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|---|-------------------------------------|---------------------------------------|----------------------|------------------|
|  | PVSYST V5.05 | | 19/04/10 | Page 1/6 |
| Stand Alone System: Simulation parameters | | | | |
| Project : | South Africa Solar Challenge | | | |
| Geographical Site | Johannesburg | Country | South Africa | |
| Situation | Latitude | 26.2°S | Longitude | 28.0°E |
| Time defined as | Legal Time | Time zone UT+1 | Altitude | 1649 m |
| | Albedo | 0.20 | | |
| Meteo data : | Johannesburg, Synthetic Hourly data | | | |
| Simulation variant : | Johannesburgo | | | |
| | Simulation date | 19/04/10 16h43 | | |
| Simulation parameters | | | | |
| Collector Plane Orientation | Tilt | 0° | Azimuth | 0° |
| Horizon | Average Height | 3.0° | | |
| Near Shadings | According to strings | | Electrical effect | 80 % |
| PV Array Characteristics | | | | |
| PV module | Si-mono | Model | Electric car 39 cell | |
| | | Manufacturer | Electric car cell | |
| Number of PV modules | In series | 1 modules | In parallel | 10 strings |
| Total number of PV modules | Nb. modules | 10 | Unit Nom. Power | 104 Wp |
| Array global power | Nominal (STC) | 1.04 kWp | At operating cond. | 967 Wp (50°C) |
| Array operating characteristics (50°C) | U mpp | 18 V | I mp p | 53 A |
| Total area | Module area | 6.0 m² | Cell area | 6.0 m² |
| PV Array loss factors | | | | |
| Thermal Loss factor | Uc (const) | 29.0 W/m²K | Uv (wind) | 0.0 W/m²K / m/s |
| => Nominal Oper. Coll. Temp. (G=800 W/m², Tamb=20°C, Wind velocity = 1m/s.) | NOCT | 45 °C | | |
| Wiring Ohmic Loss | Global array res. | 5.6 mOhm | Loss Fraction | 1.4 % at STC |
| Serie Diode Loss | Voltage Drop | 0.7 V | Loss Fraction | 3.4 % at STC |
| Module Quality Loss | | | Loss Fraction | 3.0 % |
| Module Mismatch Losses | | | Loss Fraction | 2.0 % at MPP |
| Incidence effect, ASHRAE parametrization | IAM = | 1 - bo (1/cos i - 1) | bo Parameter | 0.05 |
| System Parameter | System type | Stand Alone System | | |
| Battery | Model | Compact Power | | |
| | Manufacturer | Oerlikon | | |
| Battery Pack Characteristics | Voltage | 48 V | Nominal Capacity | 39 Ah |
| | Nb. of units | 4 in series | | |
| | Temperature | Fixed (20°C) | | |
| Regulator | Model | Generic Default with MPPT converter | | |
| | Technology | MPPT converter | Temp coeff. | -5.0 mV/°C/elem. |
| Converter | Maxi and EURO efficiencies | 96.0/94.0 % | | |
| Battery Management Thresholds | Charging | 54.0/52.3 V | Discharging | 47.0/50.4 V |
| | Back-Up Genset Command | 47.3/51.6 V | | |
| User's needs : | Daily household consumers average | Constant over the year 4.9 kWh/Day | | |

Stand Alone System: Horizon definition

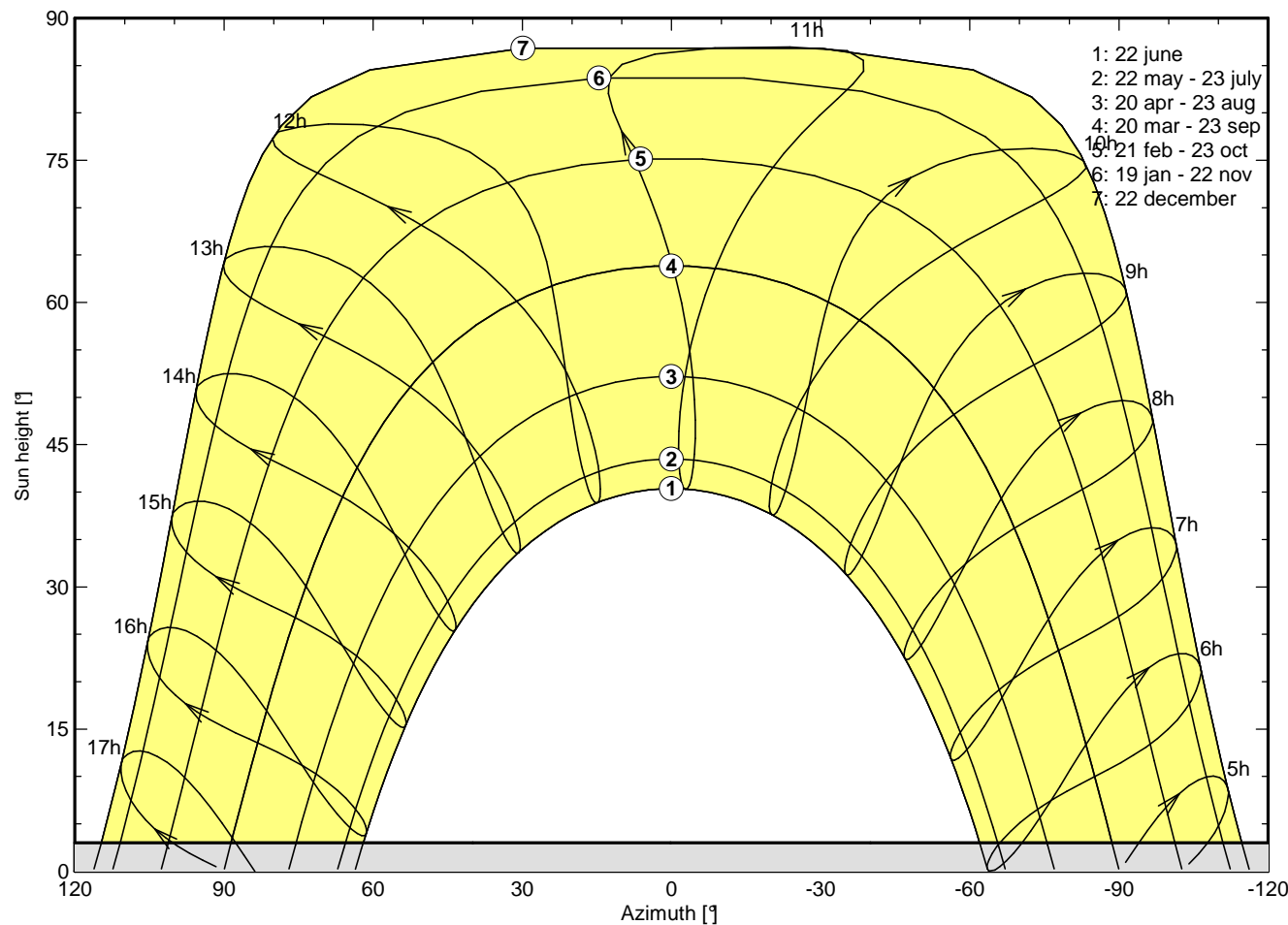
Project : South Africa Solar Challenge
Simulation variant : Johannesburgo

| | | | | |
|-------------------------------|--|---------------------------|------------------------|--|
| Main system parameters | | System type | Stand alone | |
| Horizon | | Average Height | 3.0° | |
| Near Shadings | | According to strings | | |
| PV Field Orientation | | tilt | 0° | azimuth 0° |
| PV Array | | Nb. of modules | 10 | Pnom total 1.04 kWp |
| Battery | | Model | Compact Power | Technology sealed, plates |
| battery Pack | | Nb. of units | 4 | Voltage / Capacity 48 V / 39 Ah |
| User's needs | | Daily household consumers | Constant over the year | global 1788 kWh/year |

| | | | | |
|----------------|----------------|-------|-----------------|------|
| Horizon | Average Height | 3.0° | Diffuse Factor | 1.00 |
| | Albedo Factor | 100 % | Albedo Fraction | 0.00 |

| | | | | | |
|-------------|------|-----|-----|-----|-----|
| Height [°] | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| Azimuth [°] | -120 | -40 | 0 | 40 | 120 |

Horizon line at Johannesburg, (Lat. 26.2°S, long. 28.0°E, alt. 1649 m)



Stand Alone System: Near shading definition

Project : South Africa Solar Challenge

Simulation variant : Johannesburgo

Main system parameters

Horizon

Near Shadings

PV Field Orientation

PV Array

Battery

battery Pack

User's needs

System type

Average Height

According to strings

tilt

Nb. of modules

Model

Nb. of units

Daily household consumers

Stand alone

3.0°

0°

10

Compact Power

4

Constant over the year

azimuth

0°

Pnom total

1.04 kWp

Technology

sealed, plates

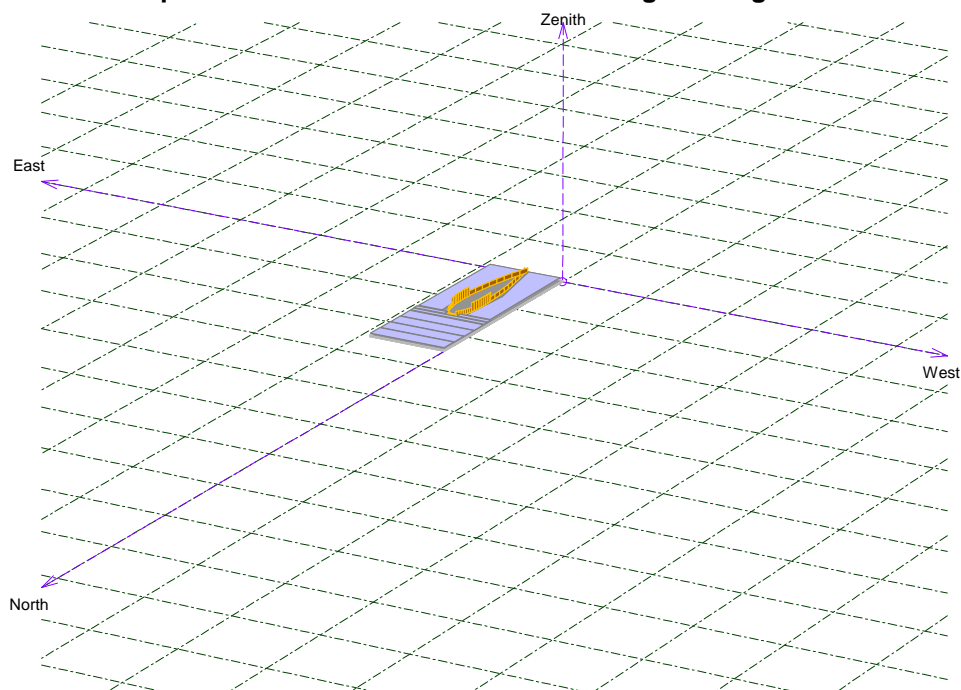
Voltage / Capacity

48 V / 39 Ah

global

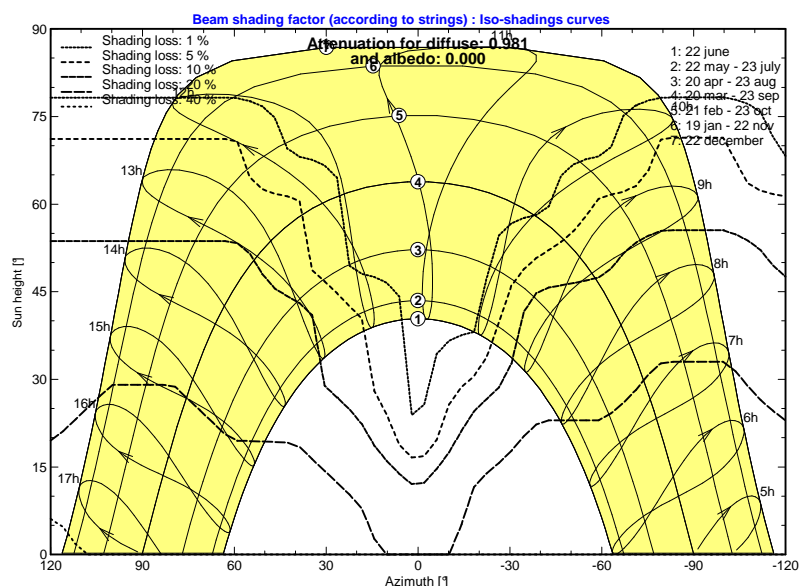
1788 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

South Africa Solar Challenge: Solar car1



Stand Alone System: Detailed User's needs

Project : South Africa Solar Challenge

Simulation variant : Johannesburgo

| | | | | |
|-------------------------------|---------------------------|------------------------|--------------------|---------------------|
| Main system parameters | System type | Stand alone | | |
| Horizon | Average Height | 3.0° | | |
| Near Shadings | According to strings | | | |
| PV Field Orientation | tilt | 0° | azimuth | 0° |
| PV Array | Nb. of modules | 10 | Pnom total | 1.04 kWp |
| Battery | Model | Compact Power | Technology | sealed, plates |
| battery Pack | Nb. of units | 4 | Voltage / Capacity | 48 V / 39 Ah |
| User's needs | Daily household consumers | Constant over the year | global | 1788 kWh/year |

Daily household consumers, Constant over the year, average = 4.9 kWh/day

Annual values

| | Number | Power | Use | Energy |
|--------------------|--------|-----------|---------|-------------|
| Other uses | 1 | 700 W tot | 7 h/day | 4900 Wh/day |
| Total daily energy | | | | 4900 Wh/day |

Stand Alone System: Main results

Project : South Africa Solar Challenge

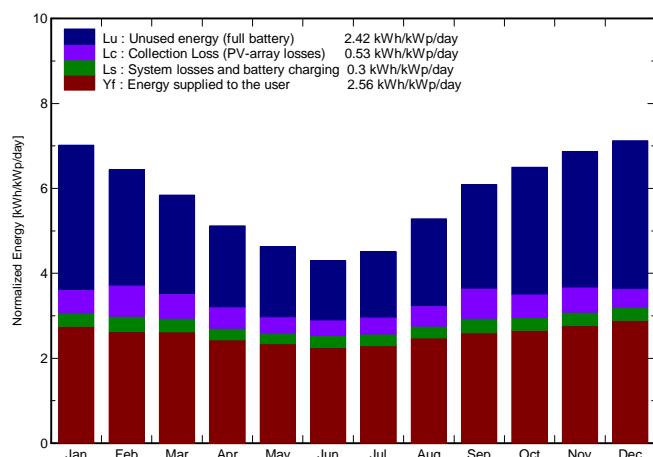
Simulation variant : Johannesburgo

| | | |
|-------------------------------|---------------------------|------------------------|
| Main system parameters | System type | Stand alone |
| Horizon | Average Height | 3.0° |
| Near Shadings | According to strings | |
| PV Field Orientation | tilt | 0° |
| PV Array | Nb. of modules | 10 |
| Battery | Model | Compact Power |
| battery Pack | Nb. of units | 4 |
| User's needs | Daily household consumers | Constant over the year |
| | azimuth | 0° |
| | Pnom total | 1.04 kWp |
| | Technology | sealed, plates |
| | Voltage / Capacity | 48 V / 39 Ah |
| | global | 1788 kWh/year |

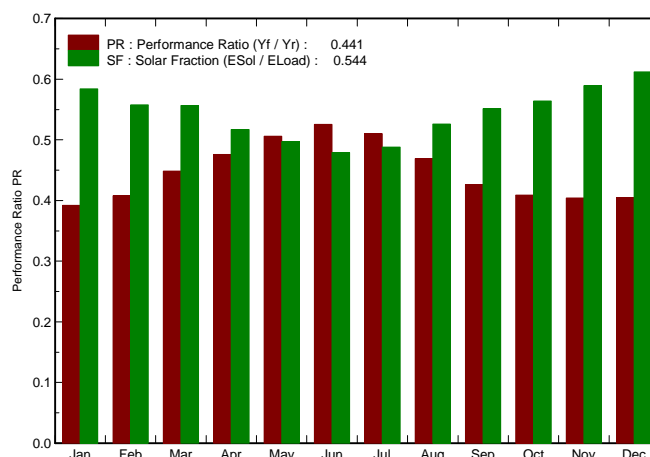
Main simulation results

| | | | | |
|-------------------|-------------------------|----------------------|-------------------|-------------------|
| System Production | Available Energy | 2020 kWh/year | Specific prod. | 1943 kWh/kWp/year |
| | Used Energy | 972 kWh/year | Excess (unused) | 919 kWh/year |
| | Performance Ratio PR | 44.1 % | Solar Fraction SF | 54.4 % |
| Loss of Load | Time Fraction | 44.8 % | Missing Energy | 816 kWh |

Normalized productions (per installed kWp): Nominal power 1.04 kWp



Performance Ratio PR and Solar Fraction SF



Johannesburgo Balances and main results

| | GlobHor | GlobEff | E Avail | EUnused | E Miss | E User | E Load | SolFrac |
|-----------|---------|---------|---------|---------|--------|--------|--------|---------|
| | kWh/m² | kWh/m² | kWh | kWh | kWh | kWh | kWh | |
| January | 217.6 | 200.4 | 206.7 | 109.5 | 63.16 | 88.74 | 151.9 | 0.584 |
| February | 180.3 | 165.6 | 170.4 | 79.1 | 60.70 | 76.50 | 137.2 | 0.558 |
| March | 181.2 | 166.2 | 171.5 | 74.7 | 67.36 | 84.54 | 151.9 | 0.557 |
| April | 153.6 | 139.4 | 145.2 | 59.5 | 70.98 | 76.02 | 147.0 | 0.517 |
| May | 143.5 | 127.9 | 138.5 | 53.2 | 76.37 | 75.53 | 151.9 | 0.497 |
| June | 128.8 | 113.4 | 119.1 | 43.4 | 76.60 | 70.40 | 147.0 | 0.479 |
| July | 139.7 | 123.6 | 132.8 | 49.5 | 77.78 | 74.12 | 151.9 | 0.488 |
| August | 163.8 | 146.9 | 159.0 | 65.8 | 71.96 | 79.94 | 151.9 | 0.526 |
| September | 182.7 | 165.9 | 171.3 | 76.1 | 65.97 | 81.03 | 147.0 | 0.551 |
| October | 201.5 | 185.0 | 192.7 | 96.2 | 66.19 | 85.71 | 151.9 | 0.564 |
| November | 206.1 | 189.9 | 198.1 | 99.6 | 60.39 | 86.61 | 147.0 | 0.589 |
| December | 220.9 | 203.6 | 215.1 | 112.4 | 58.94 | 92.96 | 151.9 | 0.612 |
| Year | 2119.7 | 1927.9 | 2020.4 | 919.0 | 816.40 | 972.10 | 1788.5 | 0.544 |

| | | | | |
|----------|---------|--|---------|--------------------------------|
| Legends: | GlobHor | Horizontal global irradiation | E Miss | Missing energy |
| | GlobEff | Effective Global, corr. for IAM and shadings | E User | Energy supplied to the user |
| | E Avail | Available Solar Energy | E Load | Energy need of the user (Load) |
| | EUnused | Unused energy (full battery) loss | SolFrac | Solar fraction (EUsed / ELoad) |

Stand Alone System: Loss diagram

Project : South Africa Solar Challenge

Simulation variant : Johannesburgo

| | | |
|-------------------------------|---------------------------|------------------------|
| Main system parameters | System type | Stand alone |
| Horizon | Average Height | 3.0° |
| Near Shadings | According to strings | |
| PV Field Orientation | tilt | 0° |
| PV Array | Nb. of modules | 10 |
| Battery | Model | Compact Power |
| battery Pack | Nb. of units | 4 |
| User's needs | Daily household consumers | Constant over the year |
| | azimuth | 0° |
| | Pnom total | 1.04 kWp |
| | Technology | sealed, plates |
| | Voltage / Capacity | 48 V / 39 Ah |
| | global | 1788 kWh/year |

Loss diagram over the whole year

