An-Najah National University

Energy and Environment Engineering Department

Evaluation of 22 photovoltaic systems installed in Rujeib, Palestine

Prepared by:

Heba Sawalha

Supervisor:

Dr. Tamer Al-Khatib

A Graduation Project Submitted to Energy Engineering and Environment Department in Partial Fulfillment of the Requirements for Bachelor Degree in Energy Engineering and Environment

May, 2021

Dedication

I dedicate this work to my fear of stand still. My greatest concern, and only motive.

Acknowledgements

I would like to express the deepest appreciation to my supervisor, who has always believed in me when I am in desperate need of such support, For all his accomplishments that made me believe in the possibility of my dreams, who has also been an unstinting source of wise and advice, and his pertinent guidance has been of great importance.

To my family and a few friends who bear my mood swings during this semester, even when they didn’t know the reason for it as for most of the time I didn’t know it myself, Thank you.

Disclaimer

This report was written by Heba Sawalha submitted to the Department of Energy and Environmental Engineering of An-Najah National University in partial fulfillment of the Bachelor degree in Energy and Environmental Engineering, It has not been altered or corrected, other than editorial corrections, as a result of the assessment and it may contain language as well as content errors. The views expressed in it together with any outcomes and recommendations are solely those of the student. An-Najah National University accepts no responsibility or liability for the consequences of this report being used for a purpose other than the purpose for which it was commissioned.

Table of content:

List of Figures:

List of tables

Nomenclature:

PV	Photovoltaic
Yf	Final Yield (Kwh/Kwp)
PR	Performance ratio(%)
CUF	Capacity utilization factor(%)
STC	Standard Test Conditions
SPV	Photovoltaic system
PC-Si	Polycrystalline silicon
MC-Si	Monocrystalline silicon
CIS	Copper indium selenium
CIGS	Copper indium gallium selenide
a-Si	Amorphous silicon
BAPV	Building attached photovoltaic
E_{AC}	Energy generated (Kwh)
E_{DC}	Solar radiation (Kwh)
P_{rated}	Power rated (Kwp)
DB	Distribution
Eff	Efficiency

Abstract:

Photovoltaic systems are becoming increasingly popular world wild and that's reflect the current trend in Palestine. A 22 residential Photovoltaic systems located in a Palestinian village (Rujeib) have been analyzed in terms of performance and safety, with a total capacity equals to 195kWwp, and 28° tilt angle oriented to the south. The study shows that the mean values of the final yield, Performance ratio and the Capacity utilization factor of the systems are 1507.32 kWh/kWp, 72.87% and 17.79% respectively. The performance results of the systems are also compared with the simulation values obtained from PVsyst software with a margin of error in the PR equals to 7% from the measured values. Compared to PV plants in county near to Palestine, and particularly a PV plants in Jordan and Syria, the analyzed systems have an acceptable overall performance. A number of recommendations was proposed to improve the safety and the performance of the systems.

Chapter 1
Introduction

Energy History

If we start back in 1800 we see that nearly all of the world's energy was produced from traditional biomass (essentially burning wood and other organic matter). The world was using a small amount of coal. The expansion into oil consumption didn't begin until around 1870. Two decades later it was followed by natural gas and hydroelectricity. By 1900, coal consumption had increased significantly, accounting for almost half of global energy (the other half remaining biomass, since oil, gas and hydroelectricity remained small).

By the mid-20 th century, coal overtook traditional biofuels and oil was up to around 20 percent. By 1960 the world had moved into nuclear electricity production. Finally, today's renewable energy sources such as solar energy, wind energy and bioenergy are relatively new, not appearing until the 1980-90s. Other renewable sources, such as geothermal and marine technologies, have not been included because levels of production are so small.

In 2015, the world consumed 146,000 terrawatt-hours (TWh) of primary energy- more than 25 times more than in 1800. But it is often today's energy mix, rather than levels of consumption that people find surprising. While the expectations were that the renewable energy sources cover a huge amount of global energy consumption, In fact their total contribution remains small in the consumption [1].

Investment and the production of renewable technology is growing, as the following chart shown:

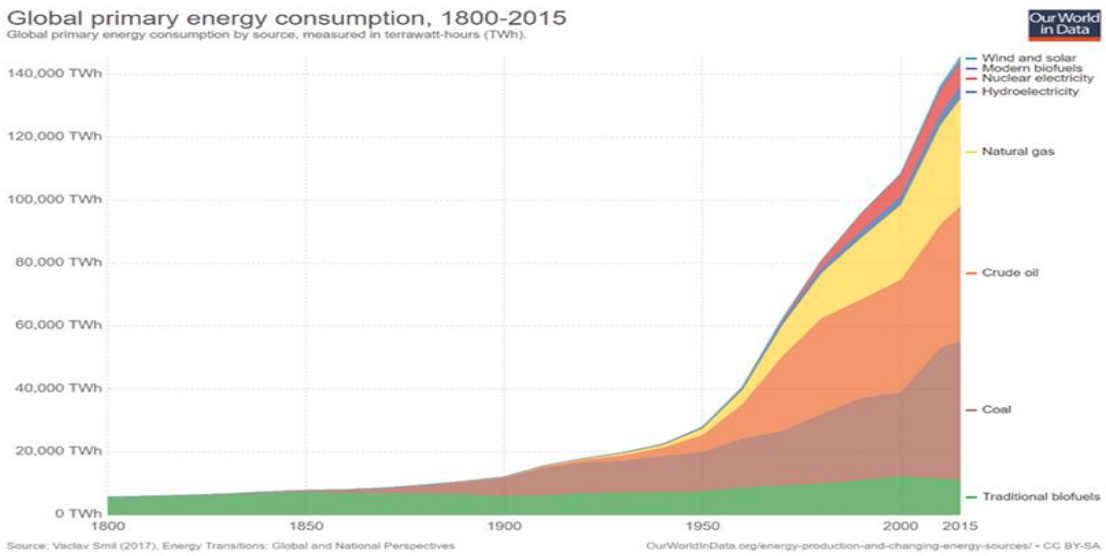


Figure 1:Global energy consumption, 1800-2015.

Electricity consumption growth in the residential sector in Palestine

The energy consumption for the residential sector constitutes is the largest part of the total electricity consumption in Palestine (61%)[2], and it is showing a steady increase through the past years due to three main reasons, one is the dramatic population growth in Palestine as a whole (see Figure 2). In the West Bank only, the number of Palestinian inhabitance has reached around 2.90 million at the end of 2015 [3].

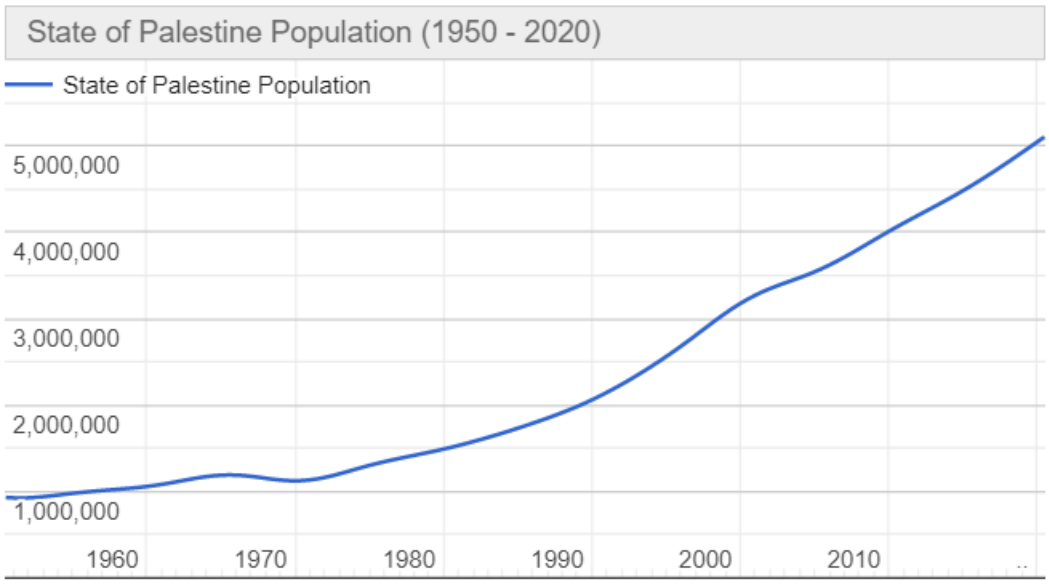


Figure 2: Population growth in Palestine.

Secondly, is the need to find an alternative to fuel for heating the residential sector, due to the increase in its price over the years. For example the price for gasoline in Palestine increased from 0.86 US dollars/liter in 1998 to 1.54 US dollars/liter in 2016 growing at an average annual rate of 7.58% [4], while the price of electricity remained almost the same, which the cost of consumption in kWh is around 0.6 NIS, which made it the alternative to the gas people were looking for. Thirdly, global warming that led to an increase in the temperatures in Palestine, that clearly shown in figure (3) the calculated trend-line indicates an overall increase in the past years[5]. This pushed people to use air conditioners in their homes attempting to reaching a comfortable living environment.

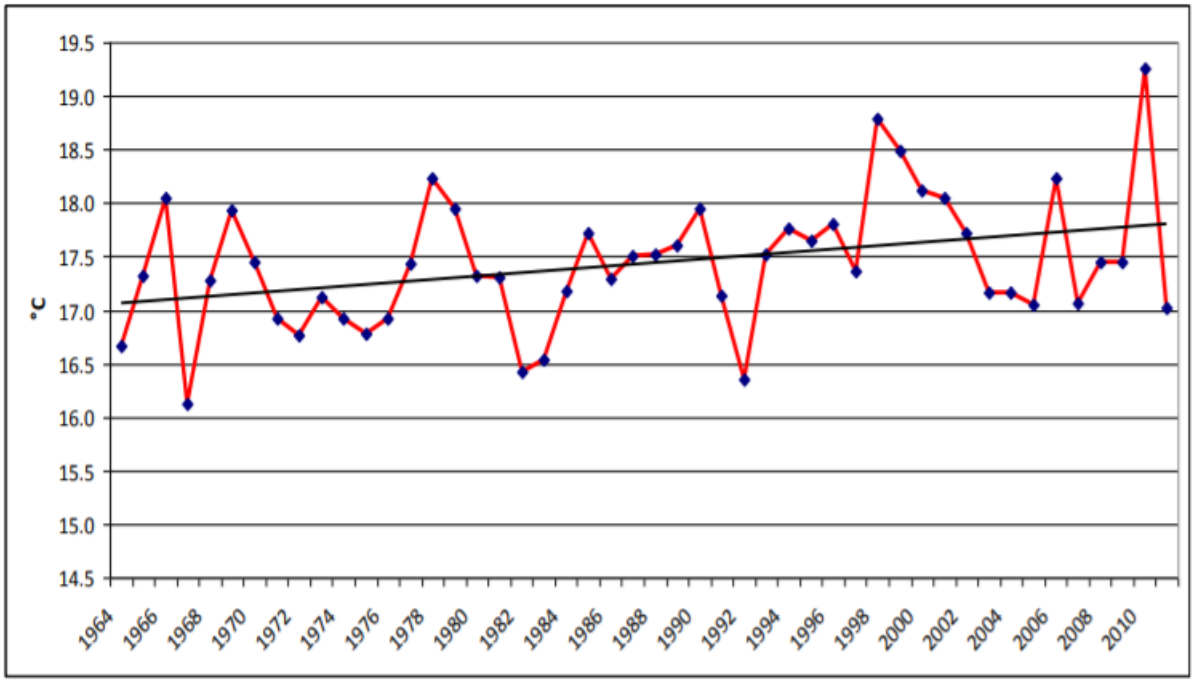


Figure 3: Mean annual temperature in Jerusalem (1964-2011)

The annual electricity consumption per capita (kWh/Capita) increased from 1048.0 in year the 2014 to 1148.7 in the year 2018. The increasing demand and scarcity in conventional sources have triggered the scientist to pave way for the development of research in the field of renewable energy sources especially solar energy.

Due to the recent promotion of solar energy and an attempt to break free from the Israeli occupation's grip on electricity, the Palestinians have tended to take advantage of the sun's energy, although they were among the pioneers in the use of water solar heaters, Photovoltaics

have started to spread recently compared to previous years. However, Its prevalence is still limited.

Even though the annual sunny days in Palestine equal 300 days, with average solar radiation equals 5.4 kW per day[6], There are still uncertainties and a lack of control over solar resources. Due to this, it always tends to support Photovoltaic systems with stable systems or ones which we have partial control on, such as diesel generators, batteries, or connect them directly to the grid, and because of the high cost of the first two options, the third option is the most widespread in Palestine.

Objectives:

As the share of solar electricity continues to grow in the global electricity mix, It becomes necessary to study the performance of existing systems and analyze them to improve their performance and the performance of new systems. The focus of this project was on:

- Understand the electricity consumption situation in Palestine.
- Evaluate the performance of 22 systems installed in Rujeib, Palestine.
- Comparing them with systems from neighboring countries and with simulated values.
- Study the safety aspects for the 22 systems.

Chapter 2

Literature Review

The performance of various photovoltaic systems

M. Sidrach-de-Cardona and Ll. Mora Lo´pez [7] studied a 2.0 kWp photovoltaic system that has been installed at the University of Ma´laga, Spain to examine the grid-connected photovoltaic system under the Southern Spain climate. The mean daily output was 7.4 kWh while the performance ratio was found to be 64.5%. Then an optimization on the final yield and the performance ratio of the system has been done to remove the influence on the system yield of losses due to problems in the grid, the optimal PR then was 67.9%.

Emmanuel Kymakis et al. [8] evaluated the 171.36 kWp grid-connected photovoltaic park of C. Rokas SA in Sitia, Crete, by studying it for a year in all respects. During the project study period, the average annual energy output was 1336.4 kWh/ kWp, and the annual performance ratio (PR) of the system was 67.36%.

B. Shiva Kumar and K. Sudhakar [9] studied a photovoltaic power plant of 10MW in Ramagundam, India. that operating at a seasonal tilt. The different types of losses were calculated so as the performance ratio was found to be 83%, and was compared with simulation values from the Posit and PV-GIS software.

Jayanta Deb Mondol et al. [10] performance of 12kWp grid-connected photovoltaic system was made during three years, and it has been analyzed on an hourly, daily and monthly basis. The annual average monthly performance ratios for the three years were 0.60, 0.61, and 0.62, respectively.

S. Bouacha et al. [11] monitored a 9.5 kWp photovoltaic grid-connected system for 3 years in Algeria. And although it was the first photovoltaic grid-connected system in Algeria its performance is still considered satisfactory as it was found to be equal to 70%.

M. Drif, P.J. Pe´rez et al [12] made a performance analysis of a grid-connected photovoltaic system of 200 kWp at Jae´n University, Spain. They obtained unsatisfactory PR values due to a consequence of the existing problems with different junction boxes of some

modules (failures in 42 modules), and to improve the project performance, the defective part of PV generators which was responsible for the reduction of PR was replaced.

Lutero Carmo de Lima et al. [13] studied the performance analysis of a 2.2 kWp photovoltaic system installed at the State University of Ceará, Fortaleza, Brazil, for a year. The performance ratio and the annual energy yield were 82.9% and 1685.5 kWh/kWp respectively.

Priya Yadav et al. [14] simulated a proposed photovoltaic system for Hamirpur, Himachal Pradesh, India, by using the predicted climate conditions for the site, and the design of the system using the PVsyst program. And the PR was found to be 72.4%.

F. Fairouz et al. [15] A performance evaluation of the first 85.05 kWp and 21.6 kWp copper indium gallium selenide (CIGS) thin-film, grid-connected PV systems on the roof of two schools in Kuwait were studied for 12 months. The effect of continuous surface cleaning has also been studied. The annual average daily final yields of the PV systems in this study were 4.5 kW h/kWp/day, and the performance ratio was maintained between 0.74 and 0.85.

Mete Cubukcu and Harun Gumus [16] studied a grid-connected photovoltaic (PV) power plant of 2130.7 kWp rated power installed in the eastern part of Turkey. A simulation of the plant data was also done to compare the results, the PR of the plant was found to be 81.15%.

Xinfang Wu et al. [17] presented the performance of the first home-based grid-connected roof-mounted building attached photovoltaic (BAPV) system in Shanghai, China for three years, With a simulation of the plant data was also done to compare the results in the PVsyst software. The average annual and average daily outputs are 3189.13 kWh and 8.74 kWh. The predicted yearly energy output is 3220.21 kWh by software of PVsyst.

Climate effect on solar system performance

Studies have proven that climate affects the performance of solar systems, and this is shown in the following studies:

M. Shravanth Vasisht et al. [18] monitored the effect of seasonal changes on a 20 kWp Solar Photovoltaic system was created to conduct this study in Bangalore, India. The average Performance Ratio (PR) of the system was around 85%. It was confirmed that the PR depends on the climatic changes from one season to another, As it directly depends on the efficiency of the

system, and the efficiency of the system directly depends on the temperature of the modules. In summer, the SPV modules attain maximum efficiency at T_{mod} = 45°C , but in winter, it is at 55 C. The efficiency decreases by 0.08/C while the temperature increases more than 45 °C in summer. While the efficiency is not affected much in the winter when the temperature increases more than 55 °C, this is due to the automatic cooling due to the wind and the low temperatures in winter.

Sebastijan Seme et al. [19] a performance analysis of 3326 solar systems was made in Slovenia under different climate conditions. The performance was found to be 68.84% and it mainly depends on the proper inclination and azimuth angle of the photovoltaic modules, shadings, and snow barrier. Due to that, the study shows that PR reaches its highest rates in the winter and declines to its lowest in the summer because of the negative effect of temperature on the efficiency of the system.

Emilio Ghiani and Fabrizio Pilo [20] worked on comparing two PV power plants in Italy. as the results showed, in general, that the highest value of the PR was in the winter season while the worst value of it was in the summer, and by comparing the two plants together, the second PV Plant had a lower PR value due to the worse azimuth angle and the higher impact of the ambient temperature. As the average PR value of the first and the second PV power plants were 87,3% and 83,2% respectively.

L.M. Ayompe et al. [21] monitored a 1.72 kWp photovoltaic system installed in Dublin, Ireland for a year. To obtain the following parameters: final yield, reference yield, array yield, system losses, array capture losses, cell temperature losses, PV module efficiency, system efficiency, inverter efficiency, performance ratio, and capacity factor. Where the system efficiency and performance ratio was 12.6% and 81.5% respectively. With a comparison of the system's performance in Ireland with other systems in other cities, it was found that the station's performance in Ireland was higher due to the low insolation levels, high average wind speeds, and low ambient temperature.

Mahmoud Dhimish [22] made a comparison between the performance of photovoltaic solar systems in terms of the PR values in Scotland, Ireland, and England. and found that the values were more reliable in Ireland and England compared to those located in Scotland. And it

found out that the system degradation was highest in relatively cold regions due to cold climate conditions, and heavy snow affecting the system.

Bing Guo et al. [23] monitored a photovoltaic system in Qatar in terms of cleaning the dust from the surface of the modules where it was found that on the average over the seven months, the PV performance loss due to soiling was 0.0042+/-0.0080 per day for modules cleaned every sixth month, and 0.0045+/-0.0091 per day for modules cleaned every second month.

Different technologies effect on solar system performance

The performance of the different systems varies according to the material from which the cells are made, which has been proven by numerous studies such as

Ramanan P et al. [24] compared the performance of two technologies (polycrystalline silicon (p-Si) and copper indium selenium (CIS) arrays) under hot and humid conditions in Tamil Nadu, Southern India. It has been found that the yearly average performance ratio was 78.48% for p-Si and 86.73% for CIS. An analysis of the data was also done on the PVsyst software to simulate the performance of the system and compare it from actual values.

Elias Urrejola et al. [25] studied the effect of soiling and sunlight on the performance ratio of different photovoltaic technologies (polycrystalline, monocrystalline array, thin-film system array), exposed outdoors for two years in Santiago, Chile. The yearly degradation of the arrays system due to the high soiling in Santiago was found to be 1.29% for the polycrystalline array, 1.74% for the monocrystalline array, and 2.77% for the thin-film system array. And a weather correction was made on the PR to be 75% for all technologies. The study showed that continuous cleaning contributes effectively to maintaining the effectiveness of the systems, and the best methods of cleaning were studied.

Vikrant Sharma et al. [26] made a performance comparison between different solar photovoltaic technologies (p-Si, HIT, a-Si arrays) under similar outdoor conditions were made, and the PR rating of HIT and a-Si arrays are found to be about 7% higher as compared to p-Si PV array under the almost outdoor conditions.

Muhammad Anser Bashir et al. [27] compared the performance of the three most common solar photovoltaic technologies used in Taxila, Pakistan (monocrystalline, polycrystalline, and single junction amorphous silicon) during the winter months, The study showed that the performance of the three types decreased with the increase in the temperature of its back surface, but the monocrystalline photovoltaic module showed higher monthly average module efficiency among them all.

Nitin Kumar [28] made a comparison of different Photovoltaic technologies (monocrystalline, polycrystalline, amorphous silicon, and CIS) in terms of effectiveness, each with a capacity of 10Kw at Hamirpur Himachal Pradesh, India. A simulation of the data was done on the PVsyst software to compare the results. And the results show that CIS technology performs considerably better than the other three technologies in terms of energy output, performance ratio, capacity factor, and economics.

Arechkik Ameur et al. [29] compared the performance of different Photovoltaic technologies of (amorphous silicon (a-Si), Polycrystalline silicon (pc-Si), and Monocrystalline silicon (mc-Si)) grid-connected systems, that generating around 2 kWp each, in Morocco. And the obtained results showed that polycrystalline technology is the most cost-effective technology for the region of Ifrane.

Surface inclination and orientation effect on solar system performance

Jayanta Deb Mondol et al. [30] using validated TRNSYS simulations the effect of surface inclination and orientation on its performance was studied. the particular location and system studied, the maximum annual PV efficiency, the inverter efficiency, the PR and the system efficiency were for a south-facing surface with an inclination of 20°.

Chapter 3
Methodology

Definitions

1. Performance indicators:

There are many parameters to indicate the system performance such as array yield, PV module efficiency, inverter efficiency, system efficiency, final yield, Performance ratio, and the capacity utilization factor. These normalized indicators act as key comparators for comparing the performance of the existing grid-connected PV systems. And the last three indicators will be used in this project.

The **final yield** is the time taken by the PV to generate energy (E_{ac}) with respect to its nominal power capacity, and its unit is kWh/kWp. Consequently, it depends on the total production, which in turn depends on the composition of the structure, the location of the system, and other influences.

The **performance ratio** is the ratio of the total energy produced from the system (when on-grid) or the useful energy produced (when off-grid), to the energy which would be produced if the system was continuously working at its nominal STC conditions. Taking into account environmental factors (temperature, irradiation, etc.), and including all the losses that might affect the system.

The **capacity utilization factor** is the percentage of actual output over the rated output that the system can output if the system is running daily without interruption. Therefore, it is suitable for continuously operating plants more than renewable energy systems, because most of the renewable energy systems work with variable input making the system intermittent[31].

However, The performance of Photovoltaic modules refers to Standard Test Conditions (STC), which does not always represent the real performance of the modules. Due to that, a lot of corrections have been created to improve system performance

prediction under real weather conditions. As Juwi Inc [32] proved that module temperature adjustment provided the closest match between modeled and measured performance.

The rise in the ambient temperature increases the temperature of the cells and thus negatively affects the system production. While increasing wind speed positively affects system productivity. Therefore, calculating the PR in isolation from climate change does not necessarily increase the PR, but rather gives more stable values throughout the year.

2. PVsyst software:

It is a software for designing and simulating photovoltaic systems. It is used for project development and for giving a predictive view of the system's functioning. The program contains a meteorological database for different regions around the world, with the ability to manually enter this data, and some inputs must be provided to the program to obtain results in the form of a complete report that contains charts and tables for the progress of energy production and losses during the year [14]. The main inputs are:

1. Location
2. Tilt angle
3. Module and Inverter Specification
4. Solar Radiation Variation
5. Azimuth Angle

Case study

One of the villages that installed a several photovoltaic systems in Palestine is Rujeib. It is located southeast of Nablus, with 4,500 residents, according to 2017 statistics. With a latitude, longitude and altitude almost the same for all the systems (32.18°, 35.2°, 530 m) respectively.

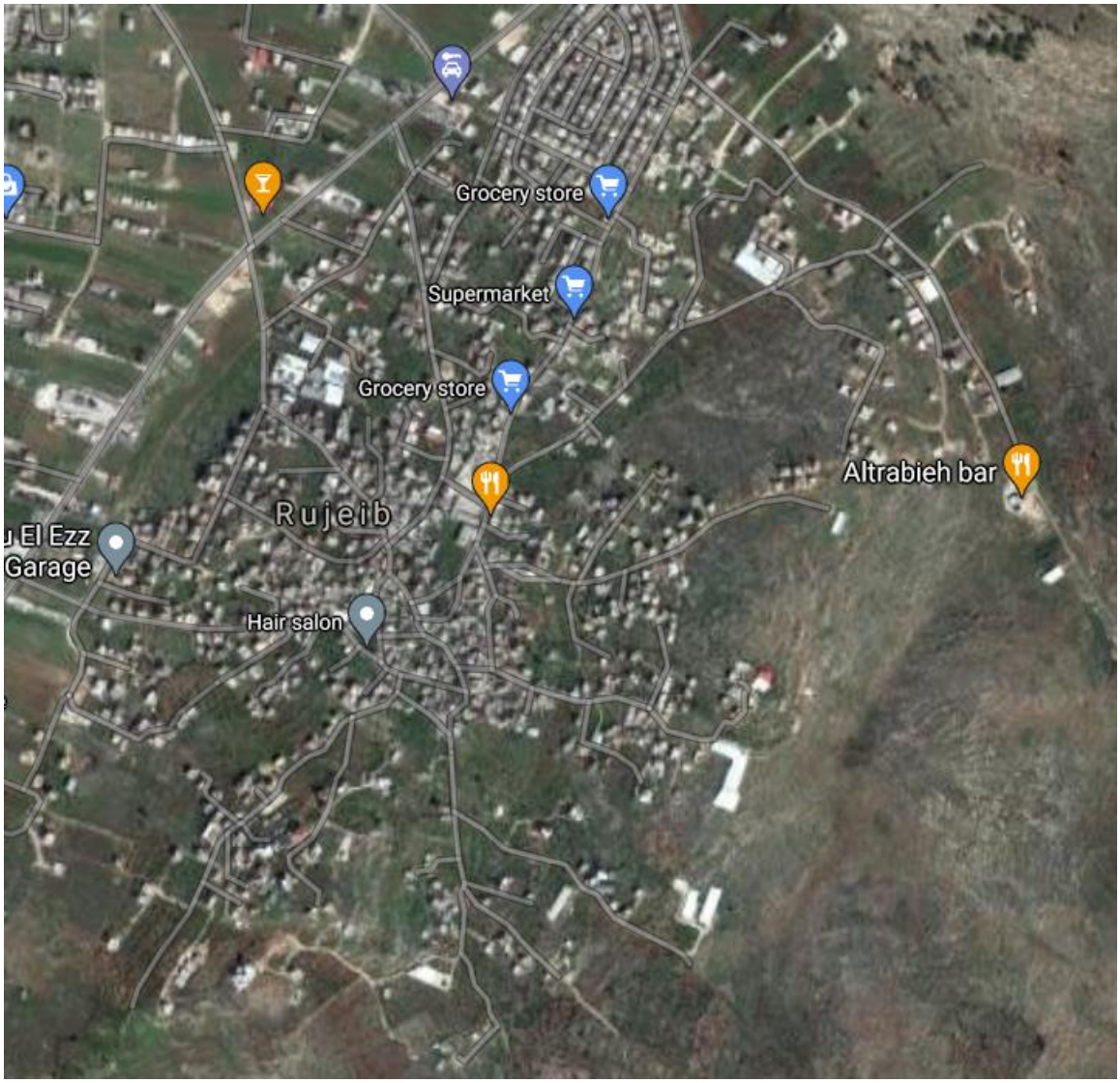


Figure 4: A satellite Photo of Rujeib Village

A 22 system located in a different location in Rujeib has been evaluated, oriented to the south with tilt angle equals to 28°, and 195 kWp in total. The smallest system capacity is equal to 5 kWp, and the largest one is 40Kwp, located on top of residential buildings. Using a varies types of PV array with different power rated, and panels number as defined in Table (1). And a varies types of inverters as well, as defined in table (2).

Table 1: Photovoltaic Specifications

No. of System	$Power_{Rated}$	No. of Panels	PV type	Eff./module area
1	385	18	JA solar	19.54
2	365	28	Sunket	19.08

3	385	15	JA solar	20.61
4	375	30	JA solar	20.07
5	325	20	Q.power	16.74
6	330	16	Q.power	19.59
7	330	16	Q.power	17
8	335	32	Asrtonergy	19.77
9	410	12	CS3W	18.57
10	385	30	JA solar	19.54
11	400	15	Trinasolar	19.49
12	400	12	Q.power	17
13	335	30	Asrtonergy	19.36
14	385	10	JA solar	19.54
15	400	15	Trinasolar	19.49
16	390	13	Philadelphia	19.57
17	330	16	Yingli solar	17.03
18	410	12	CS3W	18.57
19	410	12	CS3W	18.57
20	410	87	Cnadian solar	19.93
21	410	16	CS3W	18.57
22	400	12	Trinasolar	19.49
23	440	14	CS3W	17.49

Table 2: Inverter Specifications

No. of system	System Capacity	Inverter Capacity	No. of inverters	Inverter
1	14	10	1	ABB
2	12	10	1	ABB
3	6	5	1	INGECON
4	10	10	1	KACO plueplant
5	7	6	1	ABB
6	5	5	1	KACO plueplant
7	5	3.7	1	KACO plueplant

8	10	10	1	KACO plueplant
9	5	5	1	ABB
10	14	10	1	ABB
11	6	5	1	HUAWEI
12	5	6	1	ABB
13	10	10	1	KACO plueplant
14	5	5	1	INGECON
15	6	5	1	ABB
16	5	5	1	Sungrow
17	5	5	1	HUAWEI
18	5	5	1	SUNGROW
19	5	5	1	SUNGROW
20	40	20	2	KACO plueplant
21	5	6	1	ABB
22	5	5	1	HUAWEI
23	5	5	1	Sungrow

Calculations

The data for the total energy generated was collected once for the twenty-three systems on the same day. Therefore the **Final Yield** was calculated for each system separately taking into consideration the time each system was installed in.

$$\boldsymbol{Yf = \frac{E_{ac}}{P_{Pv(rated)}}} \quad (1)$$

Since E_{ac} is the total energy generated by the system in (kWh), and the P is the power rating for the panels of the system (kWp).

The total in-plane incoming solar radiation was also calculated separately for each system by summing up the incoming solar radiation for all the months since the system has been installed until the total energy generated has been collected depending on the following data in table (3) for the total in-plane solar radiation in Palestine.

Table 3: Solar radiation in Palestine

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
Total in-plane Solar radiation/month (kWh) (E_{DC})	99	120.6	172	208.2	240.9	249	257.3	225	213.9	158	120.2	93

The **Performance Ratio** then has been calculated for each system based on the past calculations, using the following equation:

$$\boldsymbol{PR = \frac{Yf}{E_{DC}}} \tag{2}$$

Where the E_{DC} is the summation of the solar radiation for each month from the beginning of the insallation of the system, until the data collected.

The **Capacity Utilization Factor (CUF)** is another common indicator to judge the performance of grid-connected PV systems.

$$\boldsymbol{CUF = \frac{Yf}{operating\ hours} \times 100\%} \tag{3}$$

The mean values then were calculated to make the comparing task easier. However, one system was excluded from the aggregate calculations due to a major flaw in that system.

Based on the systems information, data analysis has been made for each system separately using the **PVsyst**, and the reports of the systems are attached in appendices (1). Also, safety measures were evaluated at the sites.

Chapter 4

Results and Discussion

1. Performance

Table (4) represents the monitoring period for each system which is varying from 2-25 month, and the Photovoltaic technologies used for each system which shows that only 34.7% from the photovoltaic systems used Monocrystalline-silicon and the rest was Polycrystalline-silicon, it also shows the energy produced from each system as well as the Yf, the PR, and the CUF. As can be seen from table (4), system number 7 has the lowest PR and CUF (11.59%, 2.76%) respectively. This is due to an obvious flaw in the design, it has been used as a 3.7 kW inverter with a 5 kWp system capacity. The inverter plays an important role in the overall electricity production. Therefore, when an inverter smaller than the size of the system is placed, the system will not take advantage of the maximum solar energy the photovoltaics can absorb, and it will lead to a lot of losses.

Excluding system number 7 the mean values of the Yf, PR, and the CUF for the remaining 22 systems were (1339.17 kWh/kWp, 65.86%, 15.76%), where three of them were under the nominal range of the PR for a new PV system that lays between 60-90% [33], and only one system was around 3% greater than 90%, which may be possible when the shading minimalized and when using highly efficient components [34].

Table 4: Performance inductors values

No. of system	Monitored period (month)	PV type	System Capacity (kWp)	E_{ac} (kWh)	Total Yf (kWh/kWp)	PR%	CUF%
1	21	MC-Si	6.93	21783	3143.29	80.11	20.78
2	21	MC-Si	10.22	33543	3282.09	83.65	21.70
3	21	MC-Si	5.775	15171	2627.013	66.95	17.37
4	14	MC-Si	11.25	17334	1540.8	64.97	15.28
5	16	PC-Si	6.5	13217	2033.38	74.12	17.65
6	17	MC-Si	5.28	12111	2293.75	77.27	18.73
7	16	PC-Si	5.28	1680	318.18	11.59	2.76
8	6	MC-Si	10.72	7357	686.28	64.29	15.88

9	7	PC-Si	4.92	3520.9	715.63	54.36	14.19
10	22	MC-Si	11.55	35132	3041.73	74.26	19.20
11	3	MC-Si	6	1095.7	182.61	49.18	8.45
12	25	PC-Si	4.8	19092	3977.5	90.21	22.09
13	5	MC-Si	10.05	6318	628.65	77.59	17.46
14	21	MC-Si	3.85	11091	2880.77	73.42	19.05
15	6	MC-Si	6	5524.4	920.73	86.25	21.31
16	5	MC-Si	5.07	3717	733.13	90.49	20.36
17	2	MC-Si	5.28	784.35	148.55	69.66	10.31
18	6	PC-Si	4.92	4250	863.82	80.92	19.99
19	6	PC-Si	4.92	4203	854.26	80.02	23.72
20	7	MC-Si	35.67	34221	959.37	72.87	19.03
21	4	PC-Si	6.56	2918.4	444.87	76.02	15.44
22	5	PC-Si	4.8	2125.5	442.8125	54.65	12.3
23	5	MC-Si	6.16	4682	760.06	93.81	21.11
Mean	-	-	-	-	1507.32	72.87	17.79

In order to compare the quality of the 22 systems in Rujeib, Palestine, it was compared with two grid-connected PV plants in two neighboring cities (Syria and Jordan) as shown in table (5). The first plant is in Syria that installed in November.2010 containing 45 modules with a rated power of 90 W each and a fixed tilt angle equals to 35°. The measured data from the Syrian plant showed that energy produced in the third year of operation was 6177 kWh with a Yf and a PR equals to (1525 kWh/kWp and 88.2%) respectively, which is (1.17% and 15.33) larger than the Yf and the PR in Palestine respectively. The CUF was 17.4 in Syria which was almost the same but only 0.39% lower than the CUF value in Palestine [35].

The second plant is in Jordan that is 276kWp and with 10° and 15° tilt angles. It has been installed in 2014, and the performance was made for the first year of installation and the energy production is found to be 476467 kWh, and the Yf was 1639 kWh/kWp which is 8.73% larger than the Yf in Palestine, as well as the PR and the CUF that was (87.5% and 18.7%) in Jordan that were (14.63% and 1%) higher than the values in Palestine respectively [36].

Table 5: Comparison between with systems in near countries

Country	Yf (kWh/kWp)	PF%	CUF%
Palestine	1507.32	72.87	17.79
Jordan	1639	87.5	18.7
Syria	1525	88.2	17.4

Whilst the simulated PR values from the PVsyst ranged between 76%-83% with a mean value equal to 81.9% (excluding system number 7 again because the program did not accept it due to the small size of the inverter) as shown in details in table (6). The mean value of the simulated values was 7.67% larger than the mean measured value which is still an acceptable range due to many reasons. Firstly, in the field, the system holds many losses that the PVsyst does not take into considerations such as the different types of shadows that we cannot anticipate, like clouds and living creatures as birds or their droppings and the accumulation of large layers of dust on the surface of the PV modules especially with the absence of awareness about the importance of the constant cleaning of the PV modules, and although there are some factors that can be predicted, it cannot be predicted exactly such as the ambient temperature and the irradiation as there are changing from year to year but still have a direct effect on the performance of the system. Secondly, the margin of error in the PVsyst itself, as the PVsyst shows inaccuracies from 1-2% for the yearly yield and the same inaccuracies percentage for the shadow losses [37].

Table 6: Comparison with the simulated values

No. of system	PR% (Calc.)	PR% (PVsyst)
1	80.11	80.7
2	83.65	77.3
3	66.95	83.5
4	64.97	82.6
5	74.12	82.9
6	77.27	82.5
7	11.59	-
8	64.29	83.2
9	54.36	82.7
10	74.26	82.1

11	49.18	76
12	90.21	81.3
13	77.59	83.1
14	73.42	83
15	86.25	80.1
16	90.49	83.4
17	69.66	83.9
18	80.92	81.7
19	80.02	83.3
20	72.87	83.3
21	76.02	82.7
22	54.65	83.39
23	93.81	81.1
Means	74.32	81.99

2. Safety:

Apart from the productivity and performance of the systems, there are problems with most systems in terms of safety, as figure (5) shows the manifestations of systems safety. For instance, all systems contain no solar warning signals (on the entrance, panels, or chasses), nor lightning rods, which is often placed in the top of the buildings to attract lightning bolts to provide a safe path to ground the electricity so that it does not damage the building. Also there are obvious problems with grounding in all systems as there are 14 with no grounding systems at all, and three of the rest do have grounding but with no ability to measure it due to a layer of cement that covers the electrode, while the remaining five systems have a grounding system, but the electrode resistance is more than five ohms. What worth mentioning is that grounding a system limits the voltage potential to the ground on the grounded conductor, which may come from contact with higher-voltage lines, lightning strikes, and the like.

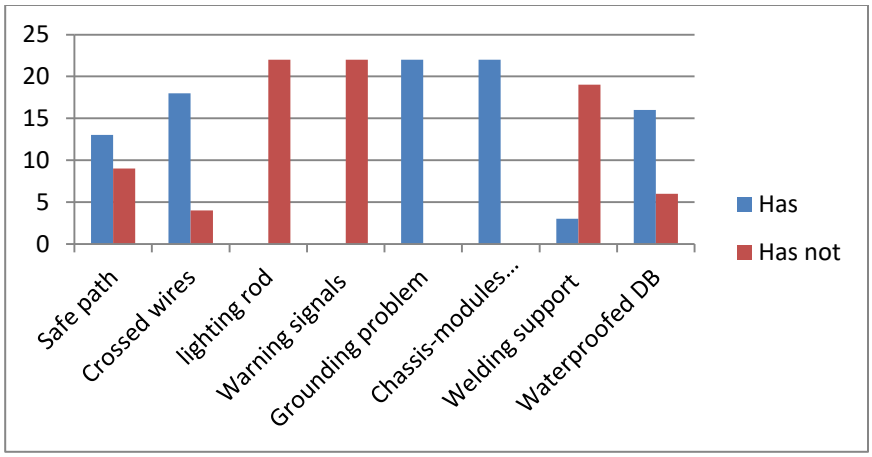


Figure 5: Manifestations of systems safety

Also, 20 out of 22 of the systems their solar cells attached to the chassis with a rusted metal as shown figure (6) and the remaining two systems do not even attach to the chassis but with screws as shown in figure (7).

Figure 6: Chassis-modules support problem1

Figure 7: Chassis-modules support problem2

It is noticeable that 19 out of 22 from the systems did not strengthened the welding areas in the structures with an extra metal as shown in figure (8). Also, the welding areas were very rusty. The last two problems are considered as weak link methods, that produce a lean structure can be easily broken in difficult weather conditions (like strong storms) or any strong blows on the structure.

Figure 8: Welding support problem

Access to the system is very important for cleaning and repairing the systems when needed, so a safe path leads to the system must be provided. However, 9 out of 22 systems have no safe paths leading to the system. In addition, the crossed power lines pose a potential danger even if they are covered with an insulating material, as the passage of high voltage through them in certain cases causes a rise in the temperature of the wires

and may leads to melt the covering material and cause electrical fault and fires. However, there are 18 out of 22 systems have crossed power lines as shown in figure (9).

Figure 9: Crossed wires problem

Distribution boards should be installed in a safe place to reduce the possibility of falling and be well-covered in a waterproof board to prevent short circuits. Along with potentially melting wires and causing power to go out, a short circuit can also lead to the development of an electrical fire. These fires can do extensive damage to the building if they are not caught immediately. However, 6 out of 22 systems their distribution boards are not water-proofed and four of the remaining 16 systems are installed on the chassis itself as shown in figure (10).

Figure 10:Installing the DB problem

Chapter 5

Conclusions and recommendations

The performance analysis of 22 residential grid-connected Photovoltaic systems with a total capacity equals to 195 kWp in Rujeib, Palestine, is carried out in terms of main performance criteria such as specific final yield (Yf), performance ratio (PR%), and capacity utilization factor (CUF%), There values were 1507.32 kWh/kWp, 72.87% and 17.79% respectively. The systems were simulated using the PVsyst Version 7.1 software and it showed PR values that only 7% greater than the mean measured values. A comparison was also made between the measured values and evaluation parameters of reported PV plants in some near countries (Jordan and Syria) that shows a good performance of the systems in total, and it gives a good indication of installing such systems in the region.

Although the systems performed well, there are some recommendations:

1. An exception of system number 7 was made, where the inverter used has smaller in size than the system capacity. As for this system, the inverter must be changed to a suitable one. This alerts us to the importance of making a professional design for solar systems by specialized engineers and not by technicians.
2. Some problems were encountered in collecting sufficient information throughout the year about the production of the system, due to the lack of a monitoring system. Therefore, a monitoring and supervision system is very important to provide when installing a new PV system to improve the system study process and its accuracy.
3. It is important to understand the frequency of cleaning the photovoltaic solar systems because the performance of the system can vary depending on the yearly degradation of the whole system and on monthly decay due to soiling.
4. Pay more attention to safety means, where should install lightning rods and grounding systems where the electrode resistance is less than five ohms for all systems, add warning signals, support the structure well by supporting weak areas with an additional piece of galvanized metal, paving safe lanes that are needed, re-extending power lines in systems that are needed, in a way that shows no crosses between them, and put the inverters and the distribution boards in safe, water-proofed placed.

References

[1]. M. R. H. Ritchie, “Energy Production & Changing Energy Sources,” 2017. [Online] Available from : https://ourworldindata.org/energy-production-and-changing-energy-sources.

[2]. E. Basel and T. Q. Yaseen, “Renewable Energy Applications in Palestine,” vol. 804, pp. 52–65, 2007, [Online]. Available: https://scholar.najah.edu/sites/default/files/conference-paper/renewable-energy-applications-palestine.pdf.

[3]. R. T. Sataloff, M. M. Johns, and K. M. Kost, “Population matters.” [Online] Available from: https://palestine.unfpa.org/ar/node/22457.

[4]. R. T. Sataloff, M. M. Johns, and K. M. Kost, “Palestine - Pump price for gasoline,” [Online]. Available: https://knoema.com/atlas/Palestine/topics/Economy/Inflation-and-Prices/Price-for-gasoline.

[5]. B. M. Richard and J. Issac, “Analysis of climatic variability and its environmental impacts across the occupied Palestinian territory,” pp. 1–20, 2012.

[6]. NEDCO, “Solar radiation in Palestine,” 2017. [Online] Available from: http://www.nedco.ps/?ID=1522.

[7]. M. Sidrach-de-Cardonaa and L. M. Lo´pezb, “Performance analysis of a grid-connected photovoltaic system,” vol. 24, pp. 93–102, 1999.

[8]. E. Kymakis, S. Kalykakis, and T. M. Papazoglou, “Performance analysis of a grid connected photovoltaic park on the island of Crete,” *Energy Convers. Manag.*, vol. 50, no. 3, pp. 433–438, 2009.

[9]. B. S. Kumar and K. Sudhakar, “Performance evaluation of 10 MW grid connected solar photovoltaic power plant in India,” *Energy Reports*, vol. 1, pp. 184–192, 2015.

[10]. J. D. Mondol, Y. Yohanis, M. Smyth, and B. Norton, “Long term performance analysis of a grid connected photovoltaic system in Northern Ireland,” vol. 47, pp. 2925–2947, 2006, doi: 10.1016/j.enconman.2006.03.026.

[11]. S. Bouacha *et al.*, “Energy for Sustainable Development Performance analysis of the fi rst photovoltaic grid-connected system in Algeria,” *Energy Sustain. Dev.*, vol. 57, pp. 1–11, 2020, doi: 10.1016/j.esd.2020.04.002.

[12]. J. Aguilera *et al.*, “Univer Project . A grid connected photovoltaic system of 200 kW p at ´ n University . Overview and performance analysis Jae,” vol. 91, pp. 670–683, 2007.

[13]. L. C. De Lima, L. D. A. Ferreira, F. Hedler, and B. De Lima, “Energy for Sustainable Development Performance analysis of a grid connected photovoltaic system in northeastern Brazil,” vol. 37, pp. 79–85, 2017.

[14]. P. Yadav, "Simulation and Performance Analysis of a lkWp Photovoltaic System Using PVsyst," pp. 358–363, 2015.

[15]. F. Fairouz, "Performance evaluation of photovoltaic systems on Kuwaiti schools ' rooftop," *Energy Convers. Manag.*, vol. 95, pp. 110–119, 2015.

[16]. M. Cubukcu and H. Gumus, "Performance analysis of a grid-connected photovoltaic plant in eastern Turkey," *Sustain. Energy Technol. Assessments*, vol. 39, no. December 2019, p. 100724, 2020.

[17]. X. Wu *et al.*, "Monitoring the performance of the building attached photovoltaic (BAPV) system in Shanghai," *Energy Build.*, vol. 88, pp. 174–182, 2015.

[18]. M. S. Vasisht, J. Srinivasan, and S. K. Ramasesha, "ScienceDirect Performance of solar photovoltaic installations : Effect of seasonal variations," *Sol. ENERGY*, vol. 131, pp. 39–46, 2016.

[19]. S. Seme, K. Sreden, Š. Bojan, and M. Had, "Analysis of the performance of photovoltaic systems in Slovenia," vol. 180, no. May 2018, pp. 550–558, 2019.

[20]. E. Ghiani, "On the performance ratio of photovoltaic installations."

[21]. L. M. Ayompe, A. Duffy, S. J. Mccormack, and M. Conlon, "Measured performance of a 1 . 72 kW rooftop grid connected photovoltaic system in Ireland," *Energy Convers. Manag.*, vol. 52, no. 2, pp. 816–825, 2020.

[22]. M. Dhimish, "clean technologies Performance Ratio and Degradation Rate Analysis of 10-Year Field Exposed Residential Photovoltaic Installations in the UK and Ireland," pp. 170–183, 2020.

[23]. B. Guo, W. Javed, B. W. Figgis, and T. Mirza, "Effect of Dust and Weather Conditions on Photovoltaic Performance in Doha , Qatar," 2015.

[24]. P. Ramanan, K. M. K, and A. Karthick, "Energy for Sustainable Development Performance analysis and energy metrics of grid-connected photovoltaic systems," *Energy Sustain. Dev.*, vol. 52, pp. 104–115, 2019.

[25]. E. Urrejola *et al.*, "Effect of soiling and sunlight exposure on the performance ratio of photovoltaic technologies in Santiago , Chile," *Energy Convers. Manag.*, vol. 114, pp. 338–347, 2016.

[26]. V. Sharma, A. Kumar, O. S. Sastry, and S. S. Chandel, "Performance assessment of different solar photovoltaic technologies under similar outdoor conditions," *Energy*, vol. 58, pp. 511–518, 2013.

[27]. M. A. Bashir, H. M. Ali, S. Khalil, M. Ali, and A. M. Siddiqui, "Comparison of Performance Measurements of Photovoltaic Modules during Winter Months in Taxila , Pakistan," vol. 2014, 2014.

[28]. N. Kumar, "Comparative Analysis of Four Different Solar Photovoltaic Technologies,"

2015.

[29]. A. Ameur, A. Sekkat, K. Loudiyi, and M. Aggour, “Energy for Sustainable Development Performance evaluation of different photovoltaic technologies in the region of Ifrane , Morocco,” *Energy Sustain. Dev.*, vol. 52, pp. 96–103, 2019.

[30]. J. Deb, Y. G. Yohanis, and B. Norton, “The impact of array inclination and orientation on the performance of a grid-connected photovoltaic system,” vol. 32, pp. 118–140, 2007.

[31]. K. P. Satsangi, D. B. Das, G. S. S. Babu, and A. K. Saxena, “Energy for Sustainable Development Performance analysis of grid interactive solar photovoltaic plant in India,” *Energy Sustain. Dev.*, vol. 47, pp. 9–16, 2018.

[32]. B. Rupnik and O. Westbrook, “Ambient temperature correction of photovoltaic system performance data,” *2014 IEEE 40th Photovolt. Spec. Conf. PVSC 2014*, pp. 1973–1977, 2014.

[33]. B. Marion *et al.*, “Performance Parameters for Grid-Connected PV Systems,” no. February, 2005.

[34]. V. Raoul, “Gehalt und Aufriss der Argonautica des Valerius Flaccus,” *Antiq. Class.*, vol. 44, no. 1, pp. 285–286, 1975.

[35]. “Private communication with National Energy Research Center (NERC), Syria.”

[36]. A. Hamzeh, S. Hamed, A. Sandouk, and G. Aldahim, “First Year Performance of a PV Plant in Jordan Compared to PV Plants in the Region,” vol. 5, no. 4, 2015.

[37]. A. Mermoud, “What is the accuracy of the PVsyst simulation results ?,” 2014. [Online] Available from: https://forum.pvsyst.com/viewtopic.php?t=1649.

Appendices

PVsyst reports

The following appendices are the reports from all the systems that had been simulated using the PVsyst software.

Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 1

Variant: 14

Building system

System power: 6.93 kWp

R2 - Palestine, State Of

Author

Project: System 1

Variant: 14

Project summary

Geographical Site
R2
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	0 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	18 units
Pnom total	6.93 kWp

Inverters

Nb. of units	1 Unit
Pnom total	10.00 kWac
Pnom ratio	0.693

Results summary

Produced Energy	12.27 MWh/year	Specific production	1771 kWh/kWp/year	Perf. Ratio PR	80.71 %
				Solar Fraction SF	50.47 %

Table of contents

General parameters

Grid-Connected System

PV Field Orientation
Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

Building system

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

Horizon
Free Horizon

PV Array Characteristics

PV module
Manufacturer JA Solar
Model JAM72-S09-385-PR
(Original PVsyst database)
Unit Nom. Power 385 Wp
Number of PV modules 18 units
Nominal (STC) 6.93 kWp
Modules 2 Strings x 9 In series
At operating cond. (50°C)
Pmpp 6.29 kWp
U mpp 325 V
I mpp 19 A

Total PV power
Nominal (STC) 7 kWp
Total 18 modules
Module area 35.5 m²

Inverter
Manufacturer ABB
Model PVI-10.0-TL-OUTD
(Original PVsyst database)
Unit Nom. Power 10.00 kWac
Number of inverters 2 * MPPT 50% 1 units
Total power 10.0 kWac
Operating voltage 175-850 V
Pnom ratio (DC:AC) 0.69

Total inverter power
Total power 10 kWac
Nb. of inverters 1 Unit
Pnom ratio 0.69

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

LID - Light Induced Degradation
Loss Fraction 2.0 %

Strings Mismatch loss
Loss Fraction 0.1 %

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

Module Quality Loss
Loss Fraction -0.8 %

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

DC wiring losses
Global array res. 282 mΩ
Loss Fraction 1.5 % at STC

Module mismatch losses
Loss Fraction 2.0 % at MPP

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

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

Array losses

Spectral correction
FirstSolar model

Coefficient Set	C0	C1	C2	C3	C4	C5
	0	0	0	0	0	0

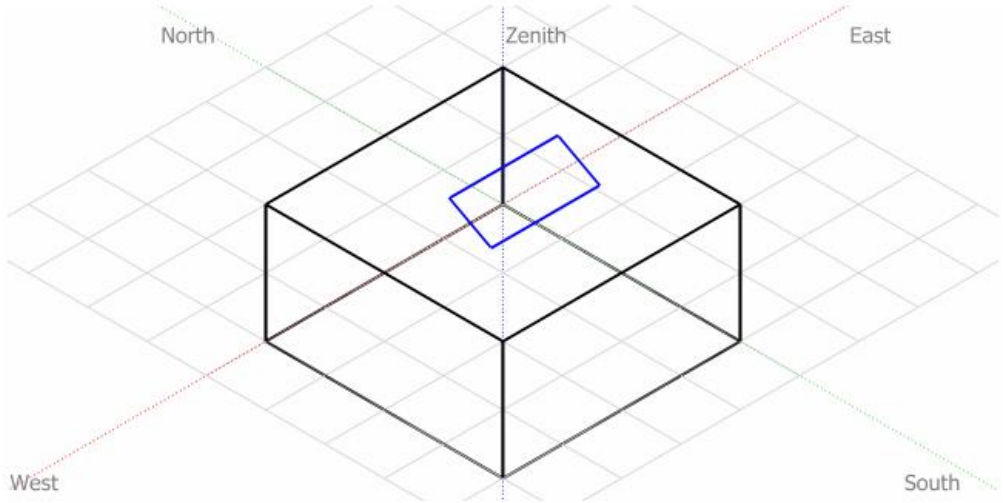
System losses

Unavailability of the system
Time fraction 2.0 %
7.3 days,
3 periods

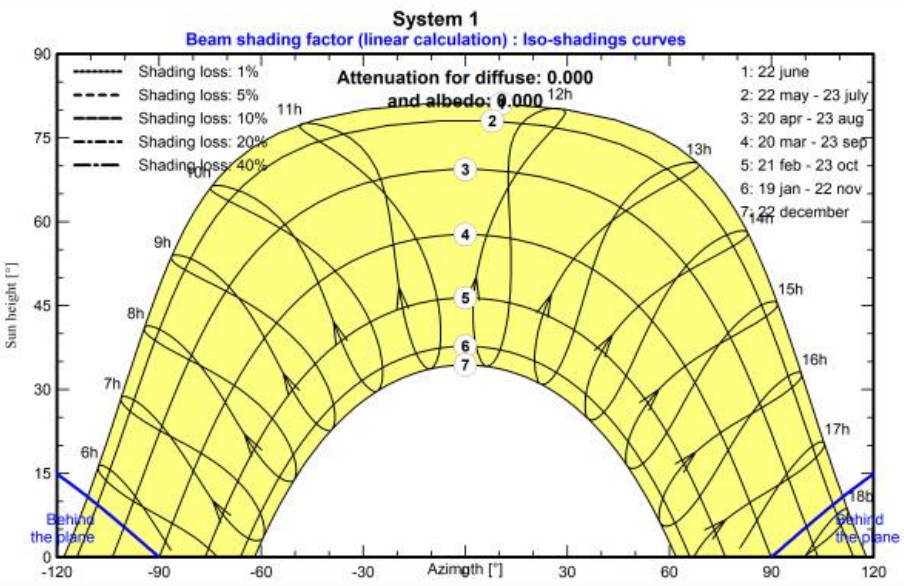
Auxiliaries loss

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

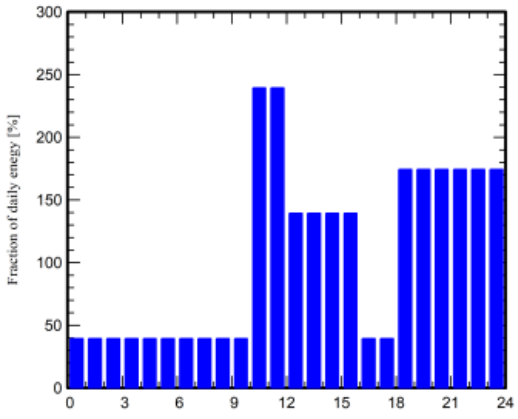
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

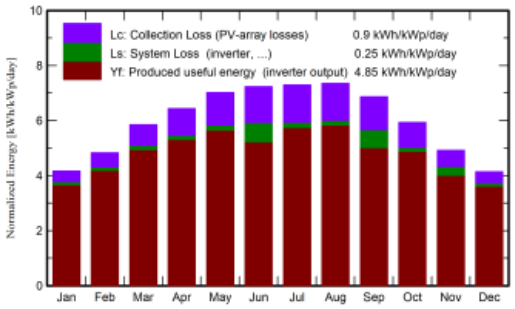


Main results

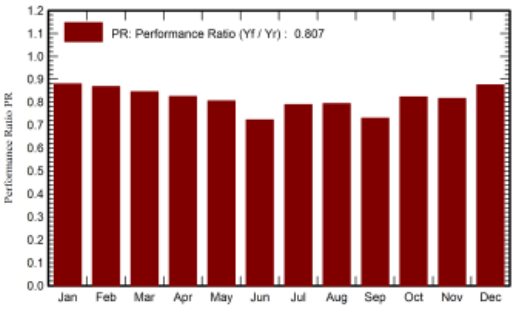
System Production

Produced Energy	12.27 MWh/year	Specific production	1771 kWh/kWp/year
		Performance Ratio PR	80.71 %
		Solar Fraction SF	50.47 %

Normalized productions (per installed kWp)



Performance Ratio PR



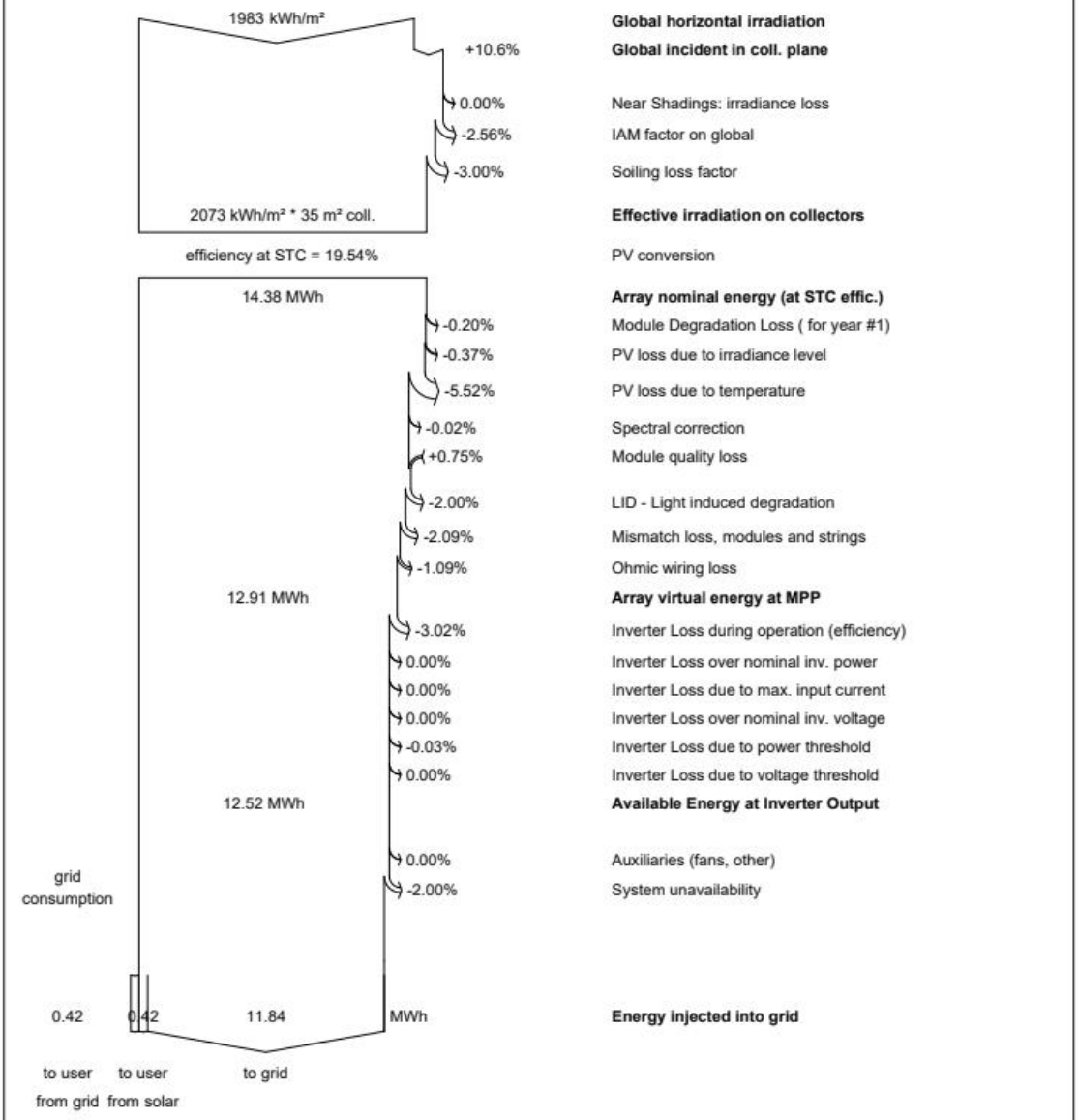
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	122.5	0.813	0.079	0.036	0.752	0.043
February	104.1	46.44	9.45	135.3	128.3	0.840	0.071	0.033	0.781	0.038
March	154.7	63.04	13.37	181.4	171.9	1.096	0.072	0.038	1.025	0.034
April	184.3	71.51	17.01	193.1	182.5	1.139	0.070	0.038	1.066	0.032
May	228.2	70.13	21.21	217.7	205.1	1.254	0.072	0.041	1.175	0.032
June	239.7	59.41	24.13	217.1	203.9	1.233	0.060	0.030	1.057	0.030
July	244.0	58.79	26.28	226.1	212.6	1.276	0.062	0.034	1.202	0.028
August	224.7	56.60	25.93	227.8	214.9	1.292	0.062	0.034	1.219	0.028
September	182.1	40.34	23.64	205.9	194.9	1.180	0.070	0.033	1.010	0.037
October	144.3	44.91	21.01	183.9	174.4	1.081	0.072	0.038	1.011	0.035
November	102.9	34.28	14.54	147.7	140.5	0.902	0.070	0.033	0.803	0.037
December	84.7	32.81	10.22	128.3	121.8	0.804	0.079	0.036	0.743	0.043
Year	1983.5	616.68	17.96	2193.6	2073.4	12.913	0.841	0.424	11.845	0.416

Legends

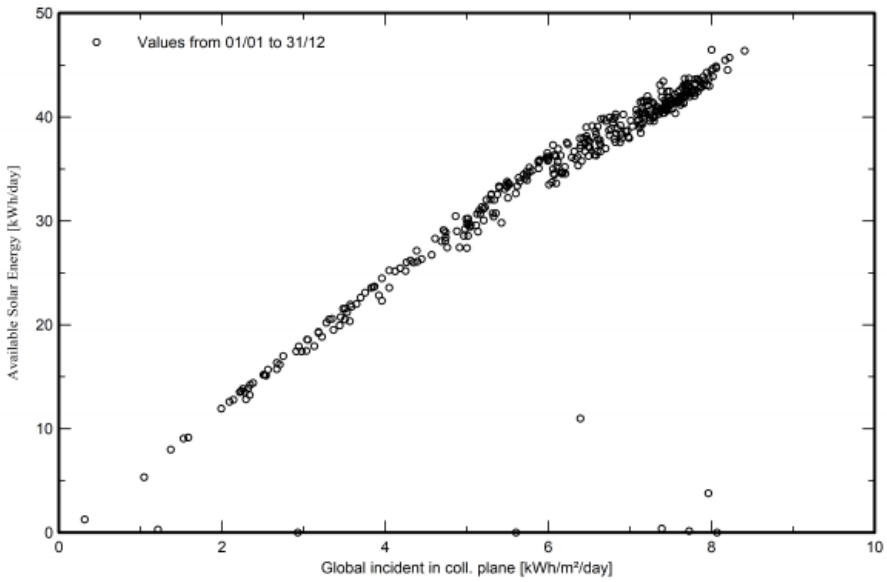
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

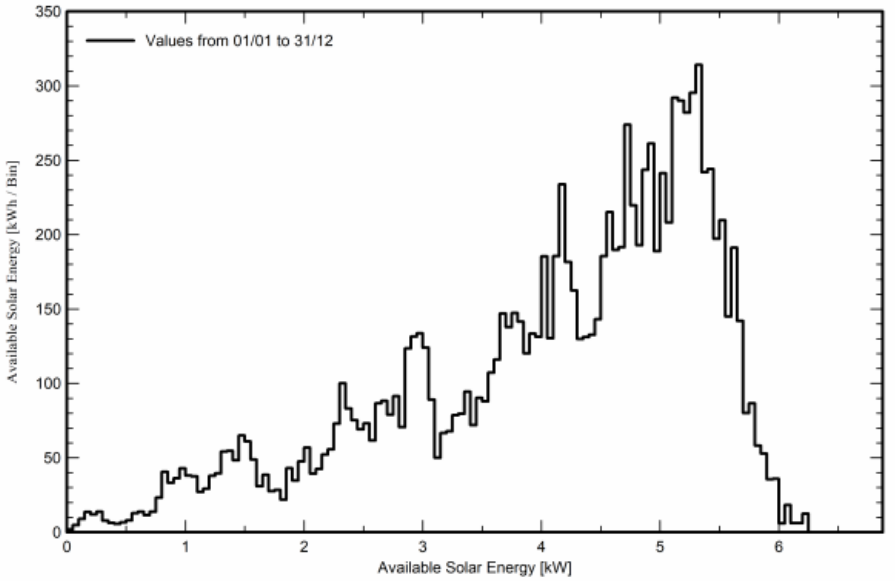


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 2

Variant: 12 SM

Building system

System power: 10.22 kWp

R3 - Palestine, State Of

Author

Project: System 2

Variant: 12 SM

Project summary

Geographical Site
R3
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	561 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	28 units
Pnom total	10.22 kWp

Inverters

Nb. of units	1 Unit
Pnom total	10.00 kWac
Pnom ratio	1.022

Results summary

Produced Energy	17.35 MWh/year	Specific production	1697 kWh/kWp/year	Perf. Ratio PR	77.30 %
				Solar Fraction SF	51.73 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Sunket
Model	SKT360M6-24
(Custom parameters definition)	
Unit Nom. Power	365 Wp
Number of PV modules	28 units
Nominal (STC)	10.22 kWp
Modules	4 Strings x 7 In series
At operating cond. (50°C)	
Pmpp	9.42 kWp
U mpp	257 V
I mpp	37 A

Inverter

Manufacturer	ABB
Model	PVI-10-I-OUTD-S1-US-600
(Original PVsyst database)	
Unit Nom. Power	10.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	10.0 kWac
Operating voltage	120-470 V
Pnom ratio (DC:AC)	1.02

Total PV power

Nominal (STC)	10 kWp
Total	28 modules
Module area	54.3 m²
Cell area	49.0 m²

Total inverter power

Total power	10 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.02

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 115 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction 3.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

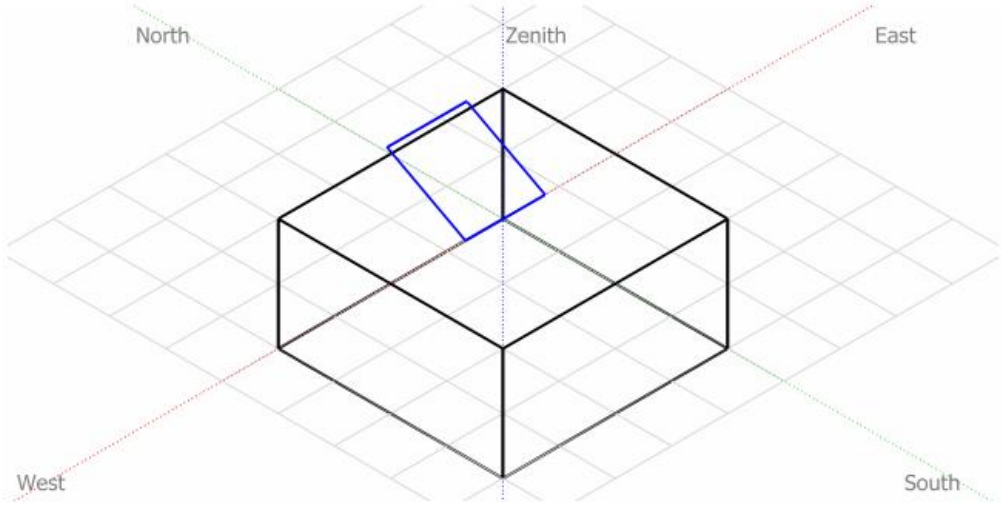
Strings Mismatch loss
Loss Fraction 0.1 %

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

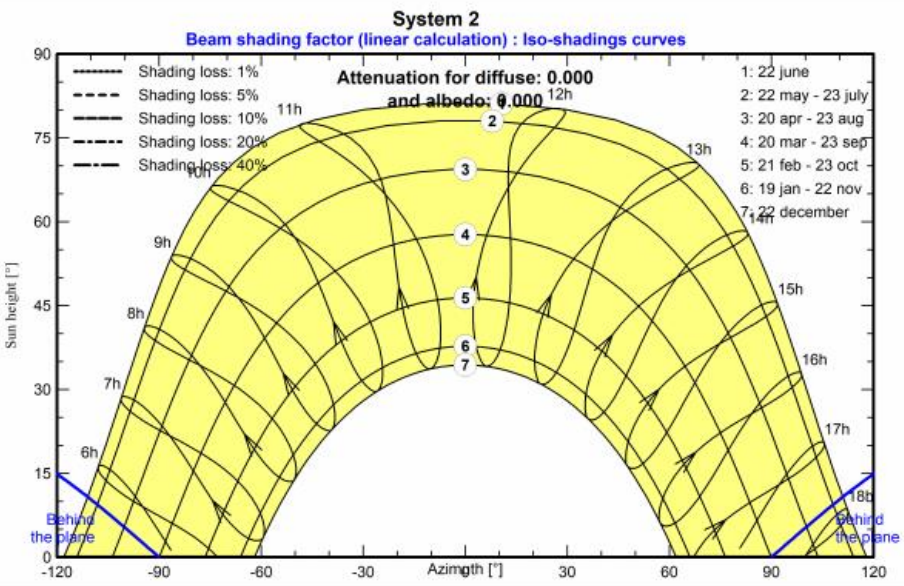
IAM loss factor
ASHRAE Param: IAM = 1 - bo(1/cosi -1)
bo Param. 0.05

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

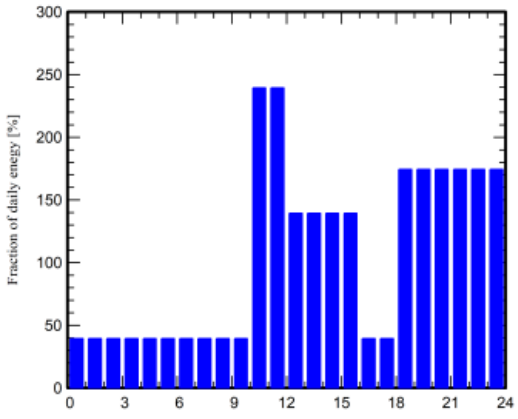
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

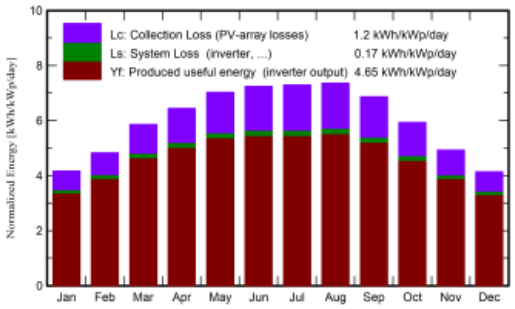


Main results

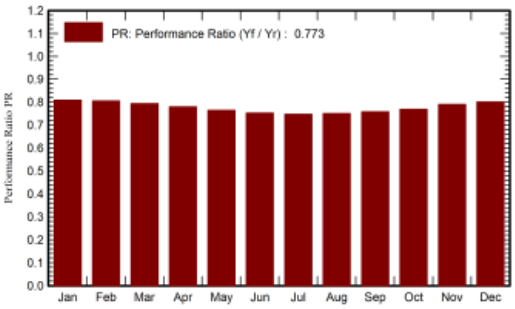
System Production

Produced Energy	17.35 MWh/year	Specific production	1697 kWh/kWp/year
		Performance Ratio PR	77.30 %
		Solar Fraction SF	51.73 %

Normalized productions (per installed kWp)



Performance Ratio PR



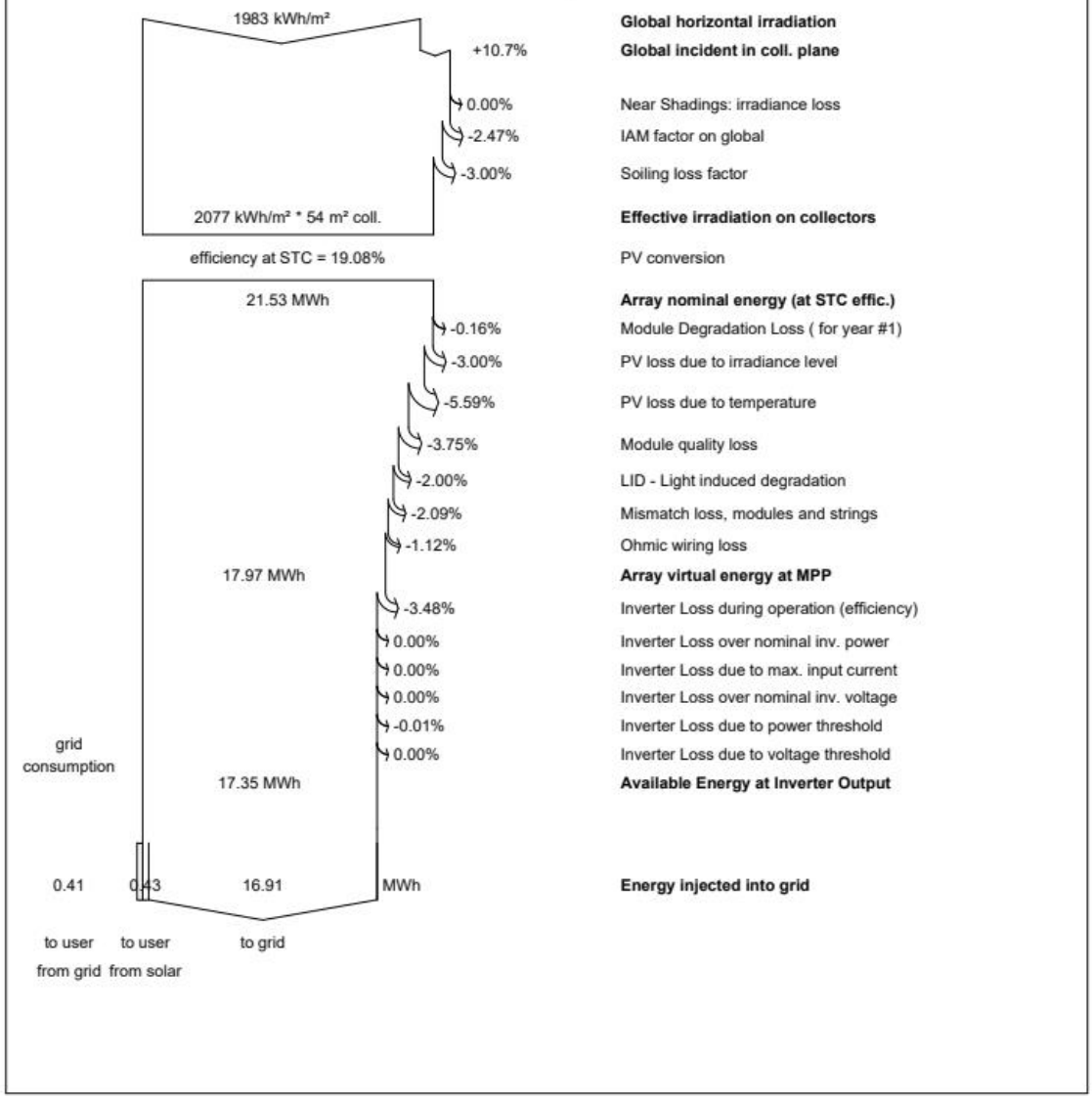
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	122.4	1.108	0.079	0.036	1.033	0.043
February	104.1	46.44	9.45	135.4	128.3	1.155	0.071	0.033	1.082	0.038
March	154.7	63.04	13.37	181.6	172.3	1.527	0.072	0.038	1.436	0.034
April	184.3	71.51	17.01	193.4	183.1	1.598	0.070	0.039	1.503	0.031
May	228.2	70.13	21.21	218.0	205.7	1.764	0.072	0.041	1.662	0.032
June	239.7	59.41	24.13	217.3	204.5	1.734	0.060	0.033	1.640	0.027
July	244.0	58.79	26.28	226.3	213.3	1.793	0.062	0.034	1.696	0.028
August	224.7	56.60	25.93	228.1	215.6	1.814	0.062	0.034	1.717	0.028
September	182.1	40.34	23.64	206.1	195.4	1.656	0.070	0.037	1.561	0.033
October	144.3	44.91	21.01	184.1	174.7	1.498	0.072	0.038	1.409	0.035
November	102.9	34.28	14.54	147.8	140.3	1.237	0.070	0.035	1.159	0.035
December	84.7	32.81	10.22	128.4	121.6	1.089	0.079	0.036	1.016	0.043
Year	1983.5	616.68	17.96	2195.7	2077.3	17.974	0.841	0.435	16.912	0.406

Legends

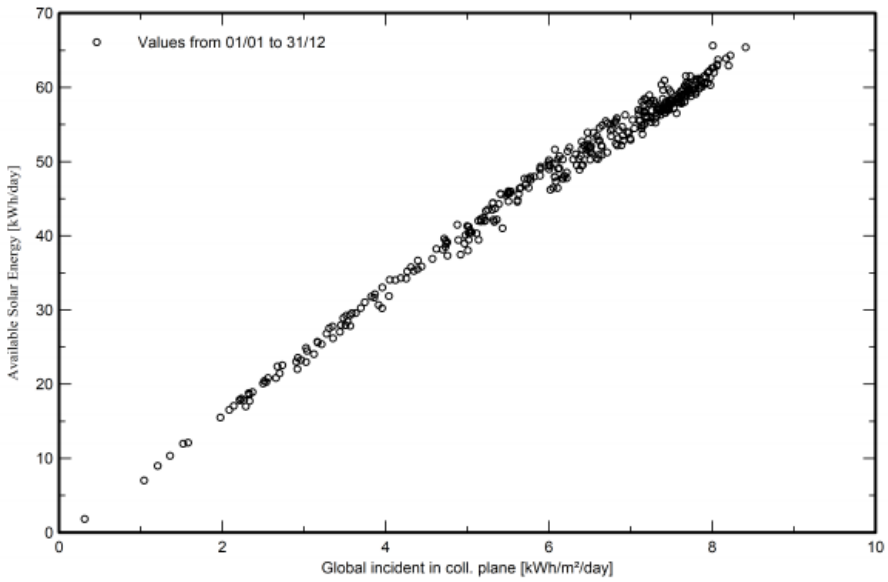
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

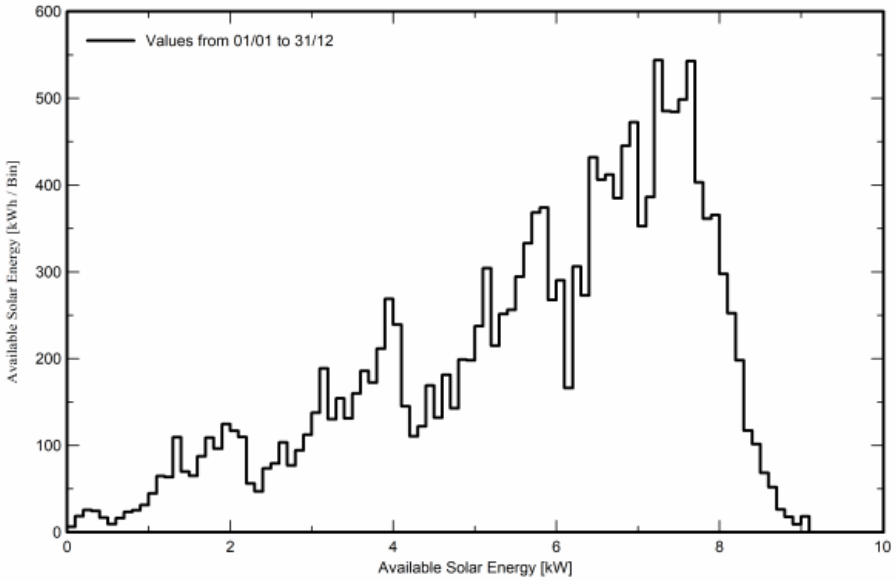


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 3

Variant: New simulation variant

Building system

System power: 5.78 kWp

R4 - Palestine, State Of

Author

Project: System 3

Variant: New simulation variant

Project summary

Geographical Site
R4
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	563 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	15 units
Pnom total	5.78 kWp

Inverters

Nb. of units	1 Unit
Pnom total	5.00 kWac
Pnom ratio	1.155

Results summary

Produced Energy	10.59 MWh/year	Specific production	1833 kWh/kWp/year	Perf. Ratio PR	83.48 %
				Solar Fraction SF	51.85 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	JA solar
Model	JAM60-S20-385-MR
(Original PVsyst database)	
Unit Nom. Power	385 Wp
Number of PV modules	15 units
Nominal (STC)	5.78 kWp
Modules	1 String x 15 In series
At operating cond. (50°C)	
Pmpp	5.27 kWp
U mpp	477 V
I mpp	11 A

Inverter

Manufacturer	Ingeteam
Model	Ingecon Sun 5TL M
(Custom parameters definition)	
Unit Nom. Power	5.00 kWac
Number of inverters	1 * MPPT 0.50 1 units
Total power	5.0 kWac
Operating voltage	125-750 V
Pnom ratio (DC:AC)	1.16

Total PV power

Nominal (STC)	6 kWp
Total	15 modules
Module area	28.0 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.16

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 716 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

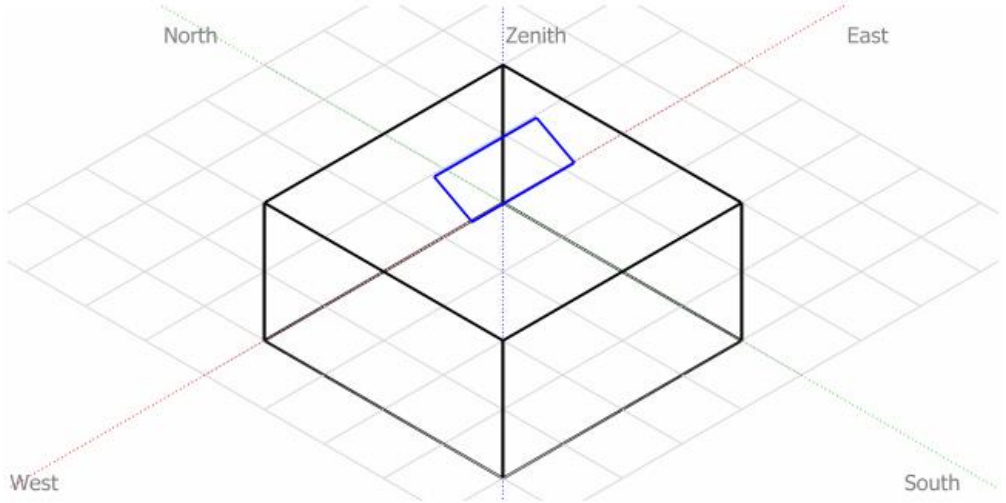
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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

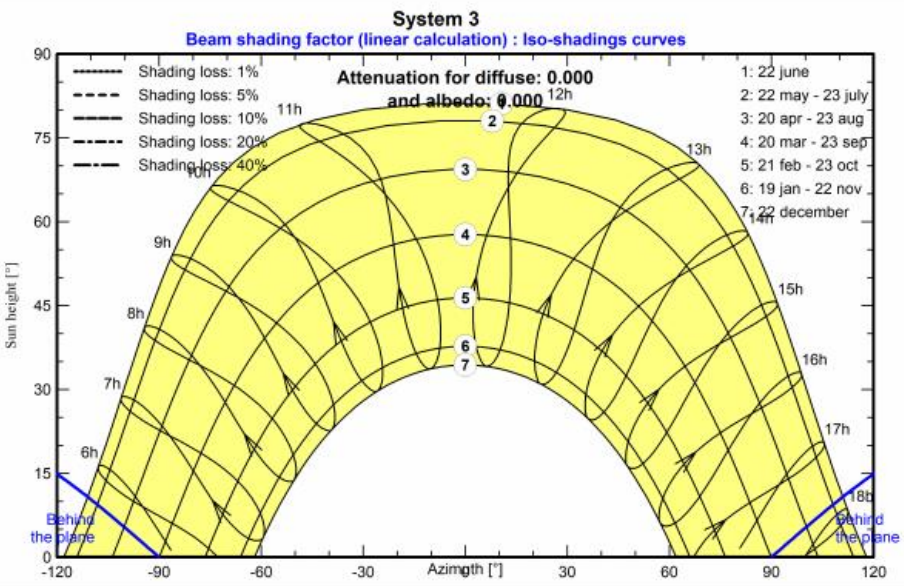
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

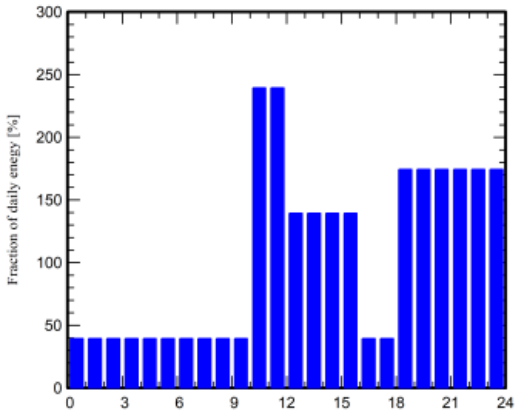
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

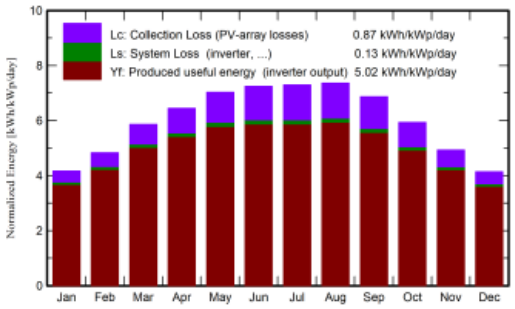


Main results

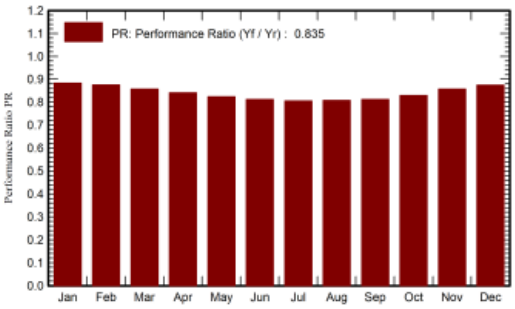
System Production

Produced Energy	10.59 MWh/year	Specific production	1833 kWh/kWp/year
		Performance Ratio PR	83.48 %
		Solar Fraction SF	51.85 %

Normalized productions (per installed kWp)



Performance Ratio PR



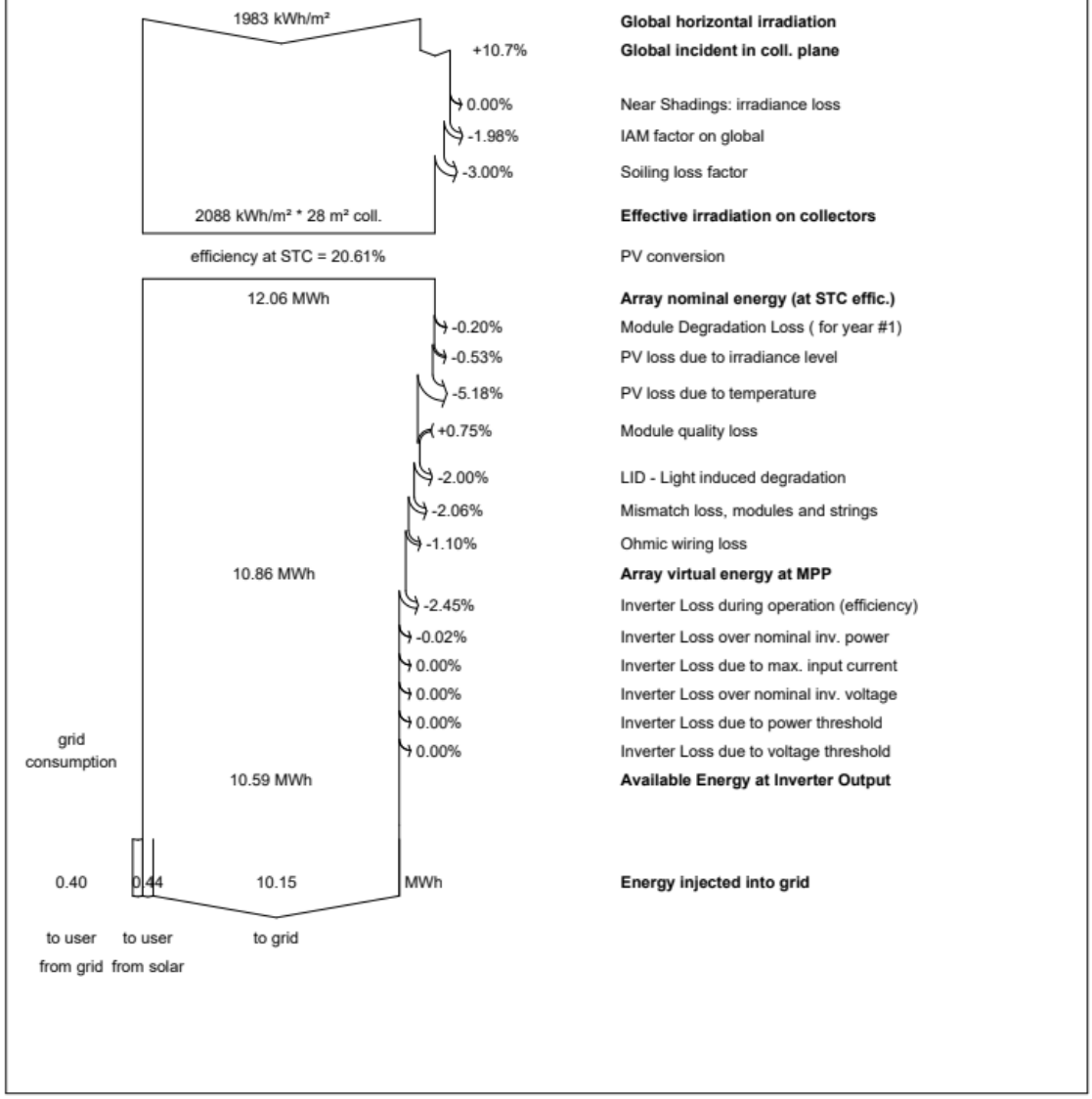
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.3	0.675	0.079	0.036	0.623	0.043
February	104.1	46.44	9.45	135.4	129.1	0.701	0.071	0.033	0.651	0.038
March	154.7	63.04	13.37	181.6	173.0	0.922	0.072	0.039	0.861	0.034
April	184.3	71.51	17.01	193.4	183.9	0.963	0.070	0.039	0.901	0.031
May	228.2	70.13	21.21	218.0	206.7	1.064	0.072	0.041	0.997	0.032
June	239.7	59.41	24.13	217.3	205.5	1.046	0.060	0.034	0.986	0.026
July	244.0	58.79	26.28	226.3	214.2	1.081	0.062	0.035	1.018	0.027
August	224.7	56.60	25.93	228.1	216.5	1.091	0.062	0.034	1.029	0.028
September	182.1	40.34	23.64	206.1	196.1	0.991	0.070	0.037	0.929	0.033
October	144.3	44.91	21.01	184.1	175.5	0.904	0.072	0.038	0.844	0.035
November	102.9	34.28	14.54	147.8	141.3	0.750	0.070	0.035	0.696	0.035
December	84.7	32.81	10.22	128.4	122.5	0.664	0.079	0.036	0.613	0.043
Year	1983.5	616.68	17.96	2195.7	2087.6	10.852	0.841	0.436	10.149	0.405

Legends

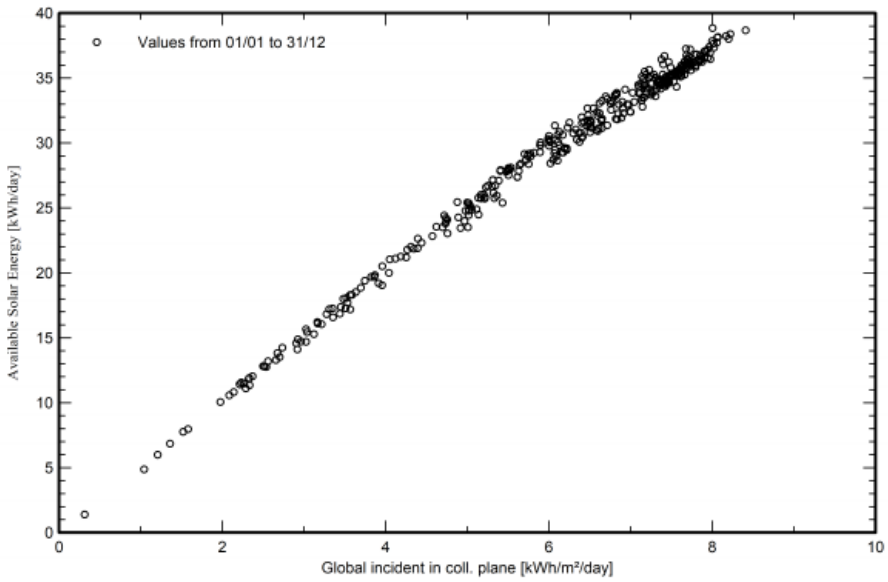
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

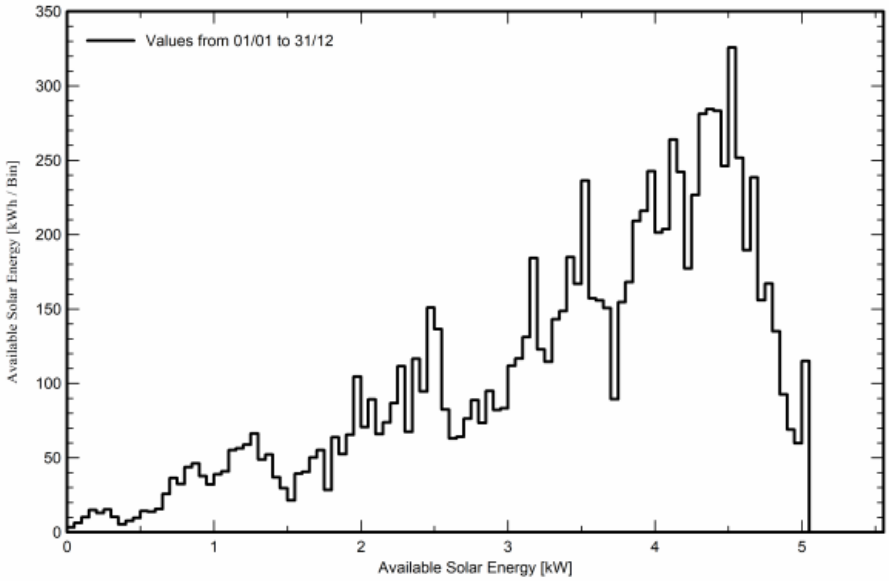


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 4

Variant: k10

Building system

System power: 11.25 kWp

R6 - Palestine, State Of

Author

Project: System 4

Variant: k10

Project summary

Geographical Site
R6
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	523 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	30 units
Pnom total	11.25 kWp

Inverters

Nb. of units	1 Unit
Pnom total	10.00 kWac
Pnom ratio	1.125

Results summary

Produced Energy	20.40 MWh/year	Specific production	1813 kWh/kWp/year	Perf. Ratio PR	82.59 %
				Solar Fraction SF	52.16 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation

Fixed plane

Tilt/Azimuth 28 / 0 °

Models used

Transposition Perez

Diffuse Perez, Meteonorm

Circumsolar separate

Horizon

Free Horizon

Near Shadings

Linear shadings

User's needs

Daily household consumers

Seasonal modulation

Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	JA solar
Model	JAM60-S20-375-MR
(Original PVsyst database)	
Unit Nom. Power	375 Wp
Number of PV modules	30 units
Nominal (STC)	11.25 kWp
Modules	2 Strings x 15 In series
At operating cond. (50°C)	
Pmpp	10.26 kWp
U mpp	471 V
I mpp	22 A

Inverter

Manufacturer	Kaco new energy
Model	Powador 12.0 TL3
(Original PVsyst database)	
Unit Nom. Power	10.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	10.0 kWac
Operating voltage	200-800 V
Pnom ratio (DC:AC)	1.13

Total PV power

Nominal (STC)	11 kWp
Total	30 modules
Module area	56.1 m²

Total inverter power

Total power	10 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.13

Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Thermal Loss factor

Module temperature according to irradiance

Uc (const) 29.0 W/m²K

Uv (wind) 0.0 W/m²K/m/s

DC wiring losses

Global array res. 358 mΩ

Loss Fraction 1.5 % at STC

Serie Diode Loss

Voltage drop 0.7 V

Loss Fraction 0.1 % at STC

LID - Light Induced Degradation

Loss Fraction 2.0 %

Module Quality Loss

Loss Fraction -0.8 %

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

Array losses

Spectral correction
FirstSolar model

Coefficient Set	C0	C1	C2	C3	C4	C5
	0	0	0	0	0	0

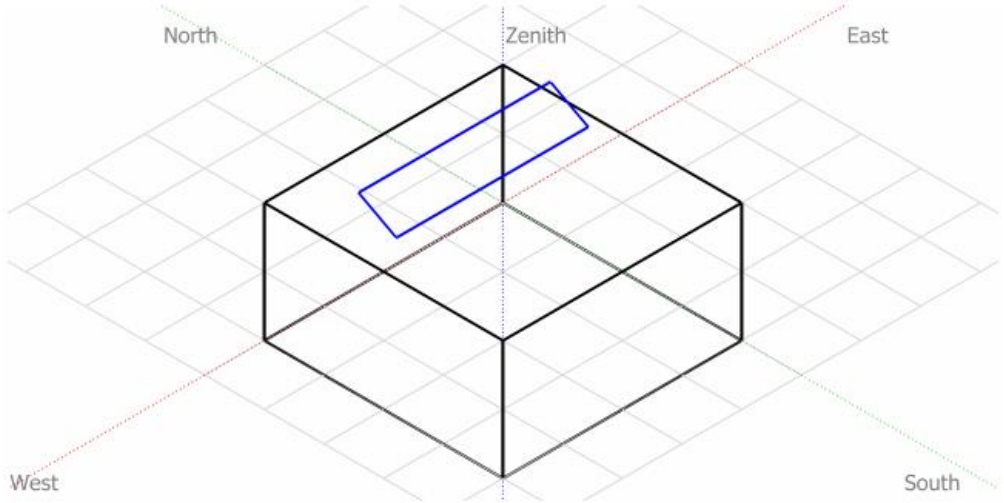
AC wiring losses

Inv. output line up to injection point

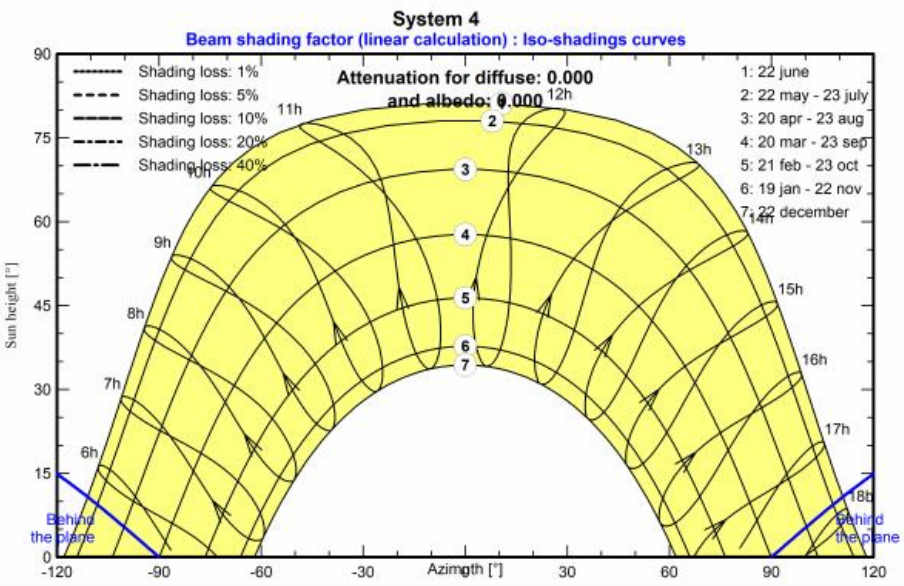
Inverter voltage	400 Vac tri
Loss Fraction	0.1 % at STC
Inverter: Powador 12.0 TL3	
Wire section (One inverter)	Copper 1 x 3 x 3 mm²
Wires length	2 m

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

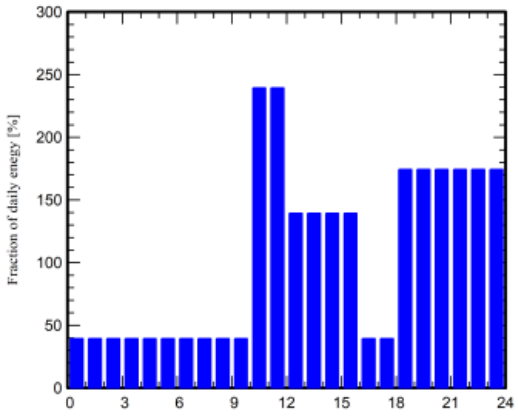
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

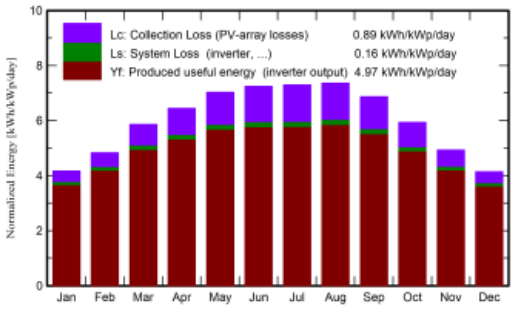


Main results

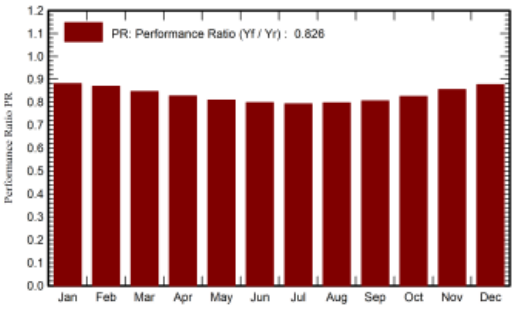
System Production

Produced Energy	20.40 MWh/year	Specific production	1813 kWh/kWp/year
		Performance Ratio PR	82.59 %
		Solar Fraction SF	52.16 %

Normalized productions (per installed kWp)



Performance Ratio PR



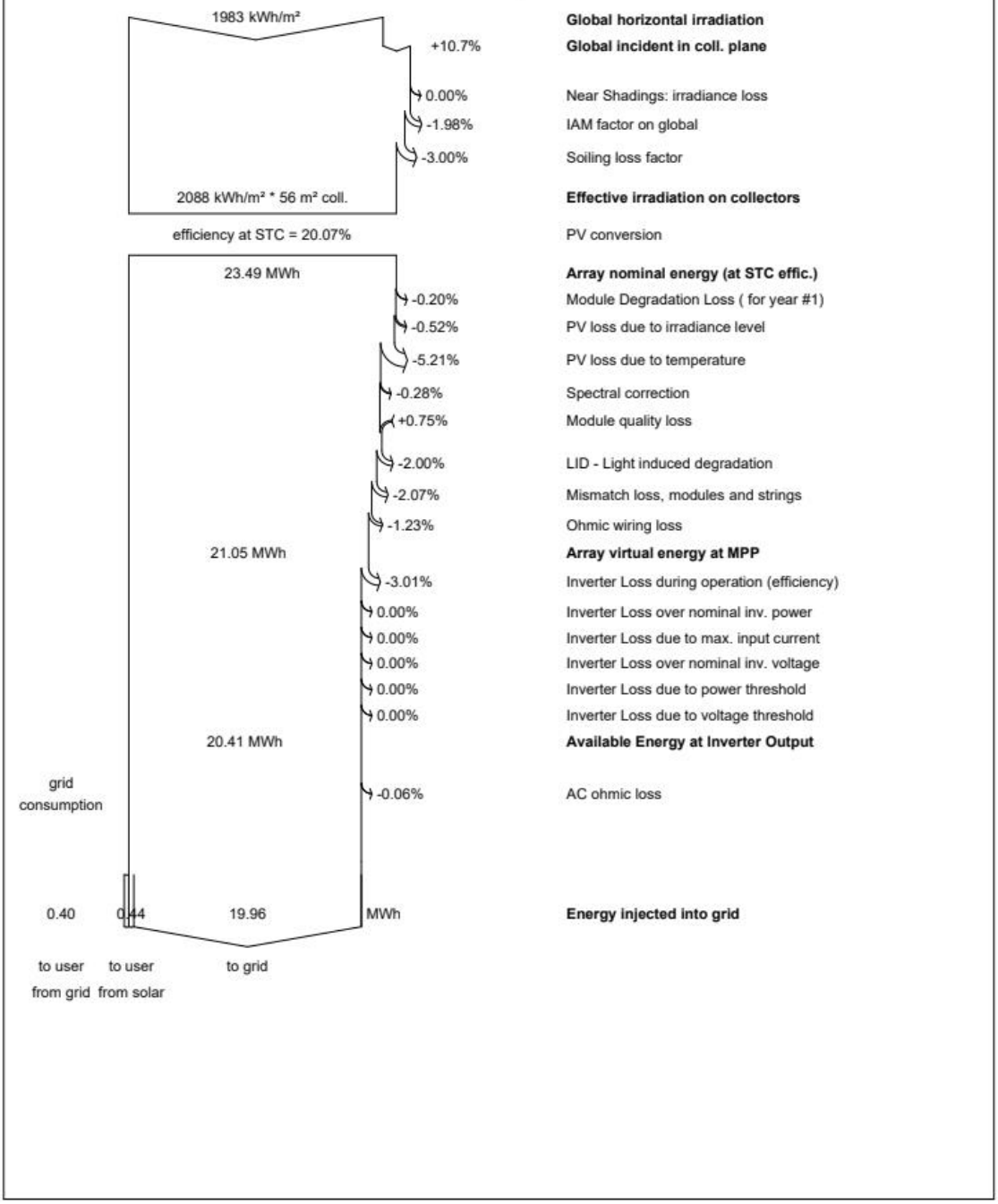
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.3	1.321	0.079	0.036	1.245	0.043
February	104.1	46.44	9.45	135.4	129.1	1.365	0.071	0.034	1.291	0.038
March	154.7	63.04	13.37	181.6	173.0	1.784	0.072	0.039	1.690	0.034
April	184.3	71.51	17.01	193.4	183.8	1.857	0.070	0.039	1.761	0.031
May	228.2	70.13	21.21	218.0	206.7	2.047	0.072	0.041	1.943	0.032
June	239.7	59.41	24.13	217.3	205.5	2.015	0.060	0.034	1.918	0.026
July	244.0	58.79	26.28	226.3	214.2	2.086	0.062	0.035	1.985	0.027
August	224.7	56.60	25.93	228.1	216.5	2.112	0.062	0.034	2.011	0.028
September	182.1	40.34	23.64	206.1	196.1	1.927	0.070	0.038	1.829	0.032
October	144.3	44.91	21.01	184.1	175.5	1.763	0.072	0.038	1.671	0.034
November	102.9	34.28	14.54	147.8	141.3	1.467	0.070	0.035	1.387	0.035
December	84.7	32.81	10.22	128.4	122.5	1.305	0.079	0.036	1.230	0.043
Year	1983.5	616.68	17.96	2195.6	2087.6	21.049	0.841	0.439	19.962	0.402

Legends

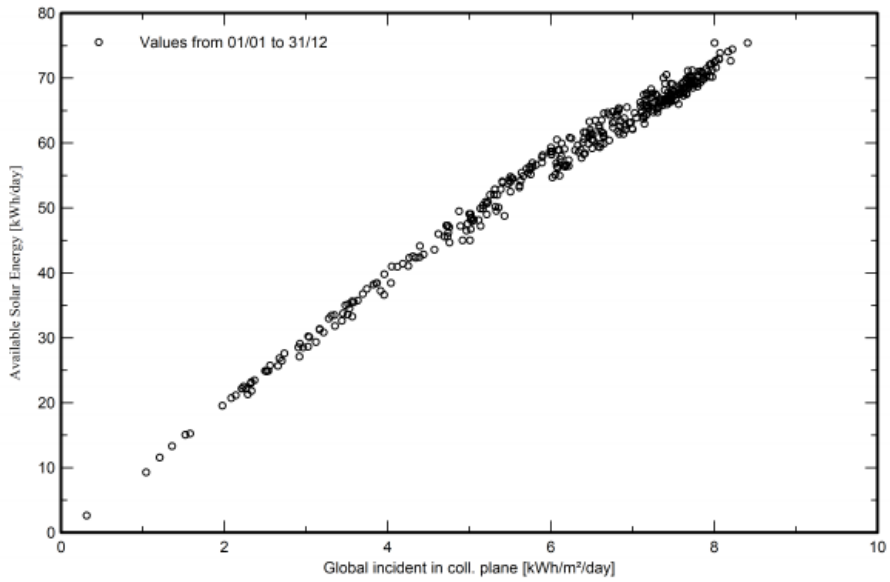
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

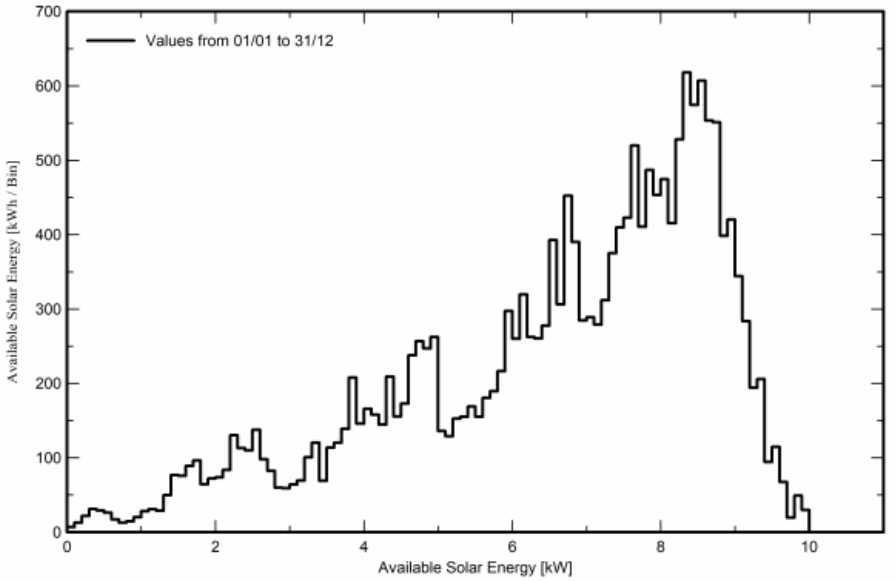


Special graphs

Daily Input/Output diagram



System Output Power Distribution



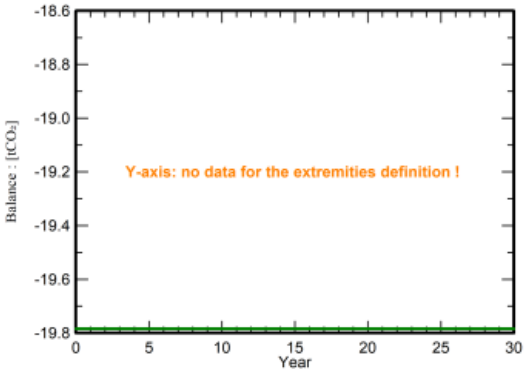
CO_2 Emission Balance

Total: -19.8 tCO_2

Generated emissions
Total: 19.78 tCO_2
Source: Detailed calculation from table below:

Replaced Emissions
Total: 0.0 tCO_2
System production: 20.40 MWh/yr
Grid Lifecycle Emissions: 0 gCO_2/kWh
Source: Custom value supplied by user
Lifetime: 30 years
Annual degradation: 1.0 %

Saved CO_2 Emission vs. Time



System Lifecycle Emissions Details

Item	LCE	Quantity	Subtotal
			[$kgCO_2$]
Modules	1758 kgCO2/kWp	11.3 kWp	19782
Supports	0.01 kgCO2/kg	300 kg	2.00
Inverters	0.66 kgCO2/	1.00	0.66

Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 5

Variant: 6Taxi

Building system

System power: 6.50 kWp

R7 - Palestine, State Of

Author

Project: System 5

Variant: 6Taxi

Project summary

Geographical Site
R7
Palestine, State Of

Situation

Latitude	32.20 °N
Longitude	35.29 °E
Altitude	480 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 0.4 kWh/Day

System information

PV Array

Nb. of modules	20 units
Pnom total	6.50 kWp

Inverters

Nb. of units	1 Unit
Pnom total	6.00 kWac
Pnom ratio	1.083

Results summary

Produced Energy	11.82 MWh/year	Specific production	1819 kWh/kWp/year	Perf. Ratio PR	82.85 %
				Solar Fraction SF	11.18 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 0.4 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Hanwha Q Cells
Model	Q.POWER L-G5.2 325
(Original PVsyst database)	
Unit Nom. Power	325 Wp
Number of PV modules	20 units
Nominal (STC)	6.50 kWp
Modules	2 Strings x 10 In series
At operating cond. (50°C)	
Pmpp	5.85 kWp
U mpp	335 V
I mpp	17 A

Inverter

Manufacturer	ABB
Model	UNO-DM-6.0-TL-PLUS
(Original PVsyst database)	
Unit Nom. Power	6.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	6.0 kWac
Operating voltage	90-580 V
Pnom ratio (DC:AC)	1.08

Total PV power

Nominal (STC)	7 kWp
Total	20 modules
Module area	38.8 m²
Cell area	35.0 m²

Total inverter power

Total power	6 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.08

Array losses

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. 325 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

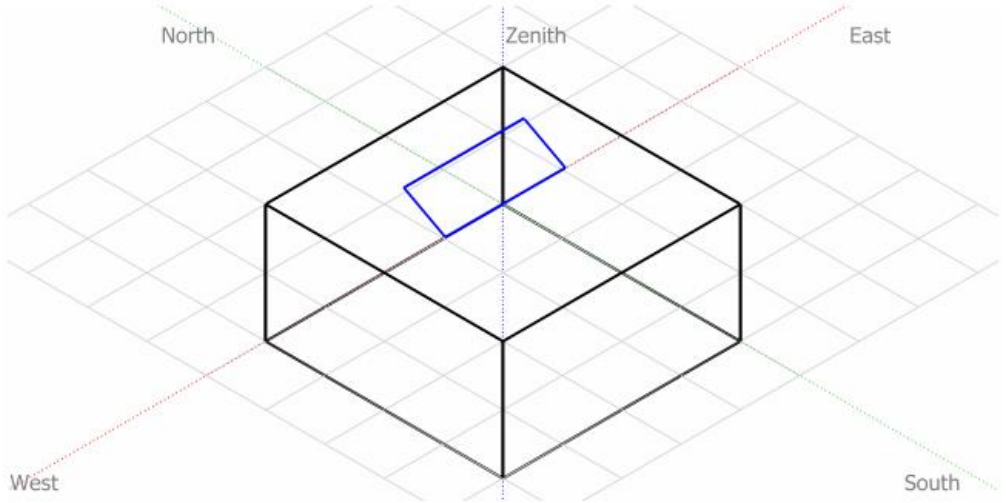
Strings Mismatch loss
Loss Fraction 0.1 %

IAM loss factor
Incidence effect (IAM): User defined profile

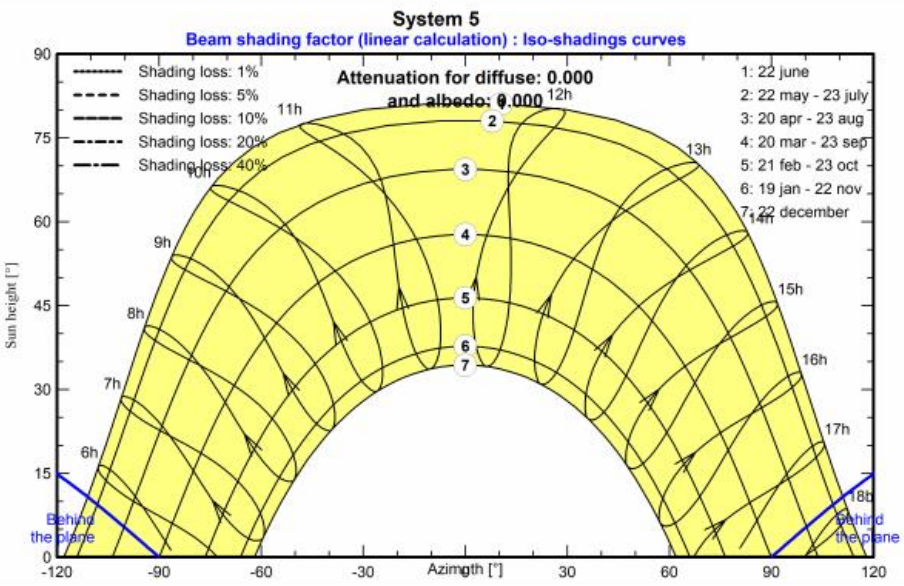
0°	30°	60°	65°	70°	75°	80°	85°	90°
1.000	1.000	0.960	0.940	0.900	0.830	0.690	0.440	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 0.4 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	2	10W/lamp	4.0	80
TV / PC / Mobile	1	80W/app	2.0	160
Stand-by consumers			24.0	96
Total daily energy				336Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	2	10W/lamp	5.0	100
TV / PC / Mobile	1	80W/app	3.0	240
Stand-by consumers			24.0	96
Total daily energy				436Wh/day

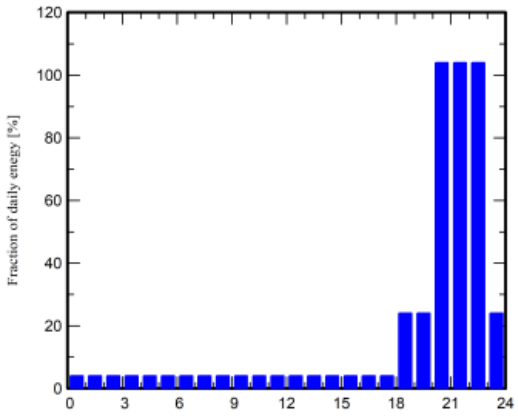
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	2	10W/lamp	6.0	120
TV / PC / Mobile	1	80W/app	3.0	240
Stand-by consumers			24.0	96
Total daily energy				456Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	2	10W/lamp	5.0	100
TV / PC / Mobile	1	80W/app	3.0	240
Stand-by consumers			24.0	96
Total daily energy				436Wh/day

Hourly distribution

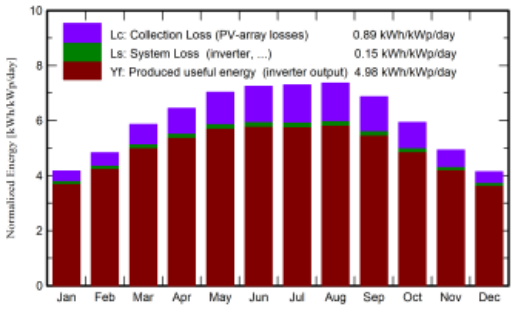


Main results

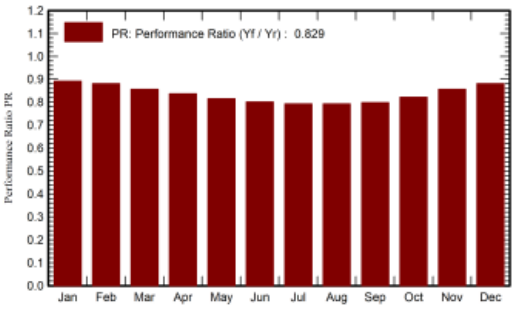
System Production

Produced Energy	11.82 MWh/year	Specific production	1819 kWh/kWp/year
		Performance Ratio PR	82.85 %
		Solar Fraction SF	11.18 %

Normalized productions (per installed kWp)



Performance Ratio PR



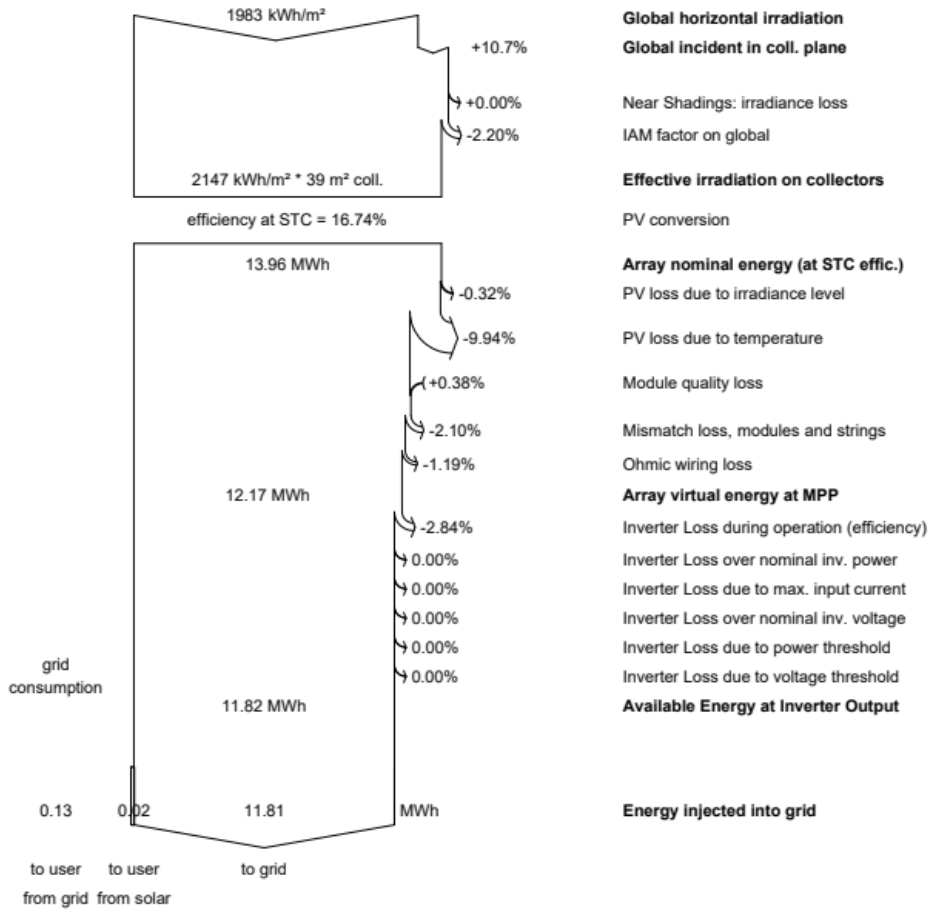
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	126.7	0.771	0.014	0.001	0.748	0.013
February	104.1	46.44	9.45	135.4	132.7	0.798	0.013	0.001	0.775	0.012
March	154.7	63.04	13.37	181.6	177.9	1.041	0.014	0.001	1.010	0.012
April	184.3	71.51	17.01	193.4	189.2	1.083	0.013	0.002	1.050	0.012
May	228.2	70.13	21.21	217.9	212.7	1.188	0.014	0.002	1.153	0.012
June	239.7	59.41	24.13	217.3	211.4	1.165	0.010	0.002	1.130	0.008
July	244.0	58.79	26.28	226.3	220.3	1.200	0.010	0.002	1.164	0.009
August	224.7	56.60	25.93	228.1	222.7	1.210	0.010	0.002	1.174	0.009
September	182.1	40.34	23.64	206.1	201.9	1.100	0.013	0.001	1.067	0.012
October	144.3	44.91	21.01	184.1	180.6	1.012	0.014	0.001	0.982	0.012
November	102.9	34.28	14.54	147.8	145.3	0.846	0.013	0.001	0.821	0.012
December	84.7	32.81	10.22	128.4	125.9	0.757	0.014	0.001	0.734	0.013
Year	1983.5	616.68	17.96	2195.6	2147.2	12.170	0.152	0.017	11.807	0.135

Legends

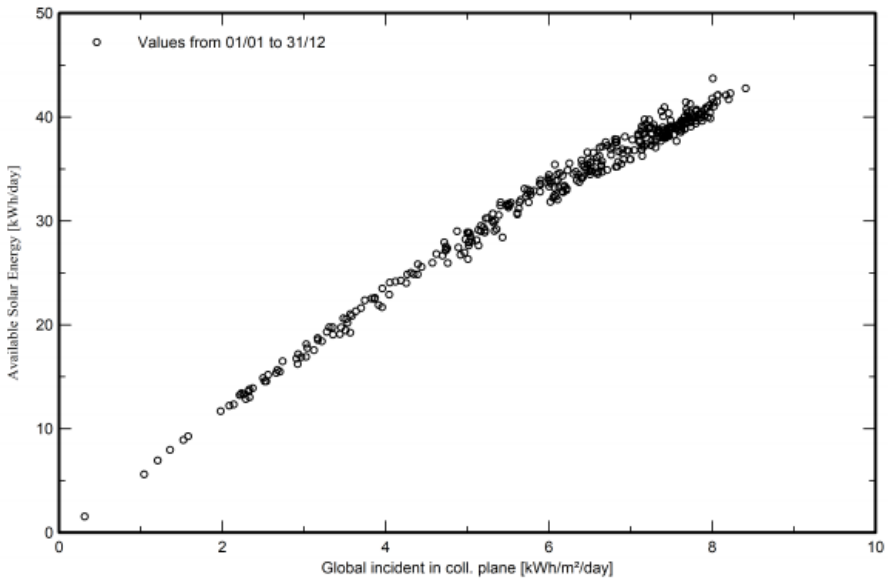
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

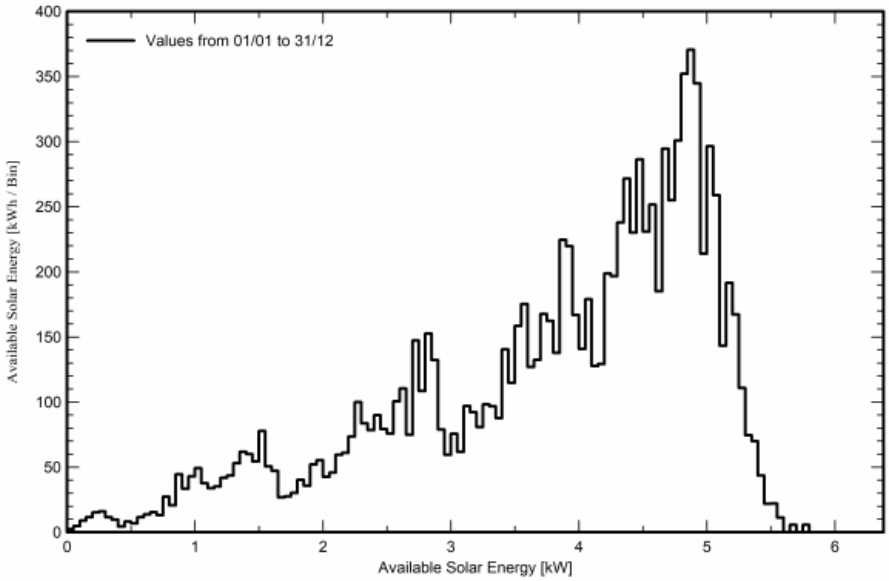


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 6

Variant: 5SH

Building system

System power: 5.28 kWp

R8 - Palestine, State Of

Author

Project: System 6

Variant: 5SH

Project summary

Geographical Site
R8
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	558 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	16 units
Pnom total	5.28 kWp

Inverters

Nb. of units	1 Unit
Pnom total	5.00 kWac
Pnom ratio	1.056

Results summary

Produced Energy	9.57 MWh/year	Specific production	1812 kWh/kWp/year	Perf. Ratio PR	82.52 %
				Solar Fraction SF	50.69 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Hanwha Q Cells
Model	Q Peak Duo L-G7-330
(Original PVsyst database)	
Unit Nom. Power	330 Wp
Number of PV modules	16 units
Nominal (STC)	5.28 kWp
Modules	2 Strings x 8 In series
At operating cond. (50°C)	
Pmpp	4819 Wp
U mpp	248 V
I mpp	19 A

Inverter

Manufacturer	Kaco new energy
Model	Blueplanet 5.0 TL3
(Original PVsyst database)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	200-800 V
Pnom ratio (DC:AC)	1.06

Total PV power

Nominal (STC)	5 kWp
Total	16 modules
Module area	27.0 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.06

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 211 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

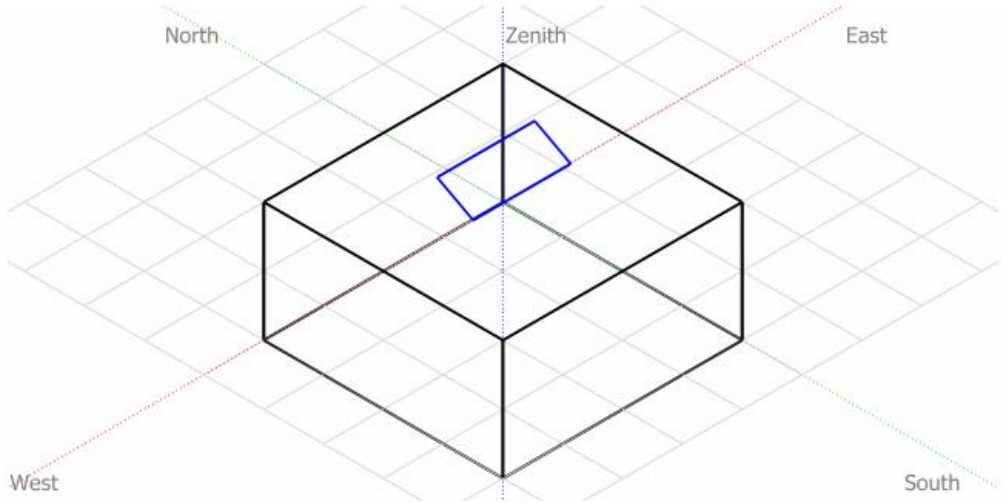
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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

Near shadings parameter

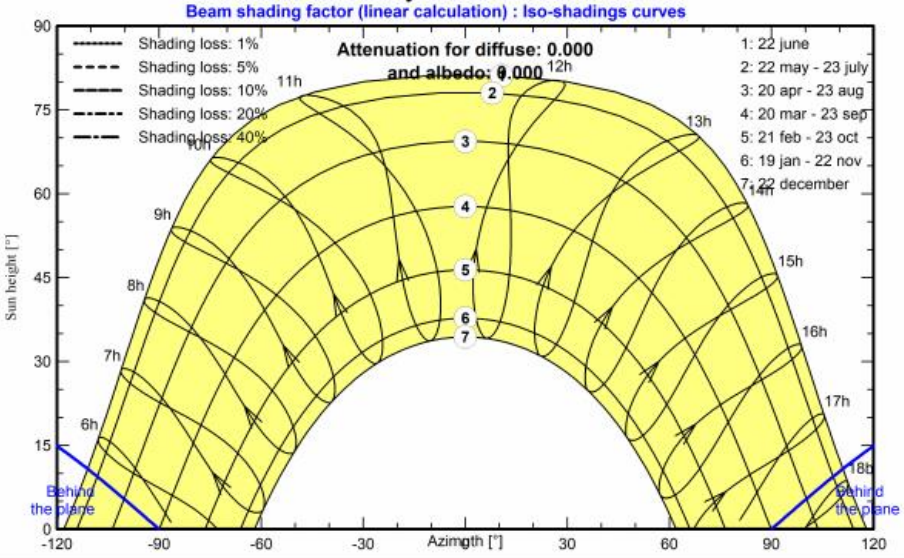
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

System 6

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



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

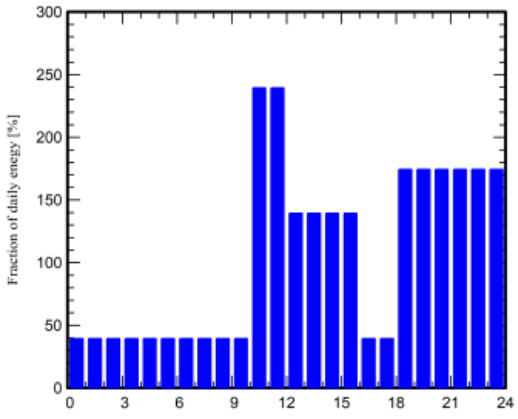
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

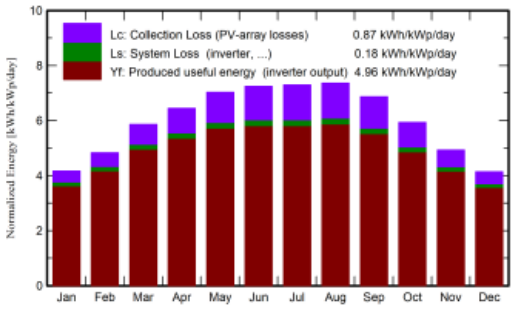


Main results

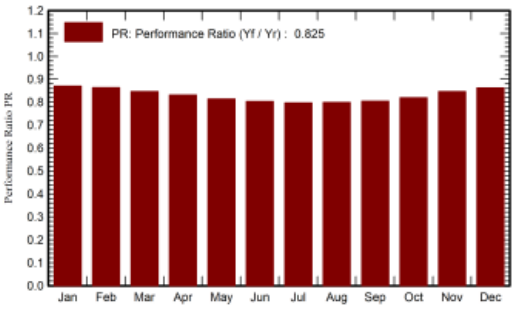
System Production

Produced Energy	9.57 MWh/year	Specific production	1812 kWh/kWp/year
		Performance Ratio PR	82.52 %
		Solar Fraction SF	50.69 %

Normalized productions (per installed kWp)



Performance Ratio PR



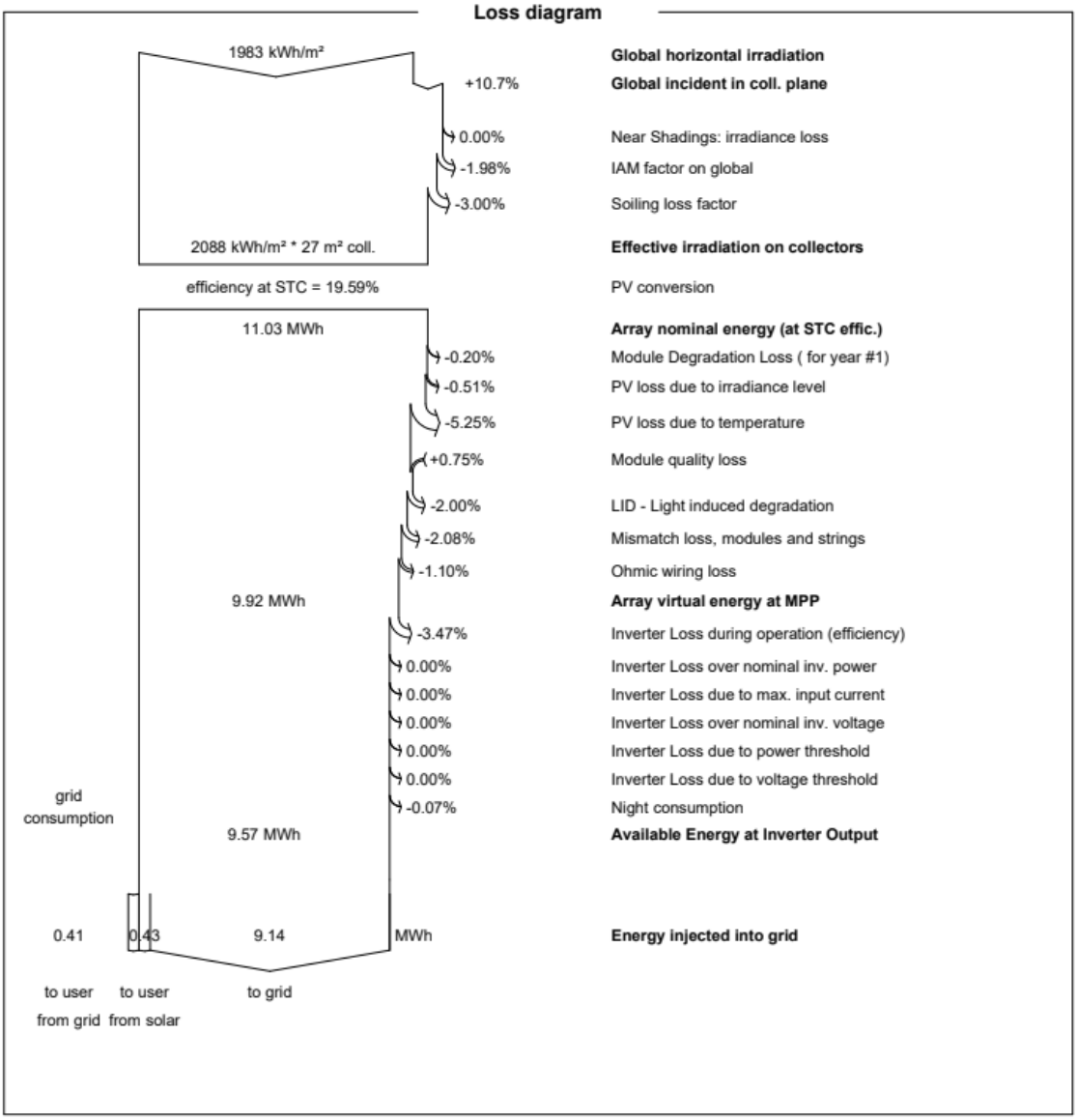
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.3	0.617	0.079	0.035	0.559	0.044
February	104.1	46.44	9.45	135.4	129.1	0.641	0.071	0.033	0.585	0.039
March	154.7	63.04	13.37	181.6	173.0	0.842	0.072	0.038	0.775	0.035
April	184.3	71.51	17.01	193.4	183.9	0.881	0.070	0.038	0.811	0.032
May	228.2	70.13	21.21	218.0	206.7	0.972	0.072	0.040	0.898	0.033
June	239.7	59.41	24.13	217.3	205.5	0.956	0.060	0.033	0.889	0.027
July	244.0	58.79	26.28	226.3	214.2	0.987	0.062	0.034	0.919	0.028
August	224.7	56.60	25.93	228.1	216.5	0.997	0.062	0.034	0.929	0.028
September	182.1	40.34	23.64	206.1	196.1	0.907	0.070	0.037	0.839	0.033
October	144.3	44.91	21.01	184.1	175.5	0.826	0.072	0.037	0.760	0.035
November	102.9	34.28	14.54	147.8	141.3	0.685	0.070	0.034	0.626	0.036
December	84.7	32.81	10.22	128.4	122.5	0.607	0.079	0.035	0.550	0.044
Year	1983.5	616.68	17.96	2195.7	2087.6	9.919	0.841	0.426	9.141	0.415

Legends

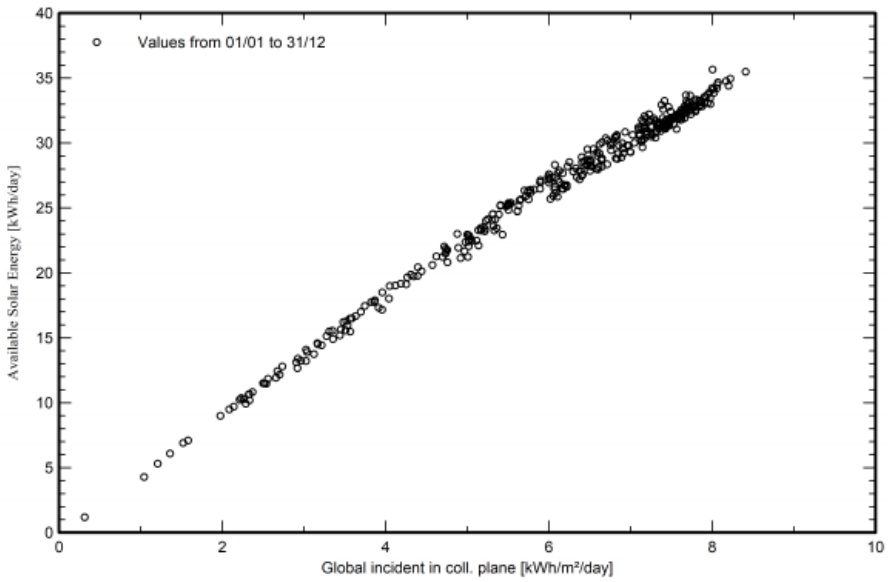
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

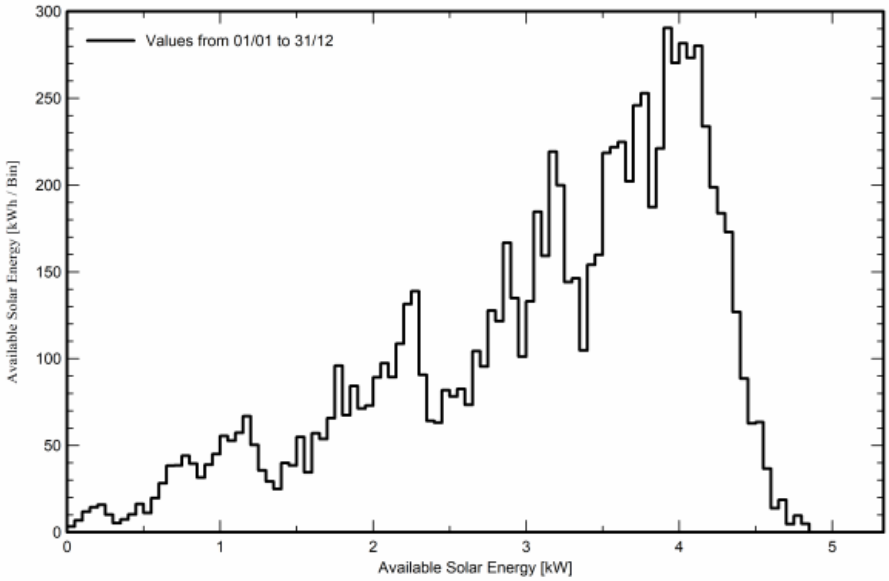


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 8

Variant: 10BH

Building system

System power: 10.72 kWp

R10 - Palestine, State Of

Author

Project: System 8

Variant: 10BH

Project summary

Geographical Site
R10
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	519 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	32 units
Pnom total	10.72 kWp

Inverters

Nb. of units	1 Unit
Pnom total	10.00 kWac
Pnom ratio	1.072

Results summary

Produced Energy	19.58 MWh/year	Specific production	1827 kWh/kWp/year	Perf. Ratio PR	83.19 %
				Solar Fraction SF	51.03 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Astronergy
Model	CHSM60M-HC-335
(Original PVsyst database)	
Unit Nom. Power	335 Wp
Number of PV modules	32 units
Nominal (STC)	10.72 kWp
Modules	2 Strings x 16 In series
At operating cond. (50°C)	
Pmpp	9.81 kWp
U mpp	505 V
I mpp	19 A

Inverter

Manufacturer	Kaco new energy
Model	Blueplanet 10.0 TL3
(Original PVsyst database)	
Unit Nom. Power	10.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	10.0 kWac
Operating voltage	200-800 V
Pnom ratio (DC:AC)	1.07

Total PV power

Nominal (STC)	11 kWp
Total	32 modules
Module area	54.3 m²

Total inverter power

Total power	10 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.07

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 427 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

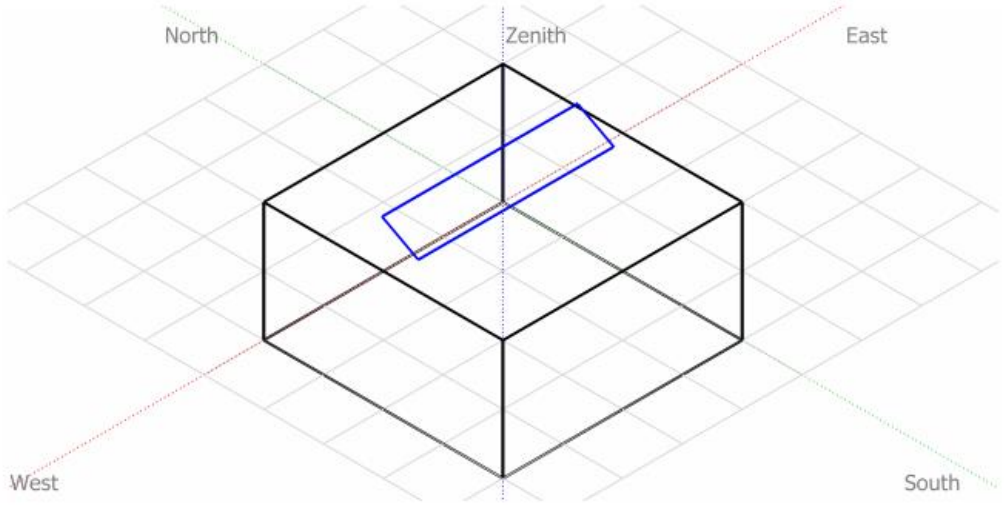
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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

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

Near shadings parameter

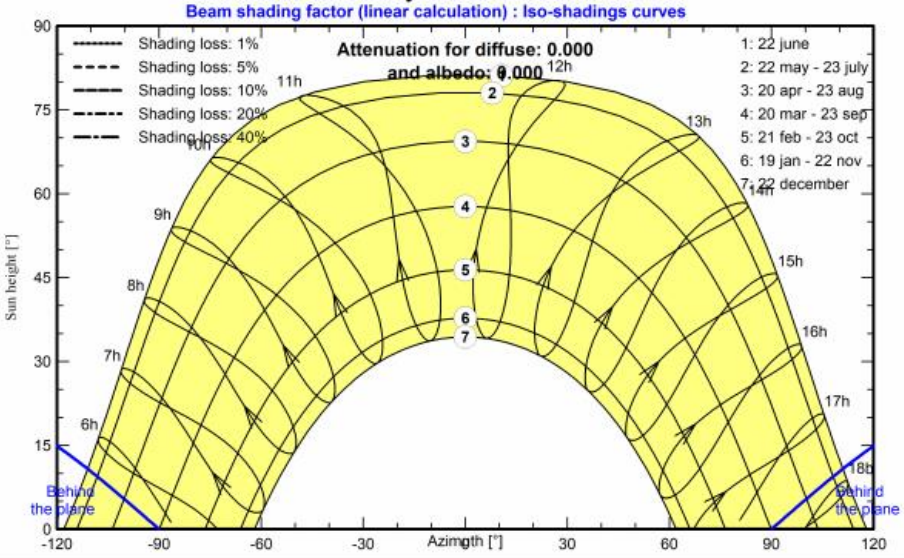
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

System 8

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



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

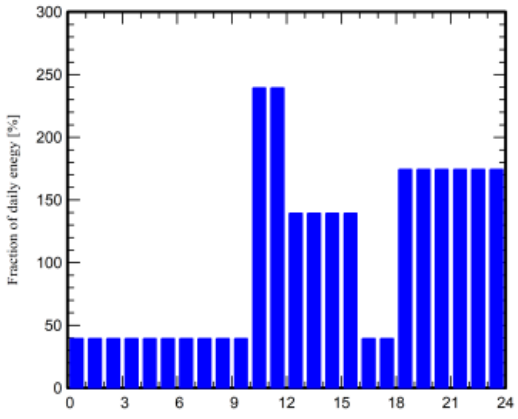
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

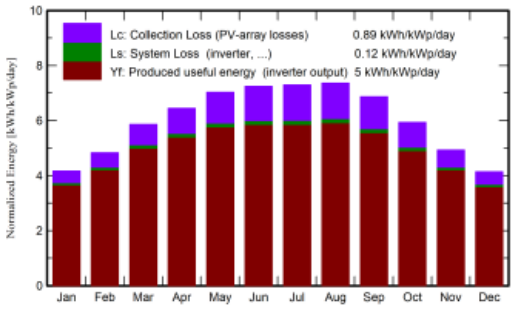


Main results

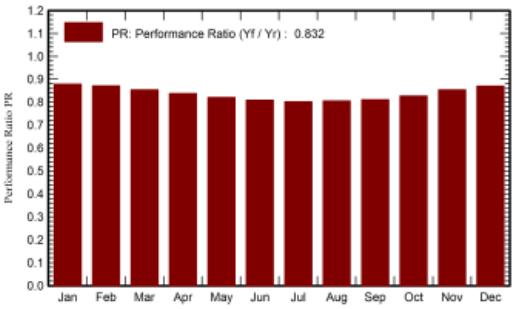
System Production

Produced Energy	19.58 MWh/year	Specific production	1827 kWh/kWp/year
		Performance Ratio PR	83.19 %
		Solar Fraction SF	51.03 %

Normalized productions (per installed kWp)



Performance Ratio PR



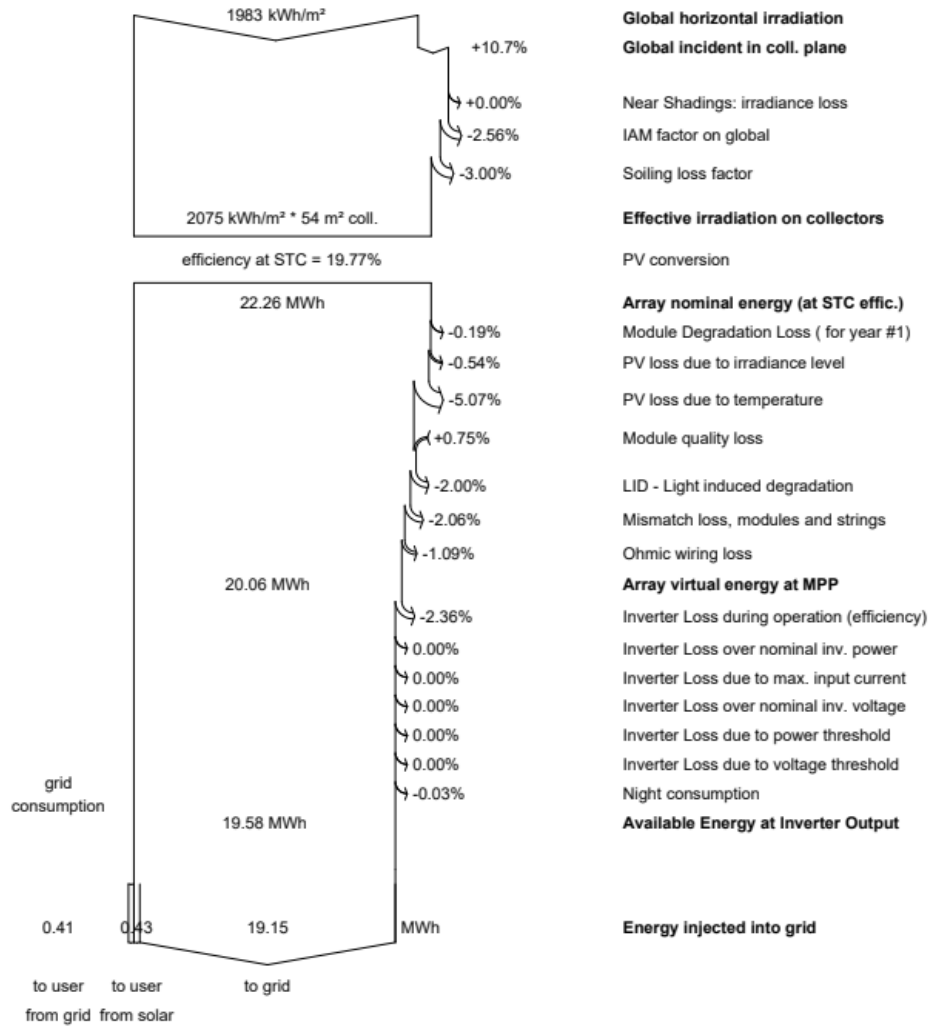
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	122.6	1.246	0.079	0.035	1.182	0.044
February	104.1	46.44	9.45	135.4	128.3	1.294	0.071	0.033	1.232	0.039
March	154.7	63.04	13.37	181.6	172.0	1.703	0.072	0.038	1.625	0.034
April	184.3	71.51	17.01	193.4	182.8	1.781	0.070	0.038	1.700	0.032
May	228.2	70.13	21.21	218.0	205.4	1.966	0.072	0.040	1.879	0.033
June	239.7	59.41	24.13	217.3	204.1	1.933	0.060	0.033	1.852	0.027
July	244.0	58.79	26.28	226.3	212.8	1.998	0.062	0.034	1.914	0.028
August	224.7	56.60	25.93	228.1	215.2	2.019	0.062	0.034	1.935	0.028
September	182.1	40.34	23.64	206.1	195.0	1.837	0.070	0.037	1.754	0.033
October	144.3	44.91	21.01	184.1	174.5	1.673	0.072	0.037	1.595	0.035
November	102.9	34.28	14.54	147.8	140.6	1.386	0.070	0.035	1.319	0.035
December	84.7	32.81	10.22	128.4	121.8	1.226	0.079	0.035	1.164	0.044
Year	1983.5	616.68	17.96	2195.6	2075.2	20.063	0.841	0.429	19.151	0.412

Legends

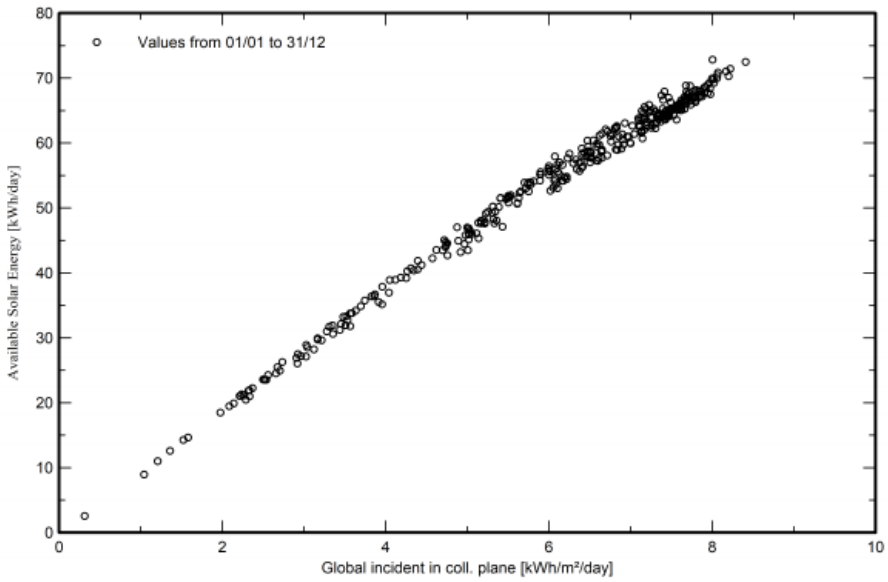
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

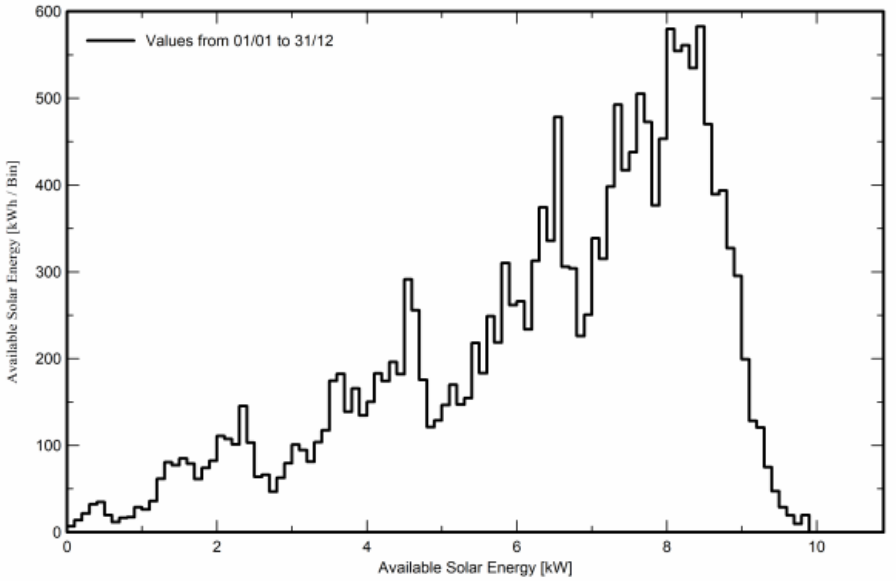


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 9

Variant: 5SB

Building system

System power: 4920 Wp

R11 - Palestine, State Of

Author

Project: System 9

Variant: 5SB

Project summary

Geographical Site
R11
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	509 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	12 units
Pnom total	4920 Wp

Inverters

Nb. of units	1 Unit
Pnom total	5.00 kWac
Pnom ratio	0.984

Results summary

Produced Energy	8.94 MWh/year	Specific production	1818 kWh/kWp/year	Perf. Ratio PR	82.78 %
				Solar Fraction SF	51.60 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used

Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Canadian Solar Inc.
Model	CS3W-410P HE
(Original PVsyst database)	
Unit Nom. Power	410 Wp
Number of PV modules	12 units
Nominal (STC)	4920 Wp
Modules	2 Strings x 6 In series
At operating cond. (50°C)	
Pmpp	4465 Wp
U mpp	213 V
I mpp	21 A

Inverter

Manufacturer	ABB
Model	UNO-DM-5.0-TL-PLUS
(Original PVsyst database)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	90-580 V
Pnom ratio (DC:AC)	0.98

Total PV power

Nominal (STC)	5 kWp
Total	12 modules
Module area	26.5 m²
Cell area	23.8 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	0.98

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 168 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.3 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

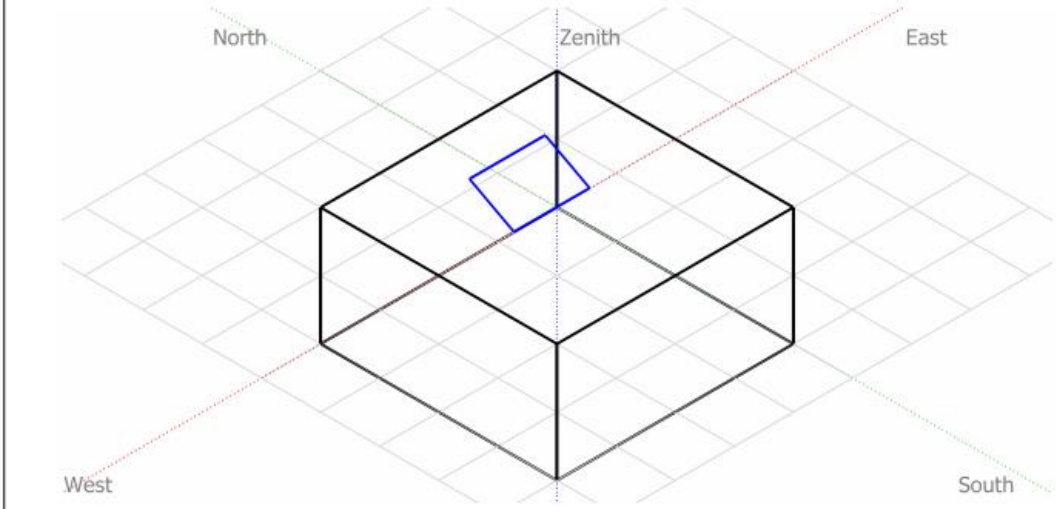
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

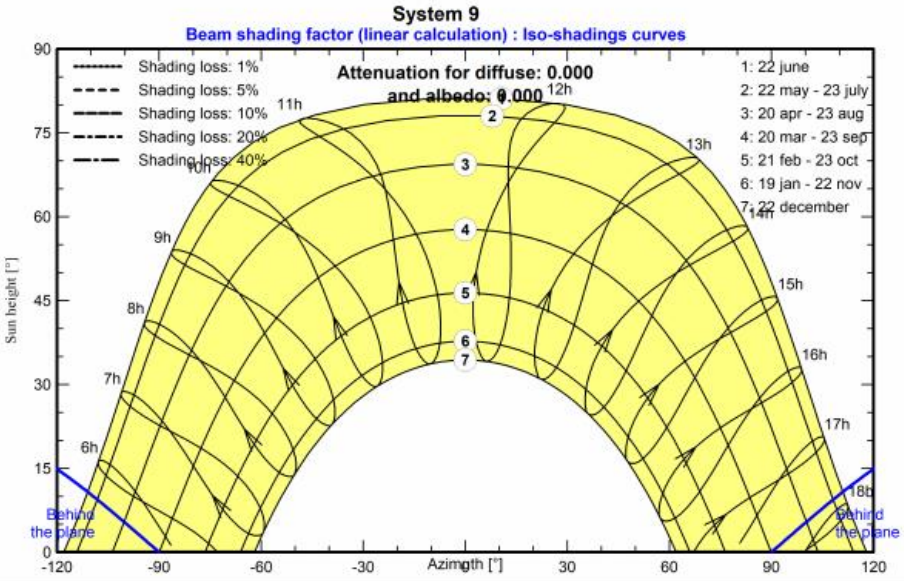
10°	20°	30°	40°	50°	60°	70°	80°	90°
1.000	1.000	1.000	0.990	0.990	0.970	0.920	0.760	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

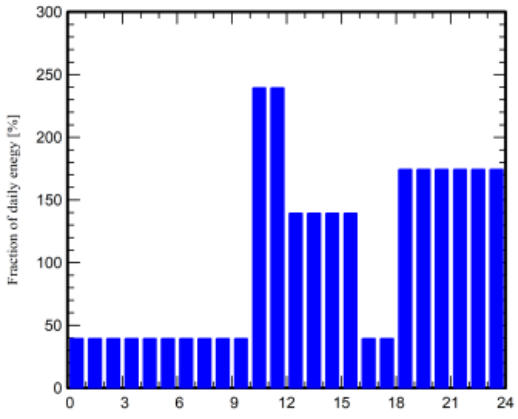
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

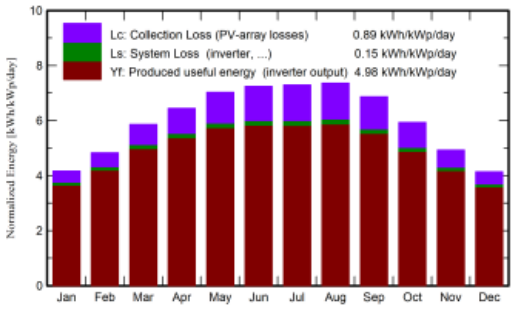


Main results

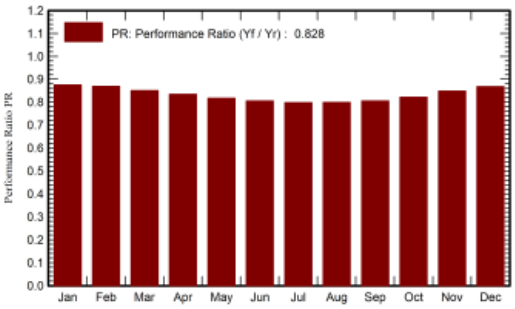
System Production

Produced Energy	8.94 MWh/year	Specific production	1818 kWh/kWp/year
		Performance Ratio PR	82.78 %
		Solar Fraction SF	51.60 %

Normalized productions (per installed kWp)



Performance Ratio PR



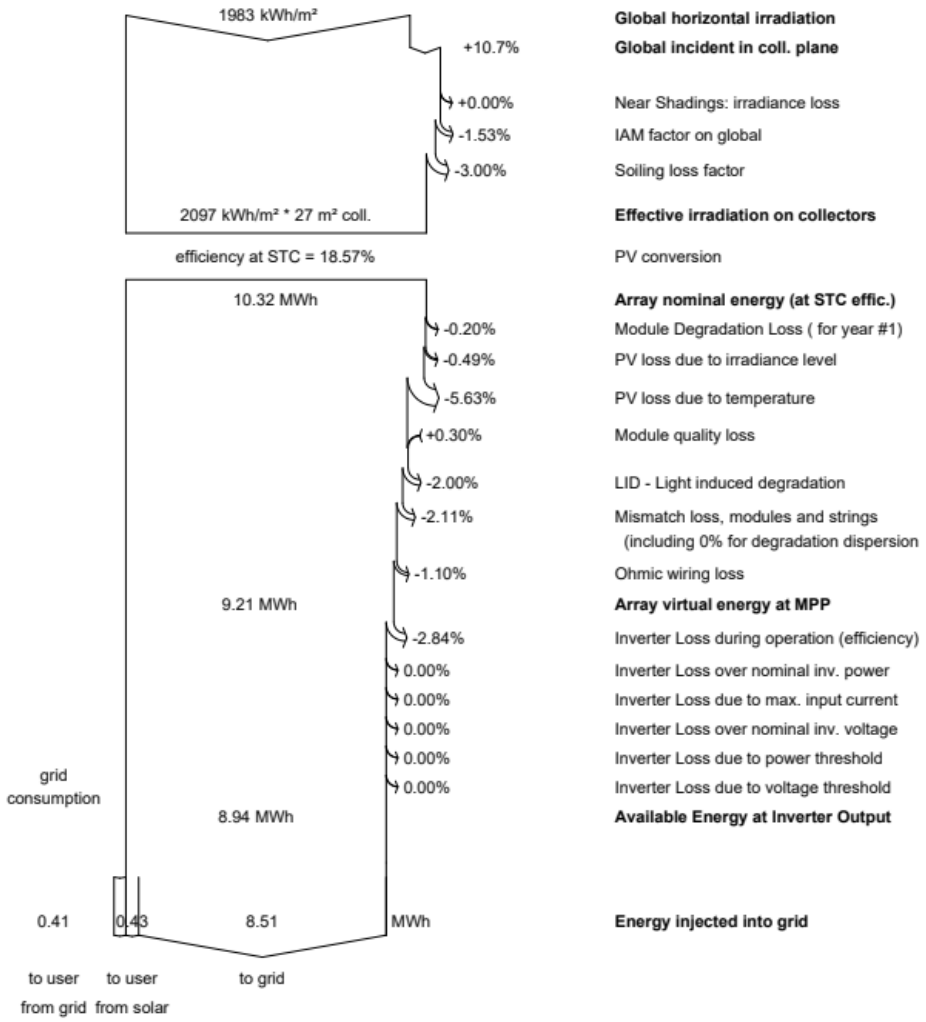
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.7	0.574	0.079	0.036	0.521	0.043
February	104.1	46.44	9.45	135.4	129.5	0.596	0.071	0.033	0.546	0.038
March	154.7	63.04	13.37	181.6	173.7	0.783	0.072	0.038	0.722	0.034
April	184.3	71.51	17.01	193.4	184.7	0.818	0.070	0.039	0.756	0.032
May	228.2	70.13	21.21	218.0	207.8	0.902	0.072	0.041	0.836	0.032
June	239.7	59.41	24.13	217.3	206.7	0.887	0.060	0.033	0.828	0.027
July	244.0	58.79	26.28	226.3	215.3	0.916	0.062	0.034	0.855	0.028
August	224.7	56.60	25.93	228.1	217.5	0.924	0.062	0.034	0.863	0.028
September	182.1	40.34	23.64	206.1	197.1	0.841	0.070	0.037	0.780	0.033
October	144.3	44.91	21.01	184.1	176.3	0.766	0.072	0.038	0.707	0.035
November	102.9	34.28	14.54	147.8	141.7	0.636	0.070	0.035	0.583	0.035
December	84.7	32.81	10.22	128.4	122.9	0.564	0.079	0.036	0.513	0.043
Year	1983.5	616.68	17.96	2195.6	2097.1	9.206	0.841	0.434	8.509	0.407

Legends

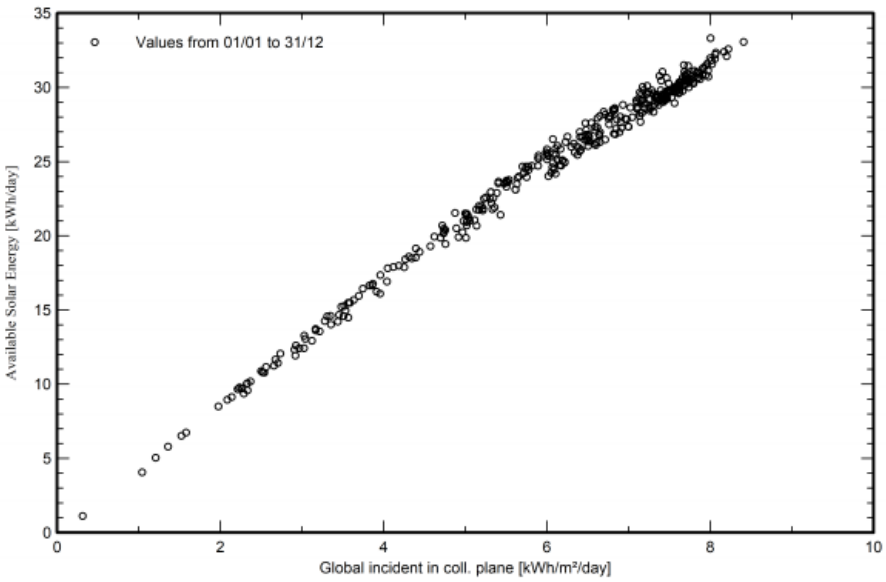
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

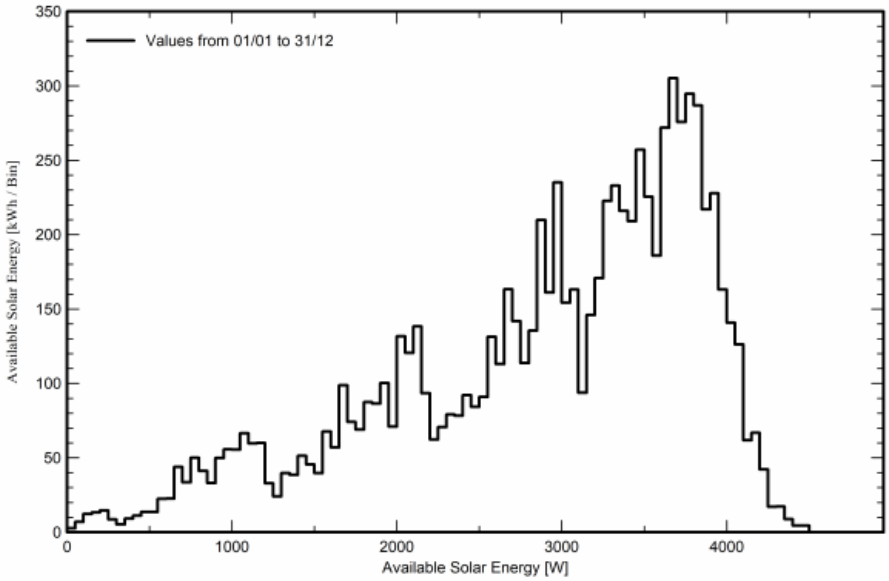


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 10

Variant: 14SK,m

Building system

System power: 11.55 kWp

R12 - Palestine, State Of

Author

Project: System 10

Variant: 14SK,m

Project summary

Geographical Site
R12
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.30 °E
Altitude	579 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	30 units
Pnom total	11.55 kWp

Inverters

Nb. of units	1 Unit
Pnom total	10.00 kWac
Pnom ratio	1.155

Results summary

Produced Energy	20.83 MWh/year	Specific production	1803 kWh/kWp/year	Perf. Ratio PR	82.11 %
				Solar Fraction SF	51.84 %

Table of contents

General parameters

Grid-Connected System

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Near Shadings
Linear shadings

Building system

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

Horizon
Free Horizon

PV Array Characteristics

PV module

Manufacturer	JA Solar
Model	JAM72-S09-385-PR
(Original PVsyst database)	
Unit Nom. Power	385 Wp
Number of PV modules	30 units
Nominal (STC)	11.55 kWp

Inverter

Manufacturer	ABB
Model	PVI-10-I-OUTD-S1-US-600
(Original PVsyst database)	
Unit Nom. Power	10.00 kWac
Number of inverters	1 Unit
Total power	10.0 kWac

Array #1 - PV Array

Number of PV modules	16 units	Number of inverters	1 * MPPT 53% 0.5 units
Nominal (STC)	6.16 kWp	Total power	5.3 kWac
Modules	2 Strings x 8 In series		
At operating cond. (50°C)		Operating voltage	120-470 V
Pmpp	5.59 kWp	Pnom ratio (DC:AC)	1.16
U mpp	289 V		
I mpp	19 A		

Array #2 - Sub-array #2

Number of PV modules	14 units	Number of inverters	1 * MPPT 47% 0.5 units
Nominal (STC)	5.39 kWp	Total power	4.7 kWac
Modules	2 Strings x 7 In series		
At operating cond. (50°C)		Operating voltage	120-470 V
Pmpp	4892 Wp	Pnom ratio (DC:AC)	1.15
U mpp	253 V		
I mpp	19 A		

Total PV power

Nominal (STC)	12 kWp
Total	30 modules
Module area	59.1 m²

Total inverter power

Total power	10 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.16

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

Array losses

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 smooth glass, n = 1.526

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

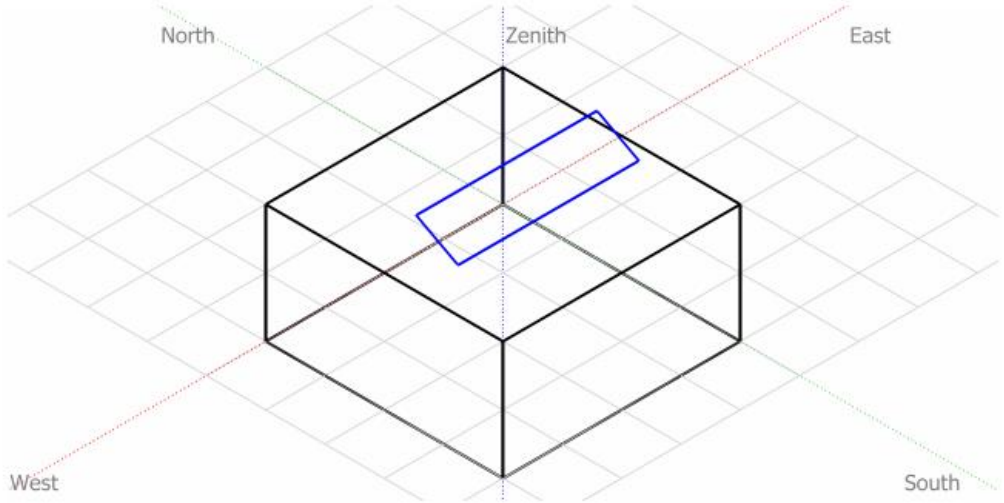
DC wiring losses

Global wiring resistance	10 mΩ
Loss Fraction	1.5 % at STC

Array #1 - PV Array		**Array #2 - Sub-array #2**	
Global array res.	251 mΩ	Global array res.	219 mΩ
Loss Fraction	1.5 % at STC	Loss Fraction	1.5 % at STC

Near shadings parameter

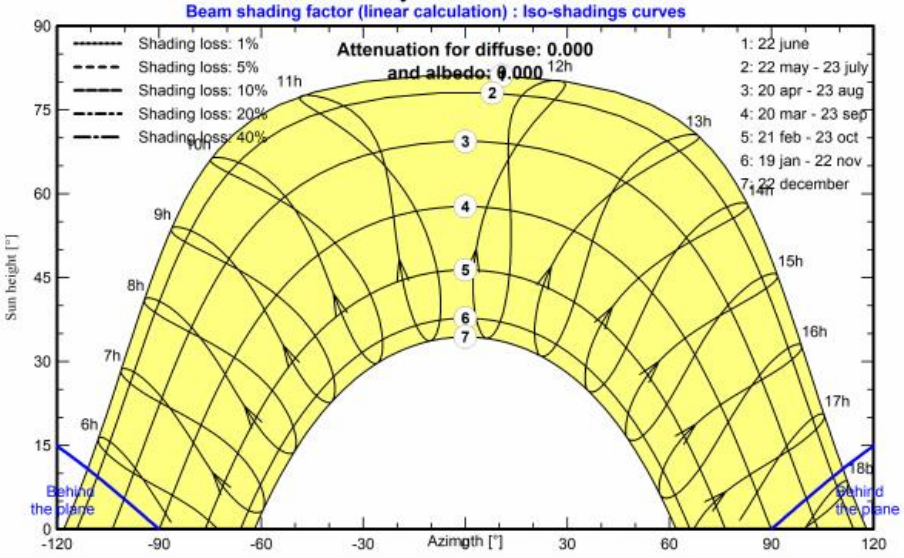
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

System 10

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



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

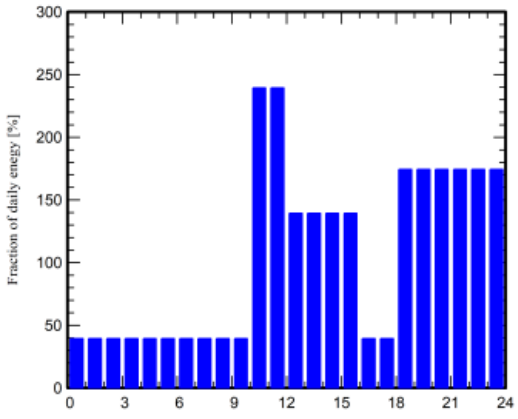
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

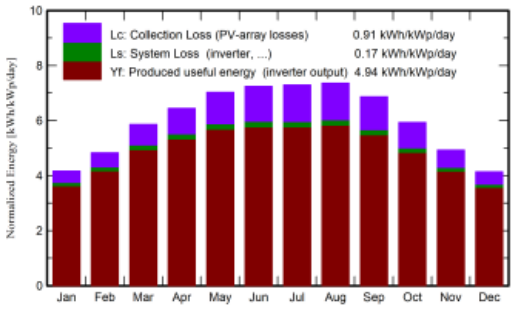


Main results

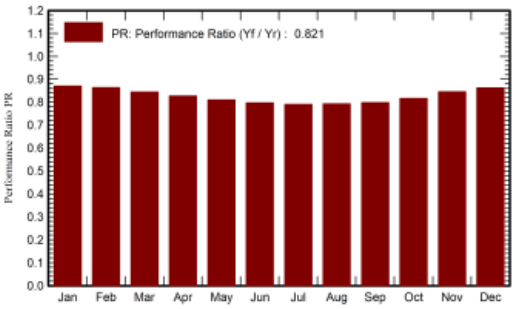
System Production

Produced Energy	20.83 MWh/year	Specific production	1803 kWh/kWp/year
		Performance Ratio PR	82.11 %
		Solar Fraction SF	51.84 %

Normalized productions (per installed kWp)



Performance Ratio PR



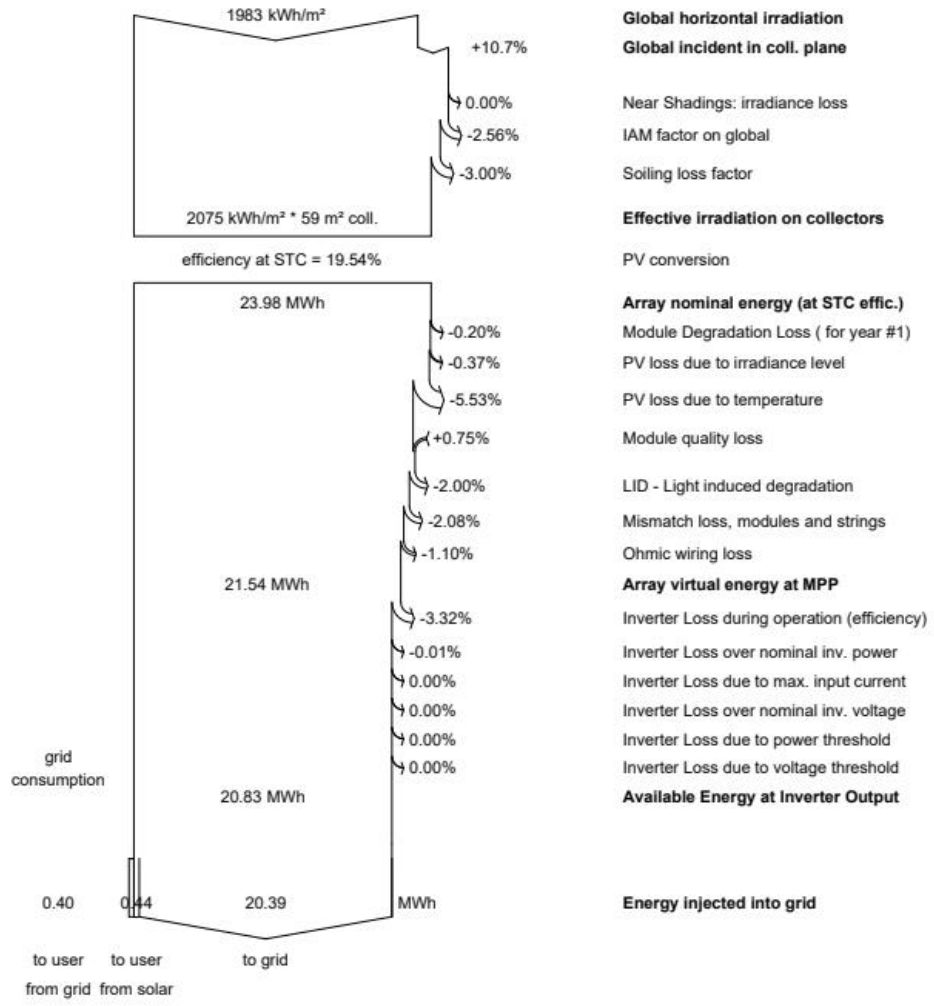
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	122.6	1.344	0.079	0.036	1.264	0.043
February	104.1	46.44	9.45	135.4	128.3	1.396	0.071	0.033	1.317	0.038
March	154.7	63.04	13.37	181.6	172.1	1.833	0.072	0.039	1.734	0.034
April	184.3	71.51	17.01	193.4	182.8	1.913	0.070	0.039	1.810	0.031
May	228.2	70.13	21.21	218.0	205.4	2.109	0.072	0.041	1.998	0.032
June	239.7	59.41	24.13	217.3	204.1	2.071	0.060	0.033	1.968	0.027
July	244.0	58.79	26.28	226.3	212.8	2.139	0.062	0.035	2.032	0.028
August	224.7	56.60	25.93	228.1	215.2	2.161	0.062	0.034	2.054	0.028
September	182.1	40.34	23.64	206.1	195.0	1.966	0.070	0.037	1.862	0.033
October	144.3	44.91	21.01	184.1	174.6	1.795	0.072	0.038	1.698	0.034
November	102.9	34.28	14.54	147.8	140.6	1.492	0.070	0.035	1.408	0.035
December	84.7	32.81	10.22	128.4	121.8	1.323	0.079	0.036	1.244	0.043
Year	1983.5	616.68	17.96	2195.7	2075.4	21.542	0.841	0.436	20.388	0.405

Legends

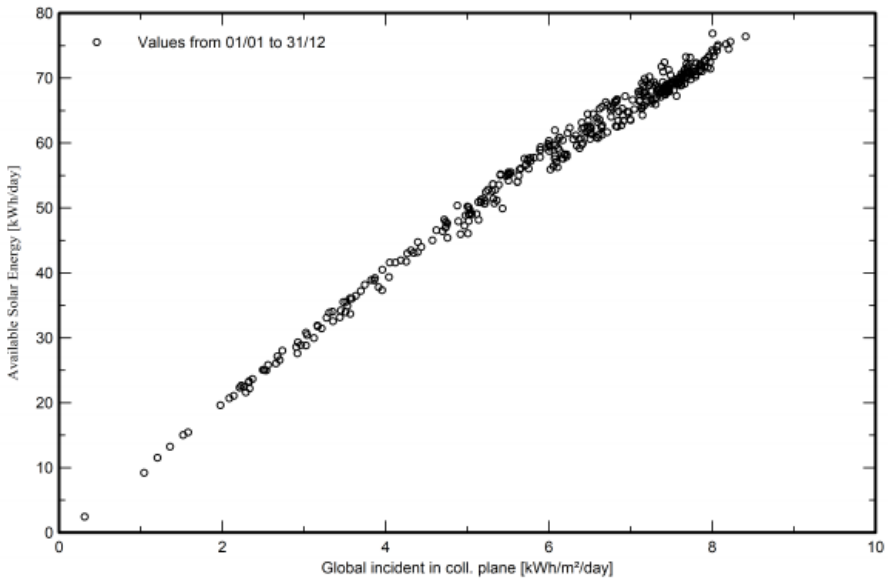
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

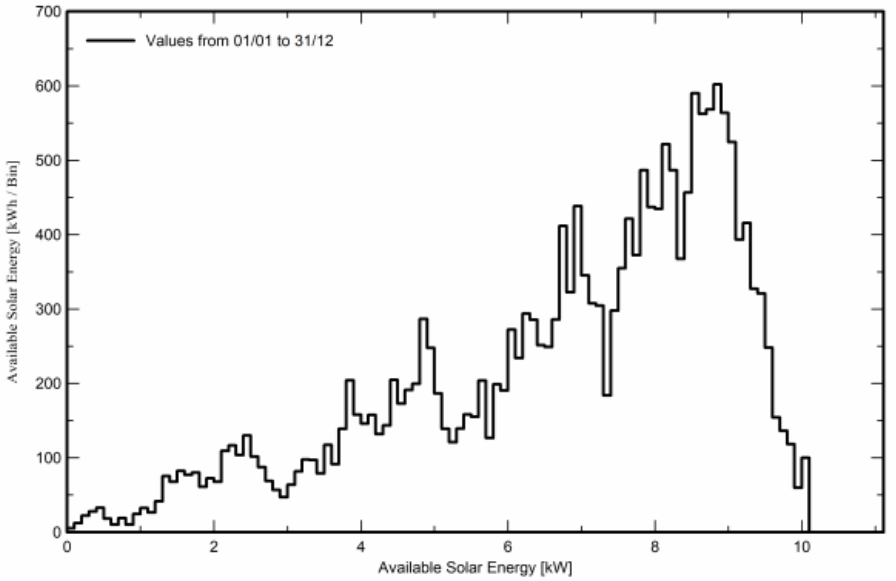


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 11

Variant: 6 ST

Building system

System power: 6.00 kWp

R14 - Palestine, State Of

Author

Project: System 11

Variant: 6 ST

Project summary

Geographical Site
R14
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	527 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array		Inverters	
Nb. of modules	15 units	Nb. of units	1 Unit
Pnom total	6.00 kWp	Pnom total	5.00 kWac
		Pnom ratio	1.200

Results summary

Produced Energy	10.02 MWh/year	Specific production	1669 kWh/kWp/year	Perf. Ratio PR	76.02 %
				Solar Fraction SF	51.17 %

Table of contents

General parameters

Grid-Connected System

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Near Shadings
Linear shadings

Building system

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

Horizon
Free Horizon

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG15MC-20-(II)-400-Bifacial
(Original PVsyst database)	
Unit Nom. Power	400 Wp
Number of PV modules	15 units
Nominal (STC)	6.00 kWp
Modules	3 Strings x 5 In series
At operating cond. (50°C)	
Pmpp	5.48 kWp
U mpp	185 V
I mpp	30 A

Total PV power

Nominal (STC)	6 kWp
Total	15 modules
Module area	30.8 m²
Cell area	26.1 m²

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000L-5KTL
(Custom parameters definition)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	90-500 V
Max. power (=>40°C)	5.50 kWac
Pnom ratio (DC:AC)	1.20

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.20

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

LID - Light Induced Degradation
Loss Fraction 2.0 %

Strings Mismatch loss
Loss Fraction 0.1 %

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

Module Quality Loss
Loss Fraction -0.8 %

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

DC wiring losses
Global array res. 104 mΩ
Loss Fraction 1.5 % at STC

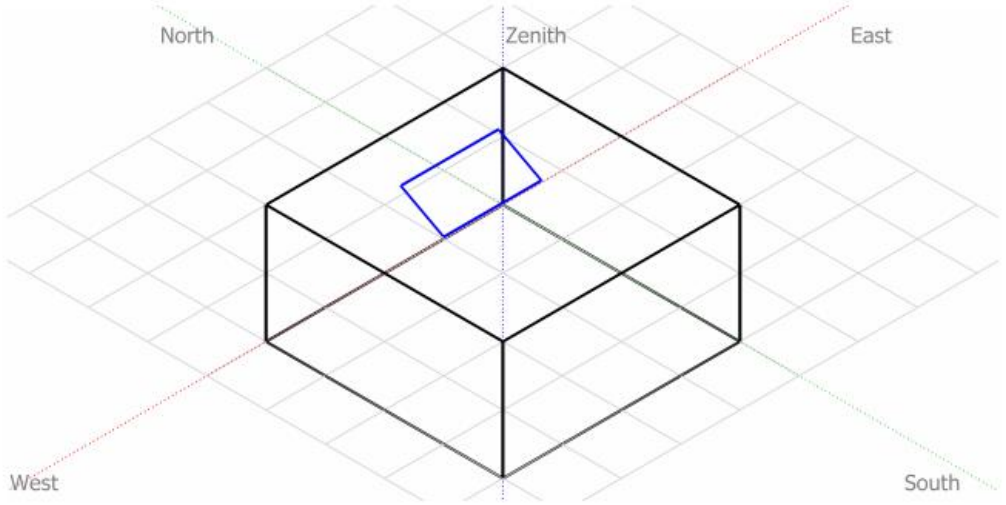
Module mismatch losses
Loss Fraction 2.0 % at MPP

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

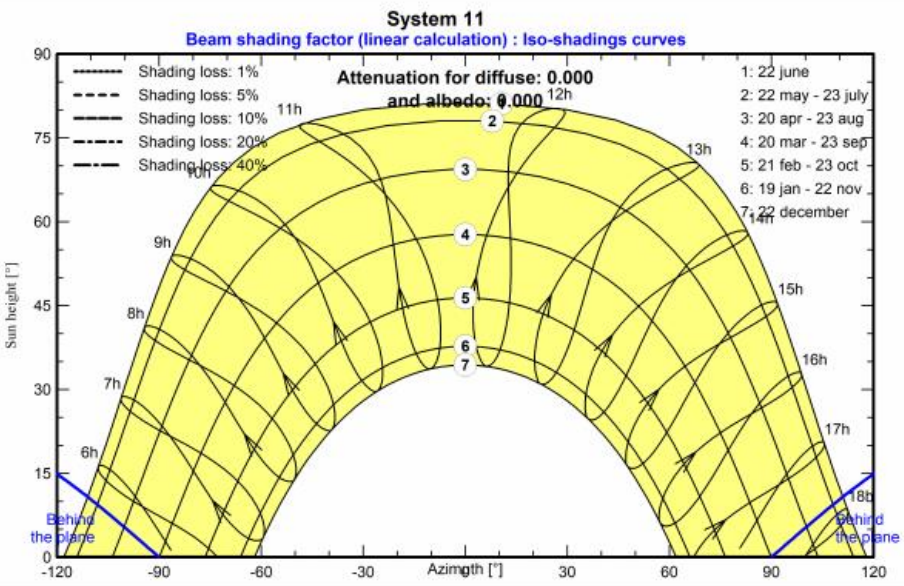
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

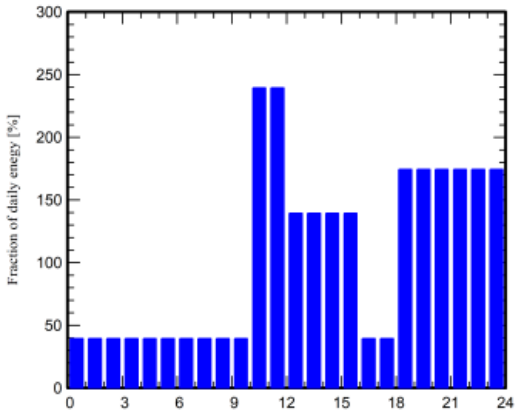
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

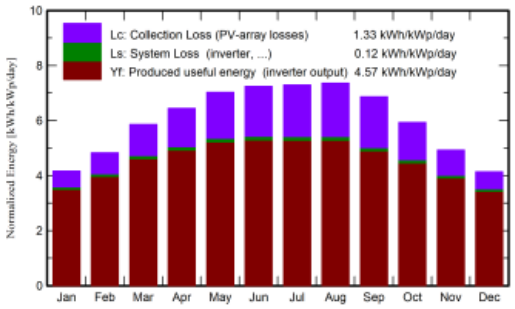


Main results

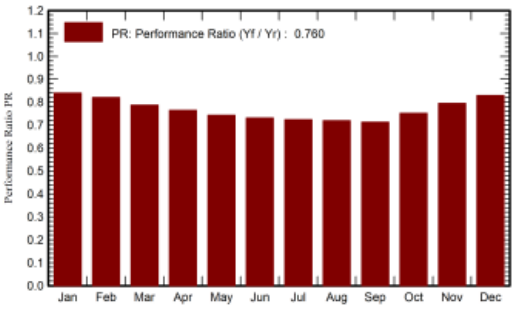
System Production

Produced Energy	10.02 MWh/year	Specific production	1669 kWh/kWp/year
		Performance Ratio PR	76.02 %
		Solar Fraction SF	51.17 %

Normalized productions (per installed kWp)



Performance Ratio PR



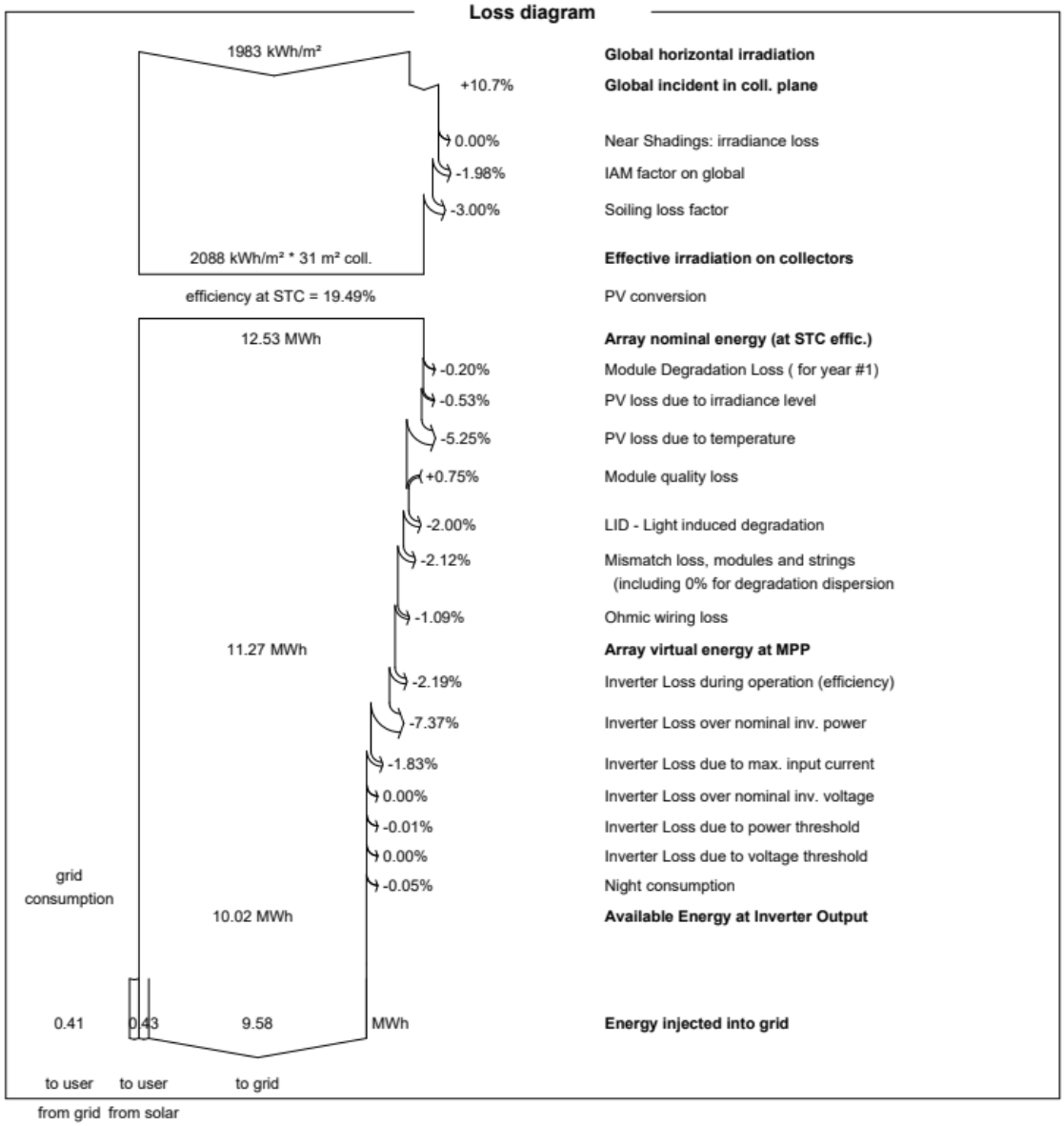
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.3	0.668	0.079	0.035	0.616	0.044
February	104.1	46.44	9.45	135.4	129.1	0.684	0.071	0.033	0.634	0.038
March	154.7	63.04	13.37	181.6	173.0	0.879	0.072	0.038	0.820	0.034
April	184.3	71.51	17.01	193.4	183.8	0.911	0.070	0.038	0.850	0.032
May	228.2	70.13	21.21	218.0	206.7	0.997	0.072	0.040	0.932	0.032
June	239.7	59.41	24.13	217.3	205.5	0.979	0.060	0.033	0.921	0.027
July	244.0	58.79	26.28	226.3	214.2	1.008	0.062	0.034	0.949	0.028
August	224.7	56.60	25.93	228.1	216.5	1.009	0.062	0.034	0.950	0.028
September	182.1	40.34	23.64	206.1	196.1	0.904	0.070	0.037	0.845	0.033
October	144.3	44.91	21.01	184.1	175.5	0.851	0.072	0.037	0.793	0.035
November	102.9	34.28	14.54	147.8	141.3	0.723	0.070	0.035	0.671	0.035
December	84.7	32.81	10.22	128.4	122.5	0.655	0.079	0.035	0.604	0.044
Year	1983.5	616.68	17.96	2195.6	2087.5	10.268	0.841	0.430	9.585	0.411

Legends

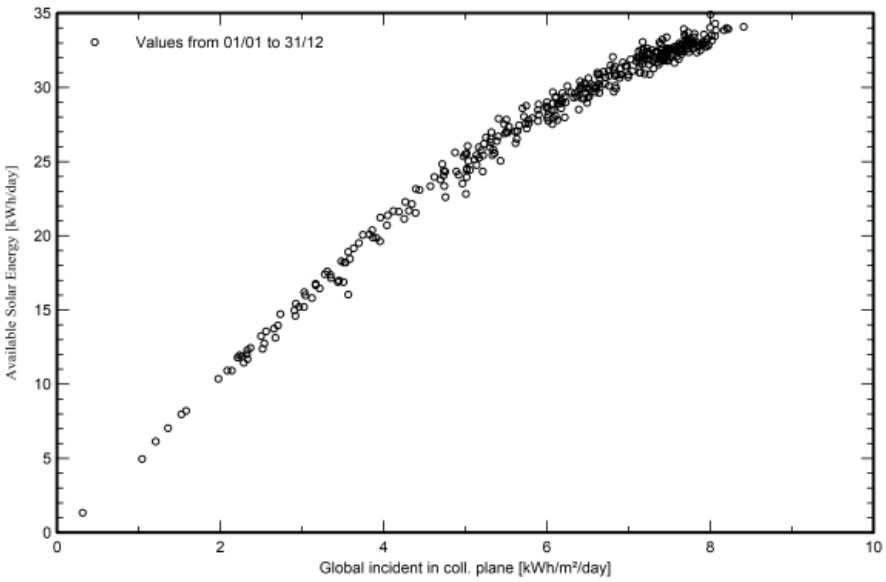
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

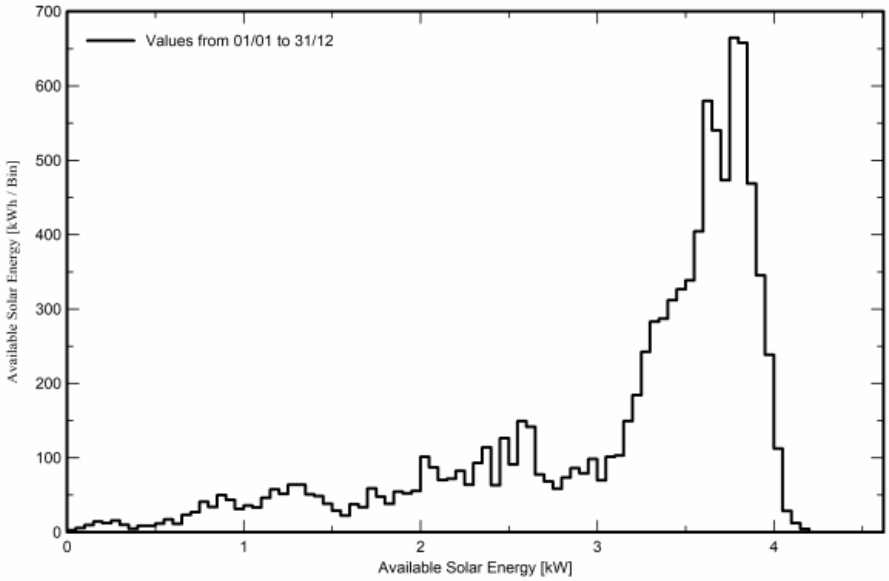


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 12

Variant: New simulation variant

Building system

System power: 3960 Wp

Rūjayb 15 - Palestine, State Of

Author

Project: System 12

Variant: New simulation variant

Project summary

Geographical Site
Rūjayb 15
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	499 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb 15
Meteonorm 7.3 (1990-2004), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	12 units
Pnom total	3960 Wp

Inverters

Nb. of units	1 Unit
Pnom total	6.00 kWac
Pnom ratio	0.660

Results summary

Produced Energy	7.06 MWh/year	Specific production	1783 kWh/kWp/year	Perf. Ratio PR	81.27 %
				Solar Fraction SF	51.22 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Hanwha Q Cells
Model	Q.POWER L-G5.2 330
(Original PVsyst database)	
Unit Nom. Power	330 Wp
Number of PV modules	12 units
Nominal (STC)	3960 Wp
Modules	2 Strings x 6 In series
At operating cond. (50°C)	
Pmpp	3565 Wp
U mpp	202 V
I mpp	18 A

Inverter

Manufacturer	ABB
Model	PVI-6000-OUTD-US (277V)
(Original PVsyst database)	
Unit Nom. Power	6.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	6.0 kWac
Operating voltage	120-530 V
Pnom ratio (DC:AC)	0.66

Total PV power

Nominal (STC)	4 kWp
Total	12 modules
Module area	23.3 m²
Cell area	21.0 m²

Total inverter power

Total power	6 kWac
Nb. of inverters	1 Unit
Pnom ratio	0.66

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 193 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

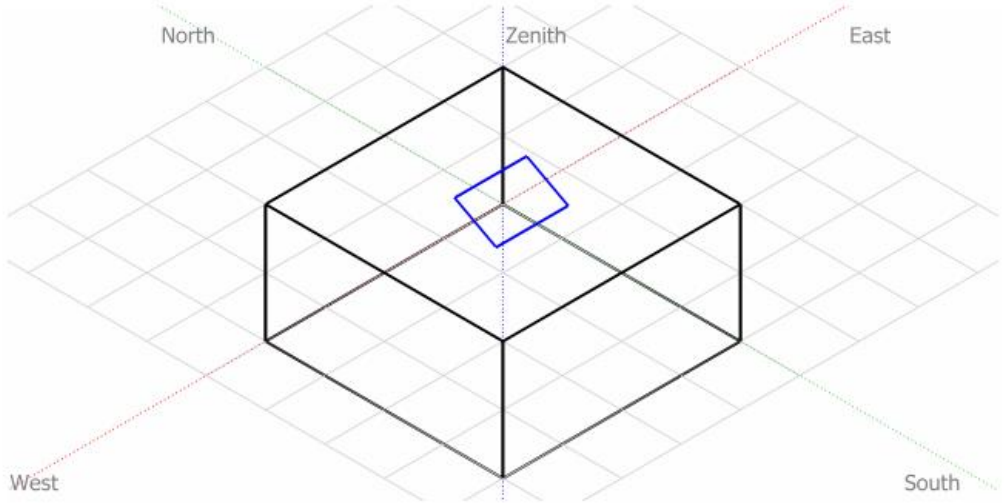
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

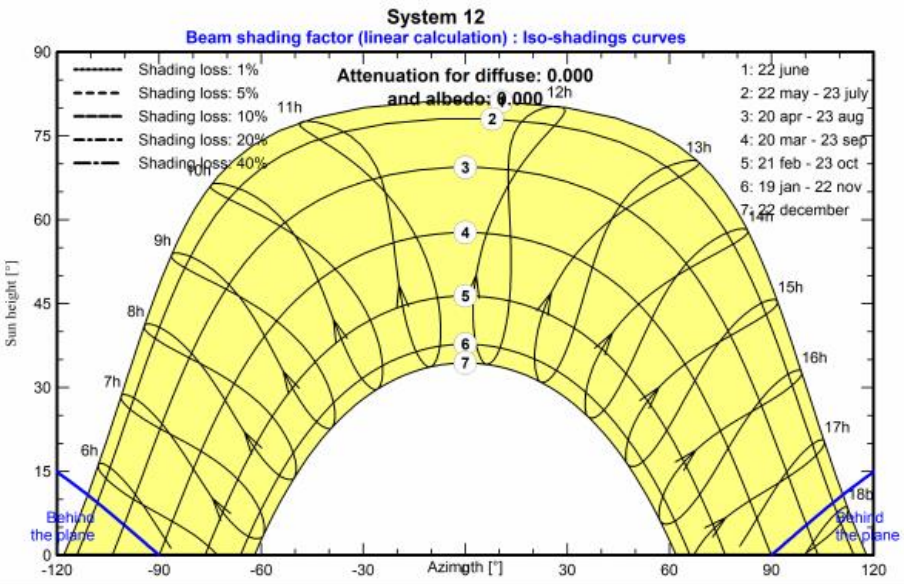
0°	20°	40°	60°	70°	75°	80°	85°	90°
1.000	1.000	1.000	0.970	0.900	0.830	0.690	0.440	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

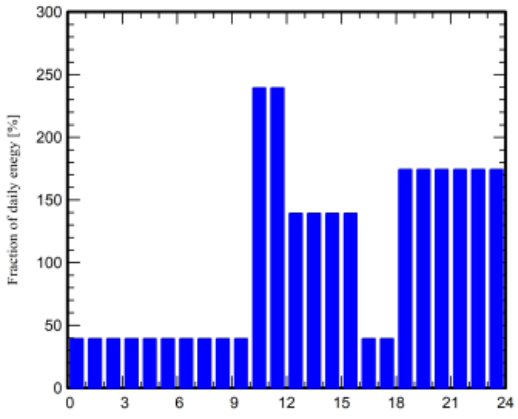
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

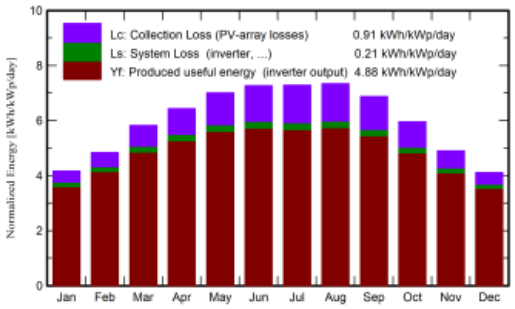


Main results

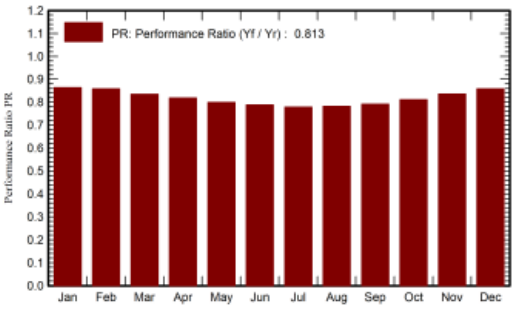
System Production

Produced Energy	7.06 MWh/year	Specific production	1783 kWh/kWp/year
		Performance Ratio PR	81.27 %
		Solar Fraction SF	51.22 %

Normalized productions (per installed kWp)



Performance Ratio PR



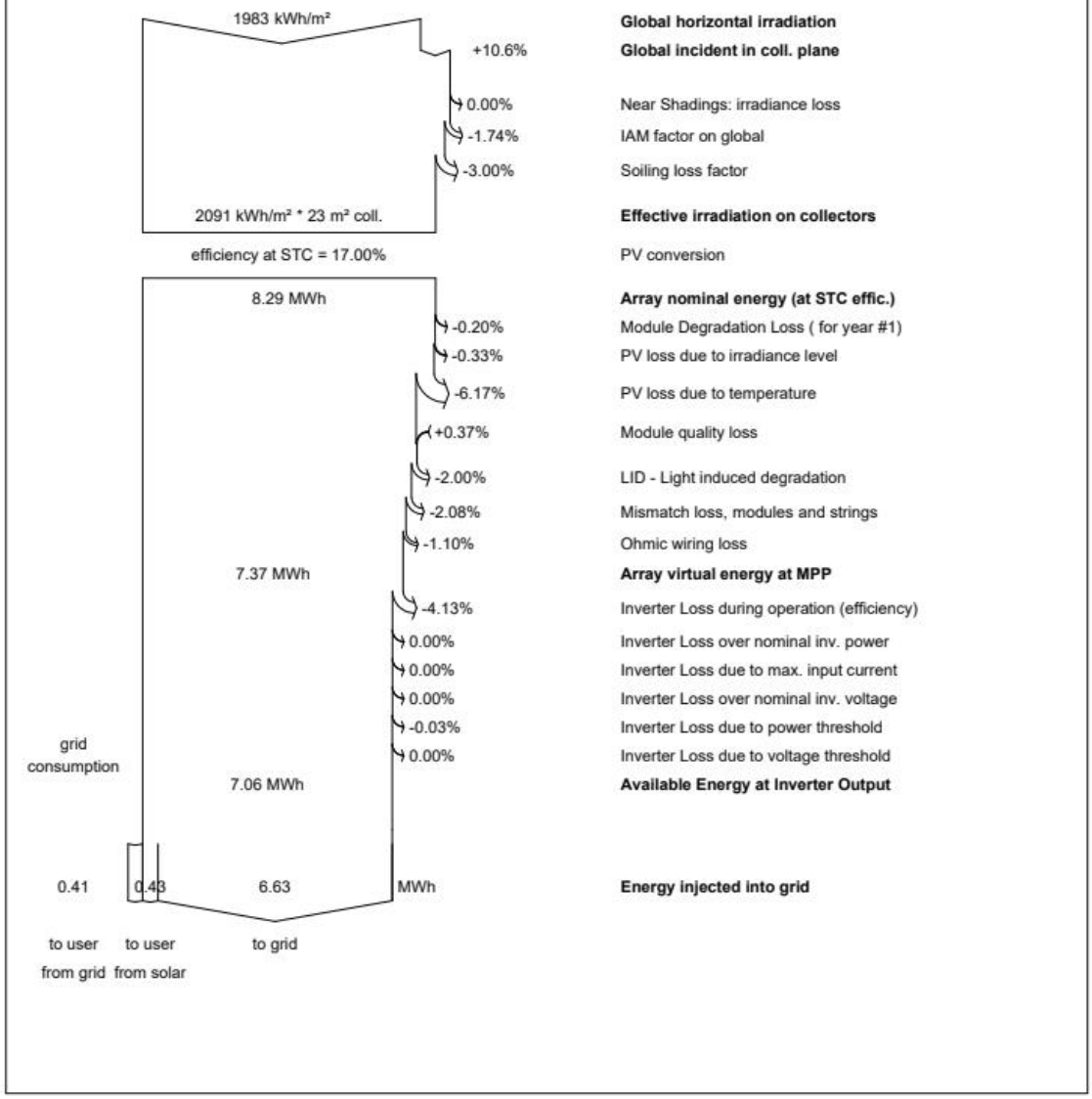
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.46	8.25	129.1	123.5	0.461	0.079	0.035	0.407	0.044
February	104.1	47.16	9.44	135.4	129.4	0.480	0.071	0.033	0.427	0.038
March	154.6	60.93	13.37	180.6	172.4	0.623	0.072	0.038	0.559	0.034
April	184.3	70.13	17.02	193.2	184.0	0.654	0.070	0.038	0.588	0.032
May	228.4	68.63	21.34	217.4	206.7	0.719	0.072	0.040	0.648	0.032
June	239.7	60.98	24.19	218.1	207.0	0.711	0.060	0.033	0.648	0.027
July	244.0	56.62	26.47	225.8	214.2	0.727	0.062	0.034	0.663	0.028
August	224.6	56.79	26.00	227.7	216.6	0.735	0.062	0.034	0.671	0.028
September	182.0	49.21	23.79	206.4	196.9	0.675	0.070	0.037	0.610	0.033
October	144.2	50.09	21.03	184.9	176.7	0.619	0.072	0.038	0.556	0.035
November	102.8	33.56	14.54	147.2	141.1	0.509	0.070	0.034	0.453	0.036
December	84.7	34.31	10.22	127.6	122.1	0.453	0.079	0.035	0.399	0.044
Year	1983.4	626.87	18.02	2193.5	2090.7	7.366	0.841	0.431	6.628	0.410

Legends

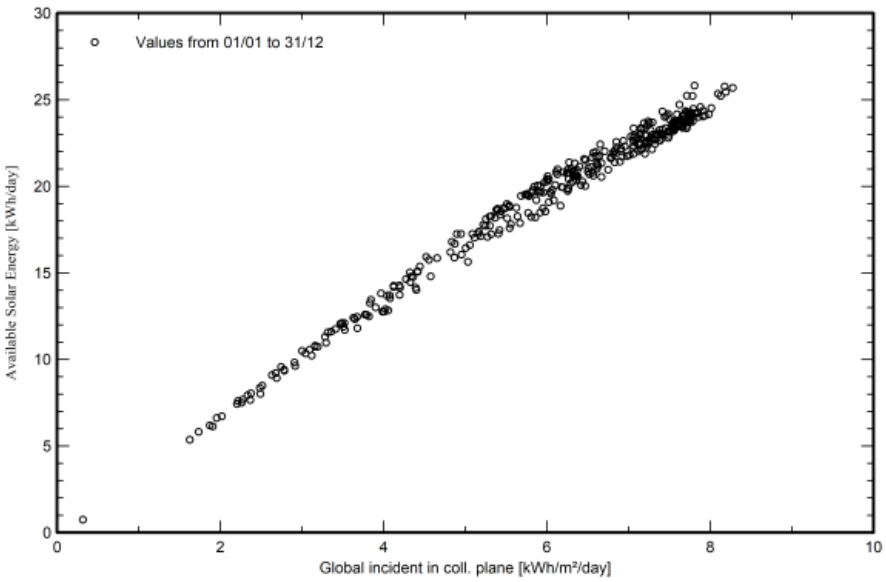
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

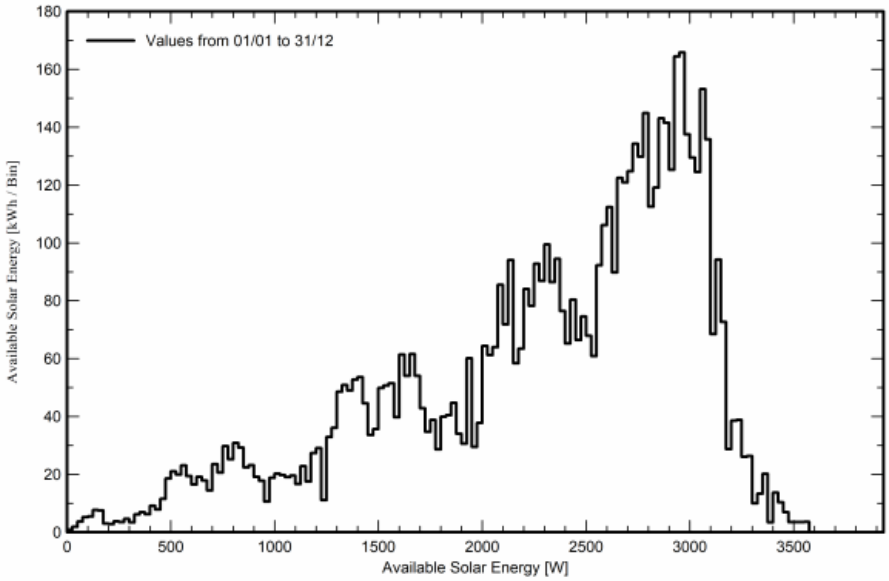


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 13

Variant: 10MR

Building system

System power: 10.05 kWp

R16 - Palestine, State Of

Author

Project: System 13

Variant: 10MR

Project summary

Geographical Site
R16
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	537 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	30 units
Pnom total	10.05 kWp

Inverters

Nb. of units	1 Unit
Pnom total	10.00 kWac
Pnom ratio	1.005

Results summary

Produced Energy	18.33 MWh/year	Specific production	1824 kWh/kWp/year	Perf. Ratio PR	83.08 %
				Solar Fraction SF	51.08 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Astronergy
Model	CHSM60M-DG-F-BH-335-Bifacial
(Original PVsyst database)	
Unit Nom. Power	335 Wp
Number of PV modules	30 units
Nominal (STC)	10.05 kWp
Modules	2 Strings x 15 In series
At operating cond. (50°C)	
Pmpp	9.20 kWp
U mpp	473 V
I mpp	19 A

Inverter

Manufacturer	Kaco new energy
Model	Blueplanet 10.0 TL3
(Original PVsyst database)	
Unit Nom. Power	10.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	10.0 kWac
Operating voltage	200-800 V
Pnom ratio (DC:AC)	1.01

Total PV power

Nominal (STC)	10 kWp
Total	30 modules
Module area	51.9 m²

Total inverter power

Total power	10 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.01

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 401 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

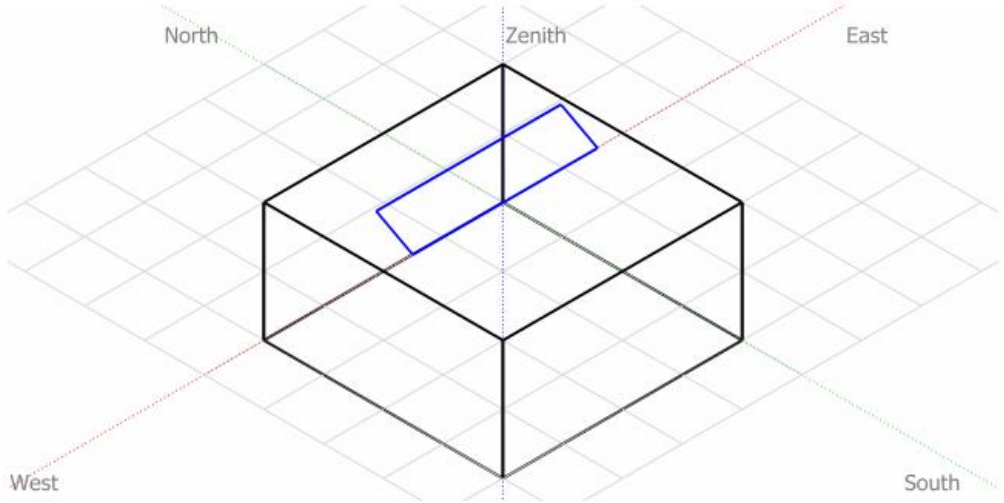
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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

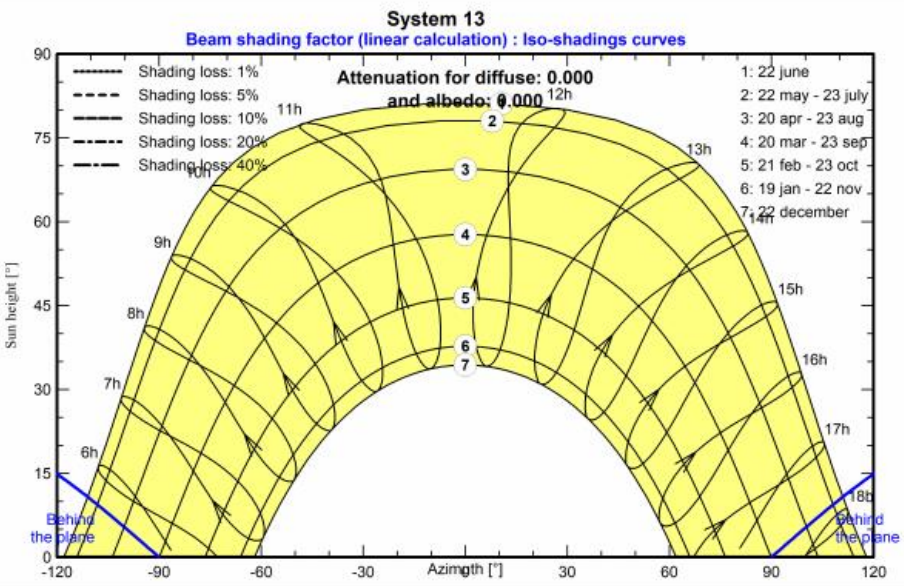
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.998	0.981	0.948	0.862	0.776	0.636	0.403	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

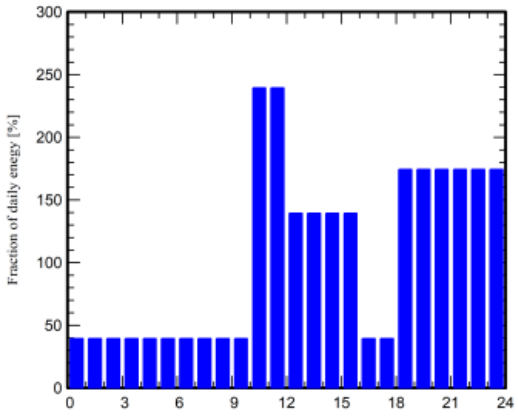
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

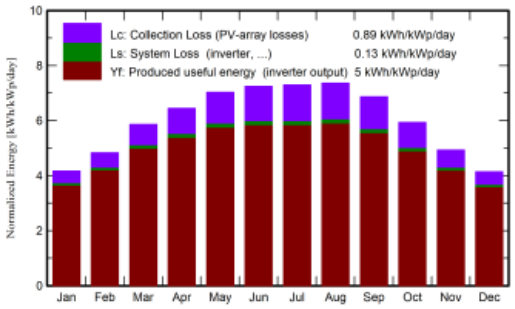


Main results

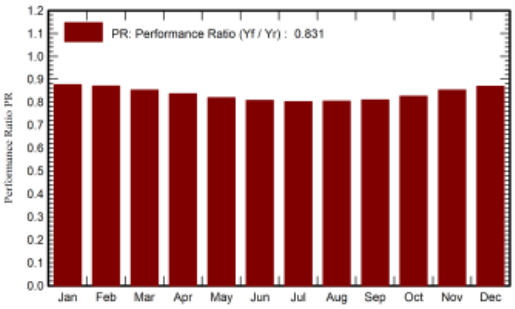
System Production

Produced Energy	18.33 MWh/year	Specific production	1824 kWh/kWp/year
		Performance Ratio PR	83.08 %
		Solar Fraction SF	51.08 %

Normalized productions (per installed kWp)



Performance Ratio PR



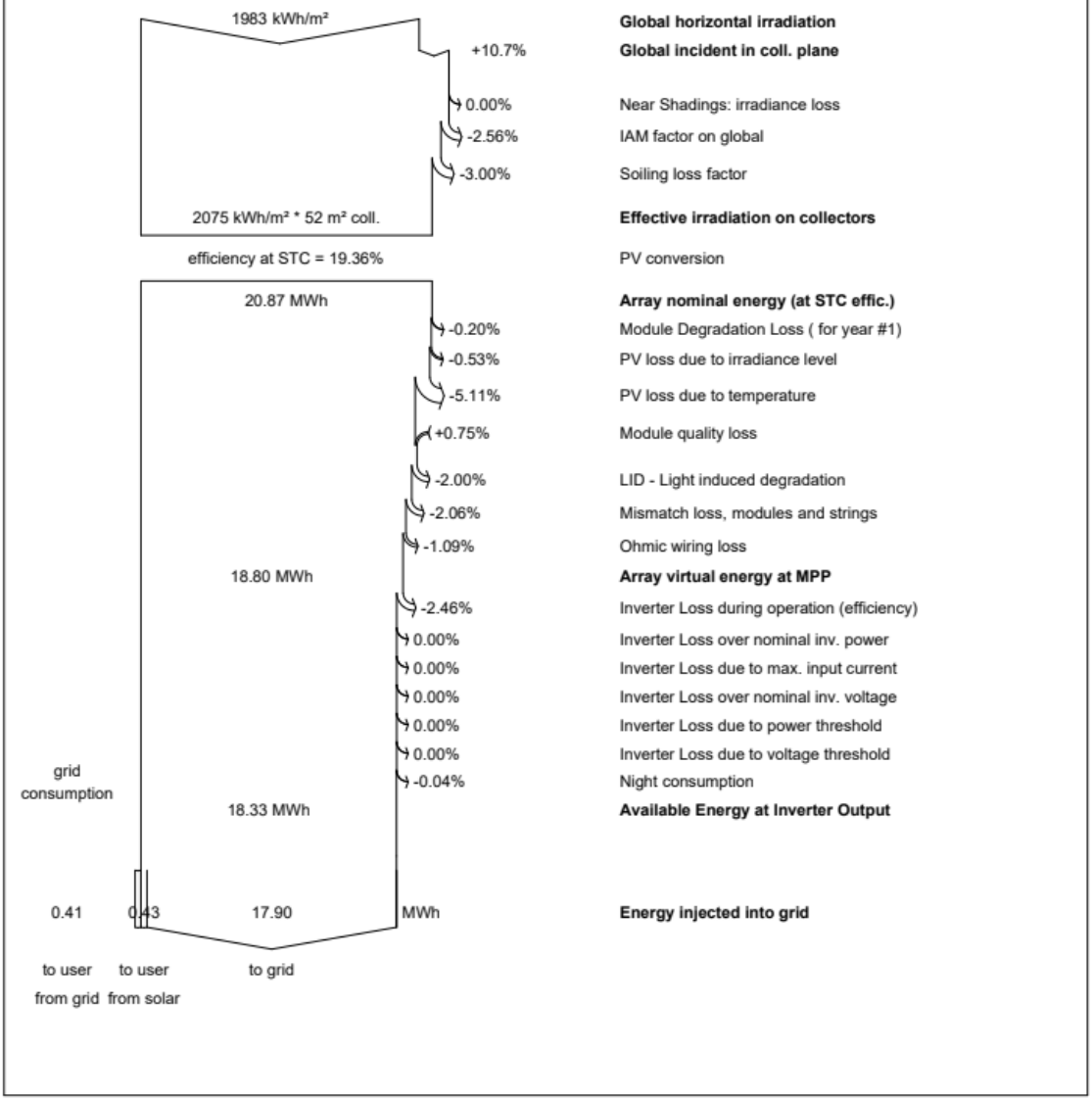
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	122.6	1.168	0.079	0.035	1.104	0.044
February	104.1	46.44	9.45	135.4	128.3	1.213	0.071	0.033	1.151	0.039
March	154.7	63.04	13.37	181.6	172.0	1.596	0.072	0.038	1.519	0.034
April	184.3	71.51	17.01	193.4	182.8	1.669	0.070	0.038	1.589	0.032
May	228.2	70.13	21.21	218.0	205.4	1.843	0.072	0.040	1.756	0.033
June	239.7	59.41	24.13	217.3	204.1	1.811	0.060	0.033	1.732	0.027
July	244.0	58.79	26.28	226.3	212.8	1.872	0.062	0.035	1.790	0.028
August	224.7	56.60	25.93	228.1	215.2	1.892	0.062	0.034	1.810	0.028
September	182.1	40.34	23.64	206.1	195.0	1.722	0.070	0.037	1.641	0.033
October	144.3	44.91	21.01	184.1	174.6	1.568	0.072	0.037	1.491	0.035
November	102.9	34.28	14.54	147.8	140.6	1.299	0.070	0.035	1.232	0.035
December	84.7	32.81	10.22	128.4	121.8	1.150	0.079	0.035	1.087	0.044
Year	1983.5	616.68	17.96	2195.7	2075.3	18.804	0.841	0.429	17.904	0.411

Legends

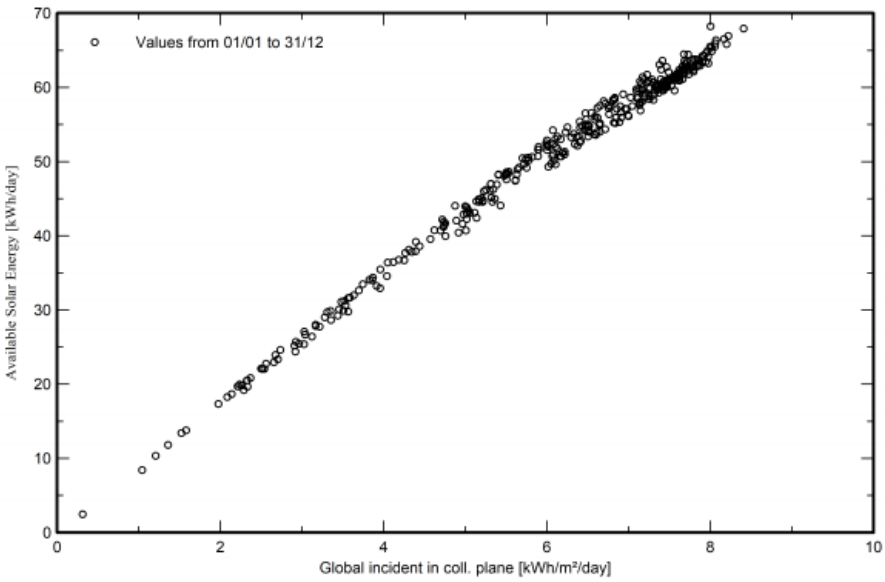
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

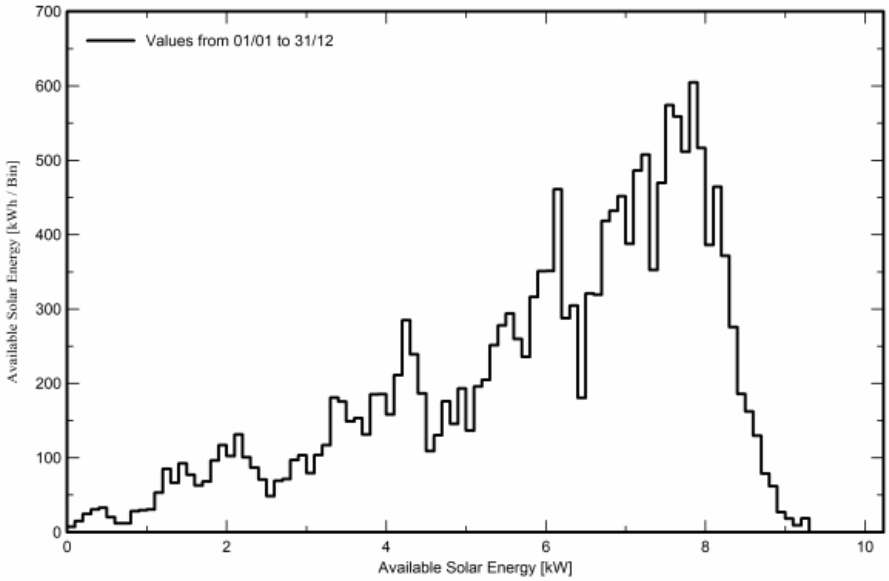


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 14

Variant: 5N

Building system

System power: 3850 Wp

R15+17 - Palestine, State Of

Author

Project: System 14

Variant: 5N

Project summary

Geographical Site
R15+17
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	499 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	10 units
Pnom total	3850 Wp

Inverters

Nb. of units	1 Unit
Pnom total	5.00 kWac
Pnom ratio	0.770

Results summary

Produced Energy	7.01 MWh/year	Specific production	1822 kWh/kWp/year	Perf. Ratio PR	82.97 %
				Solar Fraction SF	51.39 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	JA Solar
Model	JAM72-S09-385-PR
(Original PVsyst database)	
Unit Nom. Power	385 Wp
Number of PV modules	10 units
Nominal (STC)	3850 Wp
Modules	2 Strings x 5 In series
At operating cond. (50°C)	
Pmpp	3494 Wp
U mpp	181 V
I mpp	19 A

Inverter

Manufacturer	Ingeteam
Model	Ingecon Sun 5TL M
(Original PVsyst database)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	125-750 V
Pnom ratio (DC:AC)	0.77

Total PV power

Nominal (STC)	4 kWp
Total	10 modules
Module area	19.7 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	0.77

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 157 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

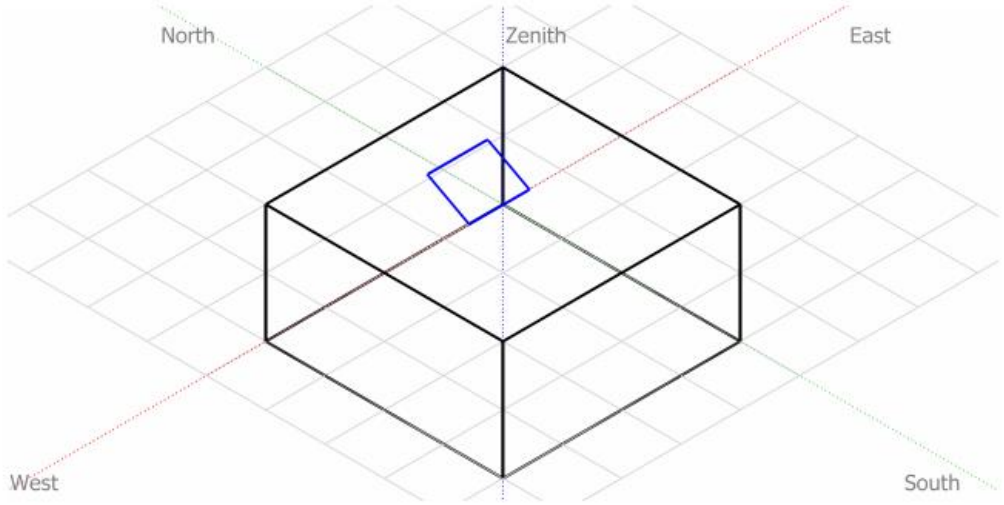
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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

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

Near shadings parameter

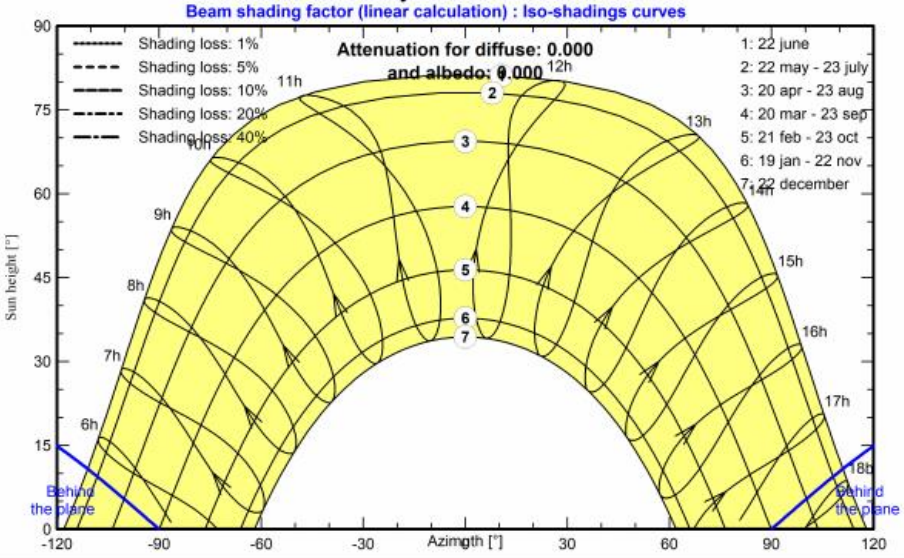
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

System 14

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



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

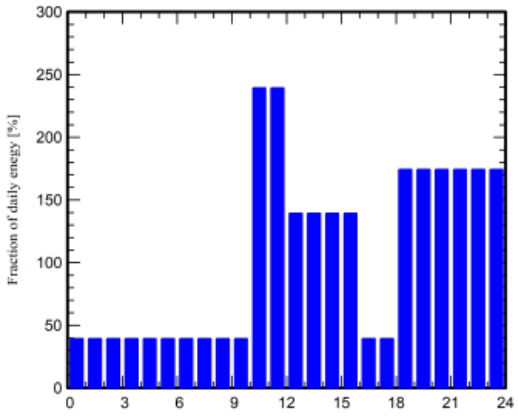
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

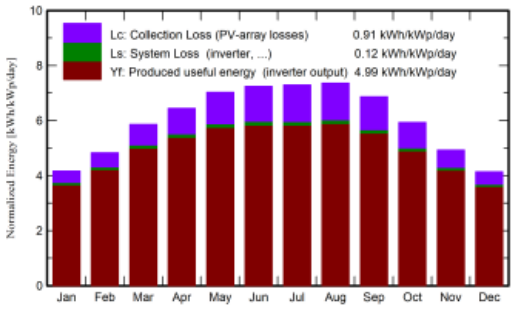


Main results

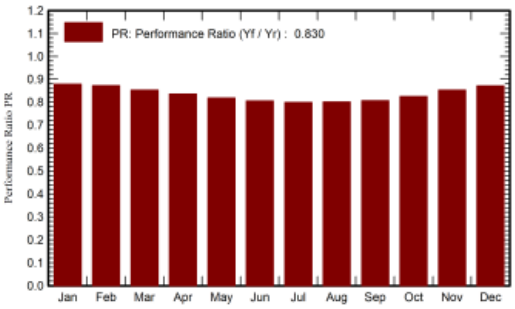
System Production

Produced Energy	7.01 MWh/year	Specific production	1822 kWh/kWp/year
		Performance Ratio PR	82.97 %
		Solar Fraction SF	51.39 %

Normalized productions (per installed kWp)



Performance Ratio PR



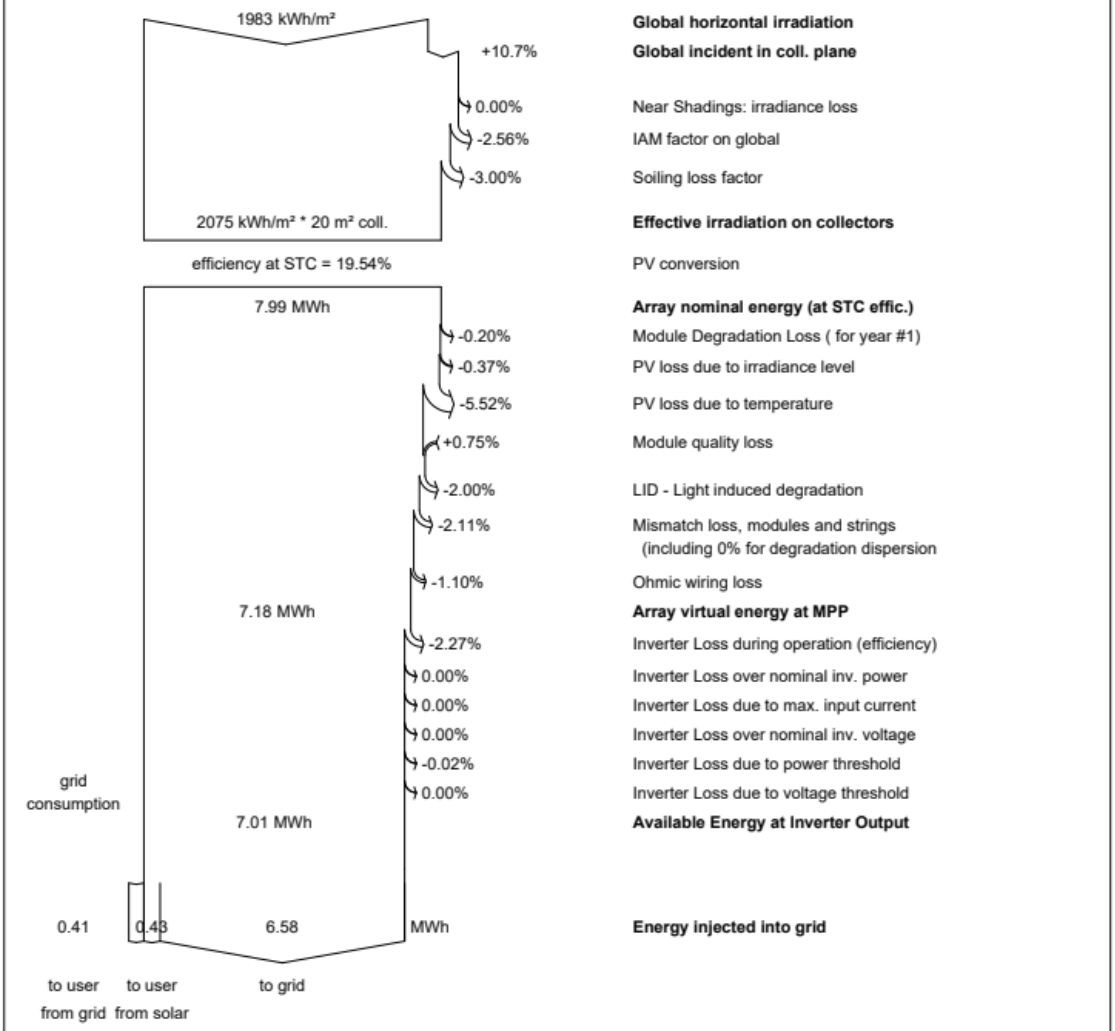
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	122.6	0.448	0.079	0.035	0.402	0.044
February	104.1	46.44	9.45	135.4	128.3	0.465	0.071	0.033	0.421	0.038
March	154.7	63.04	13.37	181.6	172.0	0.611	0.072	0.038	0.559	0.034
April	184.3	71.51	17.01	193.4	182.8	0.638	0.070	0.038	0.584	0.032
May	228.2	70.13	21.21	217.9	205.4	0.703	0.072	0.040	0.646	0.032
June	239.7	59.41	24.13	217.3	204.1	0.690	0.060	0.033	0.641	0.027
July	244.0	58.79	26.28	226.3	212.8	0.713	0.062	0.034	0.662	0.028
August	224.7	56.60	25.93	228.1	215.2	0.720	0.062	0.034	0.670	0.028
September	182.1	40.34	23.64	206.1	195.0	0.655	0.070	0.037	0.603	0.033
October	144.3	44.91	21.01	184.1	174.5	0.598	0.072	0.038	0.547	0.035
November	102.9	34.28	14.54	147.8	140.6	0.497	0.070	0.035	0.451	0.035
December	84.7	32.81	10.22	128.4	121.8	0.441	0.079	0.036	0.395	0.043
Year	1983.5	616.68	17.96	2195.6	2075.2	7.179	0.841	0.432	6.581	0.409

Legends

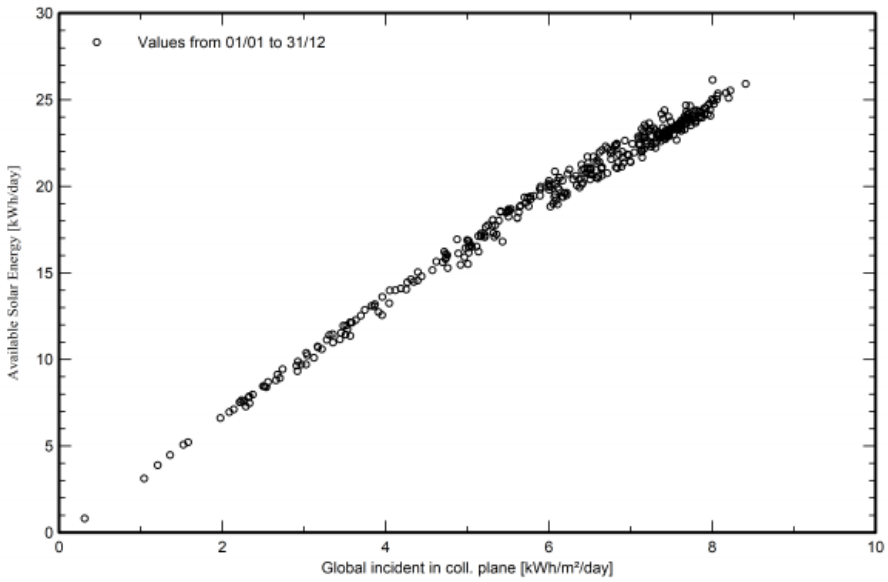
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

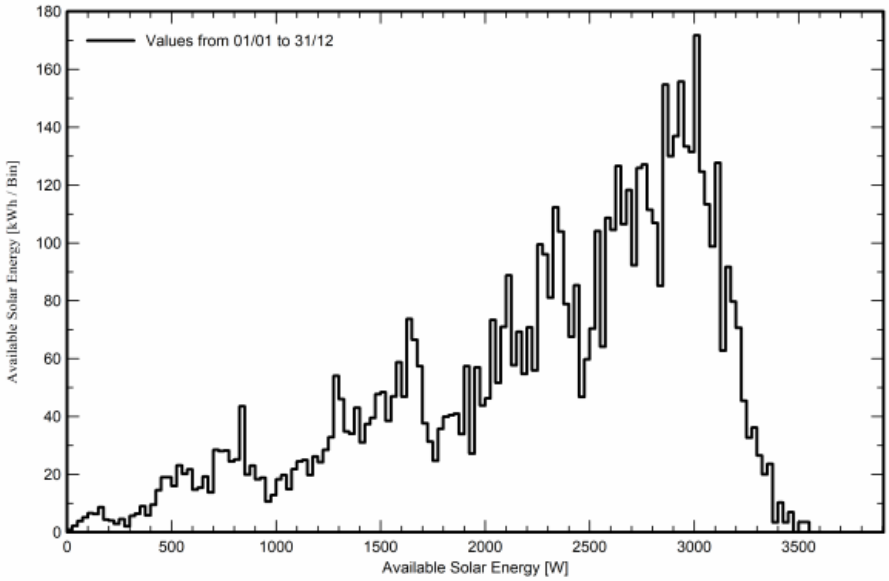


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 15

Variant: New simulation variant

No 3D scene defined, no shadings

System power: 6.00 kWp

R18 - Palestine, State Of

Author

Project: System 15

Variant: New simulation variant

Project summary

Geographical Site
R18
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	510 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System

No 3D scene defined, no shadings

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

System information

PV Array		Inverters	
Nb. of modules	15 units	Nb. of units	1 Unit
Pnom total	6.00 kWp	Pnom total	5.00 kWac
		Pnom ratio	1.200

Results summary

Produced Energy	10.55 MWh/year	Specific production	1758 kWh/kWp/year	Perf. Ratio PR	80.07 %

Table of contents

General parameters

Grid-Connected System — **No 3D scene defined, no shadings**

PV Field Orientation
Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Models used
Transposition Perez
Diffuse Perez, Meteonorm
Circumsolar separate

Horizon
Free Horizon

Near Shadings
No Shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module
Manufacturer Trina Solar
Model TSM-DEG15MC-20-(II)-400-Bifacial
(Original PVsyst database)
Unit Nom. Power 400 Wp
Number of PV modules 15 units
Nominal (STC) 6.00 kWp
Modules 3 Strings x 5 In series
At operating cond. (50°C)
Pmpp 5.48 kWp
U mpp 185 V
I mpp 30 A

Inverter
Manufacturer ABB
Model UNO-DM-5.0-TL-PLUS
(Original PVsyst database)
Unit Nom. Power 5.00 kWac
Number of inverters 2 * MPPT 50% 1 units
Total power 5.0 kWac
Operating voltage 90-580 V
Pnom ratio (DC:AC) 1.20

Total PV power
Nominal (STC) 6 kWp
Total 15 modules
Module area 30.8 m²
Cell area 26.1 m²

Total inverter power
Total power 5 kWac
Nb. of inverters 1 Unit
Pnom ratio 1.20

Array losses

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. 104 mΩ
Loss Fraction 1.5 % at STC

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

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

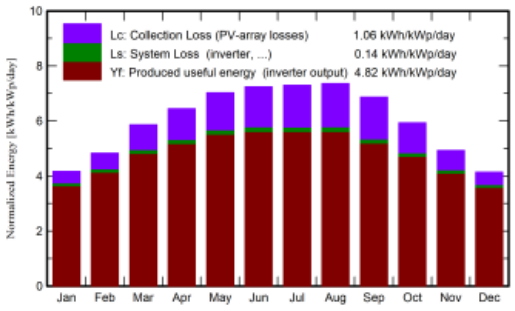
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

Main results

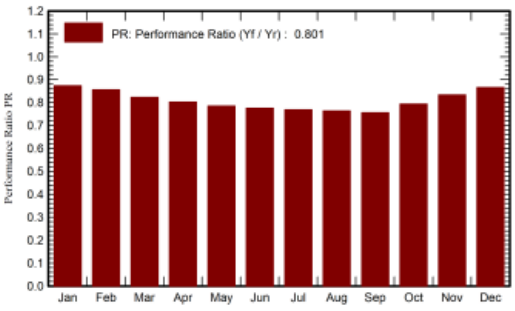
System Production

Produced Energy	10.55 MWh/year	Specific production	1758 kWh/kWp/year
		Performance Ratio PR	80.07 %

Normalized productions (per installed kWp)



Performance Ratio PR



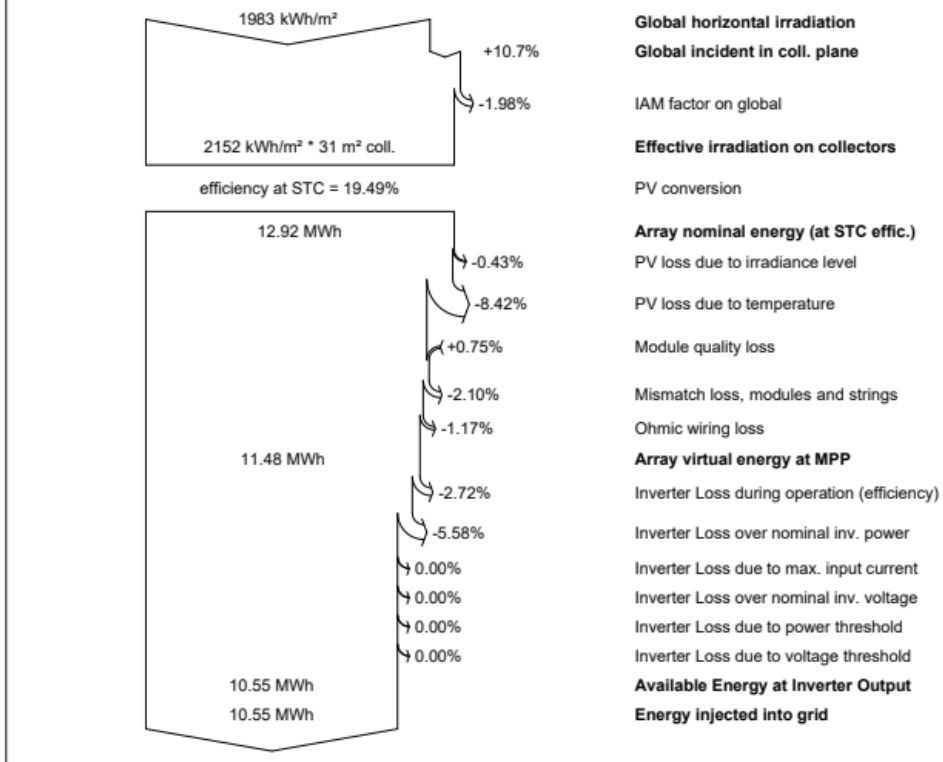
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR ratio
January	89.9	38.41	8.14	129.2	127.1	0.698	0.678	0.874
February	104.1	46.44	9.45	135.4	133.0	0.716	0.696	0.856
March	154.7	63.04	13.37	181.6	178.3	0.924	0.897	0.823
April	184.3	71.51	17.01	193.4	189.5	0.960	0.932	0.803
May	228.2	70.13	21.21	218.0	213.1	1.057	1.027	0.785
June	239.7	59.41	24.13	217.3	211.9	1.042	1.012	0.776
July	244.0	58.79	26.28	226.3	220.8	1.076	1.045	0.769
August	224.7	56.60	25.93	228.1	223.2	1.077	1.046	0.764
September	182.1	40.34	23.64	206.1	202.2	0.963	0.935	0.756
October	144.3	44.91	21.01	184.1	180.9	0.902	0.876	0.794
November	102.9	34.28	14.54	147.8	145.7	0.761	0.739	0.833
December	84.7	32.81	10.22	128.4	126.3	0.686	0.667	0.866
Year	1983.5	616.68	17.96	2195.6	2152.1	10.861	10.549	0.801

Legends

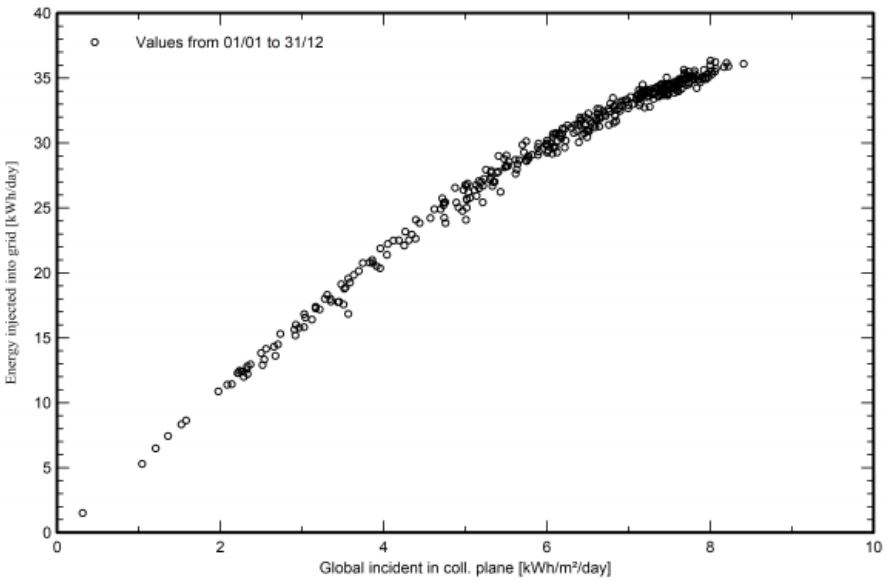
GlobHor	Global horizontal irradiation
DiffHor	Horizontal diffuse irradiation
T_Amb	Ambient Temperature
GlobInc	Global incident in coll. plane
GlobEff	Effective Global, corr. for IAM and shadings
EArray	Effective energy at the output of the array
E_Grid	Energy injected into grid
PR	Performance Ratio

Loss diagram

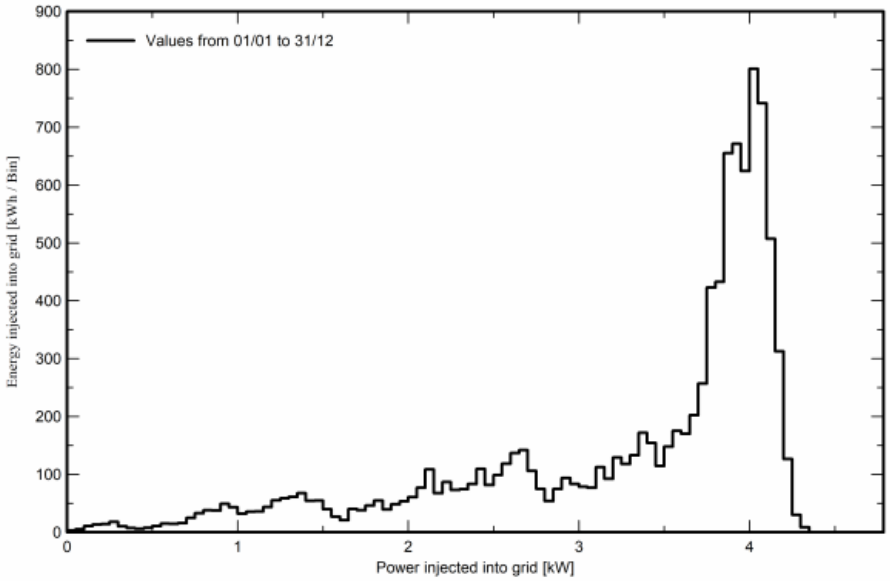


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 16

Variant: 5JJ

Building system

System power: 4560 Wp

R19 - Palestine, State Of

Author

Project: System 16

Variant: 5JJ

Project summary

Geographical Site
R19
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	523 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

System information

PV Array		Inverters	
Nb. of modules	12 units	Nb. of units	1 Unit
Pnom total	4560 Wp	Pnom total	5.00 kWac
		Pnom ratio	0.912

Results summary

Produced Energy	8.35 MWh/year	Specific production	1831 kWh/kWp/year	Perf. Ratio PR	83.37 %

Table of contents

General parameters

Grid-Connected System

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Near Shadings
Linear shadings

Building system

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

User's needs
Unlimited load (grid)

Horizon
Free Horizon

PV Array Characteristics

PV module

Manufacturer	Philadelphia Solar
Model	PS-M72-380
(Original PVsyst database)	
Unit Nom. Power	380 Wp
Number of PV modules	12 units
Nominal (STC)	4560 Wp
Modules	2 Strings x 6 In series
At operating cond. (50°C)	
Pmpp	4125 Wp
U mpp	215 V
I mpp	19 A

Inverter

Manufacturer	Sungrow
Model	SG5KTL-D
(Custom parameters definition)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	125-560 V
Pnom ratio (DC:AC)	0.91

Total PV power

Nominal (STC)	5 kWp
Total	12 modules
Module area	23.4 m²
Cell area	20.9 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	0.91

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

LID - Light Induced Degradation
Loss Fraction 2.0 %

Strings Mismatch loss
Loss Fraction 0.1 %

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

Module Quality Loss
Loss Fraction -0.8 %

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

DC wiring losses
Global array res. 187 mΩ
Loss Fraction 1.5 % at STC

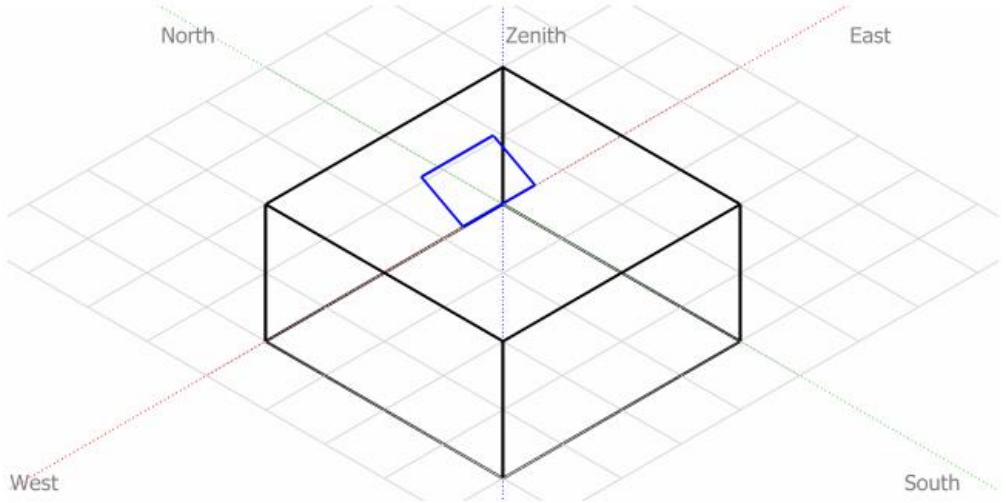
Module mismatch losses
Loss Fraction 2.0 % at MPP

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

Near shadings parameter

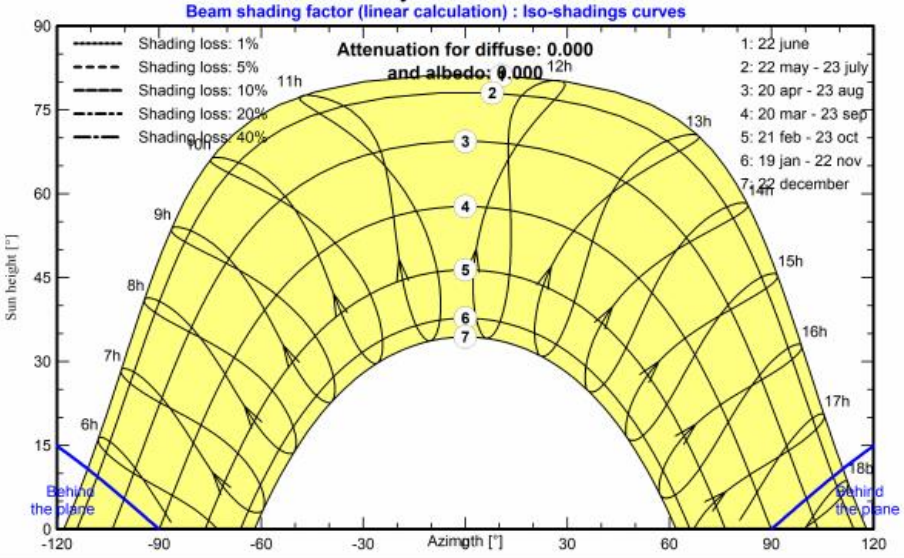
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

System 16

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

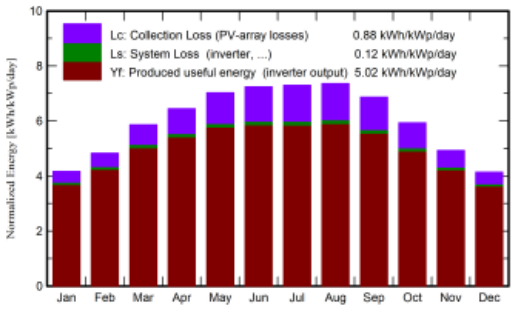


Main results

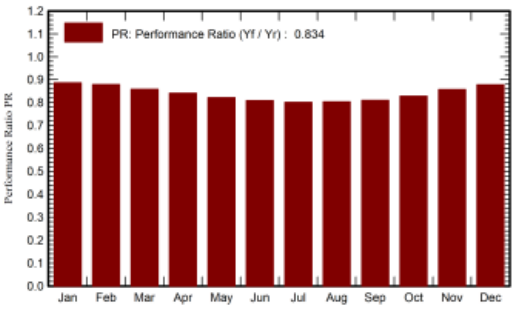
System Production

Produced Energy	8.35 MWh/year	Specific production	1831 kWh/kWp/year
		Performance Ratio PR	83.37 %

Normalized productions (per installed kWp)



Performance Ratio PR



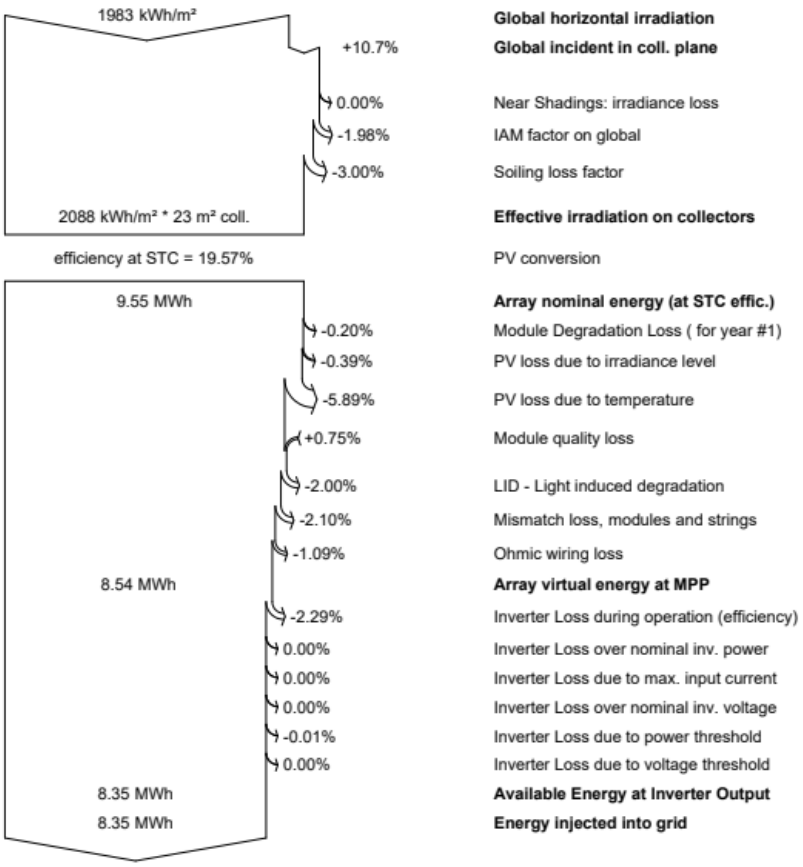
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR ratio
January	89.9	38.41	8.14	129.2	123.3	0.535	0.522	0.887
February	104.1	46.44	9.45	135.4	129.1	0.555	0.542	0.879
March	154.7	63.04	13.37	181.6	173.0	0.728	0.711	0.859
April	184.3	71.51	17.01	193.4	183.8	0.759	0.742	0.841
May	228.2	70.13	21.21	218.0	206.7	0.836	0.817	0.822
June	239.7	59.41	24.13	217.3	205.5	0.821	0.802	0.809
July	244.0	58.79	26.28	226.3	214.2	0.847	0.827	0.802
August	224.7	56.60	25.93	228.1	216.5	0.855	0.836	0.803
September	182.1	40.34	23.64	206.1	196.1	0.779	0.761	0.810
October	144.3	44.91	21.01	184.1	175.5	0.711	0.695	0.828
November	102.9	34.28	14.54	147.8	141.3	0.592	0.578	0.858
December	84.7	32.81	10.22	128.4	122.5	0.526	0.514	0.878
Year	1983.5	616.68	17.96	2195.6	2087.6	8.544	8.347	0.834

Legends

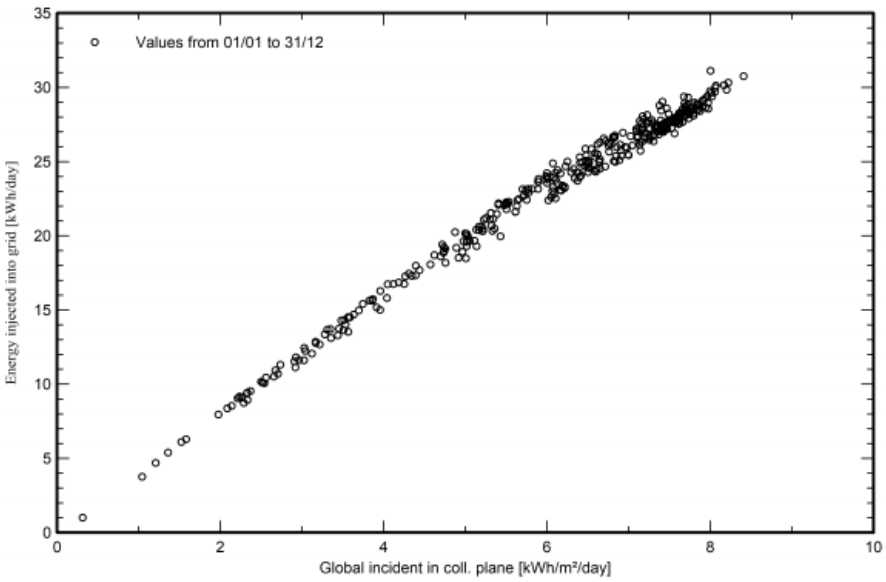
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_Grid	Energy injected into grid
T_Amb	Ambient Temperature	PR	Performance Ratio
GlobInc	Global incident in coll. plane		
GlobEff	Effective Global, corr. for IAM and shadings		

Loss diagram

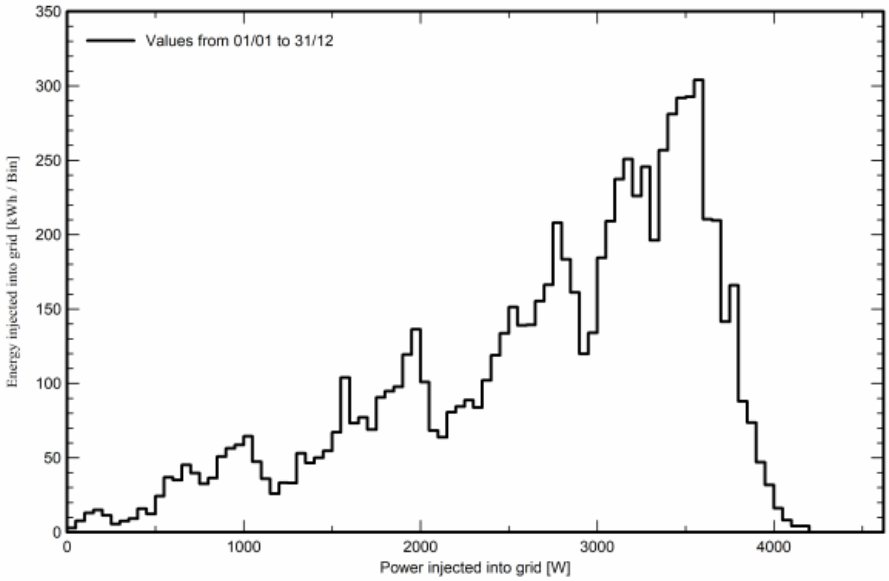


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 17

Variant: New simulation variant

Building system

System power: 5.28 kWp

R20 - Palestine, State Of

Author

Project: System 17

Variant: New simulation variant

Project summary

Geographical Site
R20
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.30 °E
Altitude	524 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array		Inverters	
Nb. of modules	16 units	Nb. of units	1 Unit
Pnom total	5.28 kWp	Pnom total	5.00 kWac
		Pnom ratio	1.056

Results summary

Produced Energy	9.73 MWh/year	Specific production	1842 kWh/kWp/year	Perf. Ratio PR	83.90 %
				Solar Fraction SF	51.00 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used

Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	YIGLI solar
Model	YLM 72 CELL 40mm SERIES
(Custom parameters definition)	
Unit Nom. Power	330 Wp
Number of PV modules	16 units
Nominal (STC)	5.28 kWp
Modules	2 Strings x 8 In series
At operating cond. (50°C)	
Pmpp	4810 Wp
U mpp	274 V
I mpp	18 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000L-5KTL
(Custom parameters definition)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	90-500 V
Max. power (=>40°C)	5.50 kWac
Pnom ratio (DC:AC)	1.06

Total PV power

Nominal (STC)	5 kWp
Total	16 modules
Module area	31.0 m²
Cell area	28.0 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.06

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 260 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -1.3 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

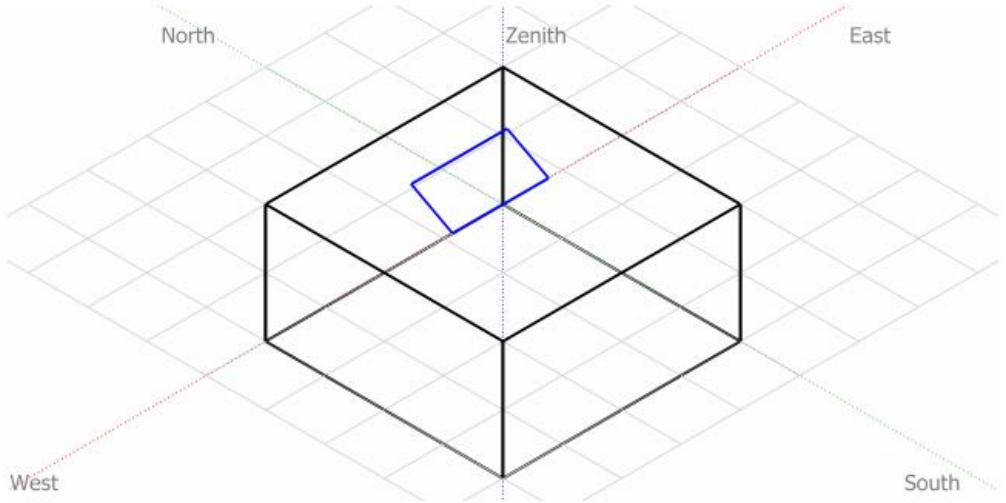
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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

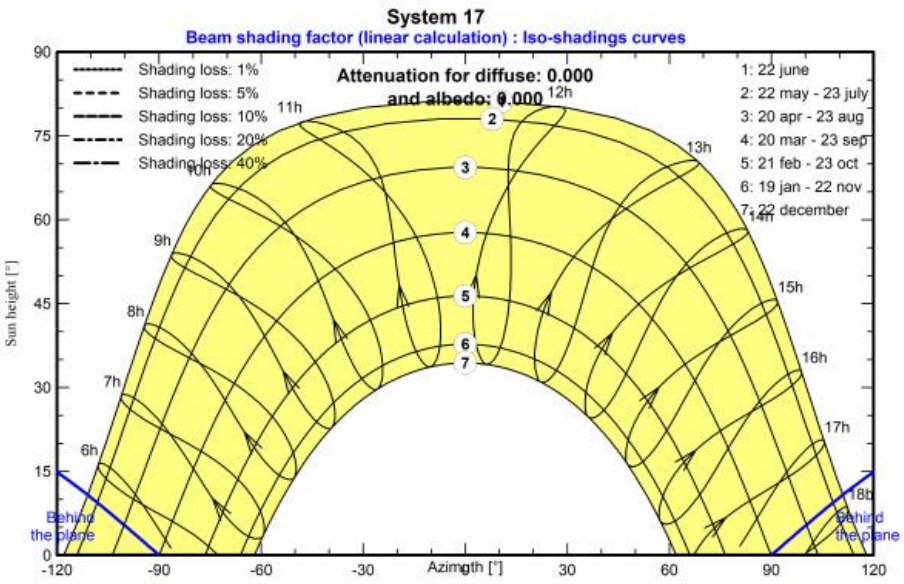
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

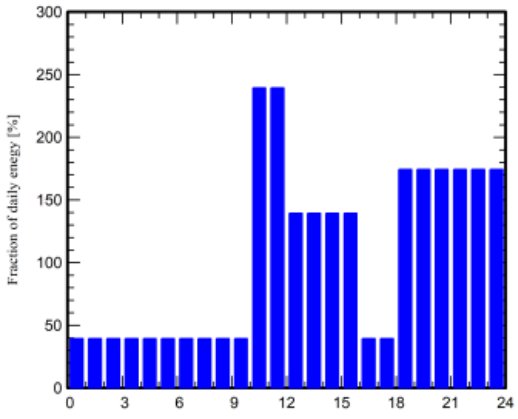
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

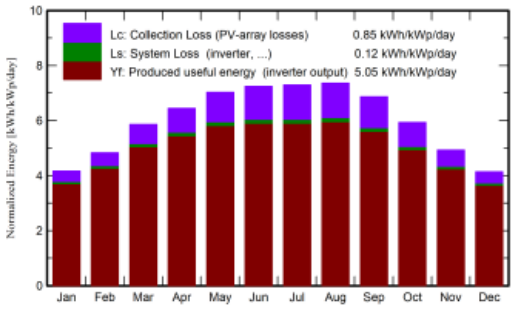


Main results

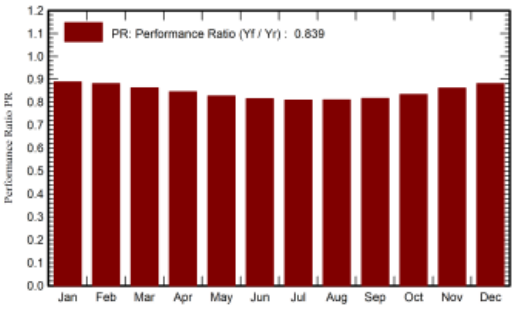
System Production

Produced Energy	9.73 MWh/year	Specific production	1842 kWh/kWp/year
		Performance Ratio PR	83.90 %
		Solar Fraction SF	51.00 %

Normalized productions (per installed kWp)



Performance Ratio PR



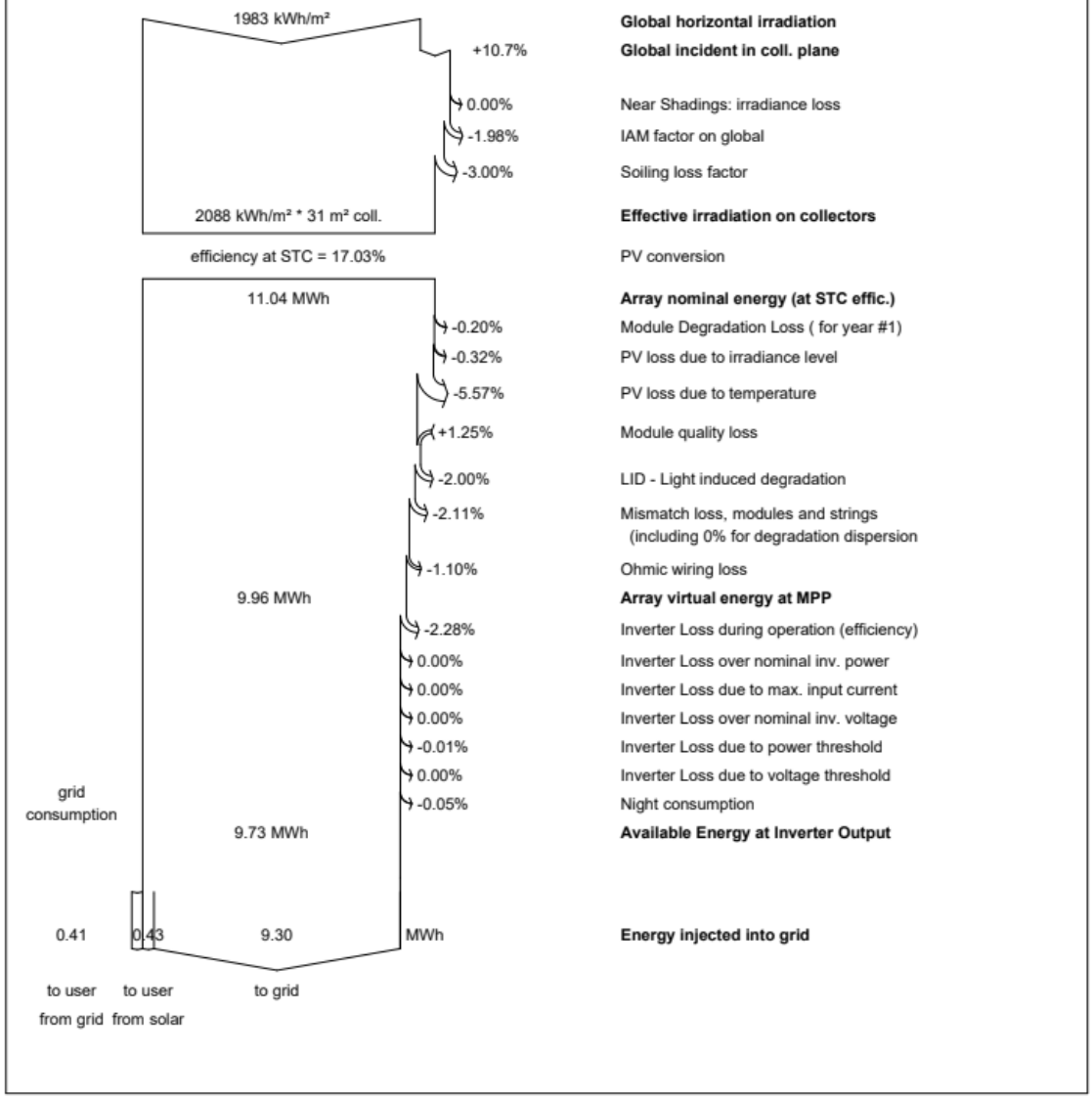
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.3	0.621	0.079	0.035	0.571	0.044
February	104.1	46.44	9.45	135.4	129.1	0.645	0.071	0.033	0.597	0.038
March	154.7	63.04	13.37	181.6	173.0	0.847	0.072	0.038	0.789	0.035
April	184.3	71.51	17.01	193.4	183.8	0.884	0.070	0.038	0.825	0.032
May	228.2	70.13	21.21	218.0	206.7	0.976	0.072	0.040	0.912	0.032
June	239.7	59.41	24.13	217.3	205.5	0.959	0.060	0.033	0.903	0.027
July	244.0	58.79	26.28	226.3	214.2	0.990	0.062	0.034	0.932	0.028
August	224.7	56.60	25.93	228.1	216.5	1.000	0.062	0.034	0.942	0.028
September	182.1	40.34	23.64	206.1	196.1	0.910	0.070	0.037	0.851	0.033
October	144.3	44.91	21.01	184.1	175.5	0.830	0.072	0.037	0.773	0.035
November	102.9	34.28	14.54	147.8	141.3	0.689	0.070	0.034	0.638	0.036
December	84.7	32.81	10.22	128.4	122.5	0.611	0.079	0.035	0.562	0.044
Year	1983.5	616.68	17.96	2195.7	2087.6	9.960	0.841	0.429	9.297	0.412

Legends

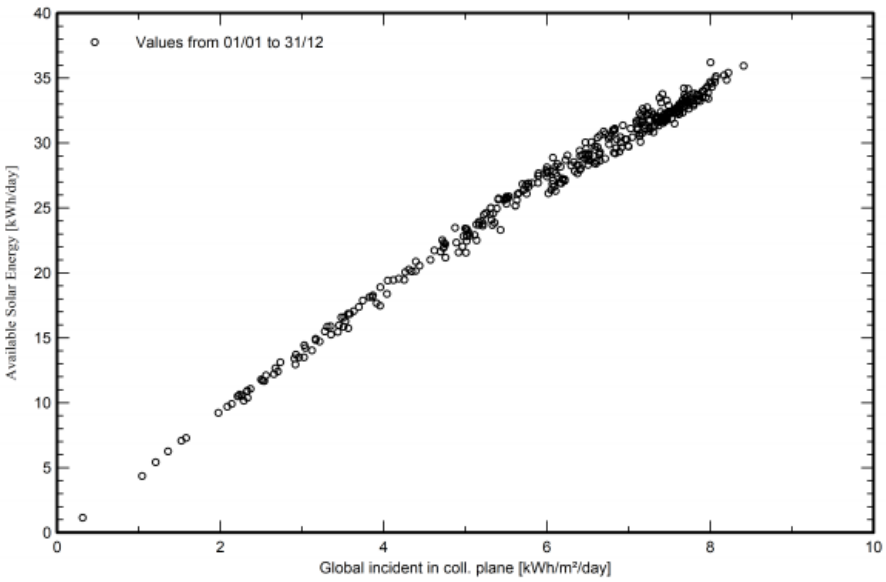
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

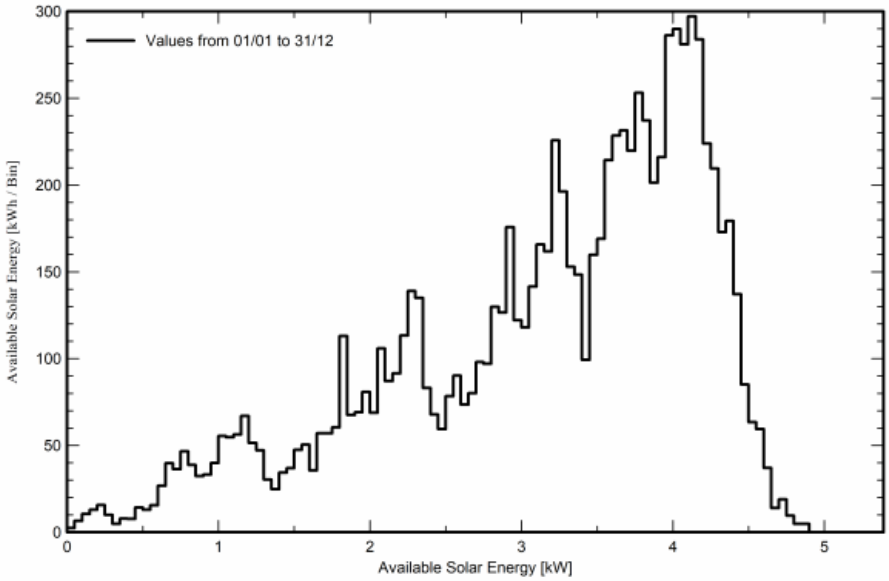


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 18

Variant: K5,JD

Building system

System power: 4920 Wp

R22+23 - Palestine, State Of

Author

Project: System 18

Variant: K5,JD

Project summary

Geographical Site
R22+23
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	524 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	12 units
Pnom total	4920 Wp

Inverters

Nb. of units	1 Unit
Pnom total	5.00 kWac
Pnom ratio	0.984

Results summary

Produced Energy	8.82 MWh/year	Specific production	1793 kWh/kWp/year	Perf. Ratio PR	81.65 %
				Solar Fraction SF	50.62 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation

Fixed plane

Tilt/Azimuth 28 / 0 °

Models used

Transposition Perez

Diffuse Perez, Meteonorm

Circumsolar separate

Horizon

Free Horizon

Near Shadings

Linear shadings

User's needs

Daily household consumers

Seasonal modulation

Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Canadian Solar Inc.
Model	CS3W-410P HE
(Original PVsyst database)	
Unit Nom. Power	410 Wp
Number of PV modules	12 units
Nominal (STC)	4920 Wp
Modules	2 Strings x 6 In series
At operating cond. (50°C)	
Pmpp	4465 Wp
U mpp	213 V
I mpp	21 A

Inverter

Manufacturer	Sungrow
Model	SG5KTL-D
(Custom parameters definition)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	125-560 V
Pnom ratio (DC:AC)	0.98

Total PV power

Nominal (STC)	5 kWp
Total	12 modules
Module area	26.5 m²
Cell area	23.8 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	0.98

Array losses

Array Soiling Losses

Loss Fraction 3.0 %

Thermal Loss factor

Module temperature according to irradiance

Uc (const) 29.0 W/m²K

Uv (wind) 0.0 W/m²K/m/s

DC wiring losses

Global array res. 168 mΩ

Loss Fraction 1.5 % at STC

LID - Light Induced Degradation

Loss Fraction 2.0 %

Module Quality Loss

Loss Fraction -0.3 %

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): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
1.000	1.000	1.000	0.990	0.990	0.970	0.920	0.760	0.000

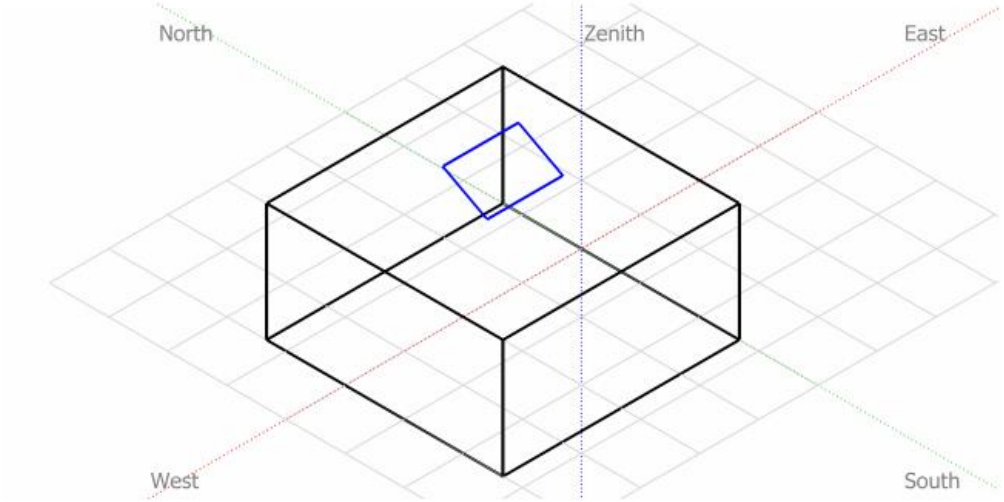
System losses

Unavailability of the system

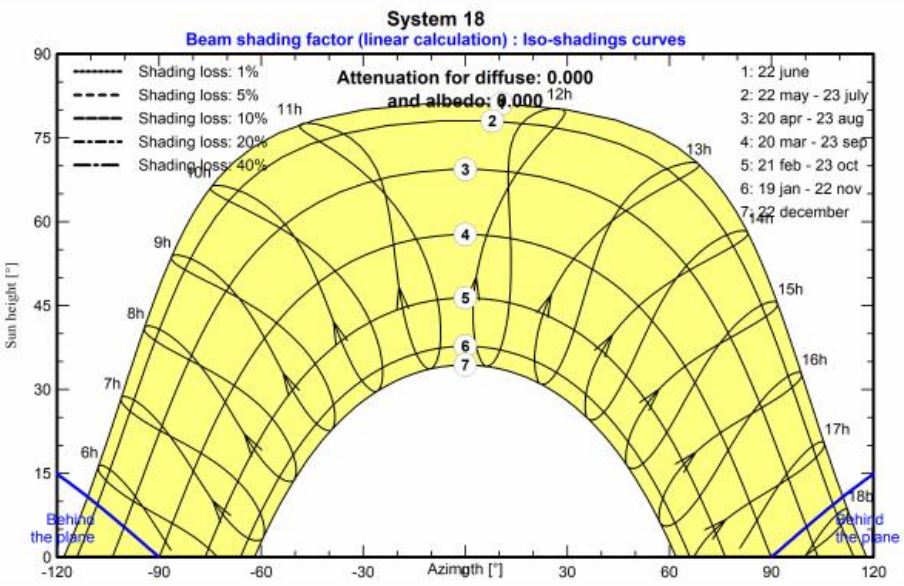
Time fraction	2.0 % 7.3 days, 3 periods

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

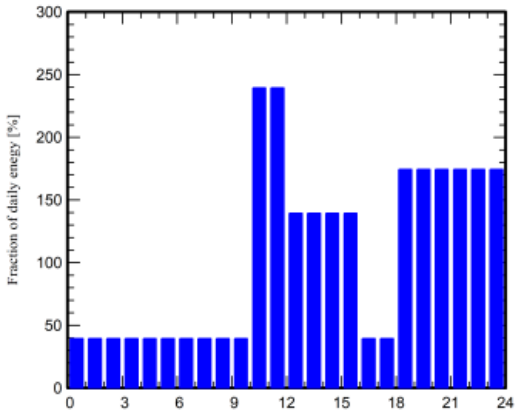
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

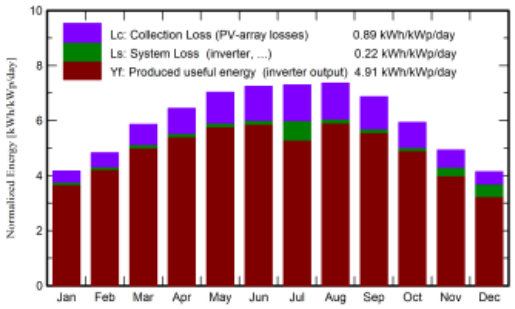


Main results

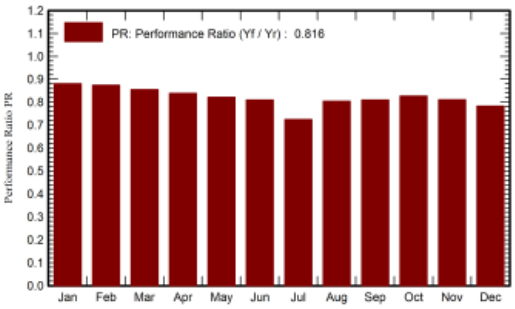
System Production

Produced Energy	8.82 MWh/year	Specific production	1793 kWh/kWp/year
		Performance Ratio PR	81.65 %
		Solar Fraction SF	50.62 %

Normalized productions (per installed kWp)



Performance Ratio PR



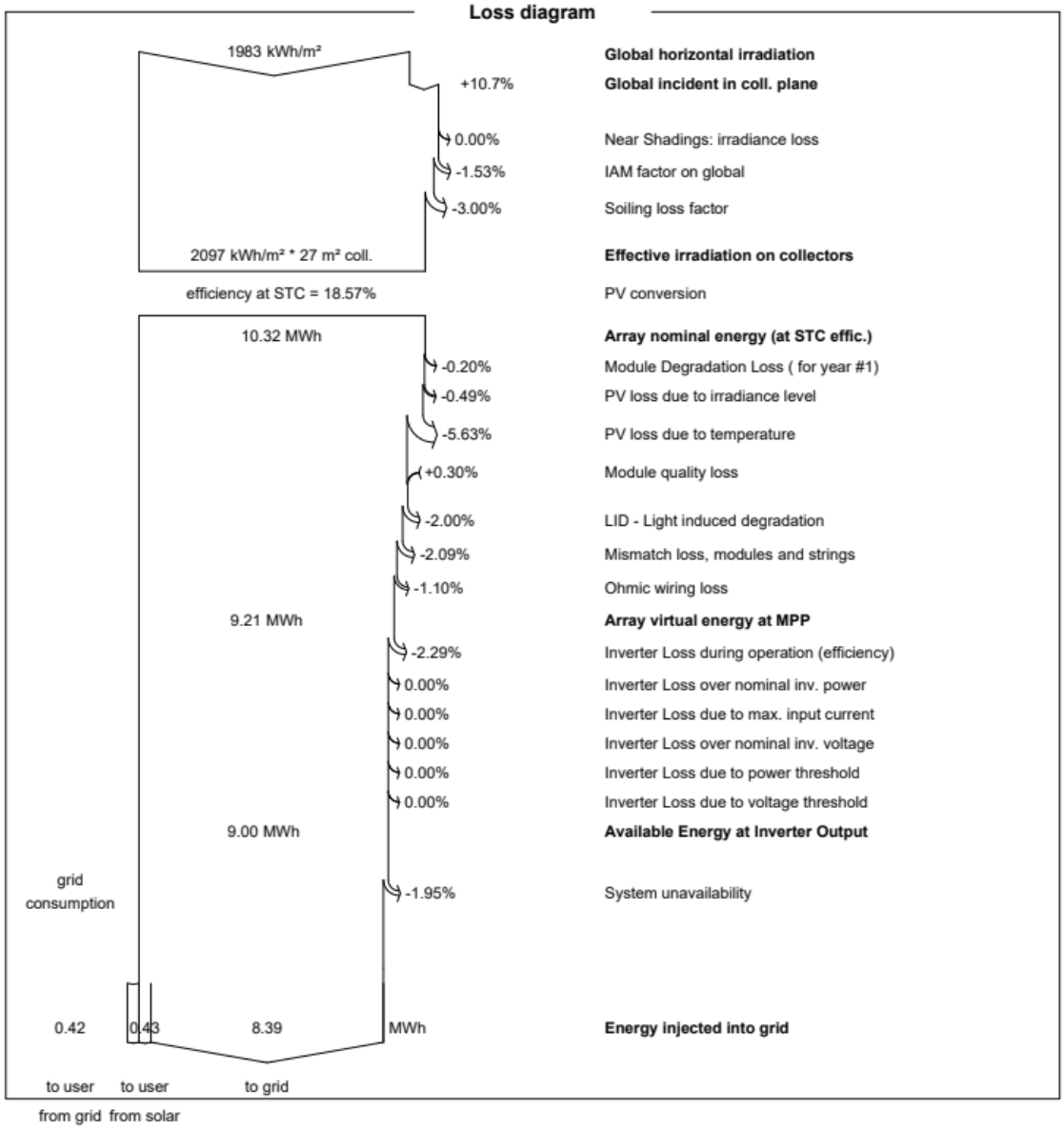
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.7	0.574	0.079	0.036	0.525	0.043
February	104.1	46.44	9.45	135.4	129.5	0.596	0.071	0.033	0.549	0.038
March	154.7	63.04	13.37	181.6	173.7	0.783	0.072	0.038	0.726	0.034
April	184.3	71.51	17.01	193.4	184.7	0.818	0.070	0.039	0.760	0.032
May	228.2	70.13	21.21	218.0	207.8	0.902	0.072	0.041	0.841	0.032
June	239.7	59.41	24.13	217.3	206.7	0.887	0.060	0.033	0.833	0.027
July	244.0	58.79	26.28	226.3	215.3	0.916	0.062	0.031	0.776	0.031
August	224.7	56.60	25.93	228.1	217.5	0.924	0.062	0.034	0.869	0.028
September	182.1	40.34	23.64	206.1	197.1	0.841	0.070	0.037	0.784	0.033
October	144.3	44.91	21.01	184.1	176.3	0.767	0.072	0.038	0.711	0.035
November	102.9	34.28	14.54	147.8	141.7	0.636	0.070	0.033	0.557	0.037
December	84.7	32.81	10.22	128.4	122.9	0.564	0.079	0.033	0.462	0.046
Year	1983.5	616.68	17.96	2195.7	2097.1	9.208	0.841	0.426	8.395	0.415

Legends

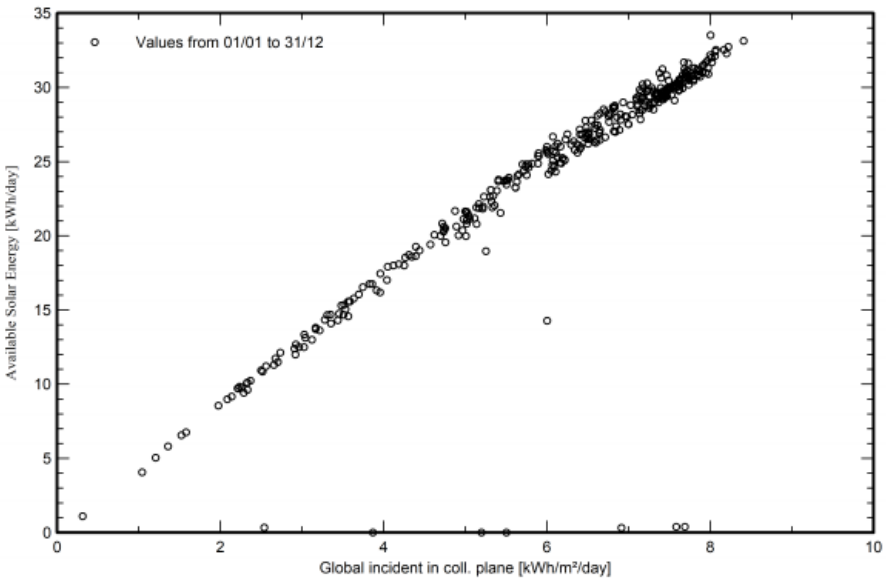
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

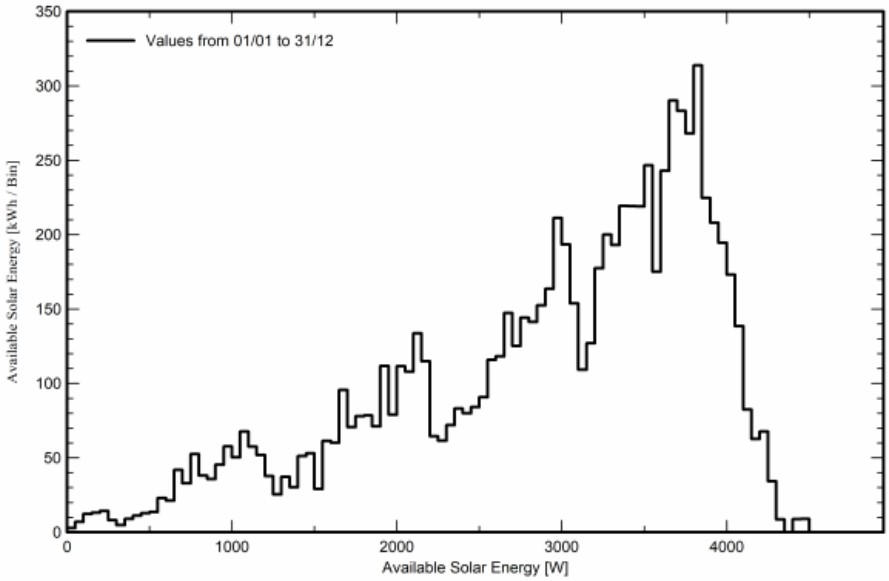


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 19

Variant: New simulation variant

Building system

System power: 4920 Wp

R22+23 - Palestine, State Of

Author

Project: System 19

Variant: New simulation variant

Project summary

Geographical Site
R22+23
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	524 m
Time zone	UTC+2

Project settings
Albedo 0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

System information

PV Array		Inverters	
Nb. of modules	12 units	Nb. of units	1 Unit
Pnom total	4920 Wp	Pnom total	5.00 kWac
		Pnom ratio	0.984

Results summary

Produced Energy	9.00 MWh/year	Specific production	1828 kWh/kWp/year	Perf. Ratio PR	83.27 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Unlimited load (grid)

PV Array Characteristics

PV module

Manufacturer	Canadian Solar Inc.
Model	CS3W-410P HE
(Original PVsyst database)	
Unit Nom. Power	410 Wp
Number of PV modules	12 units
Nominal (STC)	4920 Wp
Modules	2 Strings x 6 In series
At operating cond. (50°C)	
Pmpp	4465 Wp
U mpp	213 V
I mpp	21 A

Inverter

Manufacturer	Sungrow
Model	SG5KTL-D
(Custom parameters definition)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	125-560 V
Pnom ratio (DC:AC)	0.98

Total PV power

Nominal (STC)	5 kWp
Total	12 modules
Module area	26.5 m²
Cell area	23.8 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	0.98

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 168 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.3 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

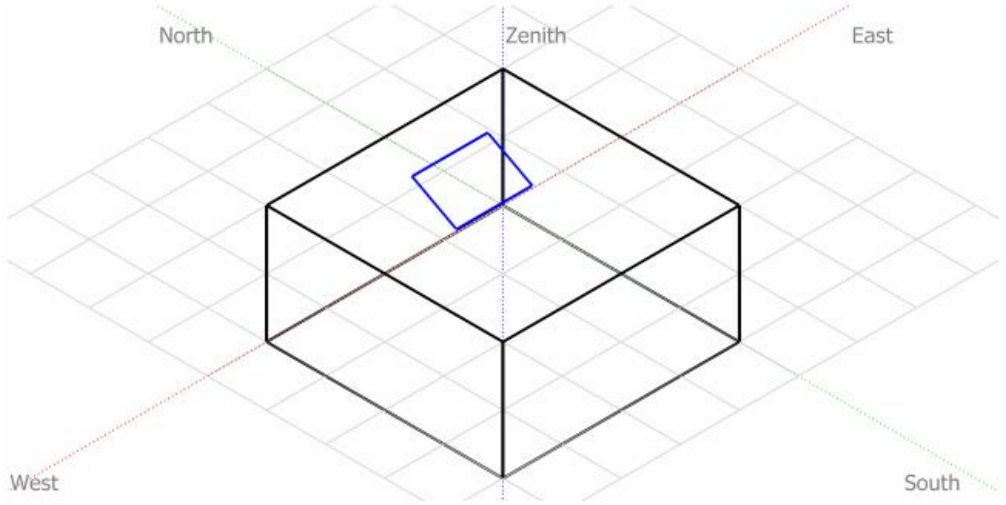
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

IAM loss factor
Incidence effect (IAM): User defined profile

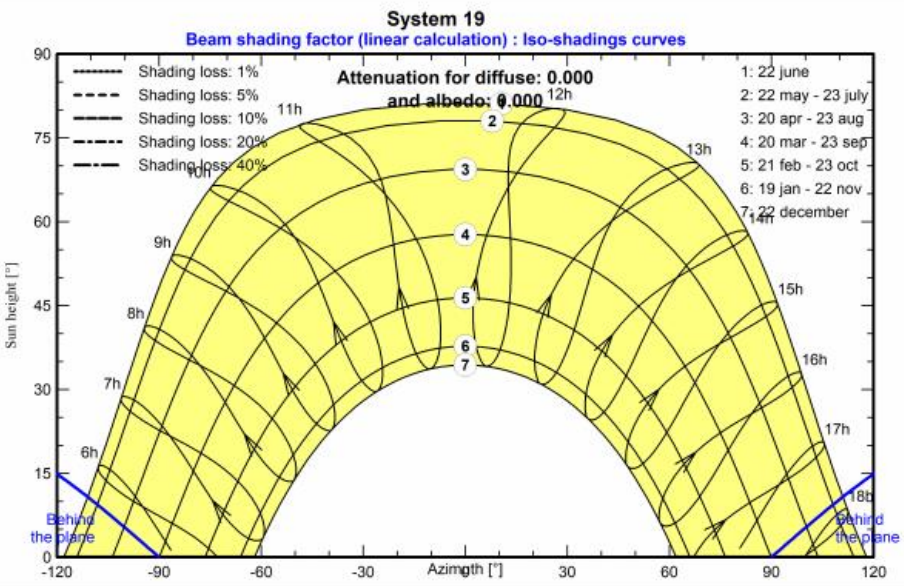
10°	20°	30°	40°	50°	60°	70°	80°	90°
1.000	1.000	1.000	0.990	0.990	0.970	0.920	0.760	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

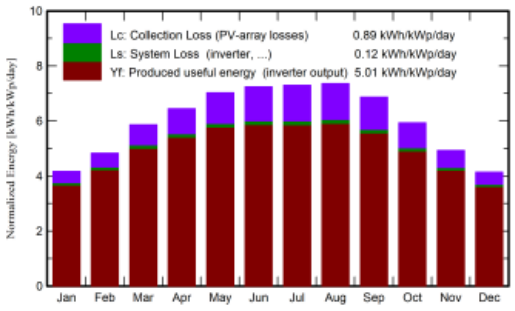


Main results

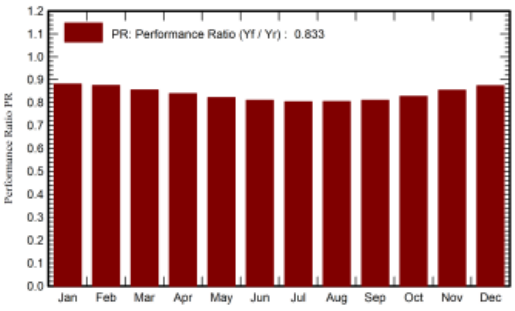
System Production

Produced Energy	9.00 MWh/year	Specific production	1828 kWh/kWp/year
		Performance Ratio PR	83.27 %

Normalized productions (per installed kWp)



Performance Ratio PR



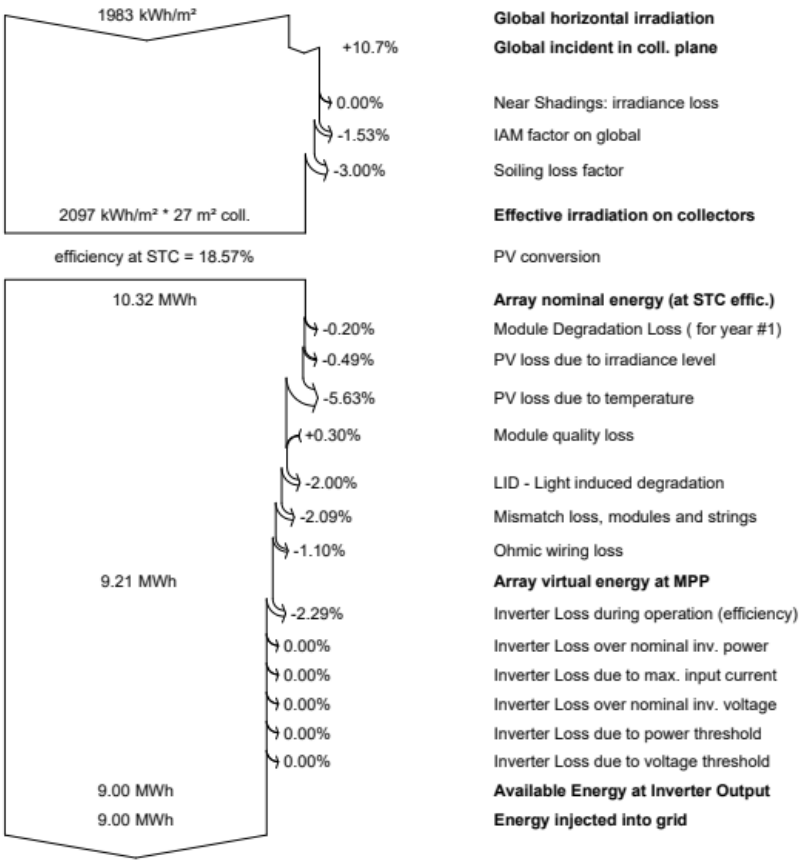
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_Grid MWh	PR ratio
January	89.9	38.41	8.14	129.2	123.7	0.574	0.560	0.881
February	104.1	46.44	9.45	135.4	129.5	0.596	0.582	0.874
March	154.7	63.04	13.37	181.6	173.7	0.783	0.765	0.856
April	184.3	71.51	17.01	193.4	184.7	0.818	0.799	0.840
May	228.2	70.13	21.21	218.0	207.8	0.902	0.882	0.822
June	239.7	59.41	24.13	217.3	206.7	0.887	0.866	0.810
July	244.0	58.79	26.28	226.3	215.3	0.916	0.894	0.803
August	224.7	56.60	25.93	228.1	217.5	0.924	0.903	0.804
September	182.1	40.34	23.64	206.1	197.1	0.841	0.822	0.811
October	144.3	44.91	21.01	184.1	176.3	0.767	0.749	0.827
November	102.9	34.28	14.54	147.8	141.7	0.636	0.621	0.854
December	84.7	32.81	10.22	128.4	122.9	0.564	0.551	0.873
Year	1983.5	616.68	17.96	2195.7	2097.1	9.207	8.996	0.833

Legends

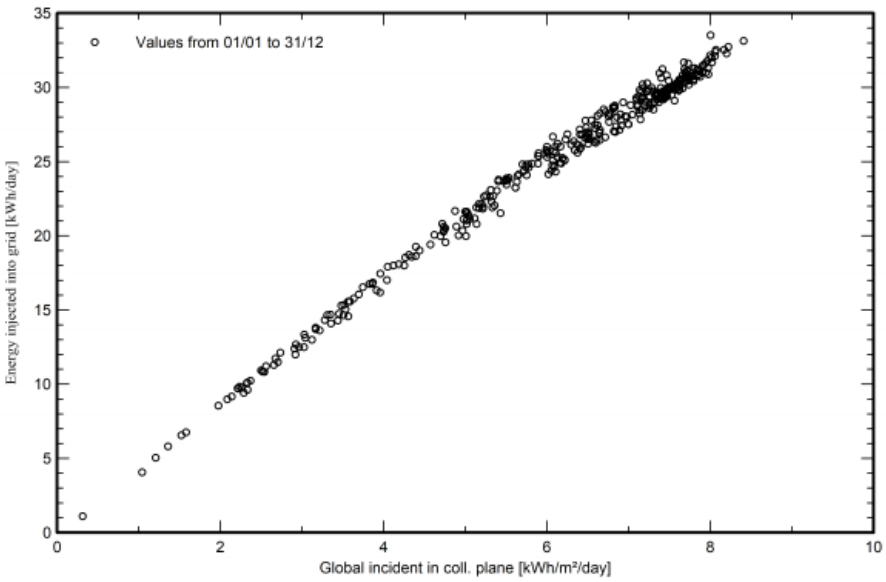
GlobHor	Global horizontal irradiation
DiffHor	Horizontal diffuse irradiation
T_Amb	Ambient Temperature
GlobInc	Global incident in coll. plane
GlobEff	Effective Global, corr. for IAM and shadings
EArray	Effective energy at the output of the array
E_Grid	Energy injected into grid
PR	Performance Ratio

Loss diagram

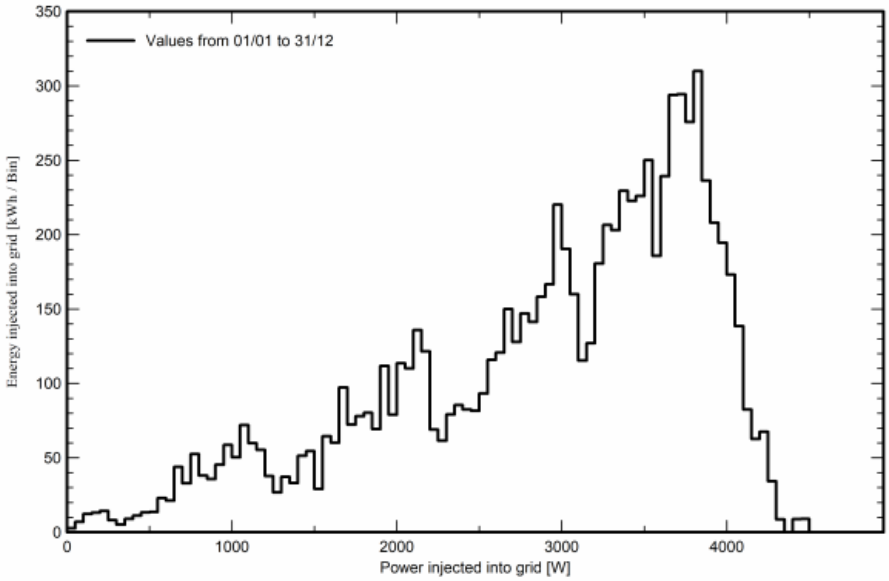


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 20

Variant: 40EKH

Building system

System power: 35.7 kWp

R24 - Palestine, State Of

Author

Project: System 20

Variant: 40EKH

Project summary

Geographical Site
R24
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.30 °E
Altitude	535 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	87 units
Pnom total	35.7 kWp

Inverters

Nb. of units	2 units
Pnom total	40.0 kWac
Pnom ratio	0.892

Results summary

Produced Energy	65.24 MWh/year	Specific production	1829 kWh/kWp/year	Perf. Ratio PR	83.30 %
				Solar Fraction SF	50.85 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Canadian Solar Inc.
Model	CS1U - 410MS
(Original PVsyst database)	
Unit Nom. Power	410 Wp
Number of PV modules	87 units
Nominal (STC)	35.7 kWp

Inverter

Manufacturer	Kaco new energy
Model	Blueplanet 20.0 TL3
(Original PVsyst database)	
Unit Nom. Power	20.0 kWac
Number of inverters	2 units
Total power	40.0 kWac

Array #1 - PV Array

Number of PV modules	42 units	Number of inverters	2 * MPPT 50% 1 units
Nominal (STC)	17.22 kWp	Total power	20.0 kWac
Modules	3 Strings x 14 In series		
At operating cond. (50°C)		Operating voltage	200-800 V
Pmpp	15.65 kWp	Pnom ratio (DC:AC)	0.86
U mpp	564 V		
I mpp	28 A		

Array #2 - Sub-array #2

Number of PV modules	45 units	Number of inverters	2 * MPPT 50% 1 units
Nominal (STC)	18.45 kWp	Total power	20.0 kWac
Modules	3 Strings x 15 In series		
At operating cond. (50°C)		Operating voltage	200-800 V
Pmpp	16.77 kWp	Pnom ratio (DC:AC)	0.92
U mpp	605 V		
I mpp	28 A		

Total PV power

Nominal (STC)	36 kWp
Total	87 modules
Module area	179 m²
Cell area	173 m²

Total inverter power

Total power	40 kWac
Nb. of inverters	2 units
Pnom ratio	0.89

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.3 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

Array losses

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): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
1.000	1.000	1.000	0.990	0.990	0.970	0.920	0.760	0.000

DC wiring losses

Global wiring resistance 10 mΩ
Loss Fraction 1.5 % at STC

Array #1 - PV Array

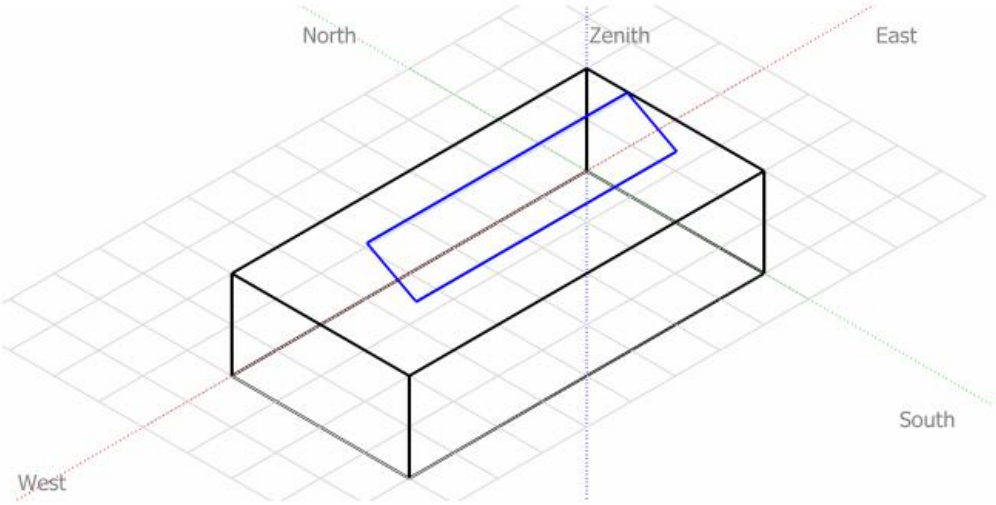
Global array res. 339 mΩ
Loss Fraction 1.5 % at STC

Array #2 - Sub-array #2

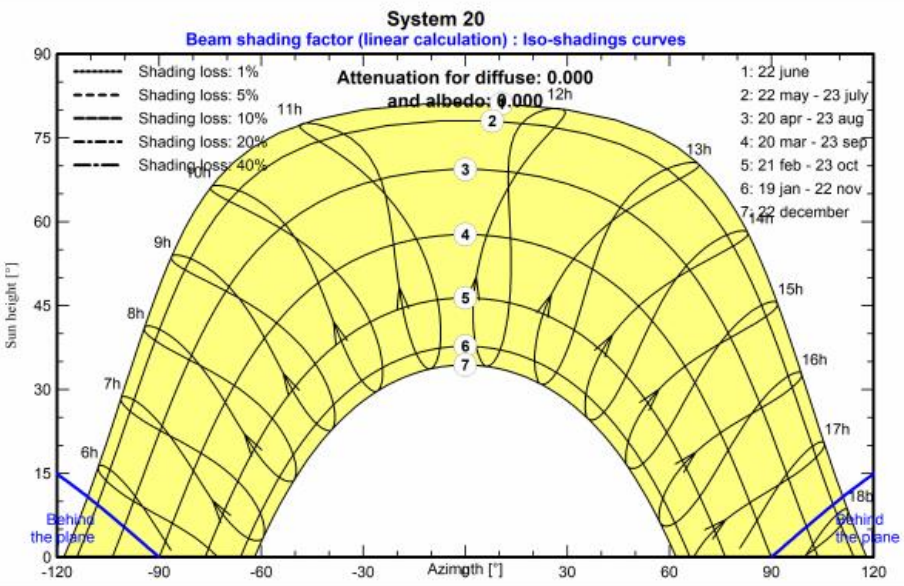
Global array res. 364 mΩ
Loss Fraction 1.5 % at STC

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

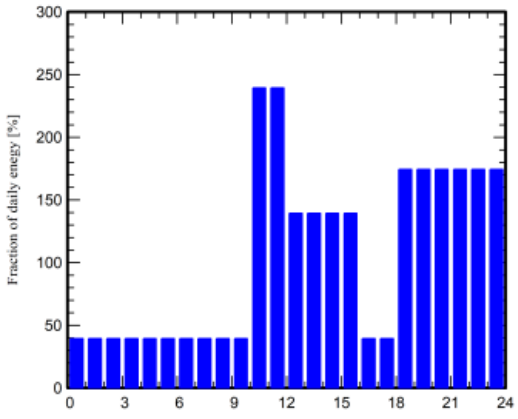
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

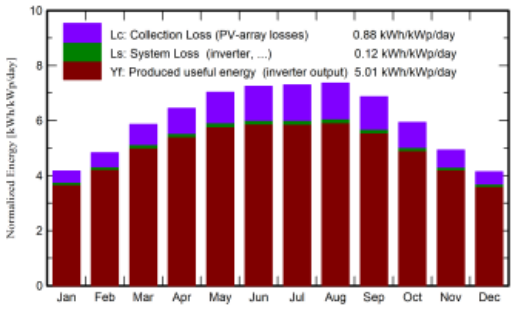


Main results

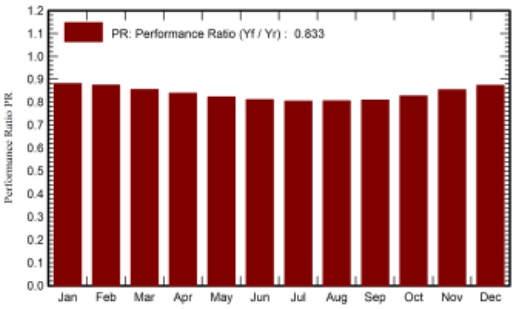
System Production

Produced Energy	65.24 MWh/year	Specific production	1829 kWh/kWp/year
		Performance Ratio PR	83.30 %
		Solar Fraction SF	50.85 %

Normalized productions (per installed kWp)



Performance Ratio PR



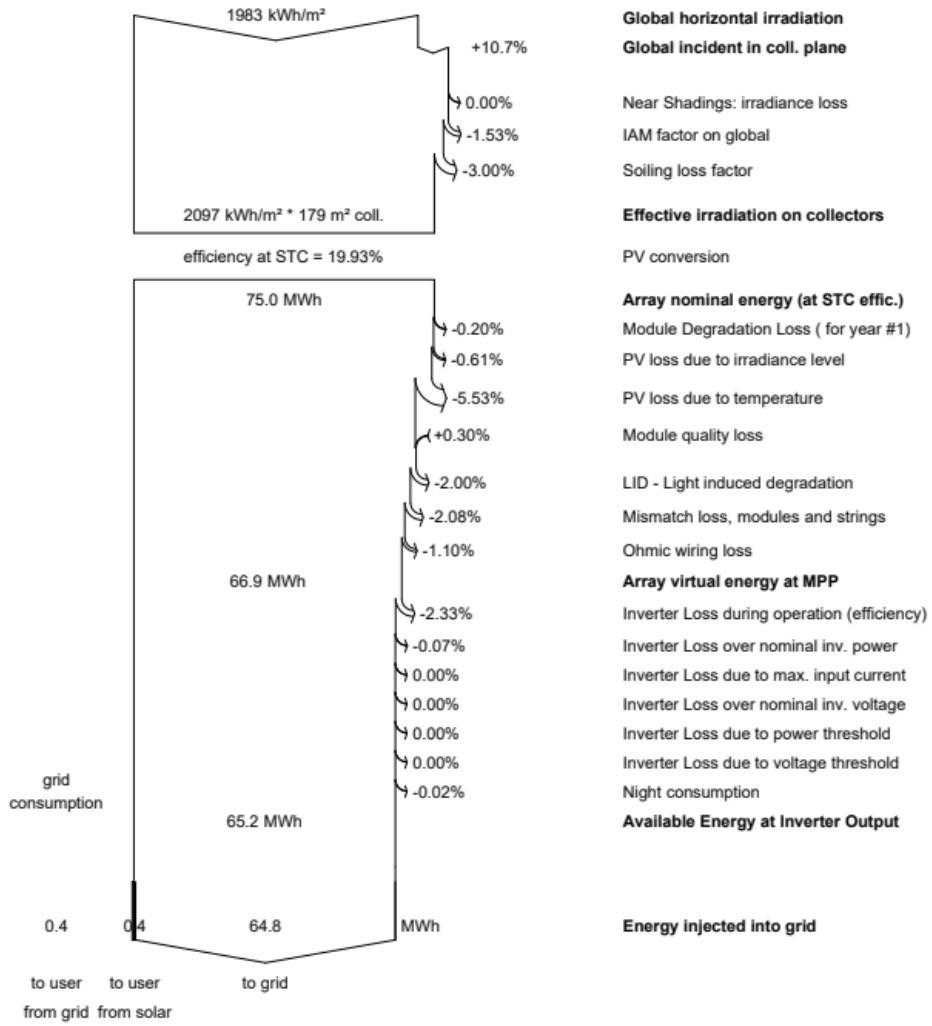
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.7	4.162	0.079	0.035	4.029	0.044
February	104.1	46.44	9.45	135.4	129.5	4.324	0.071	0.032	4.189	0.039
March	154.7	63.04	13.37	181.6	173.7	5.678	0.072	0.038	5.507	0.035
April	184.3	71.51	17.01	193.4	184.7	5.932	0.070	0.038	5.755	0.032
May	228.2	70.13	21.21	218.0	207.8	6.550	0.072	0.040	6.357	0.033
June	239.7	59.41	24.13	217.3	206.7	6.441	0.060	0.034	6.255	0.026
July	244.0	58.79	26.28	226.3	215.3	6.650	0.062	0.036	6.458	0.027
August	224.7	56.60	25.93	228.1	217.5	6.711	0.062	0.033	6.520	0.029
September	182.1	40.34	23.64	206.1	197.1	6.088	0.070	0.037	5.908	0.033
October	144.3	44.91	21.01	184.1	176.3	5.563	0.072	0.037	5.396	0.036
November	102.9	34.28	14.54	147.8	141.7	4.614	0.070	0.034	4.471	0.036
December	84.7	32.81	10.22	128.4	122.9	4.094	0.079	0.034	3.963	0.045
Year	1983.5	616.68	17.96	2195.6	2097.1	66.808	0.841	0.427	64.808	0.413

Legends

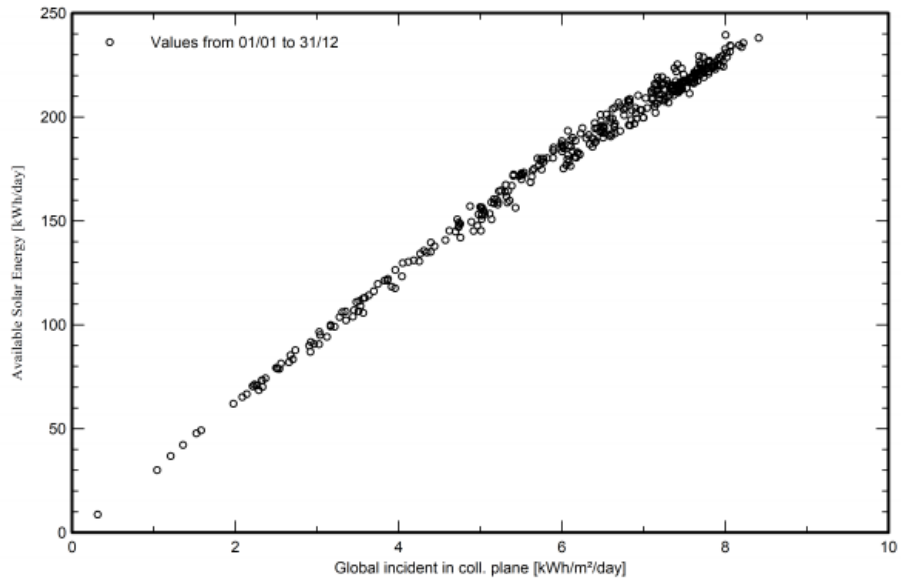
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

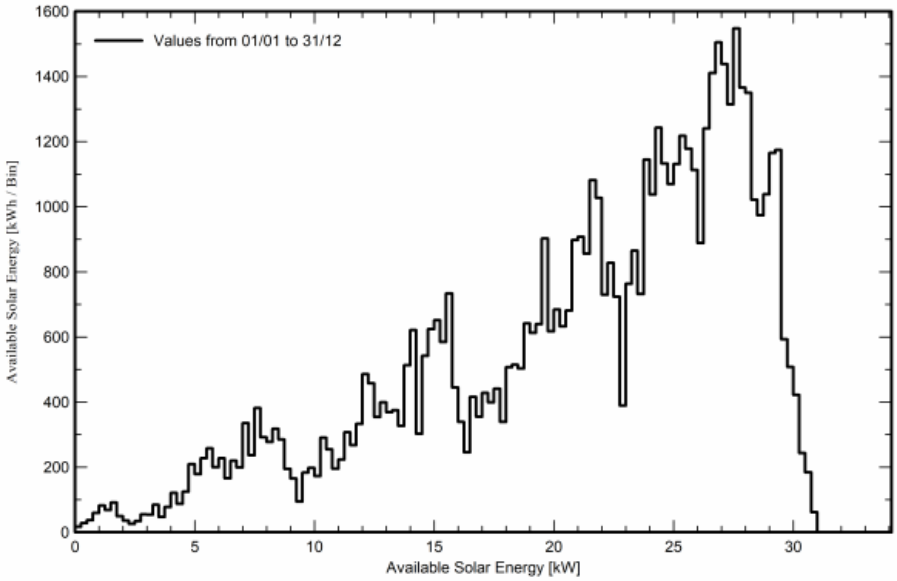


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 21

Variant: 5AD

Building system

System power: 6.56 kWp

R25 - Palestine, State Of

Author

Project: System 21

Variant: 5AD

Project summary

Geographical Site
R25
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.30 °E
Altitude	558 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	16 units
Pnom total	6.56 kWp

Inverters

Nb. of units	1 Unit
Pnom total	6.00 kWac
Pnom ratio	1.093

Results summary

Produced Energy	11.91 MWh/year	Specific production	1816 kWh/kWp/year	Perf. Ratio PR	82.69 %
				Solar Fraction SF	51.70 %

Table of contents

General parameters

Grid-Connected System

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Near Shadings
Linear shadings

Building system

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

Horizon
Free Horizon

PV Array Characteristics

PV module

Manufacturer	Canadian Solar Inc.
Model	CS3W-410P HE
(Original PVsyst database)	
Unit Nom. Power	410 Wp
Number of PV modules	16 units
Nominal (STC)	6.56 kWp
Modules	2 Strings x 8 In series
At operating cond. (50°C)	
Pmpp	5.95 kWp
U mpp	283 V
I mpp	21 A

Total PV power

Nominal (STC)	7 kWp
Total	16 modules
Module area	35.3 m²
Cell area	31.7 m²

Inverter

Manufacturer	ABB
Model	UNO-DM-6.0-TL-PLUS-US (240V)
(Original PVsyst database)	
Unit Nom. Power	6.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	6.0 kWac
Operating voltage	90-580 V
Pnom ratio (DC:AC)	1.09

Total inverter power

Total power	6 kWac
Nb. of inverters	1 Unit
Pnom ratio	1.09

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

LID - Light Induced Degradation
Loss Fraction 2.0 %

Strings Mismatch loss
Loss Fraction 0.1 %

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

Module Quality Loss
Loss Fraction -0.3 %

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

DC wiring losses
Global array res. 224 mΩ
Loss Fraction 1.5 % at STC

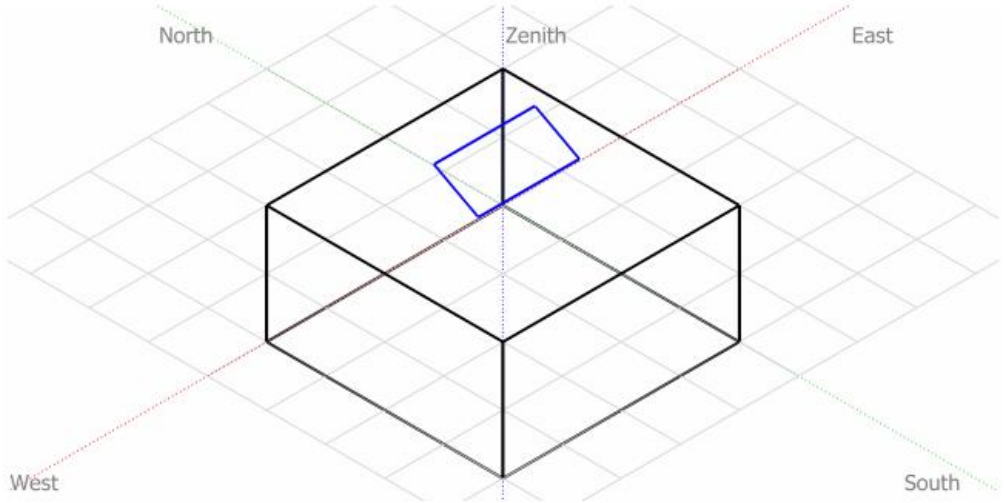
Module mismatch losses
Loss Fraction 2.0 % at MPP

IAM loss factor
Incidence effect (IAM): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
1.000	1.000	1.000	0.990	0.990	0.970	0.920	0.760	0.000

Near shadings parameter

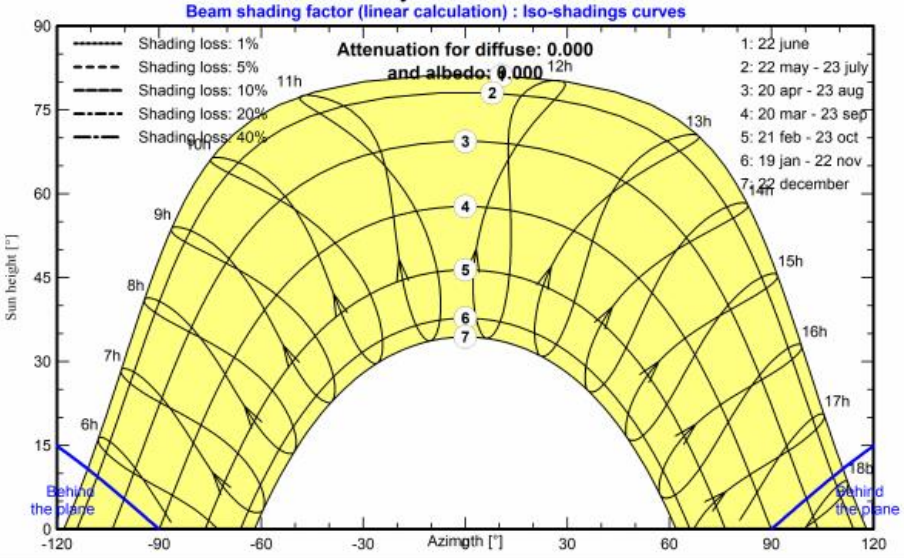
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

System 21

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



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

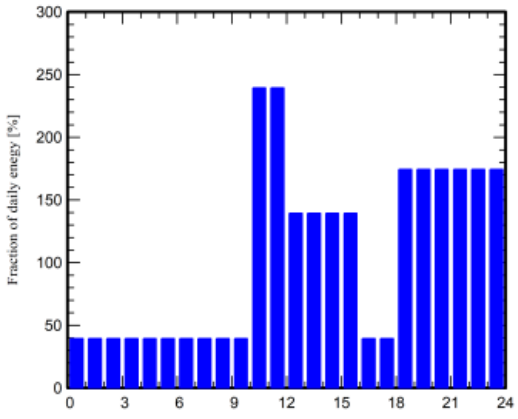
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

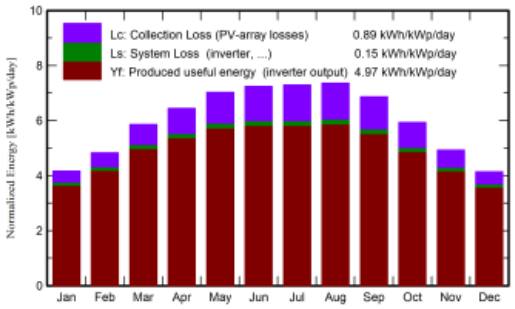


Main results

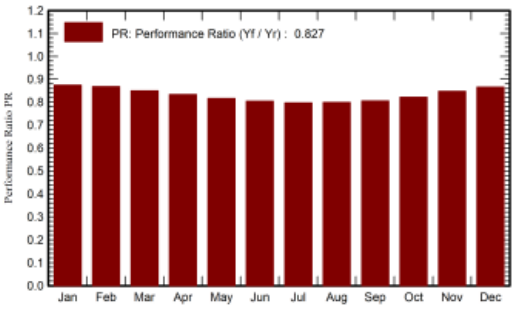
System Production

Produced Energy	11.91 MWh/year	Specific production	1816 kWh/kWp/year
		Performance Ratio PR	82.69 %
		Solar Fraction SF	51.70 %

Normalized productions (per installed kWp)



Performance Ratio PR



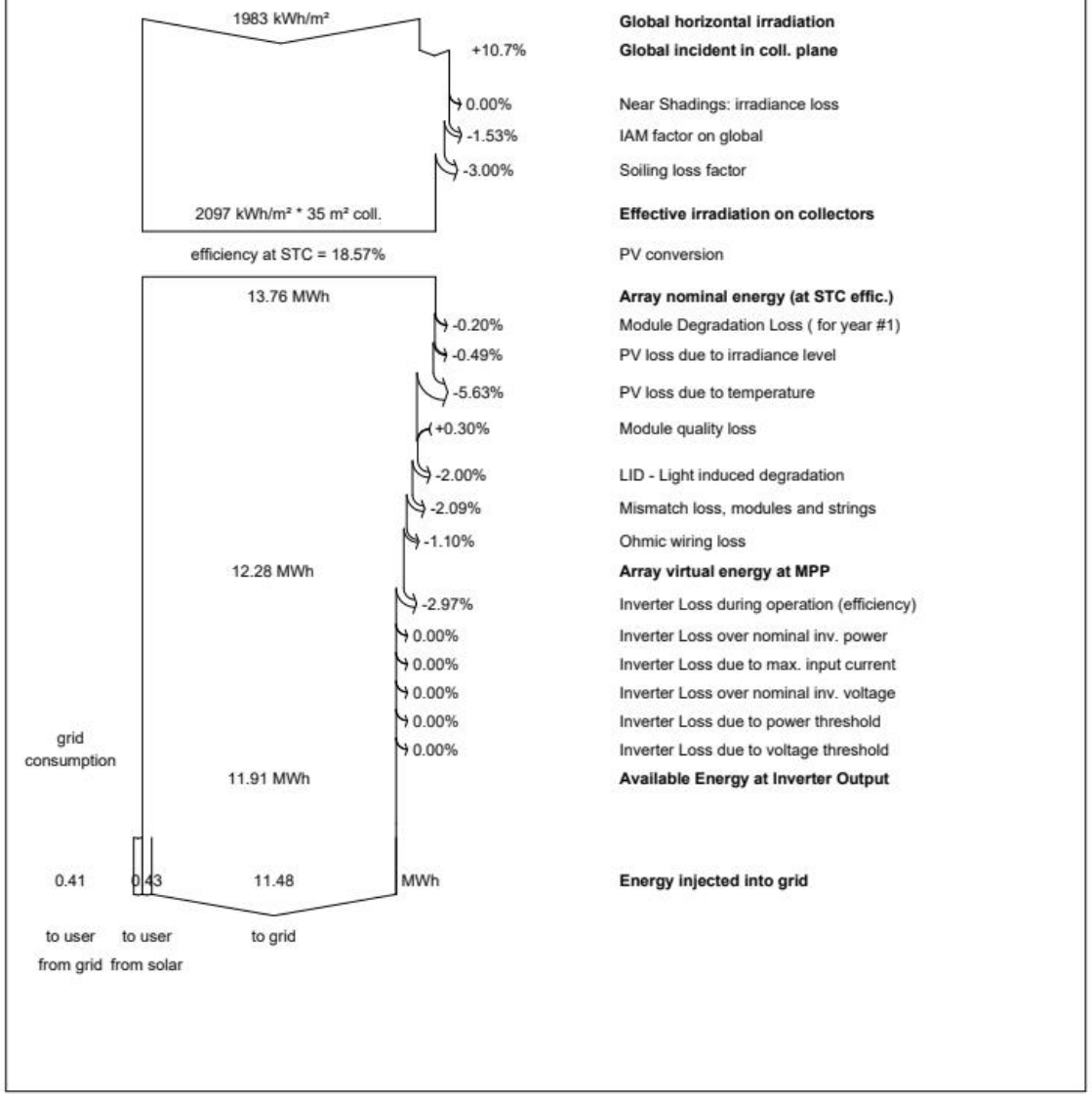
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.7	0.765	0.079	0.036	0.705	0.043
February	104.1	46.44	9.45	135.4	129.5	0.794	0.071	0.033	0.737	0.038
March	154.7	63.04	13.37	181.6	173.7	1.044	0.072	0.038	0.974	0.034
April	184.3	71.51	17.01	193.4	184.7	1.091	0.070	0.039	1.019	0.031
May	228.2	70.13	21.21	218.0	207.8	1.203	0.072	0.041	1.127	0.032
June	239.7	59.41	24.13	217.3	206.7	1.183	0.060	0.033	1.114	0.027
July	244.0	58.79	26.28	226.3	215.3	1.221	0.062	0.034	1.150	0.028
August	224.7	56.60	25.93	228.1	217.5	1.232	0.062	0.034	1.162	0.028
September	182.1	40.34	23.64	206.1	197.1	1.122	0.070	0.037	1.052	0.033
October	144.3	44.91	21.01	184.1	176.3	1.022	0.072	0.038	0.954	0.035
November	102.9	34.28	14.54	147.8	141.7	0.848	0.070	0.035	0.787	0.035
December	84.7	32.81	10.22	128.4	122.9	0.752	0.079	0.036	0.694	0.043
Year	1983.5	616.68	17.96	2195.7	2097.1	12.277	0.841	0.435	11.476	0.406

Legends

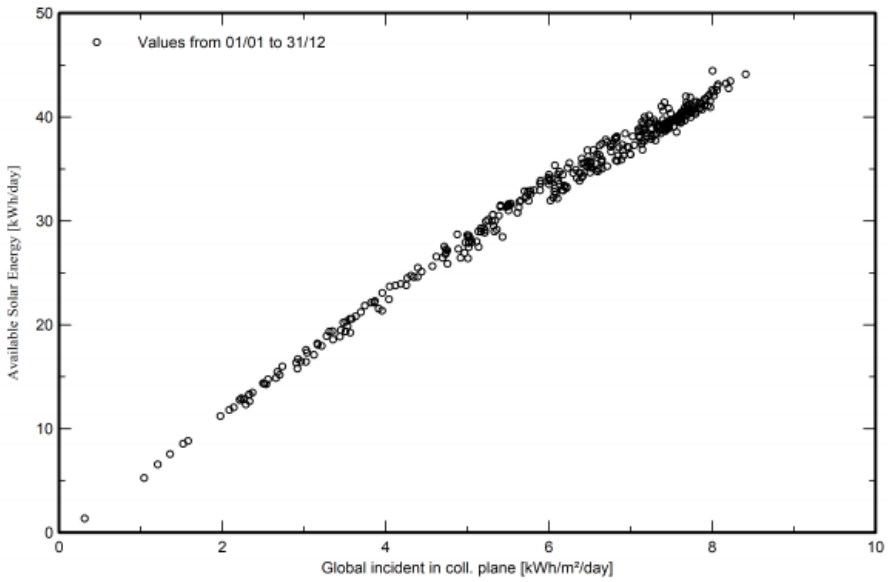
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

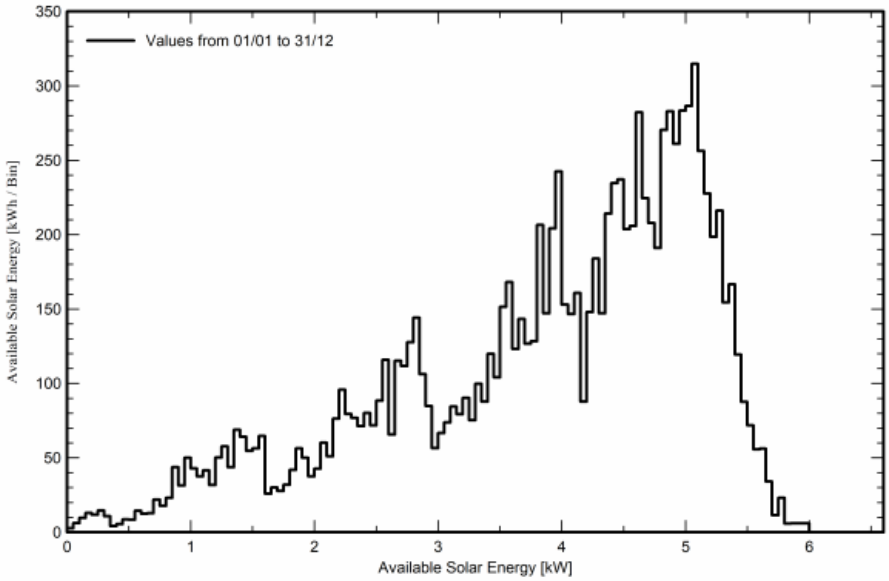


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 22

Variant: New simulation variant

Building system

System power: 4800 Wp

Rūjayb 27 - Palestine, State Of

Author

Project: System 22

Variant: New simulation variant

Project summary

Geographical Site
Rūjayb 27
Palestine, State Of

Situation

Latitude	32.20 °N
Longitude	35.30 °E
Altitude	470 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb 27
Meteonorm 7.3 (1990-2004), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	12 units
Pnom total	4800 Wp

Inverters

Nb. of units	1 Unit
Pnom total	4960 W
Pnom ratio	0.968

Results summary

Produced Energy	8.81 MWh/year	Specific production	1835 kWh/kWp/year	Perf. Ratio PR	83.39 %
				Solar Fraction SF	51.07 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used

Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Trina Solar
Model	TSM-DEG15MC-20-(II)-400-Bifacial
(Original PVsyst database)	
Unit Nom. Power	400 Wp
Number of PV modules	12 units
Nominal (STC)	4800 Wp
Modules	2 Strings x 6 In series
At operating cond. (50°C)	
Pmpp	4381 Wp
U mpp	222 V
I mpp	20 A

Inverter

Manufacturer	Huawei Technologies
Model	SUN2000L-4.95KTL-JP
(Original PVsyst database)	
Unit Nom. Power	4.95 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	90-500 V
Pnom ratio (DC:AC)	0.97

Total PV power

Nominal (STC)	5 kWp
Total	12 modules
Module area	24.6 m²
Cell area	20.9 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	0.97

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 187 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.8 %

Module mismatch losses
Loss Fraction 2.0 % at MPP

Strings Mismatch loss
Loss Fraction 0.1 %

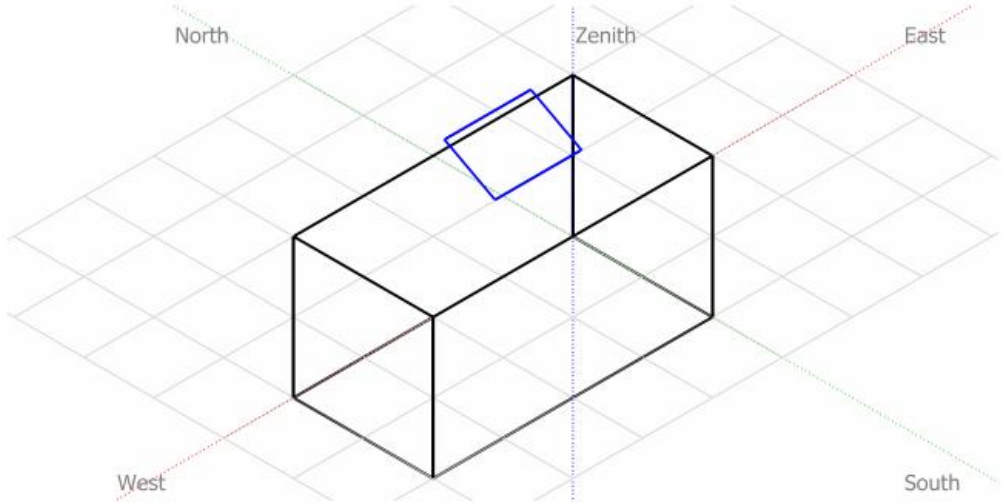
Module average degradation
Year no 1
Loss factor 0.4 %/year
Mismatch due to degradation
Imp RMS dispersion 0.4 %/year
Vmp RMS dispersion 0.4 %/year

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

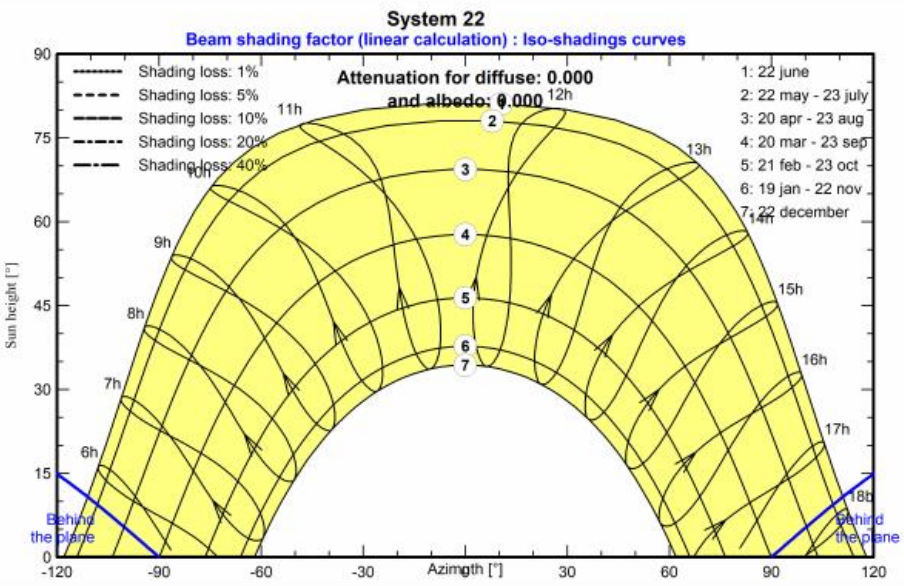
0°	30°	50°	60°	70°	75°	80°	85°	90°
1.000	0.999	0.987	0.962	0.892	0.816	0.681	0.440	0.000

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

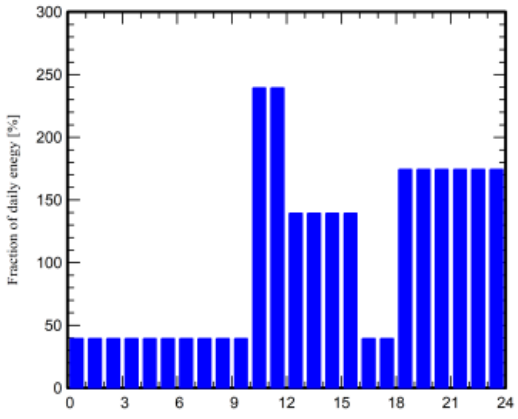
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution

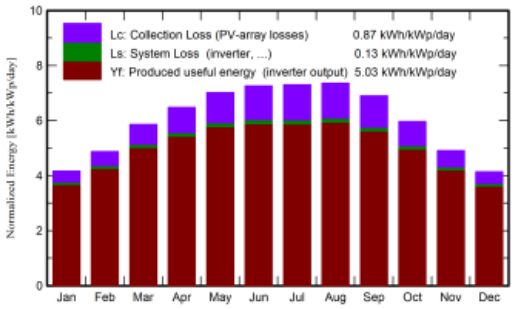


Main results

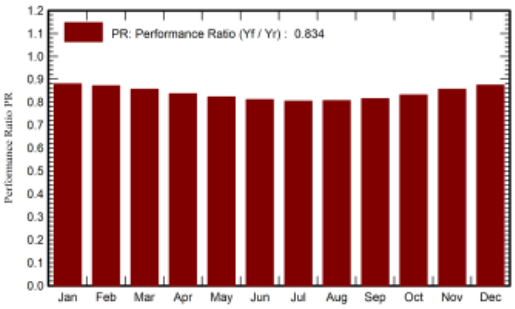
System Production

Produced Energy	8.81 MWh/year	Specific production	1835 kWh/kWp/year
		Performance Ratio PR	83.39 %
		Solar Fraction SF	51.07 %

Normalized productions (per installed kWp)



Performance Ratio PR



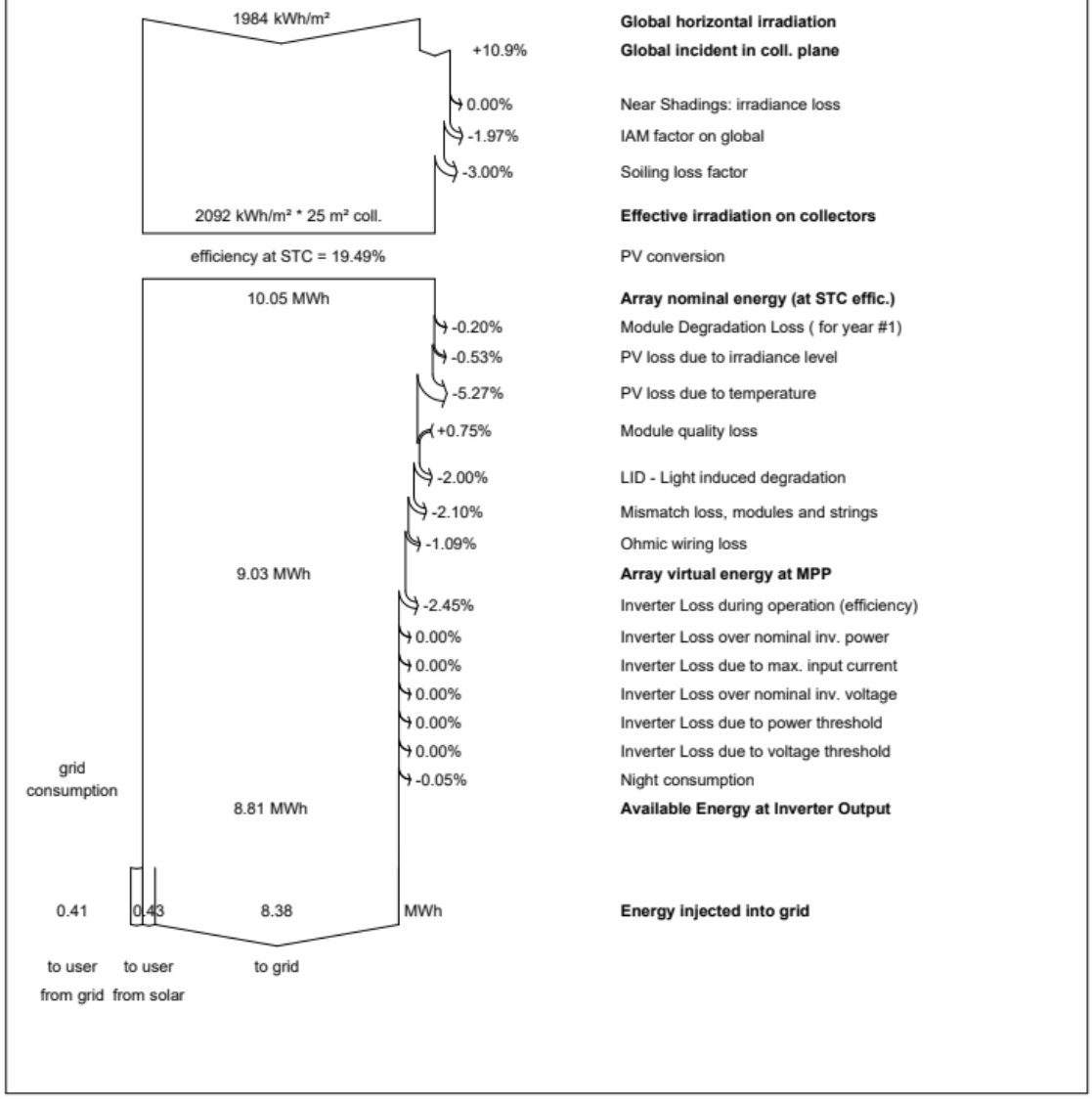
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	90.0	38.34	8.24	129.3	123.4	0.561	0.079	0.035	0.511	0.044
February	104.1	42.73	9.54	136.6	130.3	0.586	0.071	0.033	0.539	0.038
March	154.7	62.58	13.47	181.7	173.1	0.766	0.072	0.038	0.709	0.034
April	184.3	66.76	17.02	194.5	184.9	0.802	0.070	0.038	0.743	0.032
May	228.3	71.41	21.31	217.6	206.4	0.882	0.072	0.040	0.820	0.032
June	239.7	58.18	24.24	217.8	206.1	0.870	0.060	0.033	0.815	0.027
July	244.0	58.38	26.40	226.5	214.3	0.897	0.062	0.034	0.841	0.028
August	224.7	57.13	26.03	228.3	216.7	0.907	0.062	0.034	0.851	0.028
September	181.9	46.65	23.84	207.0	197.1	0.830	0.070	0.037	0.773	0.033
October	144.3	48.55	21.11	185.0	176.4	0.757	0.072	0.038	0.701	0.035
November	102.9	35.29	14.64	147.3	140.8	0.622	0.070	0.035	0.571	0.035
December	84.8	32.16	10.32	128.4	122.6	0.553	0.079	0.035	0.504	0.044
Year	1983.5	618.17	18.06	2200.1	2092.0	9.034	0.841	0.429	8.377	0.411

Legends

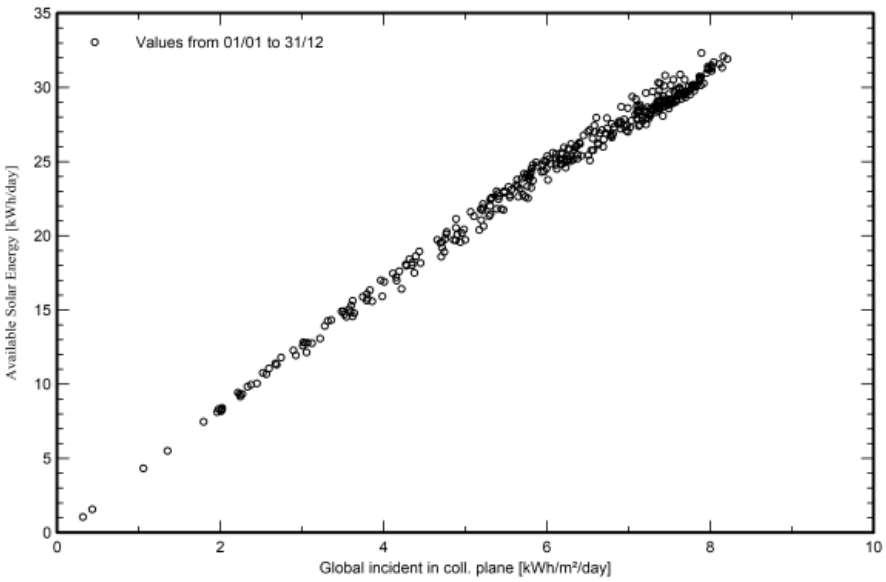
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram

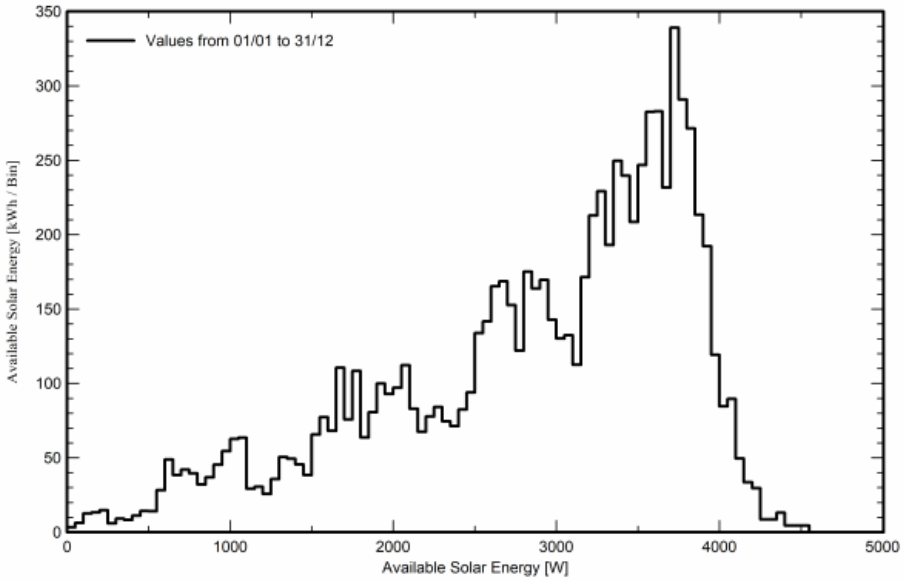


Special graphs

Daily Input/Output diagram



System Output Power Distribution



Version 7.1.1

PVsyst - Simulation report

Grid-Connected System

Project: System 23

Variant: K5

Building system

System power: 4760 Wp

R29 - Palestine, State Of

Author

Project: System 23

Variant: K5

Project summary

Geographical Site
R29
Palestine, State Of

Situation

Latitude	32.19 °N
Longitude	35.29 °E
Altitude	516 m
Time zone	UTC+2

Project settings

Albedo	0.20

Meteo data
Rūjayb
Meteonorm 7.3 (2006-2011), Sat=100% - Synthetic

System summary

Grid-Connected System
Simulation for year no 1

Building system

PV Field Orientation
Fixed plane
Tilt/Azimuth 28 / 0 °

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

System information

PV Array

Nb. of modules	14 units
Pnom total	4760 Wp

Inverters

Nb. of units	1 Unit
Pnom total	5.00 kWac
Pnom ratio	0.952

Results summary

Produced Energy	8.47 MWh/year	Specific production	1780 kWh/kWp/year	Perf. Ratio PR	81.05 %
				Solar Fraction SF	50.54 %

Table of contents

General parameters

Grid-Connected System

Building system

PV Field Orientation

Orientation	
Fixed plane	
Tilt/Azimuth	28 / 0 °

Models used	
Transposition	Perez
Diffuse	Perez, Meteonorm
Circumsolar	separate

Horizon
Free Horizon

Near Shadings
Linear shadings

User's needs
Daily household consumers
Seasonal modulation
Average 2.3 kWh/Day

PV Array Characteristics

PV module

Manufacturer	Canadian Solar Inc.
Model	CS6U-340M
(Original PVsyst database)	
Unit Nom. Power	340 Wp
Number of PV modules	14 units
Nominal (STC)	4760 Wp
Modules	2 Strings x 7 In series
At operating cond. (50°C)	
Pmpp	4270 Wp
U mpp	237 V
I mpp	18 A

Inverter

Manufacturer	Sungrow
Model	SG5KTL-D
(Custom parameters definition)	
Unit Nom. Power	5.00 kWac
Number of inverters	2 * MPPT 50% 1 units
Total power	5.0 kWac
Operating voltage	125-560 V
Pnom ratio (DC:AC)	0.95

Total PV power

Nominal (STC)	5 kWp
Total	14 modules
Module area	27.2 m²
Cell area	24.6 m²

Total inverter power

Total power	5 kWac
Nb. of inverters	1 Unit
Pnom ratio	0.95

Array losses

Array Soiling Losses
Loss Fraction 3.0 %

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

DC wiring losses
Global array res. 222 mΩ
Loss Fraction 1.5 % at STC

LID - Light Induced Degradation
Loss Fraction 2.0 %

Module Quality Loss
Loss Fraction -0.4 %

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): User defined profile

10°	20°	30°	40°	50°	60°	70°	80°	90°
0.998	0.998	0.995	0.992	0.986	0.970	0.917	0.763	0.000

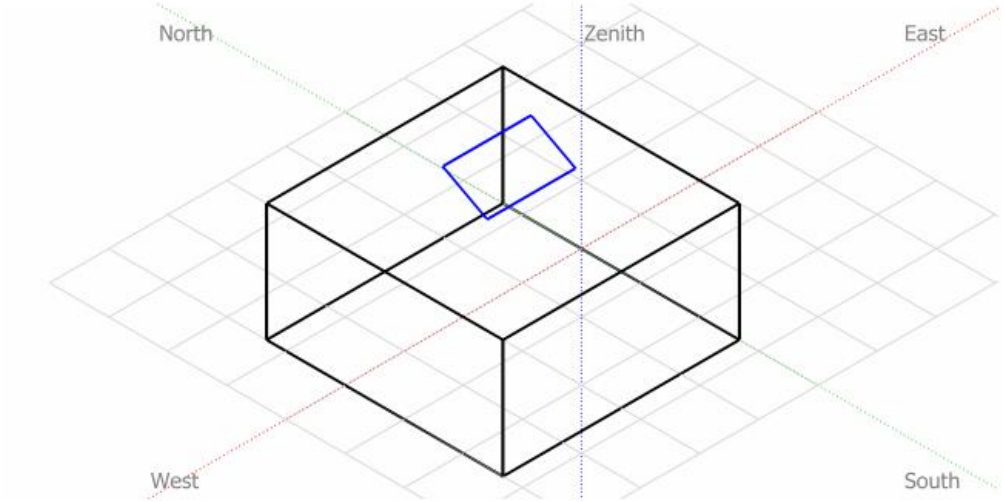
System losses

Unavailability of the system

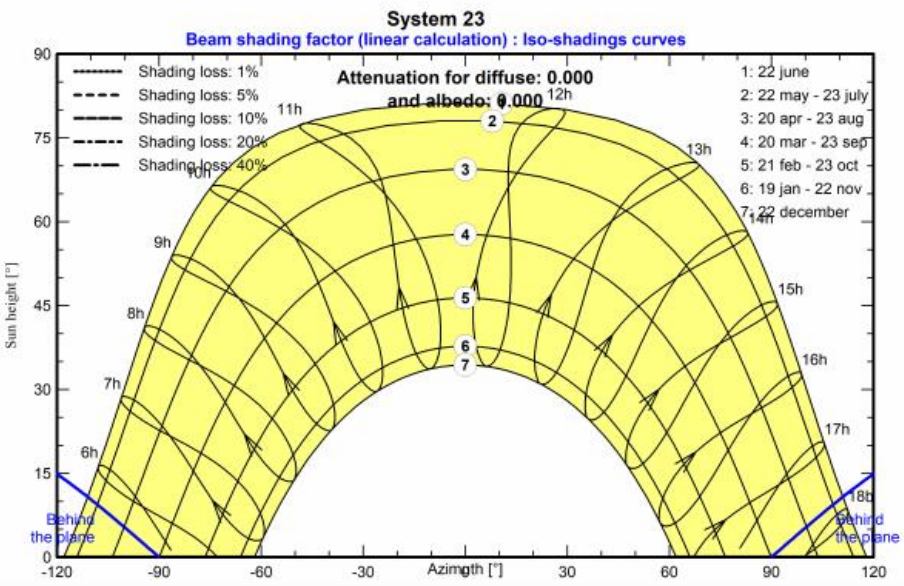
Time fraction	2.0 % 7.3 days, 3 periods

Near shadings parameter

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Detailed User's needs

Daily household consumers, Seasonal modulation, average = 2.3 kWh/day

Summer (Jun-Aug)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	4.0	240
TV / PC / Mobile	1	75W/app	3.0	225
Domestic appliances	1	200W/app	3.0	600
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2008Wh/day

Autumn (Sep-Nov)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

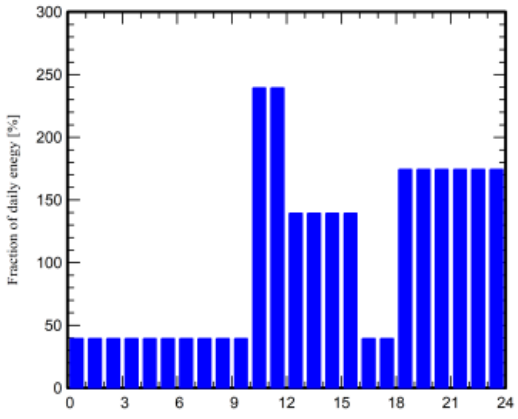
Winter (Dec-Feb)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	6.0	360
TV / PC / Mobile	1	75W/app	6.0	450
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2553Wh/day

Spring (Mar-May)

	Number	Power	Use	Energy
		W	Hour/day	Wh/day
Lamps (LED or fluo)	6	10W/lamp	5.0	300
TV / PC / Mobile	1	75W/app	4.0	300
Domestic appliances	1	200W/app	4.0	800
Fridge / Deep-freeze	1		24	799
Stand-by consumers			24.0	144
Total daily energy				2343Wh/day

Hourly distribution



Project: System 23

Variant: K5

Main results

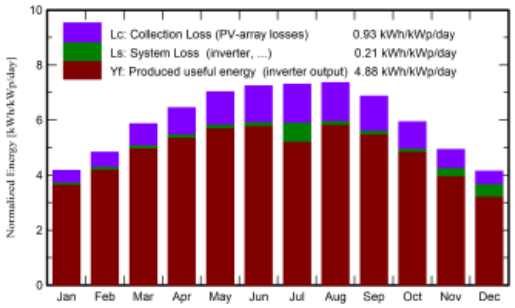
System Production

Produced Energy	8.47 MWh/year	Specific production	1780 kWh/kWp/year
		Performance Ratio PR	81.05 %
		Solar Fraction SF	50.54 %

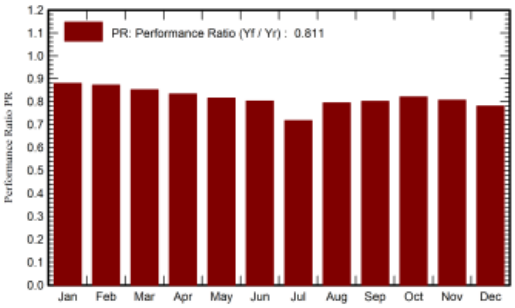
Economic evaluation

Investment		Yearly cost		LCOE	
Global	5'000.00 USD	Annuities	0.00 USD/yr	Energy cost	0.02 USD/kWh
Specific	1.05 USD/Wp	Running Costs	0.00 USD/yr		
		Payback period	Unprofitable		

Normalized productions (per installed kWp)



Performance Ratio PR



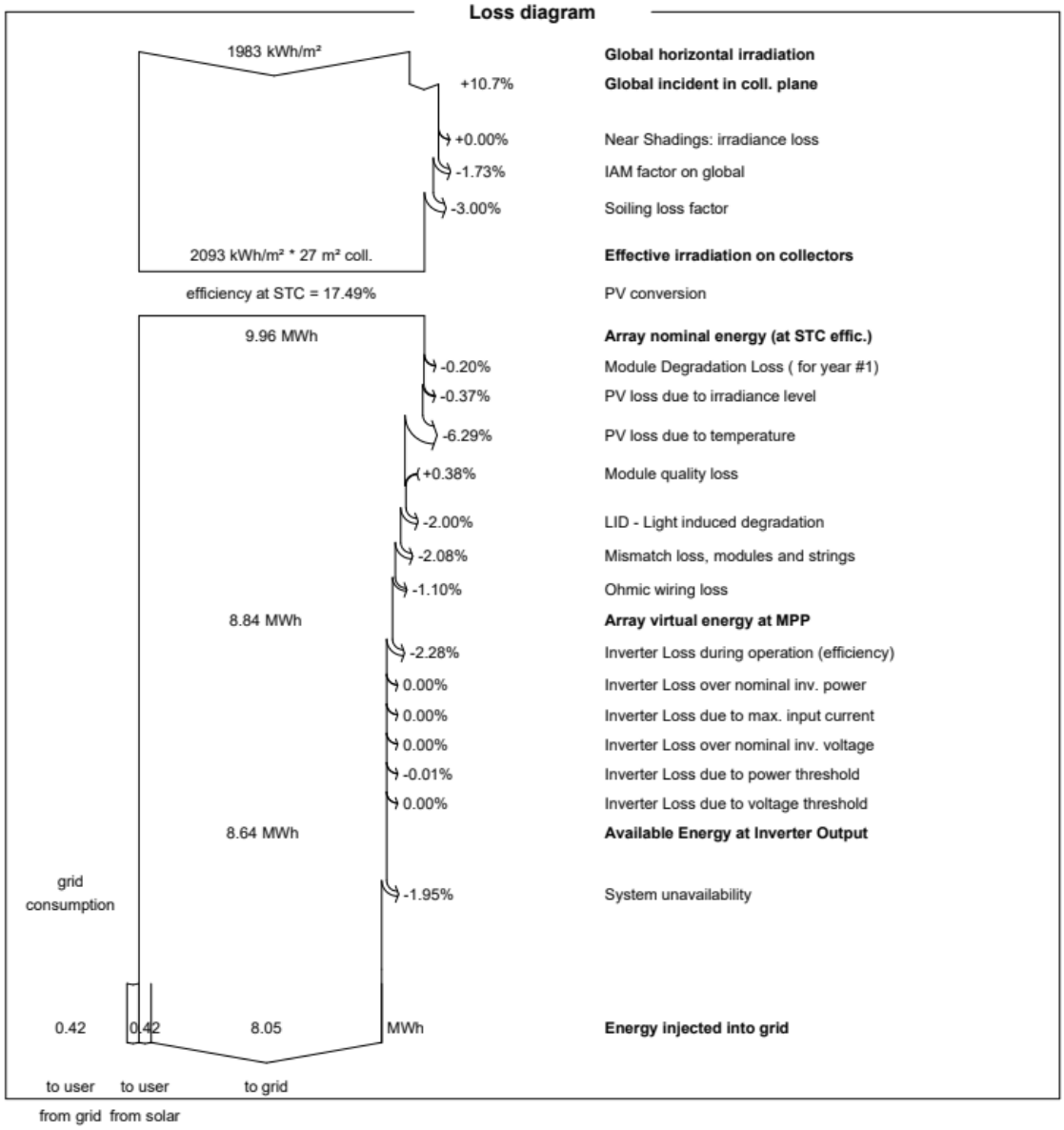
Balances and main results

	GlobHor kWh/m²	DiffHor kWh/m²	T_Amb °C	GlobInc kWh/m²	GlobEff kWh/m²	EArray MWh	E_User MWh	E_Solar MWh	E_Grid MWh	EFrGrid MWh
January	89.9	38.41	8.14	129.2	123.4	0.554	0.079	0.036	0.506	0.043
February	104.1	46.44	9.45	135.4	129.3	0.575	0.071	0.033	0.529	0.038
March	154.7	63.04	13.37	181.6	173.4	0.754	0.072	0.038	0.698	0.034
April	184.3	71.51	17.01	193.4	184.4	0.786	0.070	0.038	0.730	0.032
May	228.2	70.13	21.21	218.0	207.4	0.866	0.072	0.041	0.805	0.032
June	239.7	59.41	24.13	217.3	206.3	0.850	0.060	0.033	0.797	0.027
July	244.0	58.79	26.28	226.3	214.9	0.876	0.062	0.031	0.742	0.031
August	224.7	56.60	25.93	228.1	217.1	0.884	0.062	0.034	0.830	0.028
September	182.1	40.34	23.64	206.1	196.7	0.805	0.070	0.037	0.749	0.033
October	144.3	44.91	21.01	184.1	175.9	0.735	0.072	0.038	0.681	0.035
November	102.9	34.28	14.54	147.8	141.4	0.612	0.070	0.033	0.535	0.038
December	84.7	32.81	10.22	128.4	122.6	0.545	0.079	0.033	0.445	0.046
Year	1983.5	616.68	17.96	2195.6	2093.0	8.843	0.841	0.425	8.046	0.416

Legends

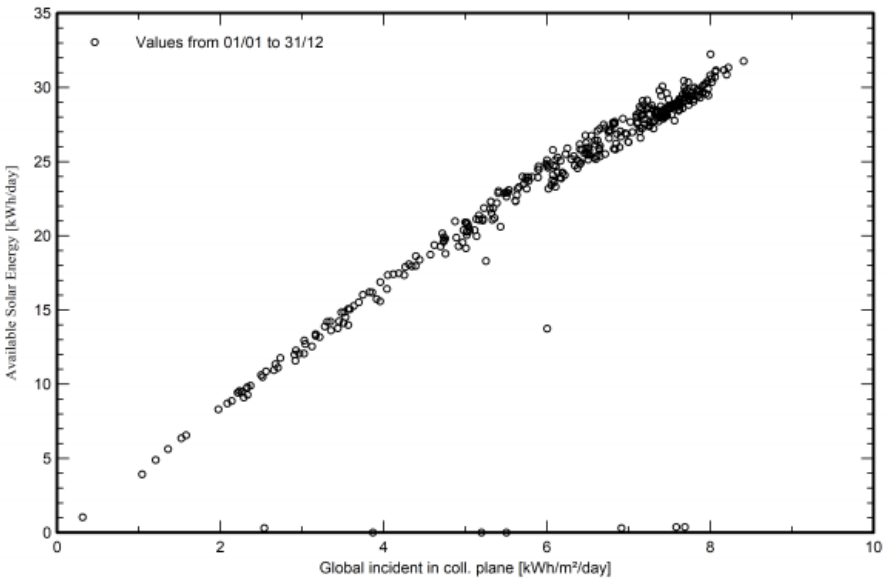
GlobHor	Global horizontal irradiation	EArray	Effective energy at the output of the array
DiffHor	Horizontal diffuse irradiation	E_User	Energy supplied to the user
T_Amb	Ambient Temperature	E_Solar	Energy from the sun
GlobInc	Global incident in coll. plane	E_Grid	Energy injected into grid
GlobEff	Effective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

Loss diagram



Special graphs

Daily Input/Output diagram



System Output Power Distribution