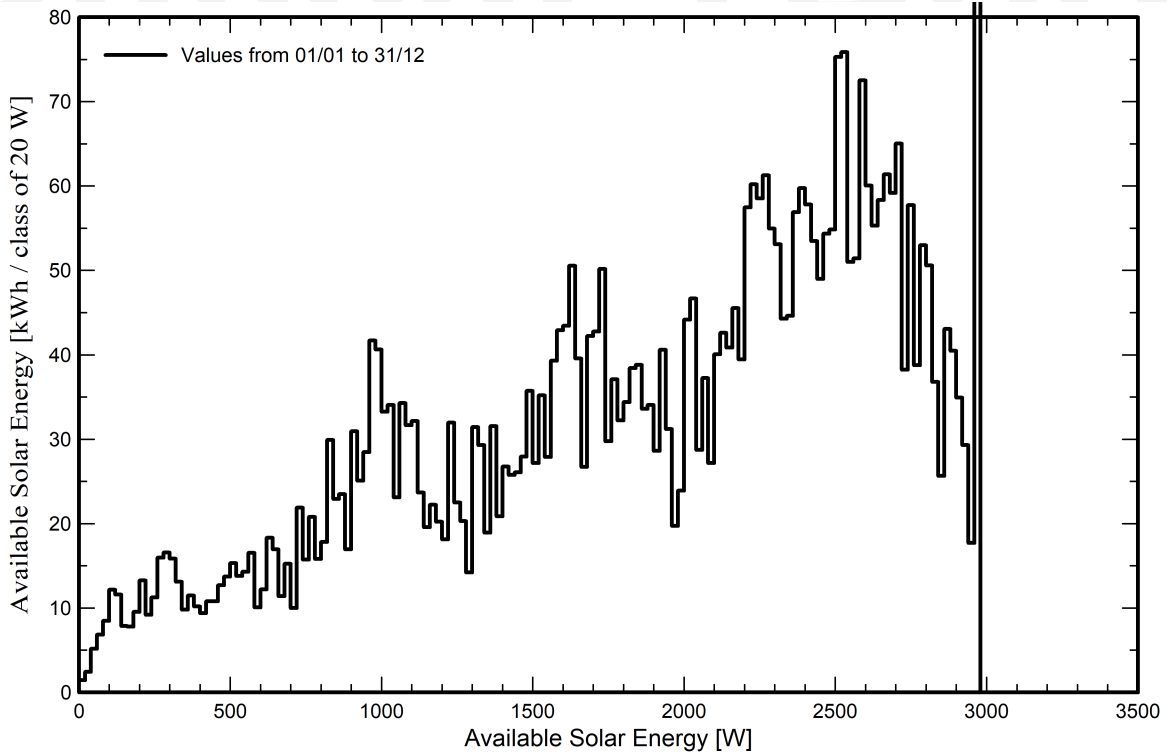
VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Special graphs

Diagrama entrada/salida diaria



Distribución de potencia de salida del sistema





PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Cost of the system

Installation costs

| Item | Quantity units | Cost EUR | Total EUR |
|----------------------|-------------------|-------------|----------------|
| PV modules | | | |
| AS-M1203-H-350 | 10 | 114.00 | 1140.00 |
| Supports for modules | 10 | 48.11 | 481.10 |
| Inverters | | | |
| SUN2000-3KTL-L1 | 1 | 976.55 | 976.55 |
| Batteries | 2 | 801.52 | 1603.04 |
| Studies and analysis | | | |
| Engineering | 1 | 960.00 | 960.00 |
| Installation | | | |
| Mano de obra | 1 | 1500.00 | 1500.00 |
| Soporte 2 | | | 218.00 |
| Total | | | 6878.69 |
| Depreciable asset | | | 4200.69 |

Operating costs

| Item | Total EUR/year |
|-----------------------------|-------------------|
| Maintenance | |
| Salaries | 80.00 |
| Repairs | 100.00 |
| Total (OPEX) | 180.00 |
| Including inflation (1.50%) | 216.45 |

System summary

| | |
|--|-----------------|
| Total installation cost | 6878.69 EUR |
| Operating costs (incl. inflation 1.50%/year) | 216.45 EUR/year |
| Unused energy | 2787 kWh/year |
| Energy sold to the grid | 1742 kWh/year |
| Cost of produced energy (LCOE) | 0.076 EUR/kWh |



PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Financial analysis

Simulation period

Project lifetime 25 years Start year 2023

Income variation over time

Inflation 1.50 %/year
Production variation (aging) -0.50 %/year
Discount rate 1.00 %/year

Income dependent expenses

Income tax rate 10.00 %/year
Other income tax 10.00 %/year
Dividends 15.00 %/year

Tax depreciation

Depreciable assets 4200.69 EUR
Salvage value 2000.00 EUR
Total redeemable 2200.69 EUR
Depreciation period 20 years

Financing

Own funds 2465.19 EUR
Subsidies 4413.00 EUR

Electricity sale

Feed-in tariff Peak tariff 0.3173 EUR/kWh
Off-peak tariff 0.2241 EUR/kWh 20:00-07:00
Duration of tariff warranty 20 years
Annual connection tax 0.00 EUR/kWh
Annual tariff variation 0.0 %/year
Feed-in tariff decrease after warranty 0.00 %

Self-consumption

Consumption tariff Peak tariff 0.0500 EUR/kWh
Off-peak tariff 0.0600 EUR/kWh 20:00-07:00
Tariff evolution 0.0 %/year

Return on investment

Payback period 5.6 years
Net present value (NPV) 6365.97 EUR
Return on investment (ROI) 258.2 %
Paid dividends 978.94 EUR



PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Financial analysis

Detailed economic results (EUR)

| | Electricity sale | Run. costs | Deprec. allow. | Taxable income | Taxes | After-tax profit | Divid. 15.00% | Self-cons. saving | Cumul. profit | % amorti. |
|--------------|---------------------|---------------|-------------------|-------------------|-------------|---------------------|------------------|----------------------|------------------|---------------|
| 2023 | 553 | 180 | 110 | 263 | 53 | 320 | 48 | 145 | -2005 | 18.7% |
| 2024 | 550 | 183 | 110 | 257 | 51 | 316 | 47 | 144 | -1553 | 37.0% |
| 2025 | 547 | 185 | 110 | 252 | 50 | 311 | 47 | 144 | -1112 | 54.9% |
| 2026 | 544 | 188 | 110 | 246 | 49 | 307 | 46 | 143 | -679 | 72.4% |
| 2027 | 542 | 191 | 110 | 241 | 48 | 303 | 45 | 142 | -256 | 89.6% |
| 2028 | 539 | 194 | 110 | 235 | 47 | 298 | 45 | 142 | 158 | 106.4% |
| 2029 | 536 | 197 | 110 | 229 | 46 | 294 | 44 | 141 | 563 | 122.8% |
| 2030 | 534 | 200 | 110 | 224 | 45 | 289 | 43 | 140 | 960 | 138.9% |
| 2031 | 531 | 203 | 110 | 218 | 44 | 285 | 43 | 139 | 1347 | 154.6% |
| 2032 | 528 | 206 | 110 | 212 | 42 | 280 | 42 | 139 | 1726 | 170.0% |
| 2033 | 526 | 209 | 110 | 207 | 41 | 275 | 41 | 138 | 2097 | 185.0% |
| 2034 | 523 | 212 | 110 | 201 | 40 | 271 | 41 | 137 | 2459 | 199.7% |
| 2035 | 520 | 215 | 110 | 195 | 39 | 266 | 40 | 137 | 2813 | 214.1% |
| 2036 | 518 | 218 | 110 | 189 | 38 | 262 | 39 | 136 | 3159 | 228.1% |
| 2037 | 515 | 222 | 110 | 183 | 37 | 257 | 39 | 135 | 3497 | 241.8% |
| 2038 | 513 | 225 | 110 | 178 | 36 | 252 | 38 | 135 | 3827 | 255.2% |
| 2039 | 510 | 228 | 110 | 172 | 34 | 247 | 37 | 134 | 4149 | 268.2% |
| 2040 | 508 | 232 | 110 | 166 | 33 | 243 | 36 | 133 | 4463 | 281.0% |
| 2041 | 505 | 235 | 110 | 160 | 32 | 238 | 36 | 133 | 4769 | 293.4% |
| 2042 | 502 | 239 | 110 | 154 | 31 | 233 | 35 | 132 | 5068 | 305.5% |
| 2043 | 500 | 242 | 0 | 258 | 52 | 206 | 31 | 131 | 5342 | 316.6% |
| 2044 | 497 | 246 | 0 | 251 | 50 | 201 | 30 | 131 | 5609 | 327.4% |
| 2045 | 495 | 250 | 0 | 245 | 49 | 196 | 29 | 130 | 5868 | 338.0% |
| 2046 | 493 | 254 | 0 | 239 | 48 | 191 | 29 | 129 | 6120 | 348.2% |
| 2047 | 490 | 257 | 0 | 233 | 47 | 186 | 28 | 129 | 6366 | 358.2% |
| Total | 13019 | 5411 | 2201 | 5407 | 1081 | 6526 | 979 | 3419 | 6366 | 358.2% |

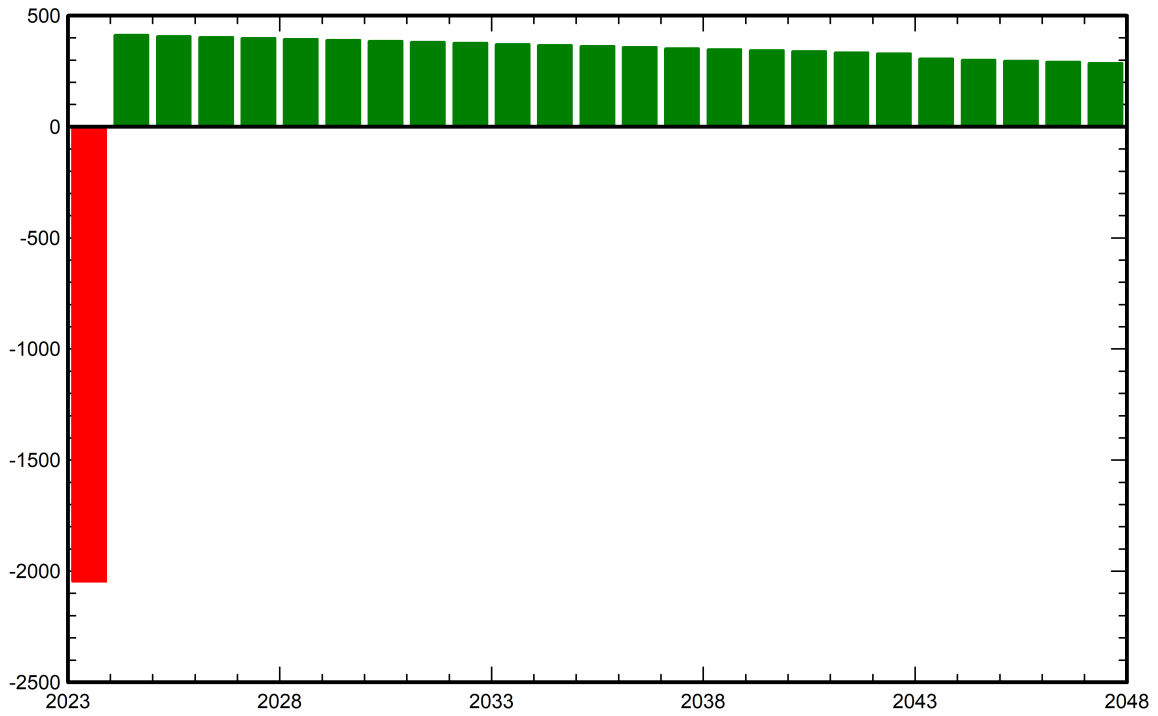


PVsyst V7.2.21

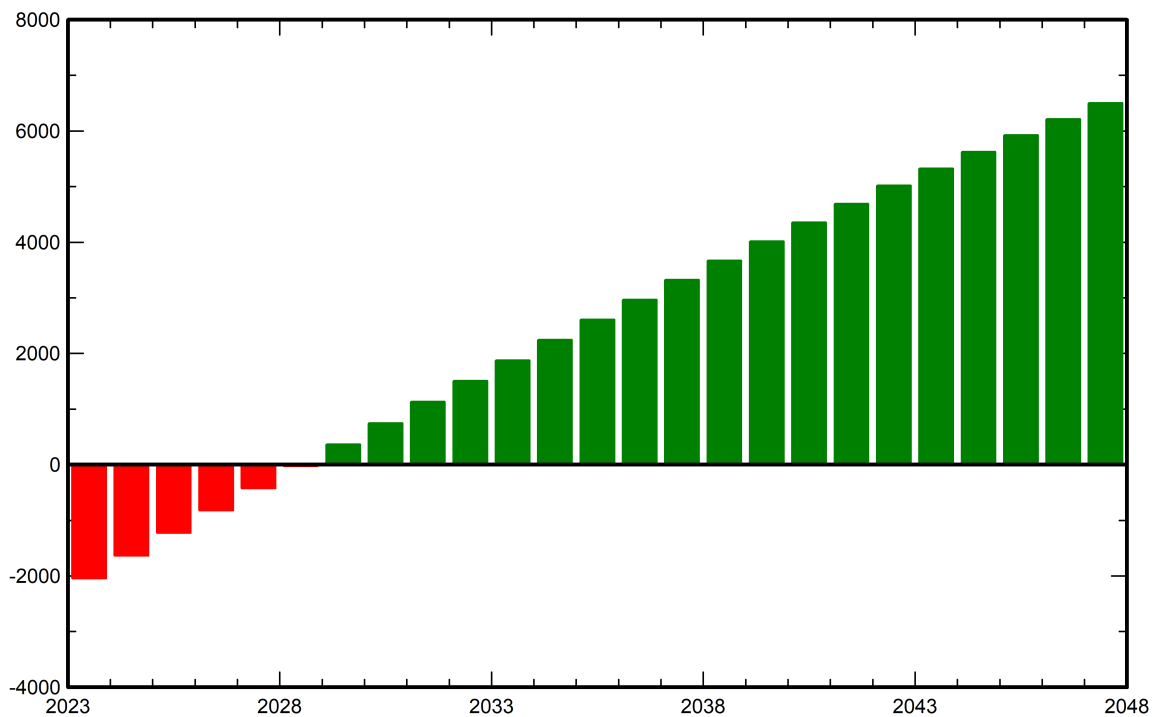
VC4, Simulation date:
03/12/22 19:31
with v7.2.21

Financial analysis

Yearly net profit (EUR)



Cumulative cashflow (EUR)





PVsyst V7.2.21

VC4, Simulation date:
03/12/22 19:31
with v7.2.21

CO₂ Emission Balance

Total: 75.9 tCO₂

Generated emissions

Total: 6.57 tCO₂

Source: Detailed calculation from table below:

Replaced Emissions

Total: 95.1 tCO₂

System production: 4801.31 kWh/yr

Grid Lifecycle Emissions: 660 gCO₂/kWh

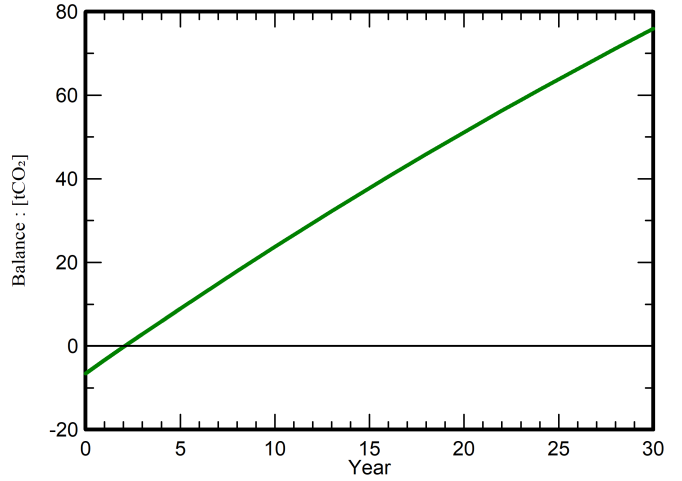
Source: IEA List

Country: Zimbabwe

Lifetime: 30 years

Annual degradation: 1.0 %

Saved CO₂ Emission vs. Time



System Lifecycle Emissions Details

| Item | LCE | Quantity | Subtotal |
|-----------|------------------------------|------------|----------------------|
| | | | [kgCO ₂] |
| Modules | 1468 kgCO ₂ /kWp | 3.85 kWp | 5652 |
| Supports | 4.40 kgCO ₂ /kg | 110 kg | 484 |
| Inverters | 436 kgCO ₂ /units | 1.00 units | 436 |

PVsyst - Simulation report

Grid-Connected System

Project: Pereira

Variant: Opción 4 Pereira (Cubierta A y B 3kW)

Tables on a building

System power: 3500 Wp

Pereira de Montes (A Merca) - España



Project: Pereira

Variant: Opción 4 Pereira (Cubierta A y B 3kW)

PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Project summary

Geographical Site
Pereira de Montes (A Merca)
España

Situation
Latitude 42.23 °N
Longitude -7.95 °W
Altitude 384 m
Time zone UTC+1

Project settings
Albedo 0.20

Meteo data

Pereira
Meteonorm 7.3 (1999-2010), Sat=100% - Sintético

System summary

Grid-Connected System

Simulation for year no 1

PV Field Orientation

Fixed planes 2 orientations
Tilts/azimuths 45 / -40 °
45 / 50 °

System information

PV Array

Nb. of modules 10 units
Pnom total 3500 Wp

Tables on a building

Near Shadings

Linear shadings

Inverters

Nb. of units 1 unit
Pnom total 3000 W
Grid power limit 2700 W
Grid lim. Pnom ratio 1.296

User's needs

Ext. defined as file
Consumo final.csv

Battery pack

Storage strategy: Self-consumption
Nb. of units 2 units
Voltage 48 V
Capacity 108 Ah

Results summary

| | | | | | |
|-----------------|---------------|---------------------|-------------------|-------------------|---------|
| Produced Energy | 4488 kWh/year | Specific production | 1282 kWh/kWp/year | Perf. Ratio PR | 78.06 % |
| Used Energy | 4784 kWh/year | | | Solar Fraction SF | 61.46 % |

Table of contents

| | |
|---|----|
| Project and results summary | 2 |
| General parameters, PV Array Characteristics, System losses | 3 |
| Horizon definition | 5 |
| Near shading definition - Iso-shadings diagram | 6 |
| Main results | 8 |
| Loss diagram | 9 |
| Special graphs | 10 |
| Cost of the system | 11 |
| Financial analysis | 12 |
| CO ₂ Emission Balance | 15 |



PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

General parameters

Grid-Connected System

PV Field Orientation

Orientation

Fixed planes 2 orientations
Tilts/azimuths 45 / -40 °
45 / 50 °

Horizon

Average Height 5.1 °

Storage

Kind Self-consumption

Charging strategy

When excess solar power is available

Tables on a building

Sheds configuration

Nb. of sheds 4 units
Several orientations

Near Shadings

Linear shadings

Models used

Transposition Perez
Diffuse Perez, Meteororm
Circumsolar separate

User's needs

Ext. defined as file
Consumo final.csv

Grid power limitation

Active Power 2700 W
Pnom ratio 1.296

Discharging strategy

As soon as power is needed

| Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Year | |
|------|------|------|------|-----|------|------|------|------|------|------|------|------|-----|
| 389 | 405 | 636 | 405 | 480 | 313 | 305 | 403 | 323 | 328 | 330 | 467 | 4784 | kWh |

PV Array Characteristics

PV module

Manufacturer Generic
Model AS-M1203-H-350
(Original PVsyst database)

Unit Nom. Power 350 Wp
Number of PV modules 10 units
Nominal (STC) 3500 Wp
Modules 2 Strings x 5 In series

At operating cond. (50°C)

Pmpp 3202 Wp
U mpp 161 V
I mpp 20 A

Total PV power

Nominal (STC) 3.50 kWp
Total 10 modules
Module area 17.0 m²

Battery Storage

Battery

Manufacturer Generic
Model DCB102Z

Battery pack

Nb. of units 2 in parallel
Discharging min. SOC 20.0 %
Stored energy 4.2 kWh

Battery input charger

Model Generic
Max. charg. power 2.4 kWdc
Max./Euro effic. 97.0/95.0 %

Battery to Grid inverter

Model Generic
Max. disch. power 3.0 kWac
Max./Euro effic. 97.0/95.0 %

Inverter

Manufacturer Generic
Model SUN2000-3KTL-L1
(Original PVsyst database)

Unit Nom. Power 3.00 kWac
Number of inverters 2 * MPPT 50% 1 unit
Total power 3.0 kWac
Operating voltage 80-600 V
Pnom ratio (DC:AC) 1.17

Total inverter power

Total power 3 kWac
Number of inverters 1 unit
Pnom ratio 1.17

Battery Pack Characteristics

Voltage 48 V
Nominal Capacity 108 Ah (C10)
Temperature Fixed 20 °C



PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Thermal Loss factor

Module temperature according to irradiance

Uc (const) 20.0 W/m²K

Uv (wind) 0.0 W/m²K/m/s

DC wiring losses

Global array res. 133 mΩ

Loss Fraction 1.5 % at STC

Module Quality Loss

Loss Fraction -1.0 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.1 %

Module average degradation

Year no 1

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 |

AC wiring losses

Inv. output line up to injection point

Inverter voltage 230 Vac mono

Loss Fraction 1.15 % at STC

Inverter: SUN2000-3KTL-L1

Wire section (1 Inv.) Copper 1 x 2 x 3 mm²

Wires length 12 m



PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Horizon definition

Horizon from PVGIS website API, Lat=42°14'5", Long=-7°57'9", Alt=384m

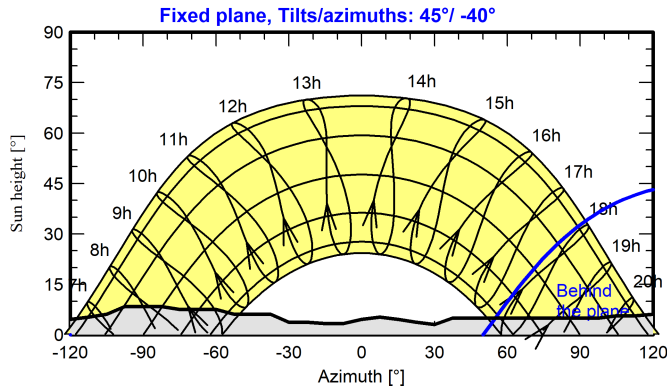
| | | | |
|----------------|-------|-----------------|-------|
| Average Height | 5.1 ° | Albedo Factor | 0.76 |
| Diffuse Factor | 0.95 | Albedo Fraction | 100 % |

Horizon profile

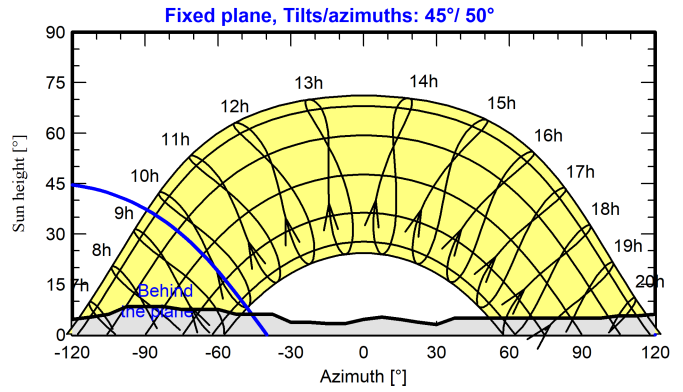
| | | | | | | | | | | | | | |
|-------------|------|------|------|------|------|------|------|------|------|------|-----|-----|-----|
| Azimuth [°] | -180 | -173 | -165 | -158 | -143 | -135 | -128 | -120 | -113 | -105 | -98 | -83 | -75 |
| Height [°] | 3.4 | 3.4 | 3.8 | 3.8 | 3.1 | 3.1 | 3.8 | 4.6 | 5.3 | 6.1 | 8.4 | 8.4 | 7.6 |
| Azimuth [°] | -60 | -53 | -38 | -30 | -23 | -15 | -8 | 0 | 8 | 15 | 23 | 30 | 38 |
| Height [°] | 7.6 | 6.1 | 6.1 | 3.8 | 3.8 | 3.4 | 3.4 | 4.6 | 5.3 | 4.6 | 3.8 | 3.1 | 5.0 |
| Azimuth [°] | 98 | 105 | 113 | 120 | 128 | 135 | 143 | 150 | 158 | 173 | 180 | | |
| Height [°] | 5.0 | 5.7 | 5.7 | 6.1 | 6.1 | 5.7 | 5.7 | 5.0 | 5.0 | 3.4 | 3.4 | | |

Sun Paths (Height / Azimuth diagram)

Orientation #1



Orientation #2



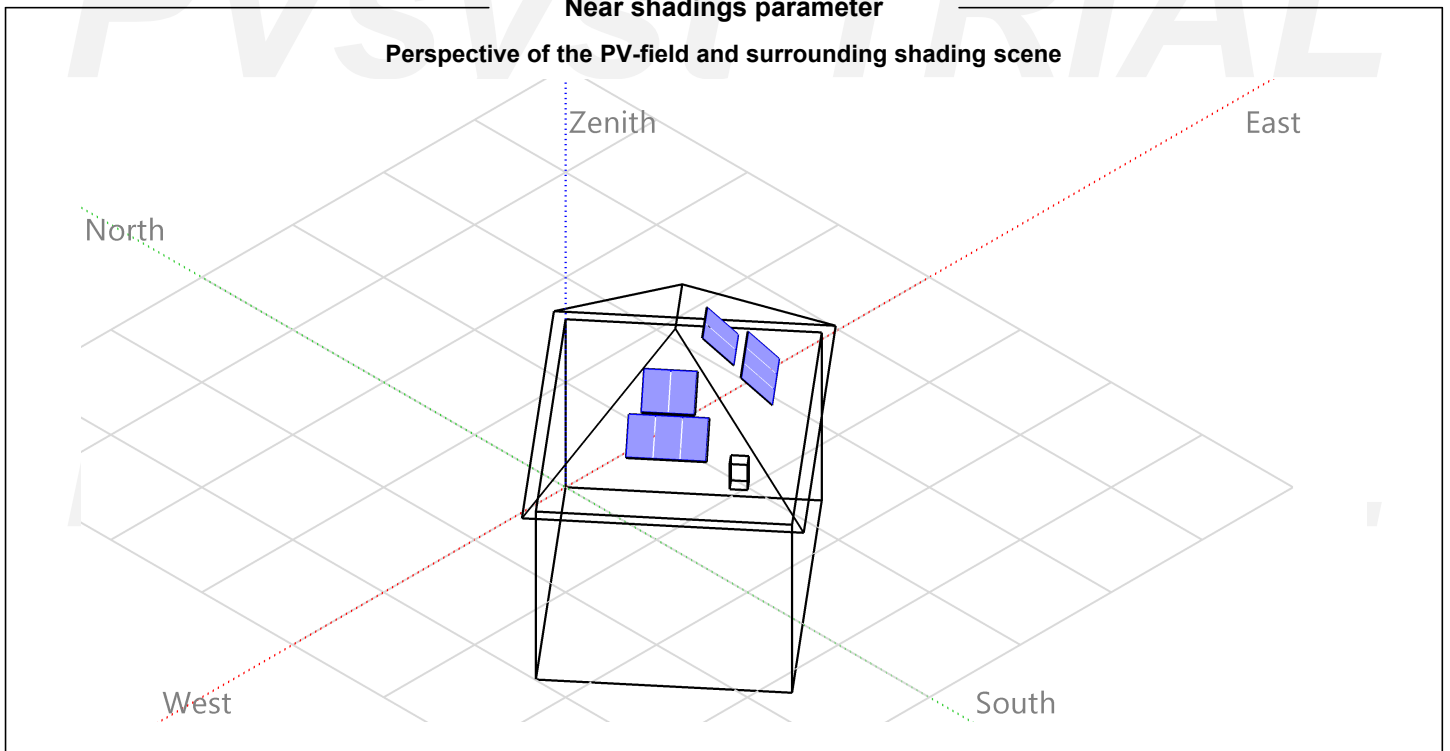


PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Near shadings parameter

Perspective of the PV-field and surrounding shading scene





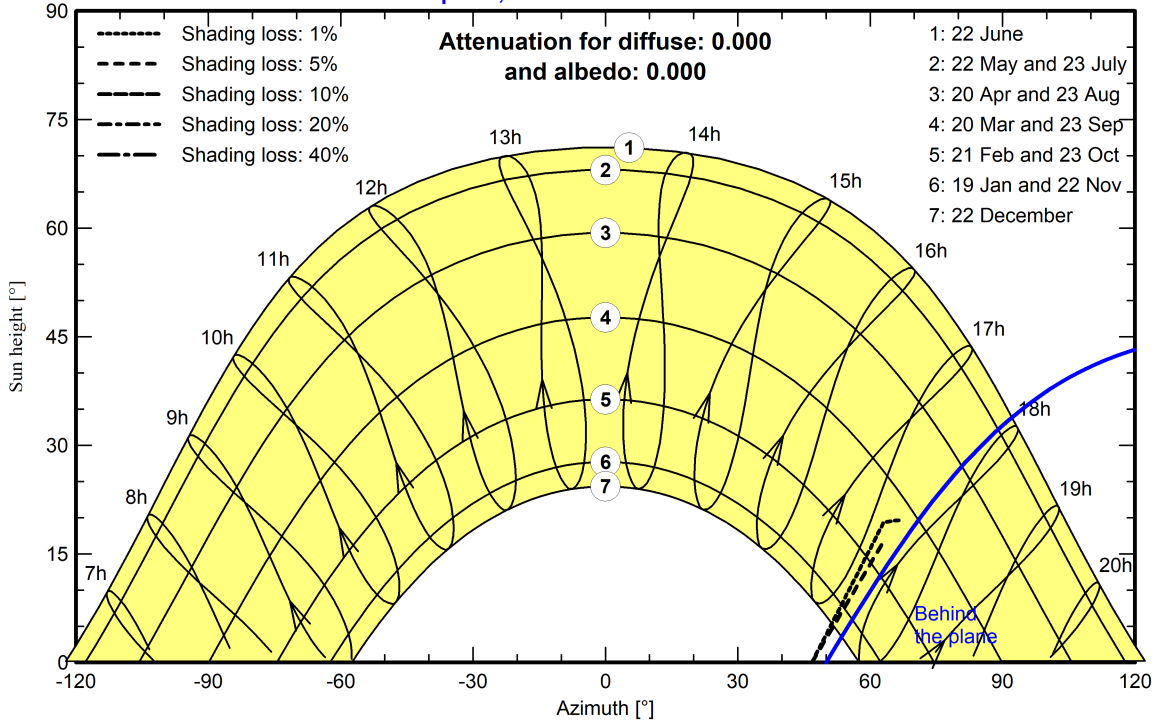
PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Iso-shadings diagram

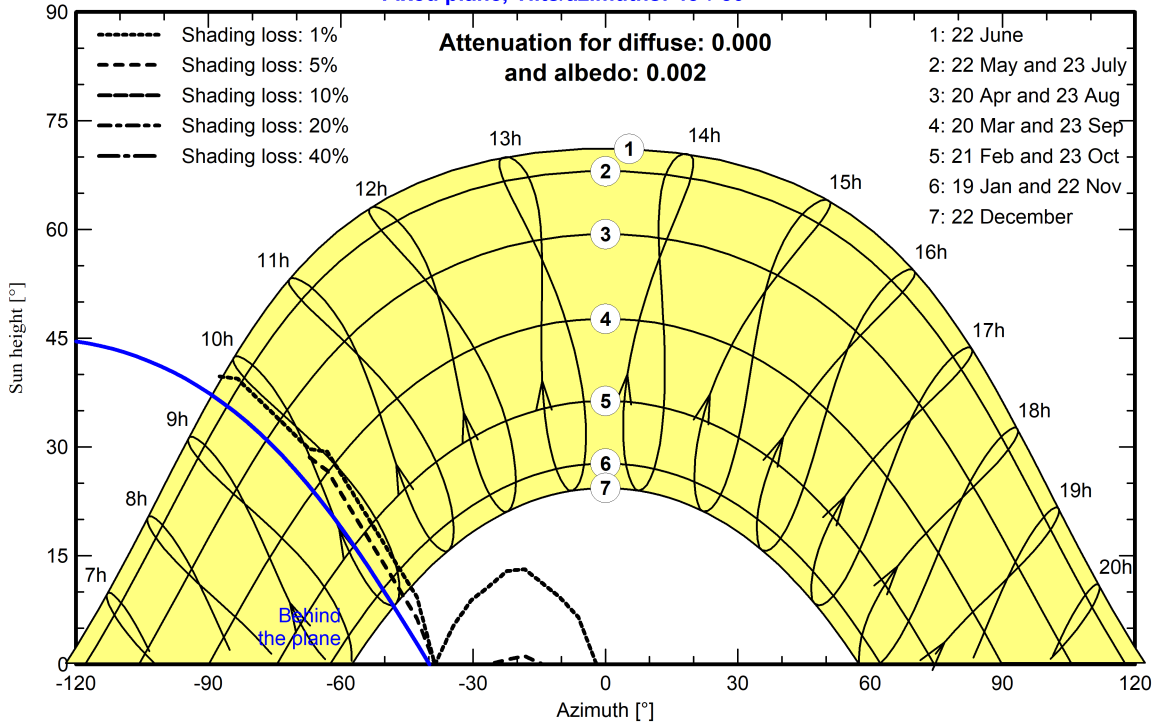
Orientation #1

Fixed plane, Tilts/azimuths: 45° / -40°



Orientation #2

Fixed plane, Tilts/azimuths: 45° / 50°





PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Main results

System Production

| | | | |
|-----------------|---------------|----------------------|-------------------|
| Produced Energy | 4488 kWh/year | Specific production | 1282 kWh/kWp/year |
| Used Energy | 4784 kWh/year | Performance Ratio PR | 78.06 % |
| | | Solar Fraction SF | 61.46 % |

Battery aging (State of Wear)

| | |
|------------------|-----------|
| Cycles SOW | 73.3 % |
| Static SOW | 90.0 % |
| Battery lifetime | 3.7 years |

Economic evaluation

Investment

| | |
|----------|-------------|
| Global | 6660.69 EUR |
| Specific | 1.90 EUR/Wp |

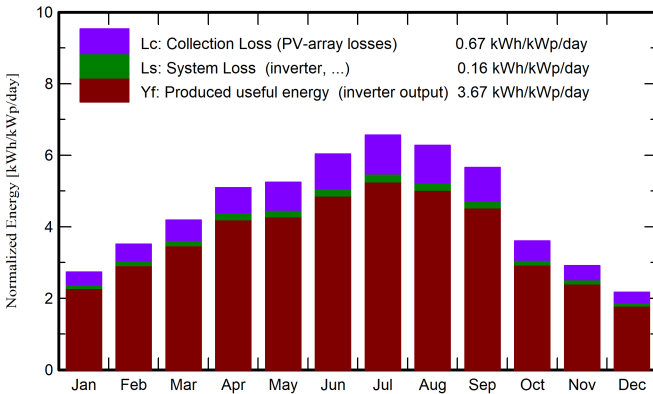
Yearly cost

| | |
|----------------|---------------|
| Annuities | 0.00 EUR/yr |
| Run. costs | 216.45 EUR/yr |
| Payback period | 5.6 years |

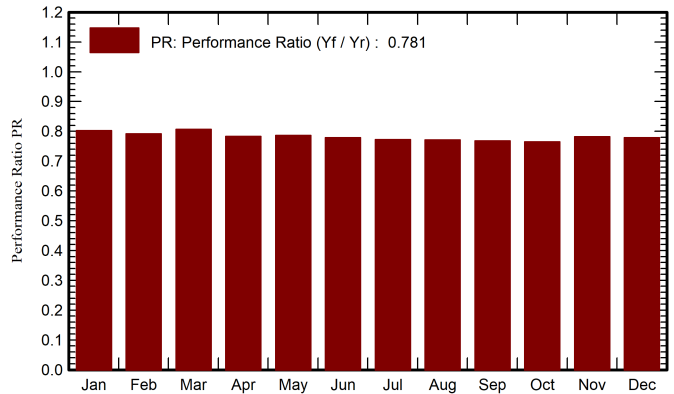
LCOE

| | |
|-------------|--------------|
| Energy cost | 0.07 EUR/kWh |
|-------------|--------------|

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

| | GlobHor | DiffHor | T_Amb | GlobInc | GlobEff | EArray | E_User | E_Solar | E_Grid | EFrGrid |
|------------------|--------------------|--------------------|-------|--------------------|--------------------|--------|--------|---------|--------|---------|
| | kWh/m ² | kWh/m ² | °C | kWh/m ² | kWh/m ² | kWh | kWh | kWh | kWh | kWh |
| January | 54.3 | 24.01 | 7.75 | 84.8 | 77.7 | 259.7 | 388.7 | 202.7 | 35.4 | 185.9 |
| February | 73.5 | 32.84 | 8.58 | 98.2 | 90.5 | 299.7 | 405.3 | 236.2 | 36.0 | 169.1 |
| March | 113.2 | 57.12 | 10.60 | 129.6 | 119.8 | 393.9 | 636.0 | 286.2 | 79.8 | 349.7 |
| April | 150.0 | 68.53 | 11.13 | 152.9 | 141.3 | 460.9 | 404.7 | 297.6 | 121.5 | 107.1 |
| May | 178.7 | 79.05 | 13.88 | 162.5 | 150.4 | 484.9 | 479.6 | 327.5 | 119.8 | 152.1 |
| June | 204.0 | 71.82 | 17.37 | 181.0 | 167.8 | 532.9 | 312.8 | 146.2 | 347.4 | 166.6 |
| July | 223.8 | 68.67 | 18.25 | 203.3 | 189.1 | 595.4 | 304.9 | 281.6 | 267.8 | 23.3 |
| August | 195.2 | 65.07 | 19.06 | 194.6 | 180.7 | 568.8 | 403.4 | 339.9 | 185.5 | 63.5 |
| September | 148.2 | 41.40 | 17.10 | 169.7 | 158.7 | 496.9 | 323.2 | 261.7 | 194.4 | 61.5 |
| October | 90.7 | 44.67 | 14.11 | 111.6 | 102.8 | 333.9 | 327.9 | 204.9 | 93.9 | 123.0 |
| November | 59.0 | 27.71 | 9.89 | 87.2 | 80.0 | 264.9 | 329.7 | 192.0 | 46.9 | 137.7 |
| December | 43.8 | 23.90 | 8.07 | 67.0 | 61.0 | 204.5 | 467.5 | 163.6 | 19.1 | 303.9 |
| Year | 1534.4 | 604.78 | 13.01 | 1642.6 | 1520.0 | 4896.4 | 4783.7 | 2940.1 | 1547.6 | 1843.6 |

Legends

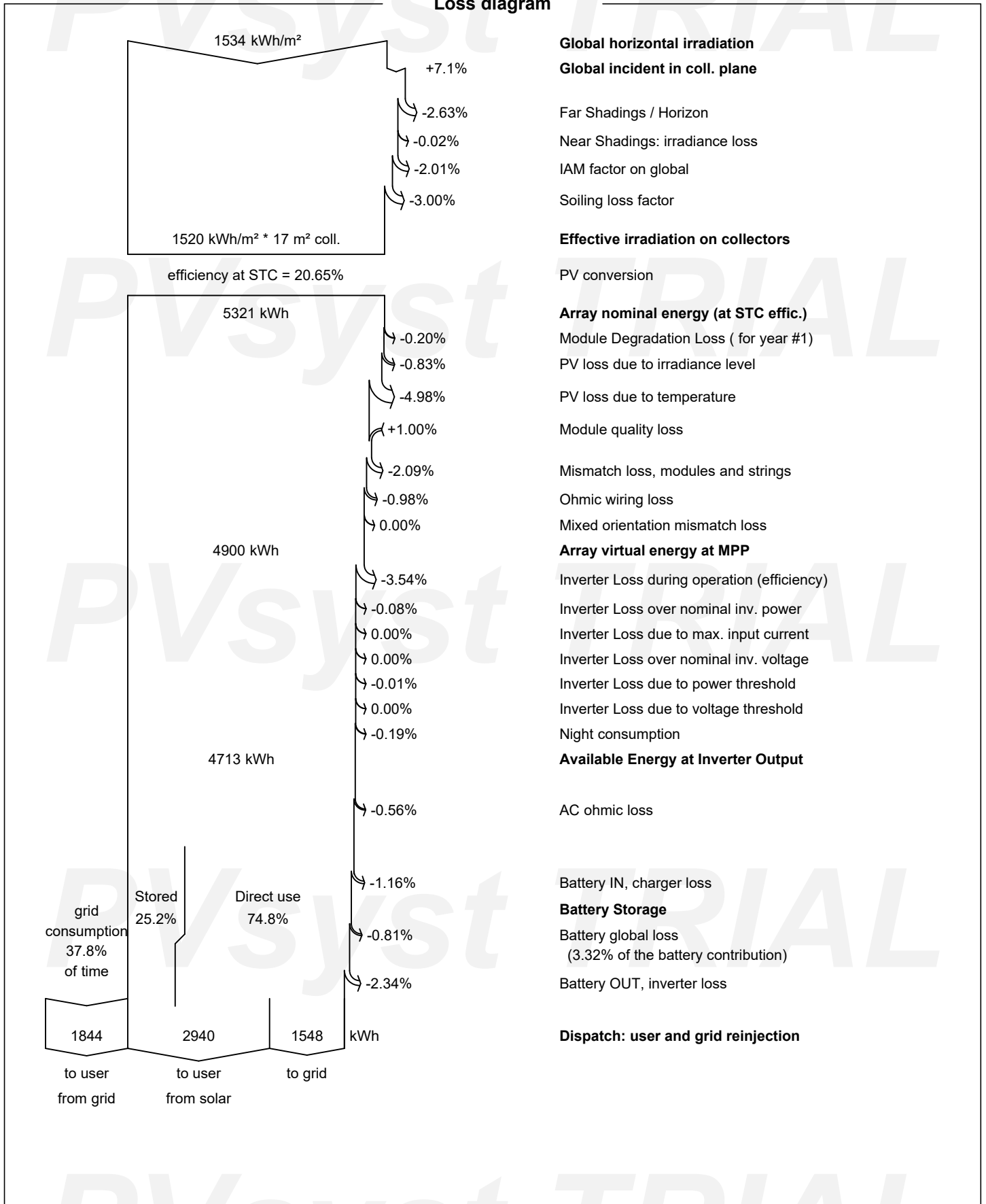
| | | | |
|---------|--|---------|---|
| GlobHor | Global horizontal irradiation | EArray | Effective energy at the output of the array |
| DiffHor | Horizontal diffuse irradiation | E_User | Energy supplied to the user |
| T_Amb | Ambient Temperature | E_Solar | Energy from the sun |
| GlobInc | Global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



PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Loss diagram



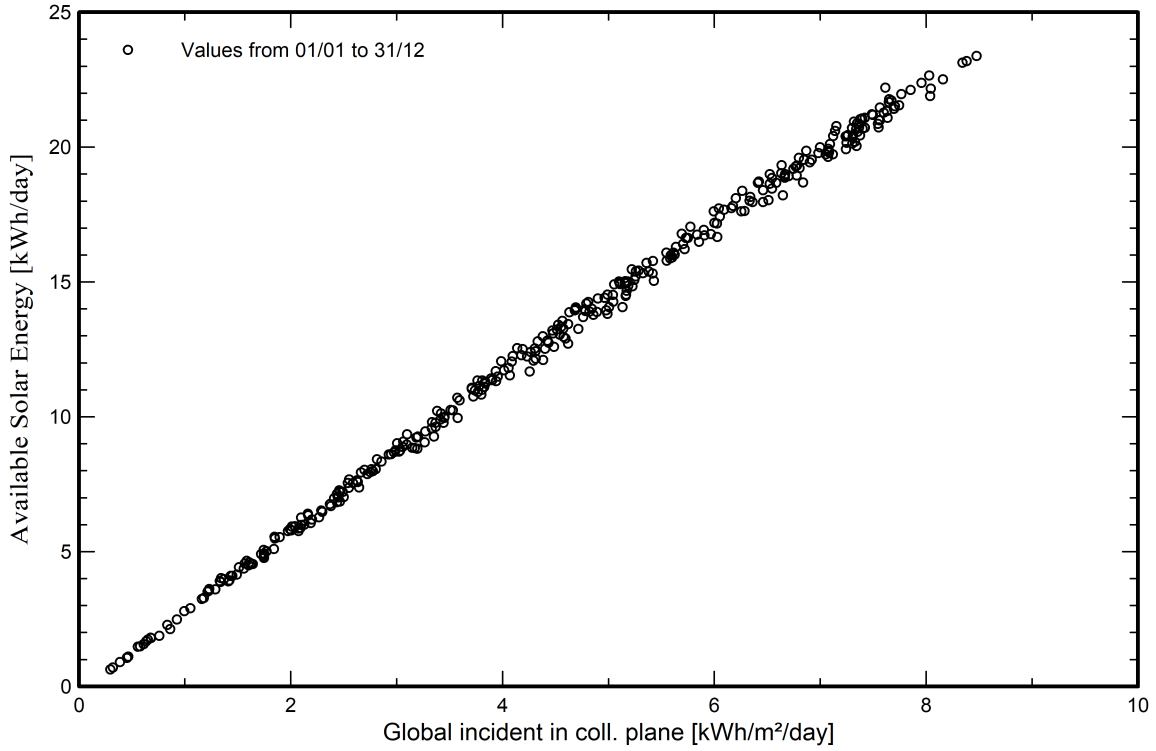


PVsyst V7.2.21

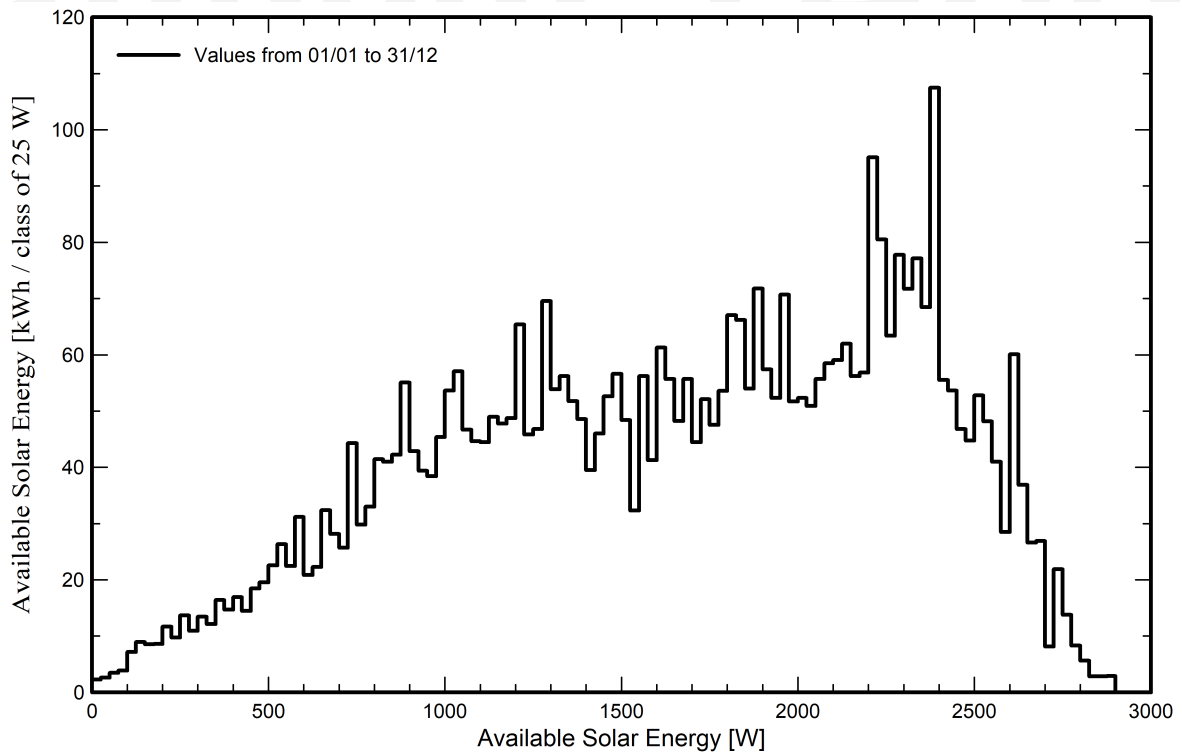
VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Special graphs

Diagrama entrada/salida diaria



Distribución de potencia de salida del sistema





PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Cost of the system

Installation costs

| Item | Quantity units | Cost EUR | Total EUR |
|----------------------|-------------------|-------------|----------------|
| PV modules | | | |
| AS-M1203-H-350 | 10 | 114.00 | 1140.00 |
| Supports for modules | 10 | 48.11 | 481.10 |
| Inverters | | | |
| SUN2000-3KTL-L1 | 1 | 976.55 | 976.55 |
| Batteries | 2 | 801.52 | 1603.04 |
| Studies and analysis | | | |
| Engineering | 1 | 960.00 | 960.00 |
| Installation | | | |
| Mano de obra | 1 | 1500.00 | 1500.00 |
| Total | | | 6660.69 |
| Depreciable asset | | | 4200.69 |

Operating costs

| Item | Total EUR/year |
|-----------------------------|-------------------|
| Maintenance | |
| Repairs | 180.00 |
| Total (OPEX) | 180.00 |
| Including inflation (1.50%) | 216.45 |

System summary

| | |
|--|-----------------|
| Total installation cost | 6660.69 EUR |
| Operating costs (incl. inflation 1.50%/year) | 216.45 EUR/year |
| Unused energy | 2940 kWh/year |
| Energy sold to the grid | 1548 kWh/year |
| Cost of produced energy (LCOE) | 0.075 EUR/kWh |



PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Financial analysis

Simulation period

Project lifetime 25 years Start year 2023

Income variation over time

Inflation 1.50 %/year
Production variation (aging) -0.50 %/year
Discount rate 1.00 %/year

Income dependent expenses

Income tax rate 10.00 %/year
Other income tax 10.00 %/year
Dividends 15.00 %/year

Tax depreciation

Depreciable assets 4200.69 EUR
Salvage value 3000.00 EUR
Total redeemable 1200.69 EUR
Depreciation period 20 years

Financing

Own funds 2247.19 EUR
Subsidies 4413.50 EUR

Electricity sale

Feed-in tariff Peak tariff 0.3173 EUR/kWh
Off-peak tariff 0.2241 EUR/kWh 20:00-07:00
Duration of tariff warranty 20 years
Annual connection tax 0.00 EUR/kWh
Annual tariff variation 0.0 %/year
Feed-in tariff decrease after warranty 0.00 %

Self-consumption

Consumption tariff Peak tariff 0.0600 EUR/kWh
Off-peak tariff 0.0500 EUR/kWh 20:00-07:00
Tariff evolution 0.0 %/year

Return on investment

Payback period 5.6 years
Net present value (NPV) 5847.44 EUR
Return on investment (ROI) 260.2 %
Paid dividends 768.75 EUR



PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Financial analysis

Detailed economic results (EUR)

| | Electricity sale | Run. costs | Deprec. allow. | Taxable income | Taxes | After-tax profit | Divid. 15.00% | Self-cons. saving | Cumul. profit | % amorti. |
|--------------|---------------------|---------------|-------------------|-------------------|------------|---------------------|------------------|----------------------|------------------|---------------|
| 2023 | 489 | 180 | 60 | 249 | 50 | 259 | 39 | 169 | -1823 | 18.9% |
| 2024 | 486 | 183 | 60 | 244 | 49 | 255 | 38 | 169 | -1408 | 37.4% |
| 2025 | 484 | 185 | 60 | 239 | 48 | 251 | 38 | 168 | -1001 | 55.4% |
| 2026 | 482 | 188 | 60 | 233 | 47 | 247 | 37 | 167 | -604 | 73.1% |
| 2027 | 479 | 191 | 60 | 228 | 46 | 243 | 36 | 166 | -215 | 90.4% |
| 2028 | 477 | 194 | 60 | 223 | 45 | 238 | 36 | 165 | 165 | 107.3% |
| 2029 | 474 | 197 | 60 | 218 | 44 | 234 | 35 | 164 | 537 | 123.9% |
| 2030 | 472 | 200 | 60 | 212 | 42 | 230 | 34 | 164 | 900 | 140.1% |
| 2031 | 470 | 203 | 60 | 207 | 41 | 226 | 34 | 163 | 1255 | 155.9% |
| 2032 | 467 | 206 | 60 | 202 | 40 | 221 | 33 | 162 | 1602 | 171.3% |
| 2033 | 465 | 209 | 60 | 196 | 39 | 217 | 33 | 161 | 1941 | 186.4% |
| 2034 | 463 | 212 | 60 | 191 | 38 | 213 | 32 | 160 | 2272 | 201.1% |
| 2035 | 460 | 215 | 60 | 185 | 37 | 208 | 31 | 160 | 2595 | 215.5% |
| 2036 | 458 | 218 | 60 | 180 | 36 | 204 | 31 | 159 | 2910 | 229.5% |
| 2037 | 456 | 222 | 60 | 174 | 35 | 199 | 30 | 158 | 3218 | 243.2% |
| 2038 | 454 | 225 | 60 | 168 | 34 | 195 | 29 | 157 | 3518 | 256.6% |
| 2039 | 451 | 228 | 60 | 163 | 33 | 190 | 29 | 156 | 3811 | 269.6% |
| 2040 | 449 | 232 | 60 | 157 | 31 | 186 | 28 | 156 | 4096 | 282.3% |
| 2041 | 447 | 235 | 60 | 151 | 30 | 181 | 27 | 155 | 4374 | 294.6% |
| 2042 | 445 | 239 | 60 | 146 | 29 | 177 | 26 | 154 | 4645 | 306.7% |
| 2043 | 442 | 242 | 0 | 200 | 40 | 160 | 24 | 153 | 4899 | 318.0% |
| 2044 | 440 | 246 | 0 | 194 | 39 | 155 | 23 | 152 | 5146 | 329.0% |
| 2045 | 438 | 250 | 0 | 188 | 38 | 151 | 23 | 152 | 5387 | 339.7% |
| 2046 | 436 | 254 | 0 | 182 | 36 | 146 | 22 | 151 | 5620 | 350.1% |
| 2047 | 434 | 257 | 0 | 176 | 35 | 141 | 21 | 150 | 5847 | 360.2% |
| Total | 11517 | 5411 | 1201 | 4905 | 981 | 5125 | 769 | 3991 | 5847 | 360.2% |

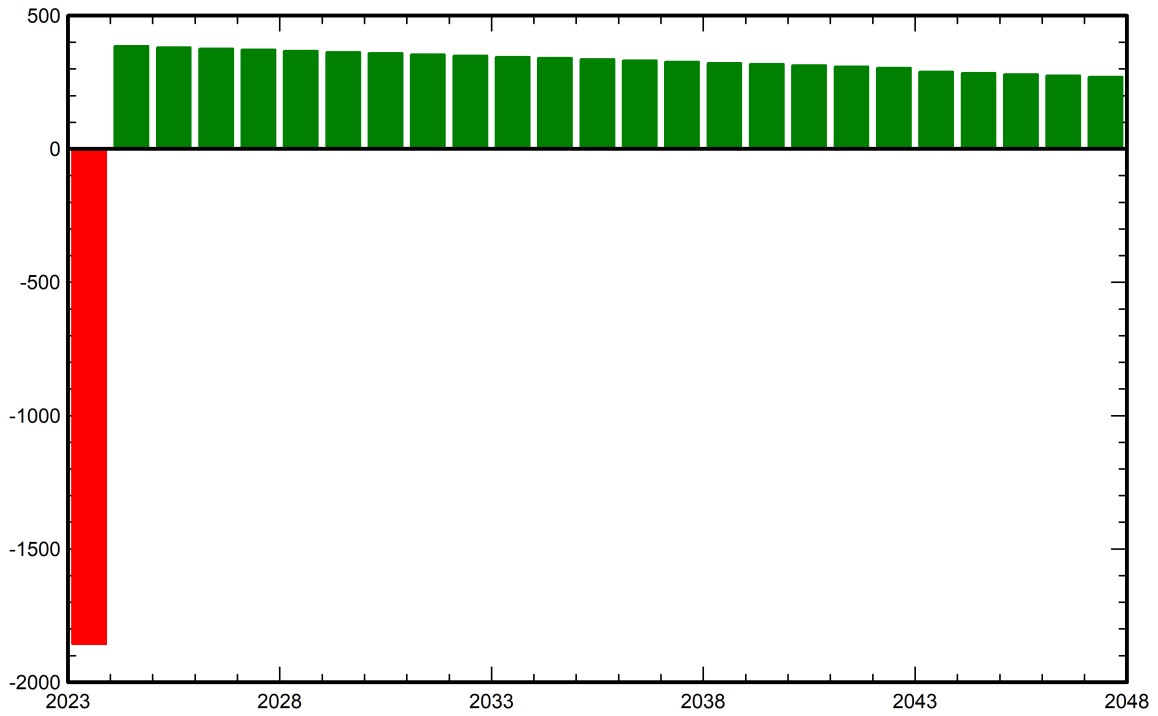


PVsyst V7.2.21

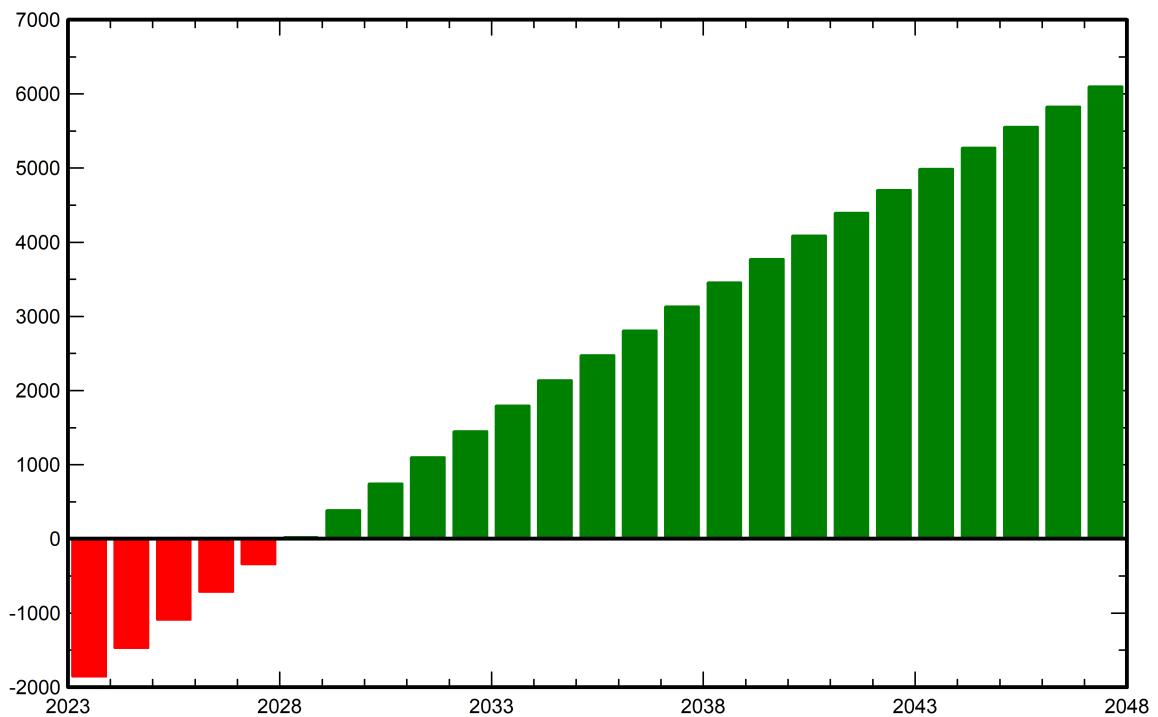
VC6, Simulation date:
03/12/22 18:58
with v7.2.21

Financial analysis

Yearly net profit (EUR)



Cumulative cashflow (EUR)





PVsyst V7.2.21

VC6, Simulation date:
03/12/22 18:58
with v7.2.21

CO₂ Emission Balance

Total: 29.1 tCO₂

Generated emissions

Total: 5.95 tCO₂

Source: Detailed calculation from table below:

Replaced Emissions

Total: 40.4 tCO₂

System production: 4686.97 kWh/yr

Grid Lifecycle Emissions: 287 gCO₂/kWh

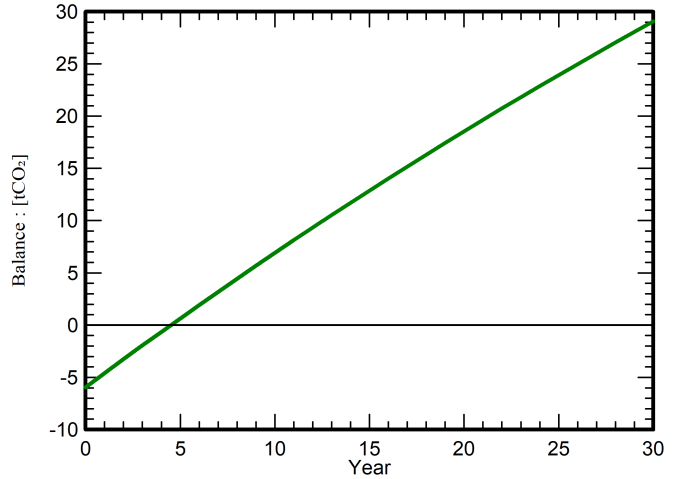
Source: IEA List

Country: Spain

Lifetime: 30 years

Annual degradation: 1.0 %

Saved CO₂ Emission vs. Time



System Lifecycle Emissions Details

| Item | LCE | Quantity | Subtotal [kgCO ₂] |
|-----------|-----------------------------|----------|----------------------------------|
| Modules | 1590 kgCO ₂ /kWp | 3.50 kWp | 5566 |
| Supports | 1.91 kgCO ₂ /kg | 100.0 kg | 191 |
| Inverters | 190 kgCO ₂ / | 1.00 | 190 |

PVsyst - Simulation report

Grid-Connected System

Project: Pereira

Variant: FINAL Pereira (Cubierta A y B 4kW)

Tables on a building

System power: 4200 Wp

Pereira de Montes (A Merca) - Spain

| Author



Project: Pereira

Variant: FINAL Pereira (Cubierta A y B 4kW)

PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Project summary

Geographical Site
Pereira de Montes (A Merca)
Spain

Situation
Latitude 42.23 °N
Longitude -7.95 °W
Altitude 384 m
Time zone UTC+1

Project settings
Albedo 0.20

Meteo data

Pereira
Meteonorm 7.3 (1999-2010), Sat=100% - Sintético

System summary

Grid-Connected System

Simulation for year no 1

PV Field Orientation

Fixed planes 2 orientations
Tilts/azimuths 45 / -40 °
45 / 50 °

System information

PV Array

Nb. of modules 12 units
Pnom total 4200 Wp

Tables on a building

Near Shadings

Linear shadings

Inverters

Nb. of units 1 unit
Pnom total 4000 W
Grid power limit 3500 W
Grid lim. Pnom ratio 1.200

User's needs

Ext. defined as file
Consumo final.csv

Battery pack

Storage strategy: Self-consumption
Nb. of units 2 units
Voltage 48 V
Capacity 108 Ah

Results summary

| | | | | | |
|-----------------|---------------|---------------------|-------------------|-------------------|---------|
| Produced Energy | 5.34 MWh/year | Specific production | 1272 kWh/kWp/year | Perf. Ratio PR | 77.44 % |
| Used Energy | 4.78 MWh/year | | | Solar Fraction SF | 63.86 % |

Table of contents

| | |
|---|----|
| Project and results summary | 2 |
| General parameters, PV Array Characteristics, System losses | 3 |
| Horizon definition | 5 |
| Near shading definition - Iso-shadings diagram | 6 |
| Main results | 8 |
| Loss diagram | 9 |
| Special graphs | 10 |
| P50 - P90 evaluation | 11 |
| Cost of the system | 12 |
| Financial analysis | 13 |
| CO ₂ Emission Balance | 16 |



PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

General parameters

Grid-Connected System

PV Field Orientation

Orientation

Fixed planes 2 orientations
Tilts/azimuths 45 / -40 °
45 / 50 °

Horizon

Average Height 5.1 °

Storage

Kind Self-consumption

Charging strategy

When excess solar power is available

Tables on a building

Sheds configuration

Near Shadings

Linear shadings

Models used

Transposition Perez
Diffuse Perez, Meteororm
Circumsolar separate

User's needs

Ext. defined as file
Consumo final.csv

Grid power limitation

Active Power 3500 W
Pnom ratio 1.200

Discharging strategy

As soon as power is needed

| Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sep. | Oct. | Nov. | Dec. | Year | |
|------|------|------|------|-----|------|------|------|------|------|------|------|------|-----|
| 389 | 405 | 636 | 405 | 480 | 313 | 305 | 403 | 323 | 328 | 330 | 467 | 4784 | kWh |

PV Array Characteristics

PV module

Manufacturer Generic
Model AS-M1203-H-350
(Original PVsyst database)

Unit Nom. Power 350 Wp
Number of PV modules 12 units
Nominal (STC) 4200 Wp
Modules 2 Strings x 6 In series

At operating cond. (50°C)

Pmpp 3843 Wp
U mpp 193 V
I mpp 20 A

Total PV power

Nominal (STC) 4.20 kWp
Total 12 modules
Module area 20.3 m²

Battery Storage

Battery

Manufacturer Generic
Model DCB102Z

Battery pack

Nb. of units 2 in parallel
Discharging min. SOC 20.0 %
Stored energy 4.2 kWh

Battery input charger

Model Generic
Max. charg. power 3.3 kWdc
Max./Euro effic. 97.0/95.0 %

Battery to Grid inverter

Model Generic
Max. disch. power 5.0 kWac
Max./Euro effic. 97.0/95.0 %

Inverter

Manufacturer Generic
Model SUN2000-4KTL-L1
(Original PVsyst database)

Unit Nom. Power 4.00 kWac
Number of inverters 2 * MPPT 50% 1 unit
Total power 4.0 kWac
Operating voltage 80-600 V
Max. power (=>50°C) 4.40 kWac
Pnom ratio (DC:AC) 1.05

Total inverter power

Total power 4 kWac
Number of inverters 1 unit
Pnom ratio 1.05

Battery Pack Characteristics

Voltage 48 V
Nominal Capacity 108 Ah (C10)
Temperature Fixed 20 °C



PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Thermal Loss factor

Module temperature according to irradiance

Uc (const) 20.0 W/m²K

Uv (wind) 0.0 W/m²K/m/s

DC wiring losses

Global array res. 159 mΩ

Loss Fraction 1.5 % at STC

Module Quality Loss

Loss Fraction -1.0 %

Module mismatch losses

Loss Fraction 2.0 % at MPP

Strings Mismatch loss

Loss Fraction 0.1 %

Module average degradation

Year no 1

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 |

AC wiring losses

Inv. output line up to injection point

Inverter voltage 230 Vac mono

Loss Fraction 1.38 % at STC

Inverter: SUN2000-4KTL-L1

Wire section (1 Inv.) Copper 1 x 2 x 3 mm²

Wires length 12 m



PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Horizon definition

Horizon from PVGIS website API, Lat=42°14'5", Long=-7°57'9", Alt=384m

| | | | |
|----------------|-------|-----------------|-------|
| Average Height | 5.1 ° | Albedo Factor | 0.76 |
| Diffuse Factor | 0.95 | Albedo Fraction | 100 % |

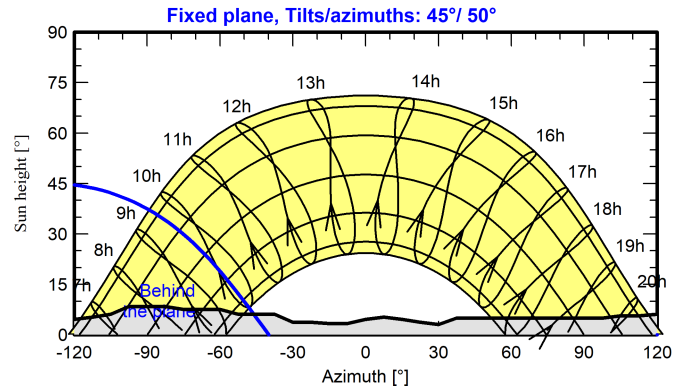
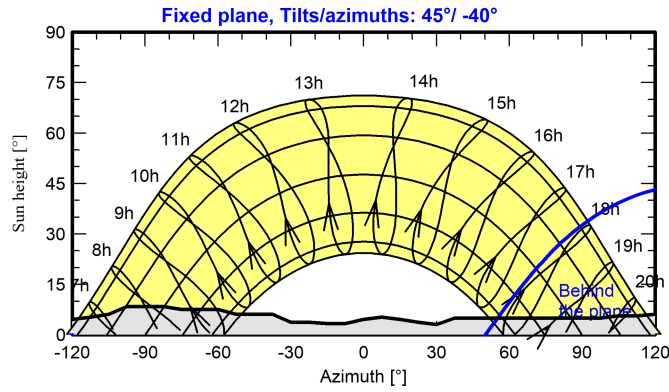
Horizon profile

| | | | | | | | | | | | | | |
|-------------|------|------|------|------|------|------|------|------|------|------|-----|-----|-----|
| Azimuth [°] | -180 | -173 | -165 | -158 | -143 | -135 | -128 | -120 | -113 | -105 | -98 | -83 | -75 |
| Height [°] | 3.4 | 3.4 | 3.8 | 3.8 | 3.1 | 3.1 | 3.8 | 4.6 | 5.3 | 6.1 | 8.4 | 8.4 | 7.6 |
| Azimuth [°] | -60 | -53 | -38 | -30 | -23 | -15 | -8 | 0 | 8 | 15 | 23 | 30 | 38 |
| Height [°] | 7.6 | 6.1 | 6.1 | 3.8 | 3.8 | 3.4 | 3.4 | 4.6 | 5.3 | 4.6 | 3.8 | 3.1 | 5.0 |
| Azimuth [°] | 98 | 105 | 113 | 120 | 128 | 135 | 143 | 150 | 158 | 173 | 180 | | |
| Height [°] | 5.0 | 5.7 | 5.7 | 6.1 | 6.1 | 5.7 | 5.7 | 5.0 | 5.0 | 3.4 | 3.4 | | |

Sun Paths (Height / Azimuth diagram)

Orientation #1

Orientation #2



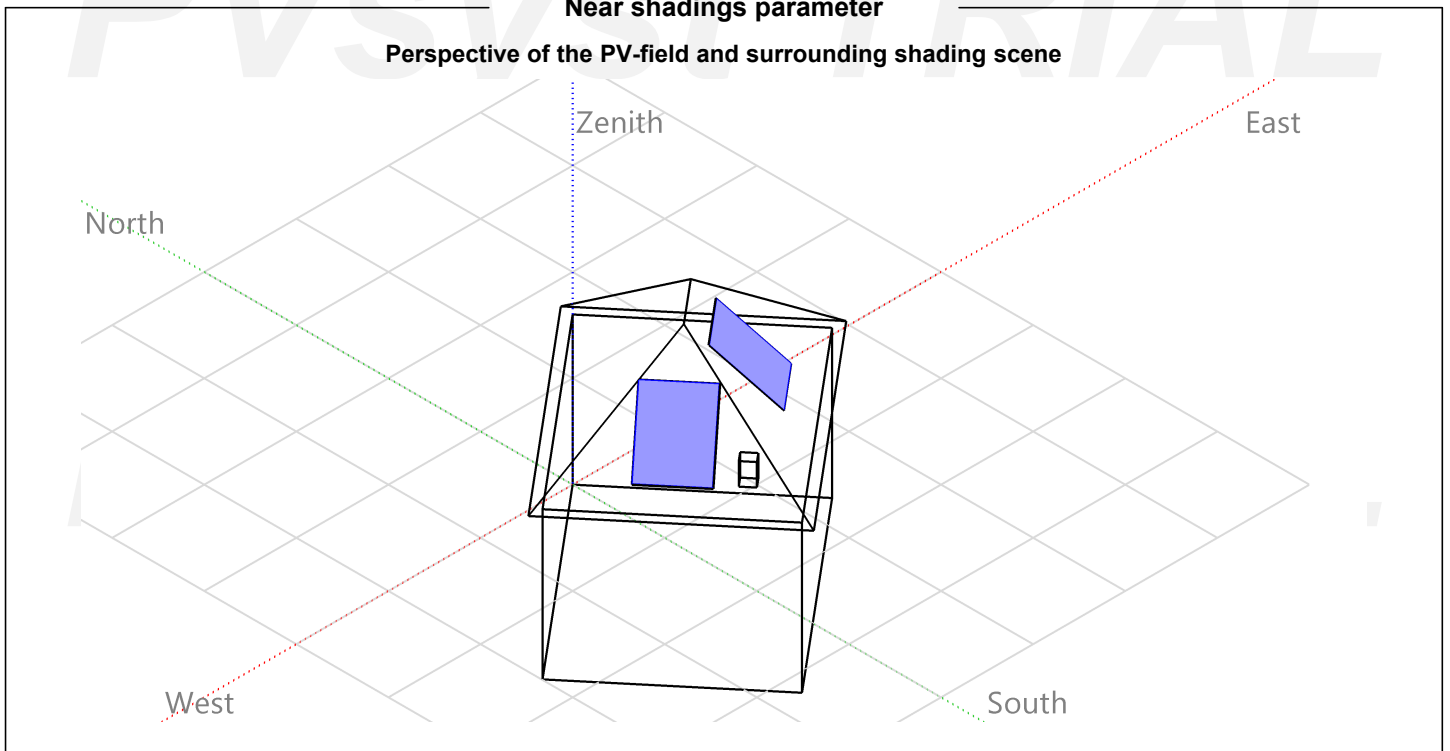


PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Near shadings parameter

Perspective of the PV-field and surrounding shading scene





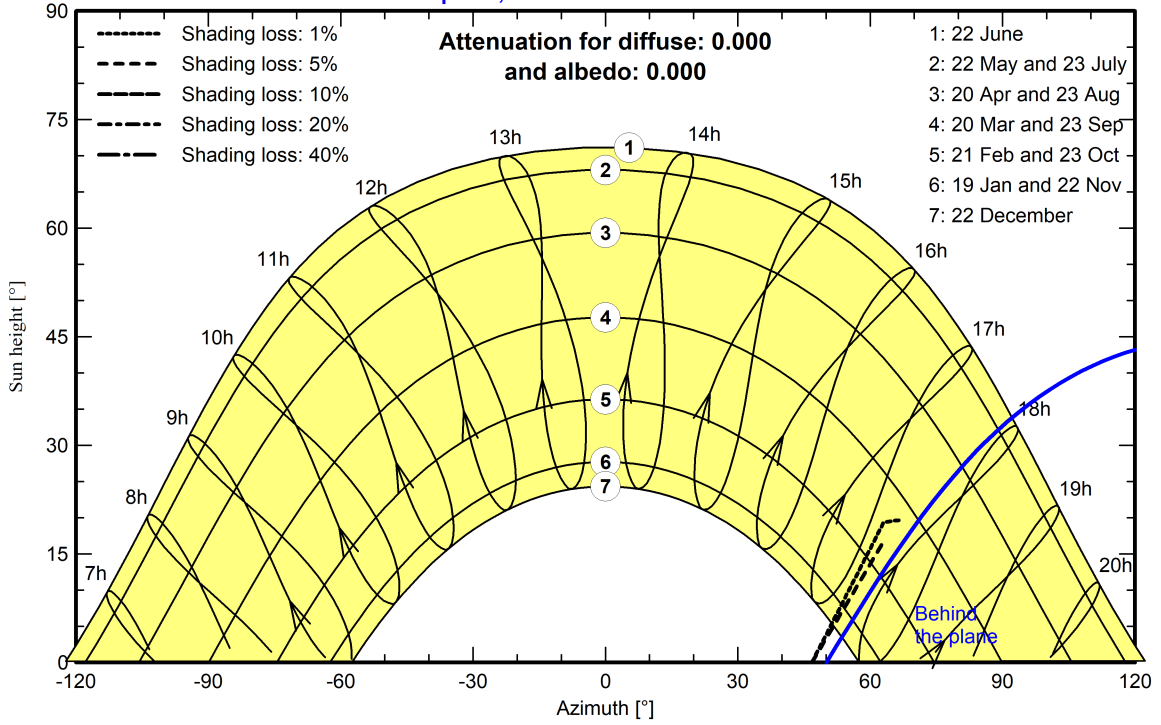
PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Iso-shadings diagram

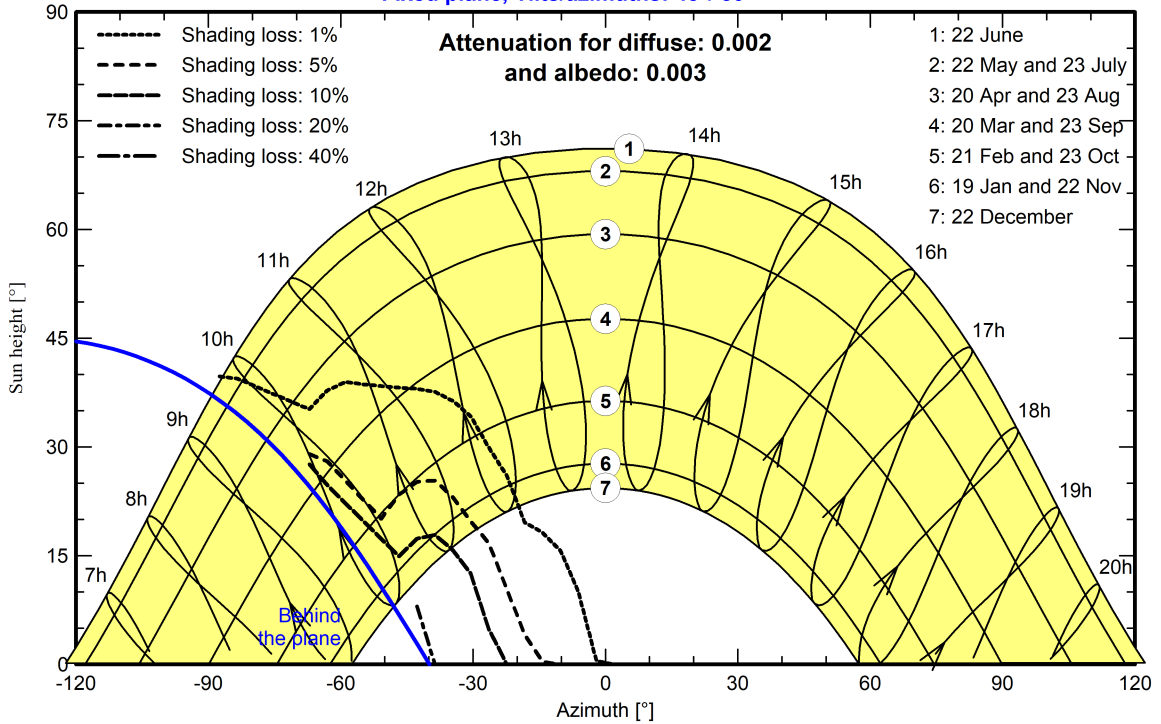
Orientation #1

Fixed plane, Tilts/azimuths: 45° / -40°



Orientation #2

Fixed plane, Tilts/azimuths: 45° / 50°





PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Main results

System Production

| | | | |
|-----------------|---------------|----------------------|-------------------|
| Produced Energy | 5.34 MWh/year | Specific production | 1272 kWh/kWp/year |
| Used Energy | 4.78 MWh/year | Performance Ratio PR | 77.44 % |
| | | Solar Fraction SF | 63.86 % |

Battery aging (State of Wear)

| | |
|------------------|-----------|
| Cycles SOW | 71.0 % |
| Static SOW | 90.0 % |
| Battery lifetime | 3.5 years |

Economic evaluation

Investment

| | |
|----------|-------------|
| Global | 9794.03 EUR |
| Specific | 2.33 EUR/Wp |

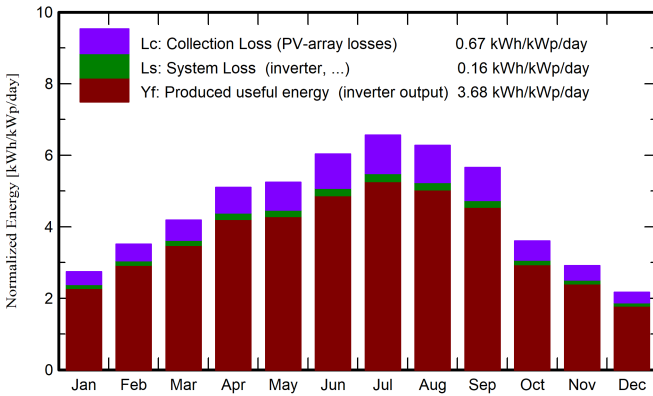
Yearly cost

| | |
|----------------|---------------|
| Annuities | 0.00 EUR/yr |
| Run. costs | 216.45 EUR/yr |
| Payback period | 8.5 years |

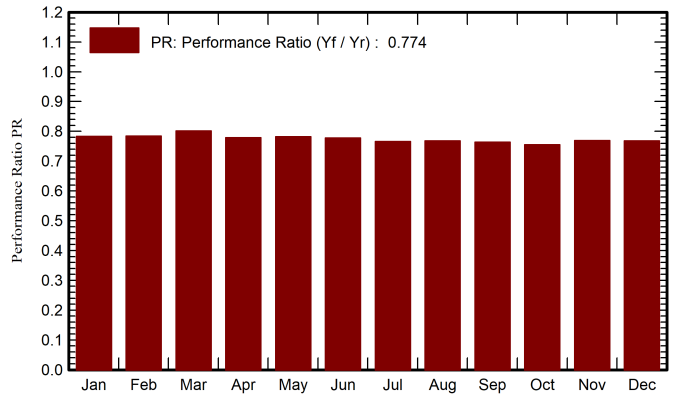
LCOE

| | |
|-------------|--------------|
| Energy cost | 0.09 EUR/kWh |
|-------------|--------------|

Normalized productions (per installed kWp)



Performance Ratio PR



Balances and main results

| | GlobHor | DiffHor | T_Amb | GlobInc | GlobEff | EArray | E_User | E_Solar | E_Grid | EFrGrid |
|-------------|--------------------|--------------------|--------------|--------------------|--------------------|--------------|--------------|--------------|--------------|--------------|
| | kWh/m ² | kWh/m ² | °C | kWh/m ² | kWh/m ² | MWh | MWh | MWh | MWh | MWh |
| January | 54.3 | 24.00 | 7.75 | 84.9 | 77.7 | 0.311 | 0.389 | 0.213 | 0.066 | 0.176 |
| February | 73.5 | 32.84 | 8.58 | 98.2 | 90.5 | 0.359 | 0.405 | 0.250 | 0.074 | 0.156 |
| March | 113.2 | 57.12 | 10.60 | 129.6 | 119.7 | 0.473 | 0.636 | 0.310 | 0.127 | 0.326 |
| April | 150.0 | 68.53 | 11.13 | 152.9 | 141.3 | 0.554 | 0.405 | 0.308 | 0.192 | 0.097 |
| May | 178.7 | 79.05 | 13.88 | 162.5 | 150.4 | 0.582 | 0.480 | 0.342 | 0.191 | 0.137 |
| June | 204.0 | 71.82 | 17.37 | 181.0 | 167.8 | 0.641 | 0.313 | 0.162 | 0.428 | 0.150 |
| July | 223.8 | 68.66 | 18.25 | 203.3 | 189.1 | 0.715 | 0.305 | 0.282 | 0.372 | 0.023 |
| August | 195.2 | 65.07 | 19.06 | 194.6 | 180.7 | 0.683 | 0.403 | 0.340 | 0.288 | 0.064 |
| September | 148.2 | 41.40 | 17.10 | 169.8 | 158.7 | 0.598 | 0.323 | 0.258 | 0.287 | 0.065 |
| October | 90.7 | 44.67 | 14.11 | 111.7 | 102.8 | 0.401 | 0.328 | 0.211 | 0.143 | 0.117 |
| November | 59.0 | 27.70 | 9.89 | 87.3 | 79.9 | 0.318 | 0.330 | 0.201 | 0.081 | 0.129 |
| December | 43.8 | 23.90 | 8.07 | 67.1 | 60.9 | 0.245 | 0.467 | 0.178 | 0.039 | 0.290 |
| Year | 1534.4 | 604.78 | 13.01 | 1642.8 | 1519.3 | 5.879 | 4.784 | 3.055 | 2.288 | 1.729 |

Legends

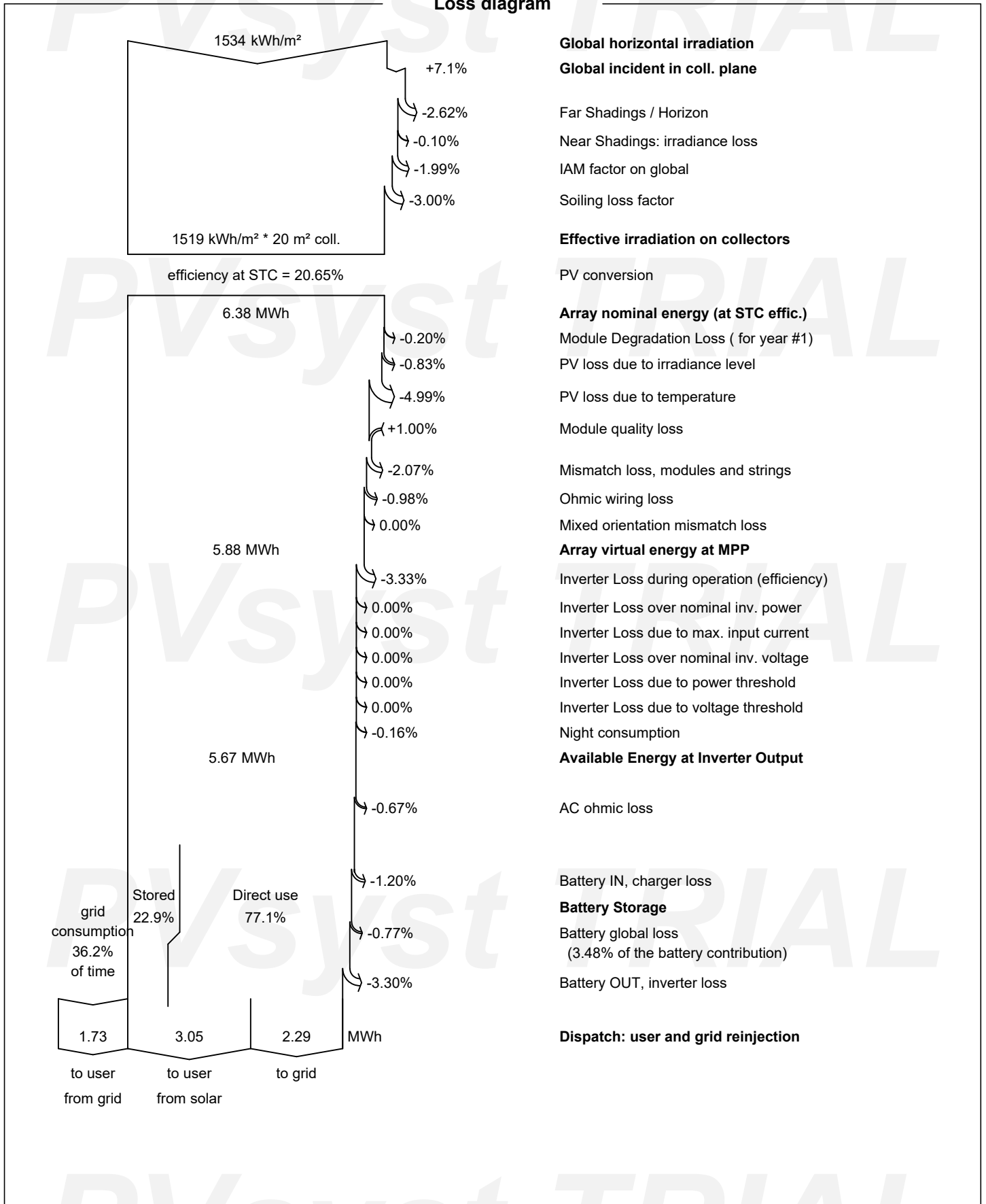
| | | | |
|---------|--|---------|---|
| GlobHor | Global horizontal irradiation | EArray | Effective energy at the output of the array |
| DiffHor | Horizontal diffuse irradiation | E_User | Energy supplied to the user |
| T_Amb | Ambient Temperature | E_Solar | Energy from the sun |
| GlobInc | Global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



PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Loss diagram



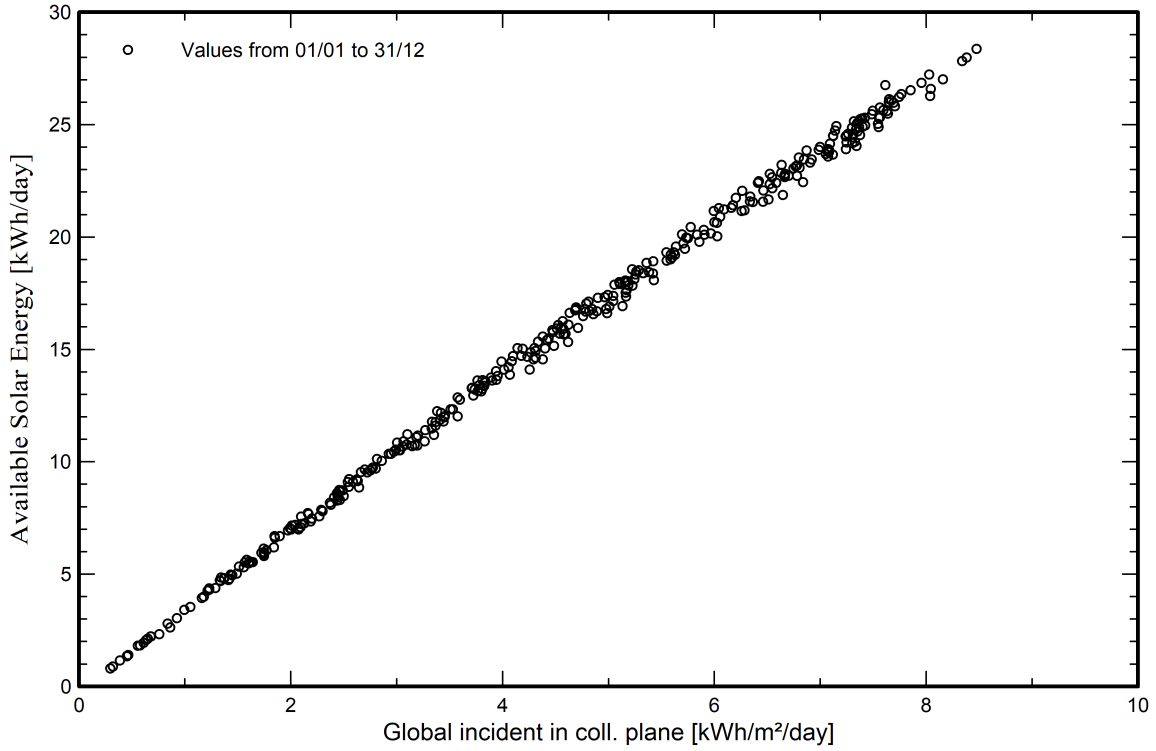


PVsyst V7.2.21

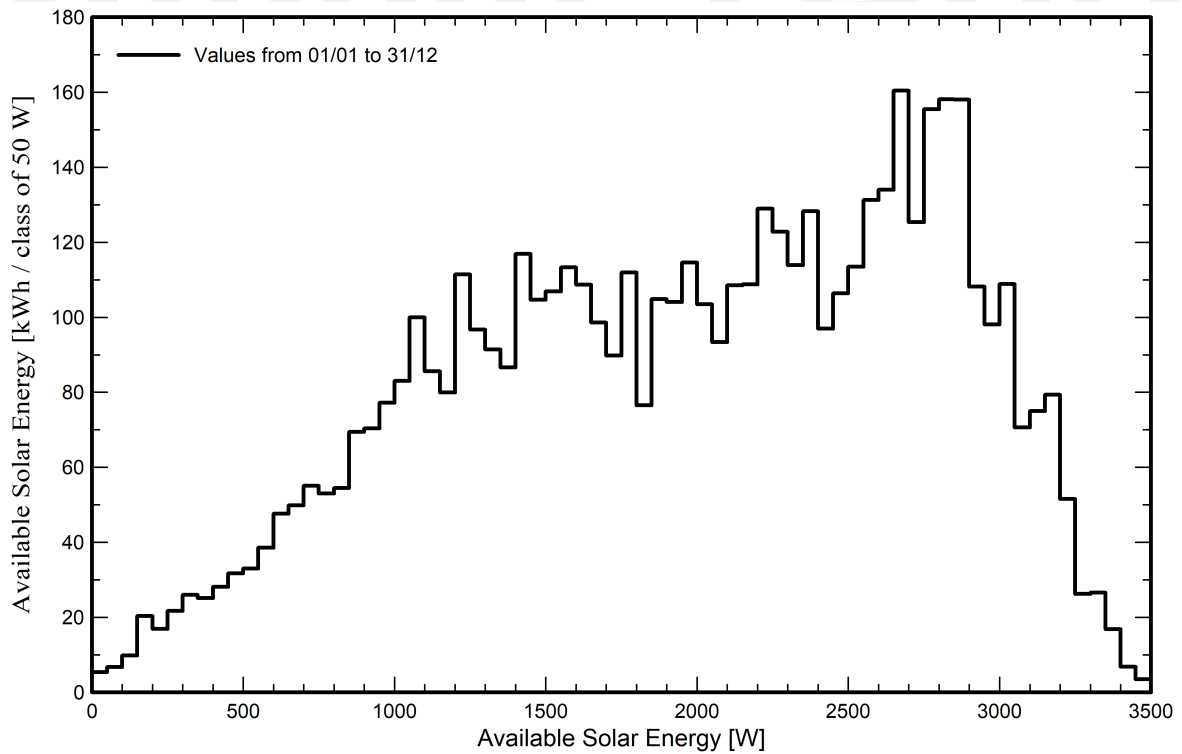
VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Special graphs

Diagrama entrada/salida diaria



Distribución de potencia de salida del sistema





PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

P50 - P90 evaluation

Meteo data

Source Meteonorm 7.3 (1999-2010), Sat=100%
Kind Monthly averages
Sintético - Multi-year average
Year-to-year variability(Variance) 3.2 %

Specified Deviation

Climate change 0.0 %

Global variability (meteo + system)

Variability (Quadratic sum) 3.6 %

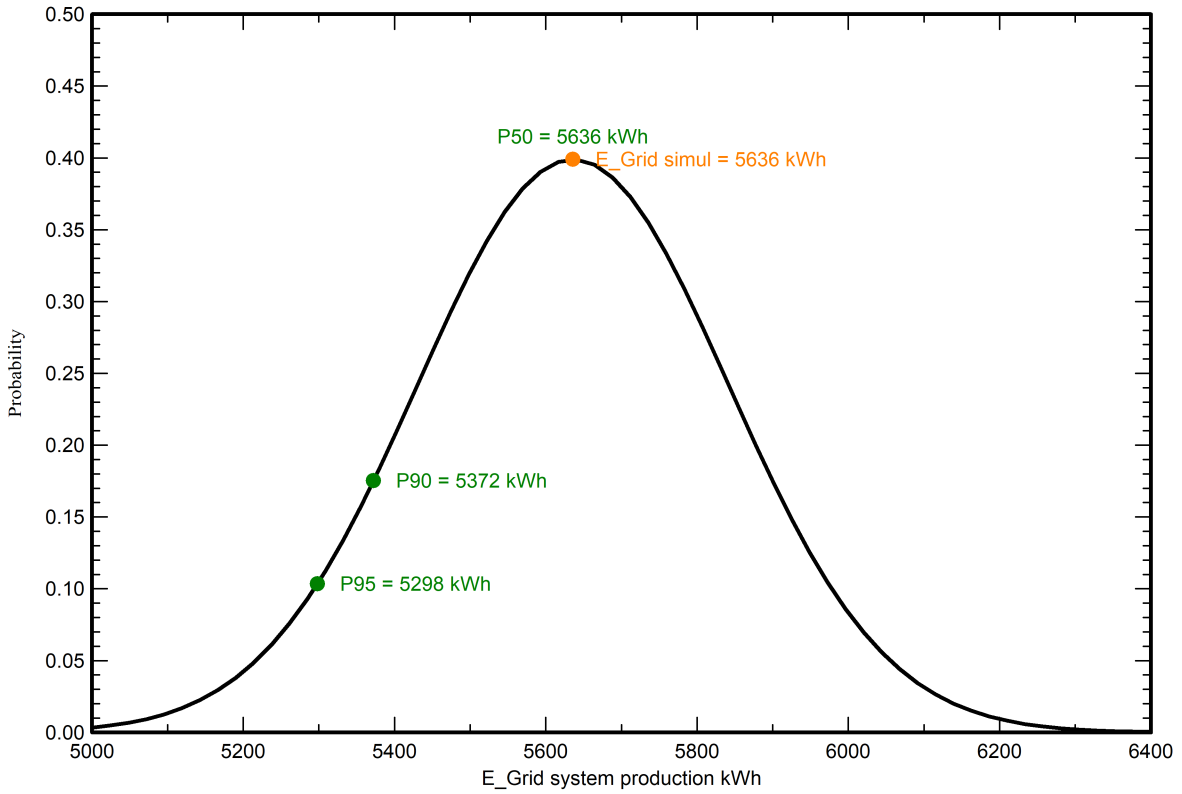
Simulation and parameters uncertainties

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 206 kWh
P50 5636 kWh
P90 5372 kWh
P95 5298 kWh

Probability distribution



**PVsyst V7.2.21**

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Cost of the system**Installation costs**

| Item | Quantity units | Cost EUR | Total EUR |
|------------------------------------|-------------------|-------------|----------------|
| PV modules | | | |
| AS-M1203-H-350 | 12 | 114.00 | 1368.00 |
| Supports for modules | 12 | 48.11 | 577.32 |
| Inverters | | | |
| SUN2000-4KTL-L1 | 1 | 1187.20 | 1187.20 |
| Batteries | 2 | 801.52 | 1603.04 |
| Other components | | | |
| Cableado y protecciones | 1 | 292.63 | 292.63 |
| Sensores | 1 | 518.95 | 518.95 |
| Smartlogger | 1 | 546.89 | 546.89 |
| Studies and analysis | | | |
| Engineering | 1 | 960.00 | 960.00 |
| Estudios y gestiones | 1 | 750.00 | 750.00 |
| Installation | | | |
| Configuración de la monitorización | 1 | 190.00 | 190.00 |
| Mano de obra | 1 | 1800.00 | 1800.00 |
| Total | | | 9794.03 |
| Depreciable asset | | | 5028.19 |

Operating costs

| Item | Total EUR/year |
|-----------------------------|-------------------|
| Maintenance | |
| Repairs | 180.00 |
| Total (OPEX) | 180.00 |
| Including inflation (1.50%) | 216.45 |

System summary

| | |
|--|-----------------|
| Total installation cost | 9794.03 EUR |
| Operating costs (incl. inflation 1.50%/year) | 216.45 EUR/year |
| Unused energy | 3055 kWh/year |
| Energy sold to the grid | 2288 kWh/year |
| Cost of produced energy (LCOE) | 0.087 EUR/kWh |



PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Financial analysis

Simulation period

Project lifetime 25 years Start year 2023

Income variation over time

Inflation 1.50 %/year
Production variation (aging) -0.50 %/year
Discount rate 1.00 %/year

Income dependent expenses

Income tax rate 10.00 %/year
Other income tax 10.00 %/year
Dividends 15.00 %/year

Tax depreciation

Depreciable assets 5028.19 EUR
Salvage value 3000.00 EUR
Total redeemable 2028.19 EUR
Depreciation period 20 years

Financing

Own funds 4922.03 EUR
Subsidies 4872.00 EUR

Electricity sale

Feed-in tariff Peak tariff 0.3173 EUR/kWh
Off-peak tariff 0.2241 EUR/kWh 20:00-07:00
Duration of tariff warranty 20 years
Annual connection tax 0.00 EUR/kWh
Annual tariff variation 0.0 %/year
Feed-in tariff decrease after warranty 0.00 %

Self-consumption

Consumption tariff Peak tariff 0.0600 EUR/kWh
Off-peak tariff 0.0500 EUR/kWh 20:00-07:00
Tariff evolution 0.0 %/year

Return on investment

Payback period 8.5 years
Net present value (NPV) 7358.24 EUR
Return on investment (ROI) 149.5 %
Paid dividends 1455.12 EUR



PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Financial analysis

Detailed economic results (EUR)

| | Electricity sale | Run. costs | Deprec. allow. | Taxable income | Taxes | After-tax profit | Divid. 15.00% | Self-cons. saving | Cumul. profit | % amorti. |
|--------------|---------------------|---------------|-------------------|-------------------|-------------|---------------------|------------------|----------------------|------------------|---------------|
| 2023 | 723 | 180 | 101 | 442 | 88 | 455 | 68 | 176 | -4297 | 12.7% |
| 2024 | 719 | 183 | 101 | 435 | 87 | 450 | 67 | 175 | -3685 | 25.1% |
| 2025 | 716 | 185 | 101 | 429 | 86 | 445 | 67 | 174 | -3084 | 37.3% |
| 2026 | 712 | 188 | 101 | 423 | 85 | 439 | 66 | 174 | -2495 | 49.3% |
| 2027 | 709 | 191 | 101 | 416 | 83 | 434 | 65 | 173 | -1917 | 61.0% |
| 2028 | 705 | 194 | 101 | 410 | 82 | 429 | 64 | 172 | -1351 | 72.5% |
| 2029 | 702 | 197 | 101 | 403 | 81 | 424 | 64 | 171 | -796 | 83.8% |
| 2030 | 698 | 200 | 101 | 397 | 79 | 419 | 63 | 170 | -252 | 94.9% |
| 2031 | 695 | 203 | 101 | 390 | 78 | 414 | 62 | 169 | 281 | 105.7% |
| 2032 | 691 | 206 | 101 | 384 | 77 | 408 | 61 | 168 | 803 | 116.3% |
| 2033 | 688 | 209 | 101 | 377 | 75 | 403 | 60 | 168 | 1315 | 126.7% |
| 2034 | 684 | 212 | 101 | 371 | 74 | 398 | 60 | 167 | 1816 | 136.9% |
| 2035 | 681 | 215 | 101 | 364 | 73 | 393 | 59 | 166 | 2307 | 146.9% |
| 2036 | 677 | 218 | 101 | 358 | 72 | 387 | 58 | 165 | 2787 | 156.6% |
| 2037 | 674 | 222 | 101 | 351 | 70 | 382 | 57 | 164 | 3258 | 166.2% |
| 2038 | 671 | 225 | 101 | 344 | 69 | 377 | 57 | 163 | 3719 | 175.6% |
| 2039 | 667 | 228 | 101 | 337 | 67 | 371 | 56 | 163 | 4170 | 184.7% |
| 2040 | 664 | 232 | 101 | 331 | 66 | 366 | 55 | 162 | 4611 | 193.7% |
| 2041 | 661 | 235 | 101 | 324 | 65 | 361 | 54 | 161 | 5042 | 202.4% |
| 2042 | 657 | 239 | 101 | 317 | 63 | 355 | 53 | 160 | 5465 | 211.0% |
| 2043 | 654 | 242 | 0 | 412 | 82 | 329 | 49 | 159 | 5861 | 219.1% |
| 2044 | 651 | 246 | 0 | 405 | 81 | 324 | 49 | 159 | 6249 | 227.0% |
| 2045 | 647 | 250 | 0 | 398 | 80 | 318 | 48 | 158 | 6627 | 234.6% |
| 2046 | 644 | 254 | 0 | 391 | 78 | 313 | 47 | 157 | 6997 | 242.2% |
| 2047 | 641 | 257 | 0 | 384 | 77 | 307 | 46 | 156 | 7358 | 249.5% |
| Total | 17030 | 5411 | 2028 | 9591 | 1918 | 9701 | 1455 | 4150 | 7358 | 249.5% |

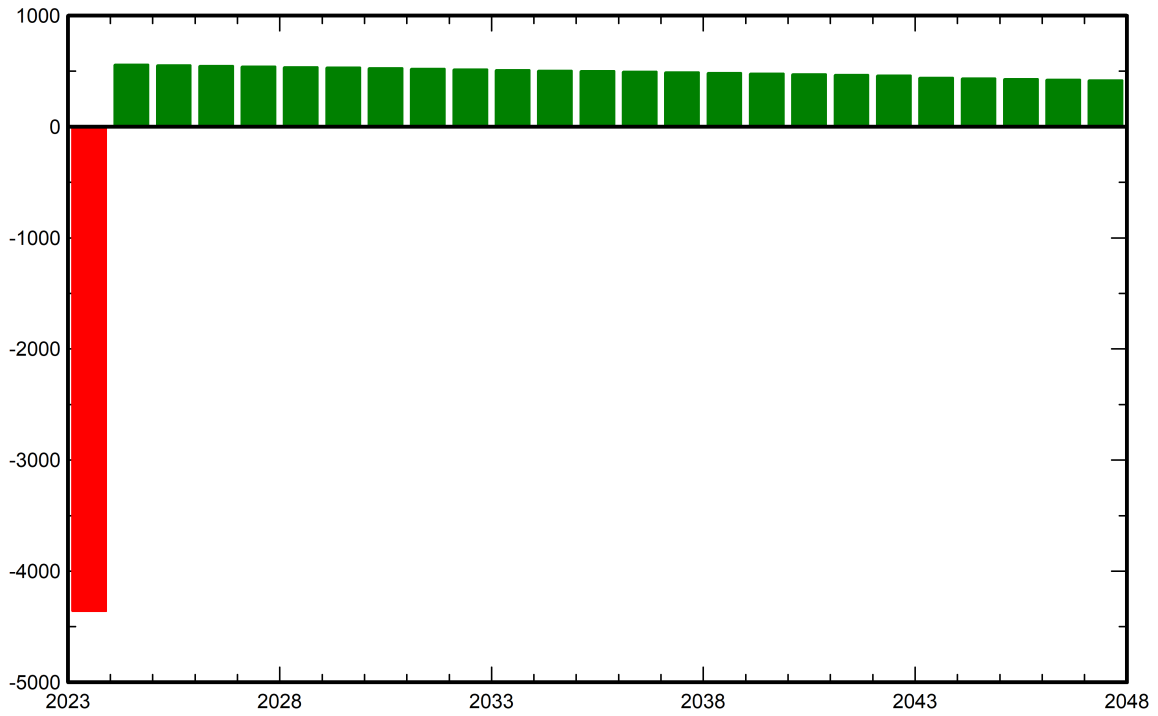


PVsyst V7.2.21

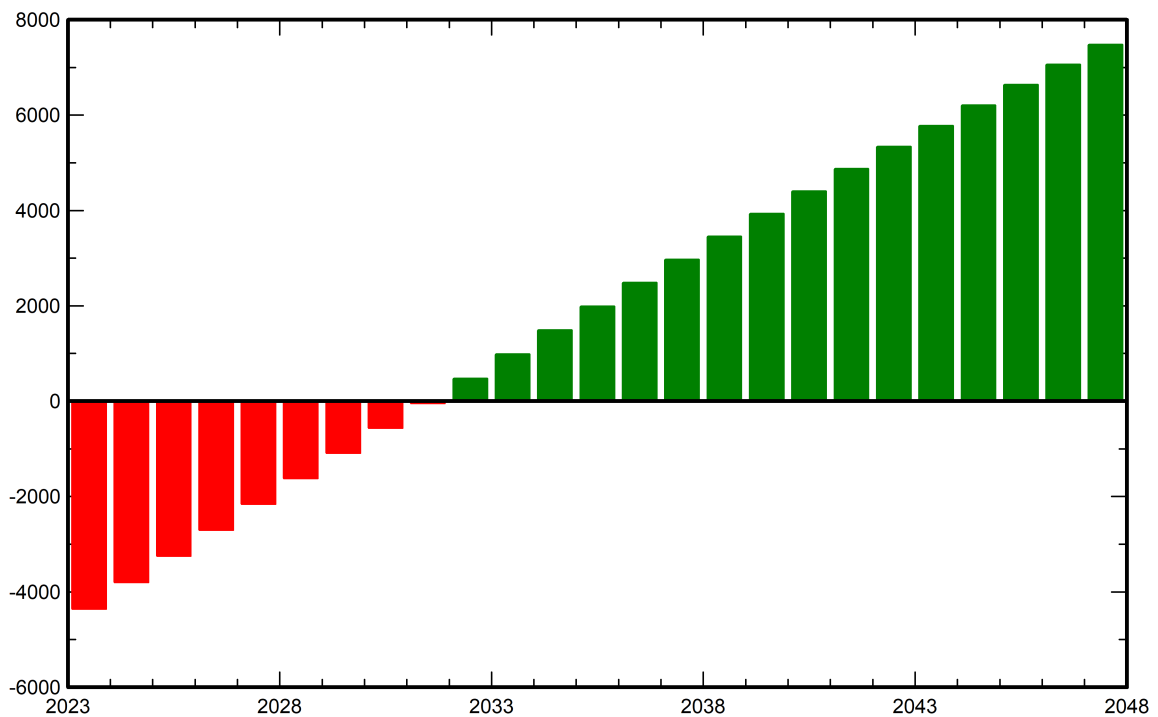
VC7, Simulation date:
04/12/22 12:35
with v7.2.21

Financial analysis

Yearly net profit (EUR)



Cumulative cashflow (EUR)





PVsyst V7.2.21

VC7, Simulation date:
04/12/22 12:35
with v7.2.21

CO₂ Emission Balance

Total: 34.5 tCO₂

Generated emissions

Total: 7.61 tCO₂

Source: Detailed calculation from table below:

Replaced Emissions

Total: 48.5 tCO₂

System production: 5635.97 kWh/yr

Grid Lifecycle Emissions: 287 gCO₂/kWh

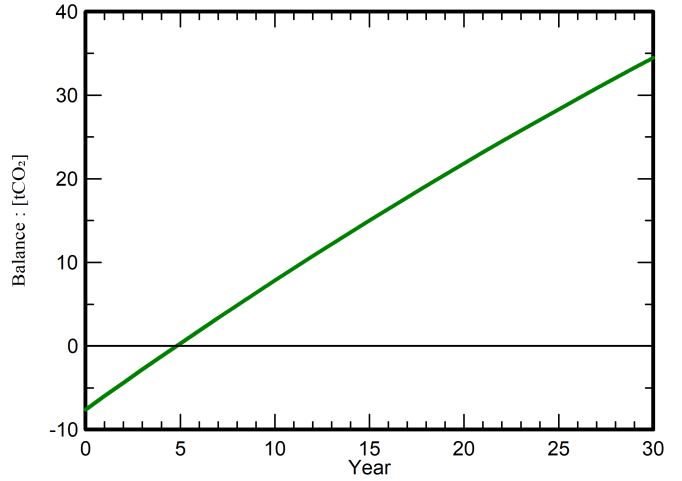
Source: IEA List

Country: Spain

Lifetime: 30 years

Annual degradation: 1.0 %

Saved CO₂ Emission vs. Time



System Lifecycle Emissions Details

| Item | LCE | Quantity | Subtotal |
|-----------|------------------------------|------------|----------------------|
| | | | [kgCO ₂] |
| Modules | 1713 kgCO ₂ /kWp | 4.20 kWp | 7193 |
| Supports | 1.91 kgCO ₂ /kg | 120 kg | 230 |
| Inverters | 190 kgCO ₂ /units | 1.00 units | 190 |

GIPUZKOAKO INGENIARITZA ESKOLA

ESCUELA DE INGENIERÍA DE GIPUZKOA

EIBAR

Instalación fotovoltaica conectada a red en Pereira de Montes

DOCUMENTO Nº6: ANEXO Nº2 FICHAS TÉCNICAS

Grado: Ingeniería de Energías Renovables

Curso: 2022-2023

Autor: Pérez Castro, Iker

Director: Aguirre Porturas, Iñigo



335 - 350 Wp 120 MONOCRYSTALLINE HALF-CUT CELLS

AEG solar modules combine the most advanced technology with high reliability in manufacture to offer you a product meant for high achievements.



OPTIMIZED DESIGN MAXIMUM EFFICIENCY

AEG solar modules with half-cut cells and 9 busbar technology are designed to maximize efficiency and plant performance. The 110 cm extra-long cables allow more installation flexibility and comfort.



CAREFUL SELECTION, PREMIUM LOOK

The careful selection of components (cells, backsheet and frames) ensures a premium product look and provides extra aesthetical value.

COMPREHENSIVELY CERTIFIED

AEG solar modules and production facilities are compliant with the the latest standards to guarantee safety and reliability. Production facilities are certified according to ISO 9001, ISO 14001 and OHSAS 18001. AEG solar products are certified among others by:



YOUR ADVANTAGE AT A GLANCE

Premium solar panel with quality components
High efficiency - up to 350 Wp
Product certified IEC 61215:2016, IEC 61730:2016
15 years Product warranty
25 years linear Power warranty



PHOTOVOLTAIC MODULE AS-M1203-H



ELECTRICAL CHARACTERISTICS AT STC¹

AS-M1203-H-335

AS-M1203-H-340

AS-M1203-H-345

AS-M1203-H-350

| Parameter | Unit | AS-M1203-H-335 | AS-M1203-H-340 | AS-M1203-H-345 | AS-M1203-H-350 |
|-----------------------------|------|----------------|----------------|----------------|----------------|
| Nominal Power (Pmax) | [Wp] | 335 | 340 | 345 | 350 |
| Power Sorting ² | [Wp] | -0 / +5 | -0 / +5 | -0 / +5 | -0 / +5 |
| Maximum Power Voltage (Vmp) | [V] | 34.44 | 34.69 | 34.96 | 35.22 |
| Maximum Power Current (Imp) | [A] | 9.73 | 9.80 | 9.87 | 9.94 |
| Open Circuit Voltage (Voc) | [V] | 41.61 | 41.88 | 42.16 | 42.44 |
| Short Circuit Current (Isc) | [A] | 10.22 | 10.30 | 10.38 | 10.46 |
| Module Efficiency (ηm) | | 19.8% | 20.1% | 20.3% | 20.6% |
| Maximum System Voltage | [V] | 1000 | 1000 | 1000 | 1000 |
| Series Fuse Maximum Rating | [A] | 20 | 20 | 20 | 20 |

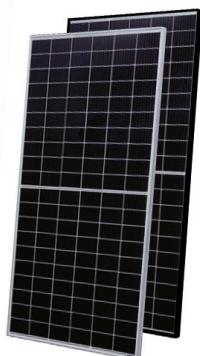
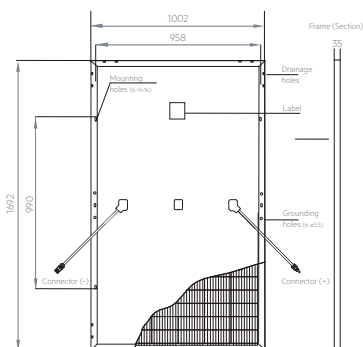
ELECTRICAL CHARACTERISTICS NMOT³

| Parameter | Unit | AS-M1203-H-335 | AS-M1203-H-340 | AS-M1203-H-345 | AS-M1203-H-350 |
|-----------------------------|------|----------------|----------------|----------------|----------------|
| Maximum Power (Pmax) | [W] | 2498 | 2535 | 2573 | 2610 |
| Maximum Power Voltage (Vmp) | [V] | 32.10 | 32.35 | 32.59 | 32.83 |
| Maximum Power Current (Imp) | [A] | 7.78 | 7.84 | 7.89 | 7.95 |
| Open Circuit Voltage (Voc) | [V] | 39.12 | 39.37 | 39.64 | 39.90 |
| Short Circuit Current (Isc) | [A] | 8.22 | 8.28 | 8.35 | 8.41 |

MECHANICAL CHARACTERISTICS

| | |
|--------------|---|
| Solar cells | 120 [(6 x 10) x 2] monocrystalline silicon, 158.75 x 78 mm half-cut cells |
| Front glass | 3.2 mm (0.12") high-transparency |
| Backsheet | White backsheet |
| Encapsulant | EVA (Ethylene-Vinyl Acetate) |
| Frame | Anodized aluminum alloy, silver or black color |
| Junction box | IP67, 3 bypass diodes |
| Cables | UV resistant cable 110 cm (43.3"), sec.4.0 mm ² |
| Connectors | MC4 compatible connectors |
| Dimensions | 1692 mm x 1002 mm x 35 mm (66.6" x 39.4" x 1.38") |
| Weight | 19.1 kg (42.1 lbs) |
| Maximum load | Wind: 2400 Pa / Snow: 5400 Pa |

TECHNICAL DRAWINGS



Module dimensions in the technical picture are expressed in mm with tolerance ±2 mm (+0.079")

1- Standard Test Conditions (STC): Irradiance 1000 W/m²; Air Mass AM = 1.5; Cell Temperature 25°C; Tolerance on Pmax ± 3%; Tolerance on Voc ± 3%; Tolerance on Isc ± 5%

2- AEG photovoltaic modules are classified according to a principle of positive power tolerance: the Power Output measured at STC of the delivered modules exceeds their assigned Nameplate Nominal Power at STC within a power tolerance range between -0 Wp and +5 Wp.

3- Nominal Module Operating Temperature (NMOT): Irradiance 800 W/m²; Wind Speed 1m/s; Ambient Temperature 20°C; Air Mass AM=1.5

4- No less than 98% of the minimum "Peak Power at STC" in the first year; power output decline no more than 0.55% per year thereafter). Full text of the Warranty Terms available at: www.aeg-industrialsolar.de

© Solar Solutions GmbH. Specifications in this datasheet are subject to change without notice. Code: AS-M1203-H-KM0N1-98B-335-350 / version 2020.08.V2.EN

AEG is a registered trademark used under license from AB Electrolux (publ).

TEMPERATURE CHARACTERISTICS

| | |
|----------------------------|-----------------|
| NOCT | 44°C ± 2°C |
| Pmax Temp. Coefficient (γ) | -0.34 %/C |
| Voc Temp. Coefficient (β) | -0.27 %/C |
| Isc Temp. Coefficient (α) | 0.04 %/C |
| Operating temperature | -40°C to + 85°C |

PACKING CONFIGURATION

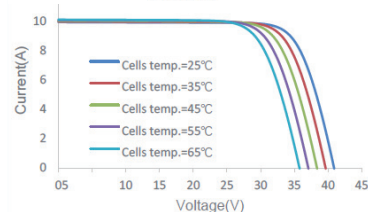
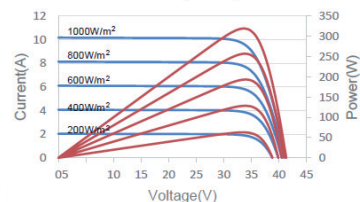
| | |
|-----------------------|--------------------|
| Packing configuration | 31 pcs / pallet |
| Loading capacity | 806 pcs / 40 ft HC |

WARRANTIES

| | |
|----------------------|-------------------------------|
| Product warranty | 15 years |
| Performance warranty | 25 years, linear ⁴ |

I-V CURVES / IRRADIANCES

Test temperature: 25 °C



CONTACT US

Solar Solutions GmbH | Brückenstrasse 94 | 60594 Frankfurt am Main | Germany

Tel: +49 69 400 500 810 | Fax: +49 69 400 500 819 | Mail: info@aeg-industrialsolar.de

www.aeg-industrialsolar.de



Seguridad activa

Protección contra arcos eléctricos
active con tecnología de IA



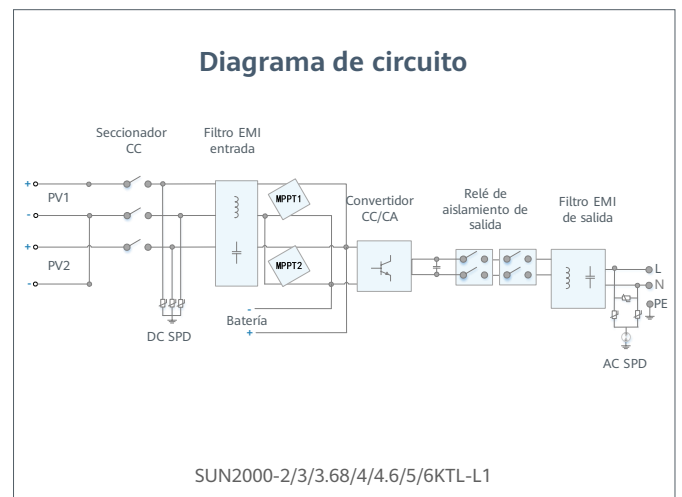
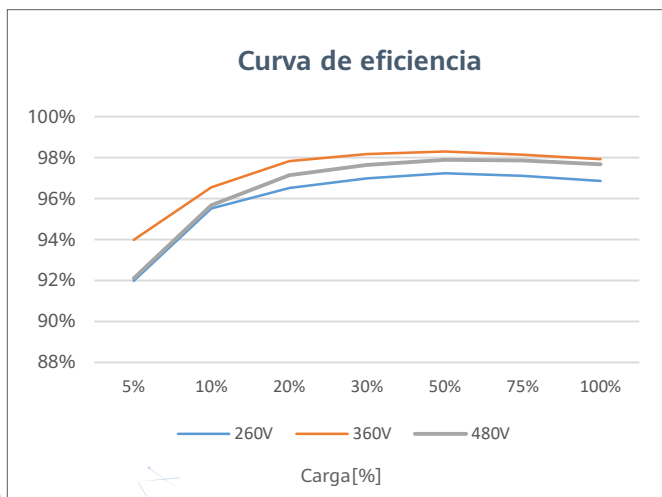
Mayor rendimiento

Hasta un 30 % más de
energía con optimizadores



2x POTENCIA de Batería

5kW de Salida en CA más
5kW de Carga en Baterías



SUN2000-2/3/3.68/4/4.6/5/6KTL-L1
Especificaciones técnicas

| Especificaciones técnicas | SUN2000 -2KTL-L1 | SUN2000 -3KTL-L1 | SUN2000 -3.68KTL-L1 | SUN2000 -4KTL-L1 | SUN2000 -4.6KTL-L1 | SUN2000 -5KTL-L1 | SUN2000 -6KTL-L1 ¹ |
|---------------------------|---------------------|---------------------|------------------------|---------------------|-----------------------|---------------------|----------------------------------|
|---------------------------|---------------------|---------------------|------------------------|---------------------|-----------------------|---------------------|----------------------------------|

Eficiencia

| | | | | | | | |
|--------------------|--------|--------|--------|--------|--------|--------|--------|
| Eficiencia Máxima | 98.2 % | 98.3 % | 98.4 % | 98.4 % | 98.4 % | 98.4 % | 98.4 % |
| Eficiencia europea | 96.7 % | 97.3 % | 97.3 % | 97.5 % | 97.7 % | 97.8 % | 97.8 % |

Entrada (FV)

| | | | | | | | |
|---|---------------------------|----------|----------|----------|----------|----------|----------|
| Entrada de CC máxima recomendada ² | 3,000 Wp | 4,500 Wp | 5,520 Wp | 6,000 Wp | 6,900 Wp | 7,500 Wp | 9,000 Wp |
| Máx. tensión de entrada | 600 V ³ | | | | | | |
| Tensión de arranque | 100 V | | | | | | |
| Rango de tensión de operación de MPPT | 90 V – 560 V ³ | | | | | | |
| Tensión nominal de entrada | 360 V | | | | | | |
| Máx. intensidad por MPPT | 12.5 A | | | | | | |
| Máx. intensidad de cortocircuito por MPPT | 18 A | | | | | | |
| Cantidad de MPPTs | 2 | | | | | | |
| Máx. número de entradas por MPPT | 1 | | | | | | |

Entrada (Batería CC)

| | | | | | | | |
|-------------------------------------|--|---------|---------|---------|---------|---------|---------|
| Batería compatible | LG Chem RESU 7H_R / 10H_R | | | | | | |
| Rango de tensión de operación | 350 ~ 450 Vcc | | | | | | |
| Max. corriente de operación | 10 A @7H_R / 15 A @10H_R | | | | | | |
| Potencia de carga máxima | 3,500 W @7H_R / 5,000 W @10H_R | | | | | | |
| Potencia máxima de descarga @ 7H_R | 2,200 W | 3,300 W | 3,500 W | 3,500 W | 3,500 W | 3,500 W | 3,500 W |
| Potencia máxima de descarga @ 10H_R | 2,200 W | 3,300 W | 3,680 W | 4,400 W | 4,600 W | 5,000 W | 5,000 W |
| Batería compatible | HUAWEI Smart ESS Battery 5kWh – 30kWh ¹ | | | | | | |
| Rango de tensión de operación | 350 ~ 560 Vdc | | | | | | |
| Max. corriente de operación | 15 A | | | | | | |
| Potencia de carga máxima | 5,000 W ⁴ | | | | | | |
| Potencia máxima de descarga | 2,200 W | 3,300 W | 3,680 W | 4,400 W | 4,600 W | 5,000 W | 5,000 W |

Salida

| | | | | | | | |
|---------------------------------|--|----------|----------|----------|-----------------------|-----------------------|----------|
| Conexión a la red eléctrica | Monofásica | | | | | | |
| Potencia de salida nominal | 2,000 W | 3,000 W | 3,680 W | 4,000 W | 4,600 W | 5,000 W ⁵ | 6,000 W |
| Máx. potencia aparente de CA | 2,200 VA | 3,300 VA | 3,680 VA | 4,400 VA | 5,000 VA ⁶ | 5,500 VA ⁷ | 6,000 VA |
| Tensión nominal de Salida | 220 Vac / 230 Vac / 240 Vac | | | | | | |
| Frecuencia nominal de red de CA | 50 Hz / 60 Hz | | | | | | |
| Máx. intensidad de salida | 10 A | 15 A | 16 A | 20 A | 23 A ⁸ | 25 A ⁸ | 27.3 A |
| Factor de potencia ajustable | 0.8 leading ... 0.8 lagging | | | | | | |
| Máx. distorsión armónica total | ≤ 3 % | | | | | | |
| Salida para SAI | Sí (a través de Backup Box-B0 ¹) | | | | | | |

Protección & Características

| | | | | | | | |
|---|--|--|--|--|--|--|--|
| Protección anti-isla | Sí | | | | | | |
| Protección contra polaridad inversa de CC | Sí | | | | | | |
| Monitorización de aislamiento | Sí | | | | | | |
| Protección contra descargas atmosféricas CC | Sí, clase de protección TIPO II compatible según EN / IEC 61643-11 | | | | | | |
| Protección contra descargas atmosféricas CA | Sí, clase de protección TIPO II compatible según EN / IEC 61643-11 | | | | | | |
| Monitorización de la corriente residual | Sí | | | | | | |
| Protección contra sobreintensidad de CA | Sí | | | | | | |
| Protección contra cortocircuito de CA | Sí | | | | | | |
| Protección contra sobretensión de CA | Sí | | | | | | |
| Protección contra sobrecalentamiento | Sí | | | | | | |
| Protección de falla de arco | Sí | | | | | | |
| Carga inversa de la batería desde la red | Sí | | | | | | |

Datos generales

| | | | | | | | |
|---|--|--|--|--|--|--|--|
| Rango de temperatura de operación | -25 ~ +60 °C | | | | | | |
| Humedad relativa de operación | 0 %RH ~ 100 %RH | | | | | | |
| Altitud de operación | 0 ~ 4,000 m (disminución de la capacidad eléctrica a partir de los 2000 m) | | | | | | |
| Ventilación | Convección natural | | | | | | |
| Pantalla | Indicadores LED; WLAN integrado + aplicación FusionSolar | | | | | | |
| Comunicación | RS485, WLAN a través del módulo WLAN incorporado en el inversor Ethernet a través de Smart Dongle-WLAN-FE (Opcional); 4G / 3G / 2G a través de Smart Dongle-4G (Opcional) | | | | | | |
| Peso (incluido soporte de montaje) | 12.0 kg | | | | | | |
| Dimensiones (incluido soporte de montaje) | 365mm * 365mm * 156 mm | | | | | | |
| Grado de protección | IP65 | | | | | | |
| Consumo de energía durante la noche | < 2,5 W | | | | | | |

Compatibilidad con optimizadores

| | | | | | | | |
|------------------------------------|----------------|--|--|--|--|--|--|
| Optimizador compatible con MBUS CC | SUN2000-450W-P | | | | | | |
|------------------------------------|----------------|--|--|--|--|--|--|

Cumplimiento de estándares (más opciones disponibles previa solicitud)

| | | | | | | | |
|--|--|--|--|--|--|--|--|
| Seguridad | EN/IEC 62109-1, EN/IEC 62109-2 | | | | | | |
| Estándares de conexión a red eléctrica | G98, G99, EN 50549-1, CEI 0-21, VDE-AR-N-4105, AS 4777.2, C10/11, ABNT, UTE C15-712, RD 1699, TOR D4, IEC61727, IEC62116 | | | | | | |

* 1 Disponible en Q3 del 2020.
 * 2 La potencia fotovoltaica de entrada máxima del inversor es de 10.000Wp cuando las cadenas largas se diseñen y conecten al completo de optimizadores de potencia SUN2000-450W-P.
 * 3 El límite máximo de tensión de entrada y de operación se reducirán a 495 V cuando el inversor se conecte y funcione con la batería LG.
 * 4 2.500W en las baterías HUAWEI ESS de 5kWh
 * 5 AS4777.2:4,991W. * 6. VDE-AR-N 4105:4,600VA / AS4777.2:4,999VA. *7. AS4777.2:4,999VA / C10/11:5,000VA. * 8. AS4777.2: 21.7A.