THE COST ANALYSIS OF IMPLEMENTING SOLAR PHOTOVOLTAIC SYSTEM FOR CONSUMERS IN PENINSULAR MALAYSIA BASED ON CURRENT AVAILABLE SCHEMES

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A project report submitted in partial fulfilment of the requirements for the award of Master of Engineering (Electrical)

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DECLARATION

I hereby declare that this project report is based on my original work except for citations and quotations which have been duly acknowledged. I also declare that it has not been previously and concurrently submitted for any other degree or award at UTAR or other institutions.

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APPROVAL FOR SUBMISSION

I certify that this project report entitled **THE COST ANALYSIS OF IMPLEMENTING SOLAR PHOTOVOLTAIC SYSTEM FOR CONSUMERS IN PENINSULAR MALAYSIA BASED ON CURRENT AVAILABLE SCHEMES** was prepared by **CHONG WEI HOU** has met the required standard for submission in partial fulfilment of the requirements for the award of Master of Engineering (Electrical) at Universiti Tunku Abdul Rahman.

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ABSTRACT

With introduction of Net Energy Metering (NEM) and Self-consumption (SELCO) scheme, consumer able to generate own electricity for own usage by promoting renewable energy while reduces the electricity bill. However, it is difficult to determine the benefits it can offered without having promising outcome restraining the public especially the household residential to participate the scheme. In this project, the cost analysis of both schemes integrated into the imitation energy load profile obtained from five sample household are studied. Energy load profile of the household residential are determined and simulation done by using PVSYST to study the effects of integration of NEM and SELCO scheme with photovoltaic system. Energy analysis was done to determine the overall energy consumption from the photovoltaic system and the energy required from the grid after implementing both NEM and SELCO scheme to maintain the household load. The result obtained is the reduction of energy consumption from the grid is highly reduced by using NEM scheme. Levelized cost of electricity (LCOE) is used to determine the cost of electricity after implementing NEM and SELCO schemes. The comparison of the levelized cost of electricity among the schemes with the residential tariff cost to determine the cost benefits of the introduced schemes. One of the results obtained is that the levelized cost of electricity for NEM and SELCO scheme able to achieve at RM 0.20 / kWh and RM 0.44 / kWh. Besides that, from the results obtained, the cost spends on the electricity on the 20th year able to achieve 27% to 51% savings for NEM implemented compare with non-PV user. The PV system with NEM have shorter payback period of 6.5 to 7.5 years with conditional requirement of minimum monthly energy consumption of 830 kWh onwards.

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LIST OF SYMBOLS / ABBREVIATIONS

kWh	Kilowatt-hour
MWh	Megawatt-hour
m	*Meter*
m^2	Area square meter
kW	Kilowatt
V	Voltage
AH	Ampere hour
COE	Cost of energy
NEM	Net Energy Metering scheme
SELCO	Self-consumption scheme
PV	Photovoltaic
SEDA	Sustainable Energy Development Authority
DOD	Depth of discharge
LCOE	Levelized cost of electricity
NPV	Net present value
ROI	Return of investment

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CHAPTER 1

INTRODUCTION

1.1 General Introduction

Solar photovoltaic system is a system that uses solar panel to capture and convert sunlight energy into electrical energy. As the world is moving towards eco-friendly environment, the demand of opting solar photovoltaic (PV) system for energy production is gained as well. In 2019, Malaysia reintroduce Self-Consumption (SELCO) and Net Energy Metering (NEM) scheme to promote renewable energy growth in the country.

SELCO scheme is a scheme, where the electricity generated from solar photovoltaic system is purely for own consumption only. Main criterion for SELCO scheme is that, the electricity generated is not permissible to be exported into the grid.

NEM scheme is a scheme similar to SELCO scheme, which electricity generated from photovoltaic system can sustain own load system. The difference between NEM and SELCO scheme is the excessive electricity is permissible to export into the grid after sustaining own load system. The consumer that taken part into the scheme is identified as prosumer, which a person that produce and consume the electricity at the same time.

1.2 Importance of the Study

Electricity consumers are always seeking cheaper cost method to maintain cheaper electricity usage for their load consumption. With the study of cost analysis of implementing PV system for the consumers based on current available schemes, it can be beneficial for consumers, who are concerned of opting for eco-friendly solution that may bring no benefits after investments made. With the study conducted, the consumers can have sufficient information to decide whether the schemes introduced are beneficial.

1.3 Problem Statement

With the promotion of renewable energy schemes by Sustainable Energy Development Authority (SEDA), it is target to cope with nationwide electricity power demand while able to help consumers to reduce electricity bill. However, without proper information and analysis being exposed to the public, it is difficult to judge whether it is benefits the consumer.

Different habits of electricity usage would have impact on the electricity bill being imposed. Energy planning is needed, so that the wastage electricity can be avoided hence the cost of electricity usage can be reduced. However, with the possibility of electricity tariff increases in the future, would directly impact the electricity bill of the consumers.

With vast of different sizes of PV system in the market, studies about household energy load are required to determine suitable PV system size that are available for residential usage. Economical PV system size is difficult to determine without sufficient household energy load profile.

1.4 Aims and Objectives

The aim of the study is to get cost analysis of implementing solar photovoltaic system for the residential consumers in Peninsula Malaysia based on current available schemes. The objectives of the study are per listed:

- To investigate household energy consumption behaviour.
- To benchmark household energy load profile by obtain meter reading from household owner.
- To perform the cost analysis of current market solar photovoltaic system based on the customer demand and solar PV generation characteristic under current schemes.

1.5 Scope and Limitation of the Study

The study is mainly focus on residential consumer that consume electricity exceed 300 kwh per month. The meter reading data is logged manually and not using data logger devices due to device safety concern. The energy load profile created by PVSYST is to emulate similar sample as close as possible and the solar irradiance data used is based on available data from PVSYST software. Two sizes of the PV system are determined in the study based on the current available market for residential load.

1.6 Contribution of the Study

With the study of the cost analysis of implementing PV system for residential consumers, it can give clear picture of how much of savings can be achieve thru the new schemes introduced by SEDA. With more information that exposed to the public, the consumers can have sufficient information to decide whether to participate in the new schemes introduced by SEDA.

1.7 Outline of the Report

In the next chapter two literature review, the works done by different researchers in the relevant field will be discussed and determine the similarity or differences in the study. The methodology how the study being carried out will be listed under chapter three. The results obtained from the works will be discuss in chapter four. In the last part of the report chapter five, conclusion for the whole study and recommendation of future works will be made.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Several factors that can affect the cost of the energy consumed in a residential home is being discussed in this chapter. One of the factors is the household energy consumption behaviour, which can affect overall total energy consumption. Besides that, other researcher paper related to the reintroduced NEM scheme, optimum battery depth of discharge and levelized cost of electricity are discussed too.

2.2 Household energy consumption behaviour

According to (Zhou & Yang, 2016), the behaviour on household energy usage can directly affect the total energy consumption of the household. In the paper written, the author discussed that the consumption behaviour can be influenced by various factors. The internal factor such as habit and environmental awareness influenced the decision on the energy consumption behaviour. The external factor such as demographic and luxurious lifestyle can affect the total assumption as well.

From the paper written by the author, it is agreed that there is high variance of energy consumption behavioural patterns that can lead to different total energy consumption. With the same kind of household appliances in two different houses, can have different total energy consumption because of the different behaviour of energy usage. Therefore, the study on the energy consumption behaviour on each household is crucial to determine the household total energy consumption.

According to survey done by (Aris et al., 2019), the air conditioners and water heaters are the main contributor to the household overall electricity consumption despite with the lower ownership rate. With the high electricity consumption by the two appliances, the usage duration of the appliances is significantly affecting the total electricity consumption. The impact on the household electricity consumption can be affected with the occupant behaviour such as setting the air conditioner timer.

In this project study, the total consumption of the household may have direct impact on the cost analysis of implementing PV system. Therefore, this behaviour factor will be one of the elements to determine the household load energy profile hence affecting total energy consumption.

2.3 NEM scheme

According to SEDA (*NEM – Renewable Energy Malaysia*, n.d.), the NEM scheme allows excessive energy generated by the consumer's solar PV to export to the grid after consumed by the consumer's load. The excessive energy exported to the grid would be given credit to offset with the energy taken from the grid on "one on one" basis. The "one on one" offset basis, would offset one unit of kWh of energy exported to the grid with one unit of kWh energy consumed from the grid. However, the credit obtained from energy exported to the grid, can only retained for 24 months and the credits obtained required to be offset within 24 months to avoid being forfeited after the duration.

With the latest NEM scheme being introduced, the medium and large residential household electricity consumer would be able to save more compared with low usage and non PV system user according to the paper written by (Razali et al., 2019). In the paper written by (Razali et al., 2019), direct comparison between initial NEM introduced in 2016 and the latest NEM scheme reintroduced, the latest NEM shows better results for large resident especially with 6 kW and 8 kW PV system.

However, the cost saving percentage shown in the paper written is based on the results tested from the Skudai, Johor state. It did not state whether the cost saving percentage are applicable to other states of Malaysia. With one same scheme, it may or may not have the same outcome for different parts of the Malaysia. Therefore, it can be study in this project whether similar results can be achieved throughout the study.

Besides that, the PV system price is getting cheaper, it can be assumed that the capital installation cost is reducing as well. Therefore, the cost saving percentage may be even higher and eventually benefits the small electricity user as well.

2.4 Optimum battery depth of discharge

Battery is one of the components that may or may not present in a PV system. In a stand-alone system, battery is one of the essential components but with grid connected system, it may not. In a modern world, battery technology comes with high cost. Depth of discharge is one of the factors that can affect the lifespan of a battery.

According to (Hlal et al., 2019), depth of discharge (DOD) is determined based on battery life cost. With high cost of a battery, it is required to determined optimum DOD to prolong the battery lifespan. In the paper written by the author, the DOD determined is 70% with the lowest cost of energy (COE) produced. With the 70% of DOD, it is cost effective with lead acid technology. In the paper written, the lowest COE able to be produced with 70% DOD is 0.20594 USD/kWh.

From the paper written by (Gomez-gonzalez et al., 2020), battery depth of discharge values affects the battery number of cycles, sizing capacity and the cost savings. With lower depth of discharge value, the number of cycles of the battery are higher, which translates to longer lifetime. However, the author stated that with lower depth of discharge, the sizing capacity of battery is smaller hence leads to smaller PV system size.

In this study, battery depth of discharge of 50% is being used. The reason is because to avoid stressing the battery with the maximum depth of discharge to prolong the battery lifespan. With battery depth of discharge lower than 50%, would require higher number of batteries need to be used in the PV system and leading to higher costing. Therefore, battery depth of discharge of 50% would be optimum choice of selection for the study.

2.5 Levelized cost of electricity

Levelized cost of electricity is a cost measurement of the electricity generated from the source. According to (Branker et al., 2011), declination of PV installation cost, and increases of grid electricity price, makes PV system become better economic benefits source of electricity. In the paper written by the author, it is stated that the summation of the present value of levelized cost of electricity multiplied with the energy generated is equivalent to present value net costs.

According to (Branker et al., 2011), the inputs for levelized cost of electricity need to be accurate as possible to achieve accurate outcome. With the lack of clear assumptions, the outcome of levelized cost of electricity can lead to higher outcome. The important inputs stated are system costs, financing, lifetime and loan term.

$$\mathrm{LCOE} = \frac{\sum_{t=0}^{T} C_t/(1+r)^t}{\sum_{t=0}^{T} E_t/(1+r)^t} \tag{2.1}$$

Where,

C_t is present net value cost

E_t is the rated energy output per year r is discount rate

t is time period

According to (Gan et al., 2014), the essential parameter to be considered in levelized cost of electricity are the system cost, inflation rate and degradation rate. It is stated that improvements in the annual energy output, extended system lifetime, lower inflation rate and operation maintenance cost could drive to lower levelized cost of electricity. With the lower levelized cost of electricity, the payback period would be reduced.

In this project study, the levelized cost of electricity would be used to determine the cost for both NEM and SELCO schemes to be compare with current residential electricity tariff. With the levelized cost of electricity calculation, alternative energy source can be taken into consideration.

CHAPTER 3

METHODOLOGY AND WORK PLAN

3.1 Introduction

The chapter explain the method to obtain energy load profile, simulation using PVSYST to emulate household load, and the analysis of the data obtained to compare cost beneficial based on the available scheme. Using causal-comparative method, the outcome of the cost analysis to be determined.

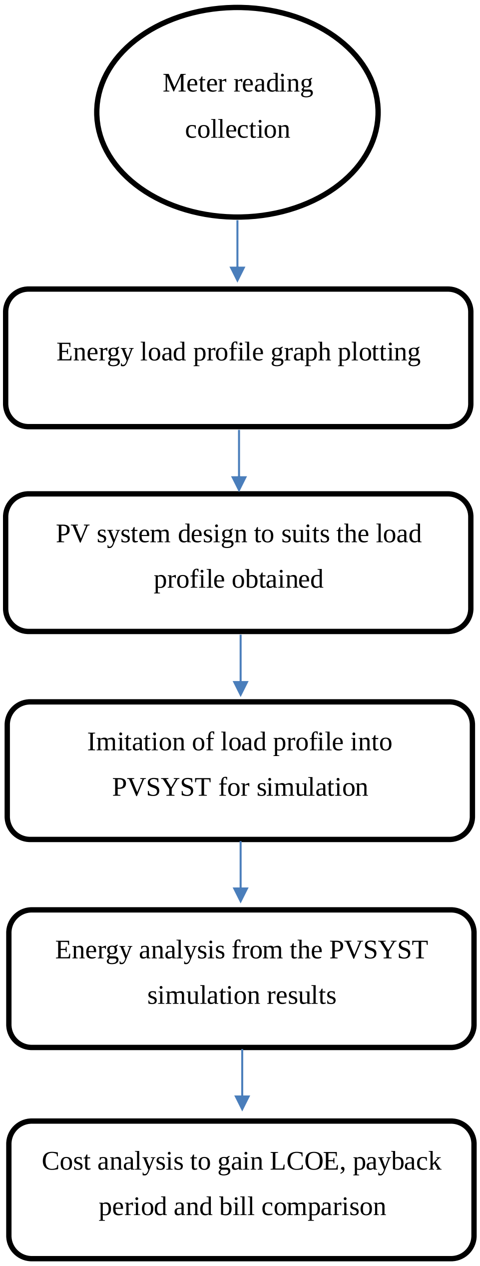


Figure 1: Flow chart of the project

3.2 Energy Load Profile

In this study, meter reading records with the interval time of one hour is recorded for five numbers of household for a duration of one week. Five different household energy consumption can be used to study whether different pattern of energy consumption would have different outcome of the cost analysis for the schemes.

With the meter reading records, the hourly energy consumption can be obtained for the weekday and weekend load profile. The average value of the five days from Monday to Friday is obtained for weekday load profile and average value of Saturday and Sunday for the weekend profile.

Total numbers of people staying in all houses are different. With more people staying in a house, the energy consumption assumed to be higher than lesser people staying in the house. Besides that, simple interview is conducted to gain more information about the type and the usage duration of loads in a household to study and understand the behaviour of the household usage for simulating the household energy consumption.

Table 3.1: Household Size

	Number of persons stay in a house
House A	2
House B	4
House C	5
House D	8
House E	7

3.3 System Design

Suitable PV system capacity that is available in the market, is obtained and use to simulate with the household load information collected. The area of PV module to be installed needed to be determined. The area size for the rooftop of the sample house is 59.5 m^2 with 8.5 m length (L) and 7 m wide (W) for one facet. The PV module used in this simulation is JA SOLAR JAM6-72-320/SI, and the inverter used are SUN2000L-5KTL and SUN2000L-8KTL by HUAWEI TECHNOLOGIES.

Two different sizes of PV system capacity, which are 6 KWp and 9 KWp used to simulate the effect of the NEM and SELCO scheme on the household load. For the

PV system of 6 kW, twenty numbers of PV modules are used and for the PV system of 9 kW, twenty-eight numbers of PV modules are used.

For the PV design for SELCO scheme, the battery size of 24 V 784 AH is used for 6 kW system capacity and battery size of 36 V 784 AH is used for 9 kW system capacity. The reason 784 AH battery is chosen because it is the nearest value to 800 AH available in PVSYST. The battery depth of discharge is set at 50% for the simulation. This is to prolong the lifecycle of the battery by not fully discharge the battery. However, assumption made is that battery optimization is not conducted. The figures shown below are the parameters set in the PVSYST for simulation.

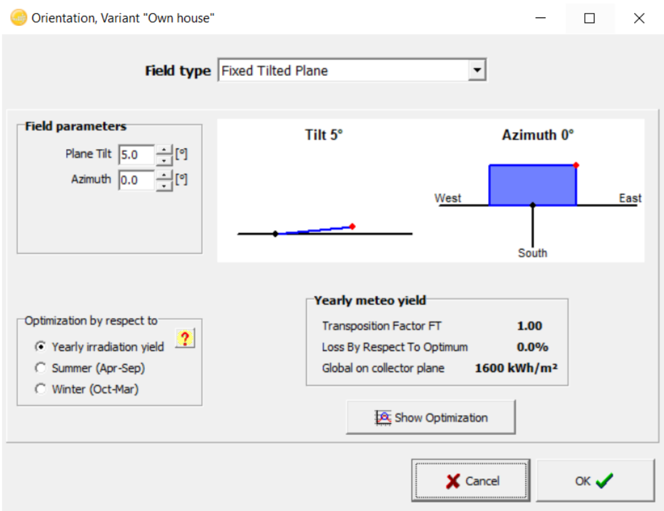


Figure 2: Orientation of the PV module

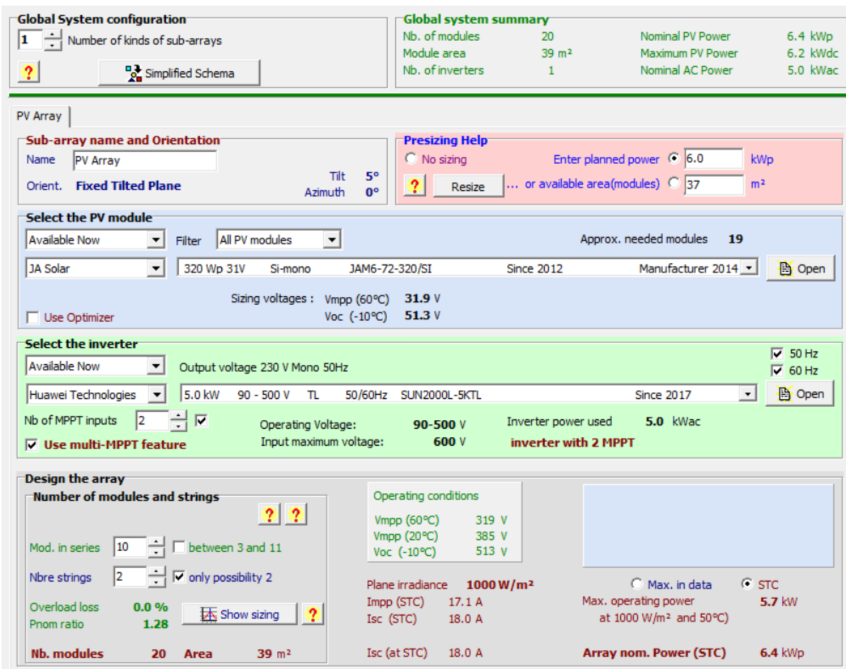


Figure 3: Parameters set for 6 kW rated power system

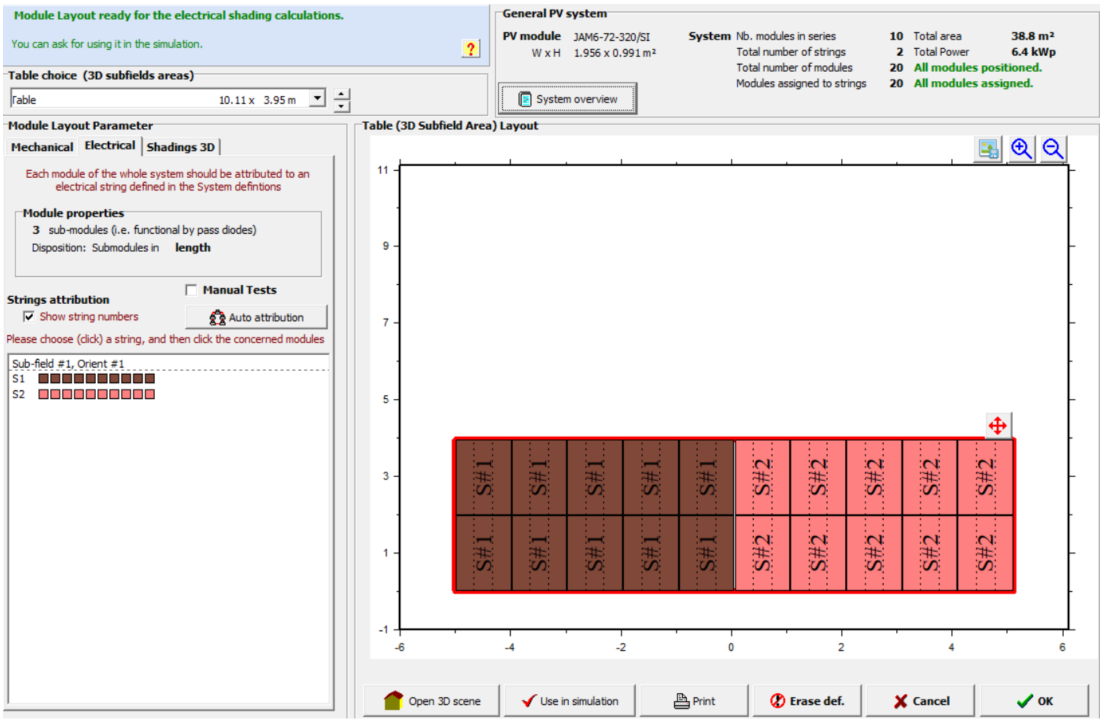


Figure 4: Module layout for 6 kW rated power system

3.4 PVSYST Simulation

The PVSYST software tool is used to simulate the five different household load consumption with NEM and SELCO scheme. The household load consumption is set for weekday and weekend load profile. Two separate simulation data will be simulated for each PV system according to two different load profile from weekday and weekend.

For the NEM scheme simulation, no battery parameter is included in the simulation. This is because NEM scheme is based on "one on one" offset basis. The NEM scheme simulation with the household load allows the remaining excessive energy after consumed by the household load to be export to the grid.

For the SELCO scheme simulation, battery parameter is needed to include in the simulation. This is because SELCO scheme is based on own load self-consumption basis. The SELCO scheme simulation with the household load set at not allowable produced energy transfer to the grid. The simulation results data such as annual energy production, energy consumption by the user from the solar and the grid are used to perform cost analysis based on the schemes.

3.5 Energy Analysis

For the energy analysis, simulation results obtained from PVSYST are analysed. Few information obtained from PVSYST such as annual energy production, energy consumption from PV and energy consumption from the grid are taking into analysis. The results obtained from the PVSYST are in annual basis and the analysis needs to be break into monthly basis because for the NEM and SELCO scheme able to compare directly with the cost of electricity bills, which obtained by monthly basis.

Few assumptions are made in this analysis to ease the studies to be carried out. For the first assumption, the irradiance data used in the PVSYST are assumed to be the same for the whole year. With this assumption made, the irradiance received on the PV module are the same for every month. Another assumption made for the analysis, is the monthly energy load consumption by the household are fixed constant. The assumption is made because it is to assume the difference on the changes of the monthly energy load consumption are not very high. Few information needed to be analysed and calculate from the results obtained from the PVSYST. Information that needed to be calculated are:

i. Household monthly energy consumption.
ii. Household monthly energy production.
iii. Remaining monthly energy required from the grid.

The household total energy consumption for the month is calculated by using the information from the results obtained from PVSYST. The equation (3.1) shows the equation to determine household monthly energy consumption.

$$E_M = \frac{E_{CPV} + E_{CG}}{12} \times 1000 \tag{3.1}$$

Where,
E_M is household monthly energy consumption (kWh)
E_{CPV} is annual energy consumption from PV (MWh)
E_{CG} is annual energy consumption from the grid (MWh)

The equation to calculate household monthly energy production for NEM and SELCO scheme are different. For NEM scheme, the total annual energy that produced by the PV system can be taken into monthly average value because of NEM scheme allows the excessive energy after consumed by the load to be export to the grid. From the results obtained from PVSYST, the energy consumed from the grid can be taken into consideration as some of the energy from the grid are exported from the PV system. Household monthly energy production for NEM scheme is shown as equation (3.2).

$$E_{MP\_NEM} = \frac{E_{AP}}{12} \times 1000 \tag{3.2}$$

Where,

E_{MP_NEM} is monthly energy production (kWh)

E_{AP} is annual energy production (MWh)

For SELCO scheme, the total energy production for the household is calculated solely based on the total energy consumption from the PV. Unlike NEM scheme, SELCO scheme does not allow any excessive energy after household consumption to be export to the grid. The energy produced from the PV system solely consumed by the household load and to charge up the battery storage if there is low demand energy usage from the load. Therefore, monthly energy production is equally to the monthly energy consumption as shown at equation (3.3).

$$E_{MP\_SELCO} = \frac{\sum E_{AC}}{12} \times 1000 \tag{3.3}$$

Where,

E_{MP_SELCO} is monthly energy production (kWh)

E_{AC} is annual energy consumption from the PV system and battery (MWh)

For the remaining monthly energy required from the grid, the calculated household monthly energy consumption deduct with the household energy production. The remaining monthly energy required from the grid, is the energy that is still required from the grid to help sustaining the household load after implementing PV system for both NEM and SELCO scheme. The equation (3.4) shows the equation for determine the remaining monthly energy required from the grid.

$$E_{RG} = E_M - E_{MP} \tag{3.4}$$

Where,

E_{RG} is remaining monthly energy required from grid (kWh)

E_M is monthly energy consumption (kWh)

E_{MP} is monthly energy production (kWh)

3.6 Cost Analysis

The analysis results obtained from Section 3.5 is used to perform cost analysis. The effects on the electricity bills can be compared between non-PV system user and the available schemes. Net present value (NPV) and levelized cost of electricity are being performed using the data obtained from the simulation and market research. The results of the levelized of cost electricity will be compared with the grid electricity cost for the residential to justify the outcome of the study.

Net present value method is a method to determine the value invested into an investment with the present value. Net present value is inclusive of the initial setup cost for PV system and the lifetime operating and maintenance cost. The discount rate in net present value is set at 3%. Return of investment is benefits that can receive by a certain period of time after investment being made. The monthly saving electrical bill would be the return of the investment in this study. With the information of net present value and return of investment, the payback period for implementing PV system with current scheme can be determined.

Table 3.2: PV System Cost

System Size	System Cost	Maintenance Cost
6 kW system without battery	RM 30 000.00	RM 100 / year
9 kW system without battery	RM 41 000.00	RM 100 / year
6 kW system with battery 24 V 786 AH	RM 46 000.00	RM 100 / year
9 kW system with battery 36 V 786 AH	RM 65 000.00	RM 100 / year

Table 3.3: Electricity Tariff A – Domestic (From TNB)

For the first 200 kWh (1 – 200 kWh) per month	RM 0.218 / kWh
For the first 100 kWh (201 – 300 kWh) per month	RM 0.334 / kWh
For the first 300 kWh (301 – 600 kWh) per month	RM 0.516 / kWh
For the first 300 kWh (601 – 900 kWh) per month	RM 0.546 / kWh
For the next kWh (901 kWh onwards) per month	RM 0.571 / kWh
Minimum monthly charge	RM 3.00

$$NPV = \sum_{y=0}^{n} \frac{R_p}{(1+D)^y} \qquad (3.5)$$

Where,

R_p is savings or returns during single period, p

D is discount rate

y is number of periods

Levelized cost of electricity can be determined by using net present total cost over with total energy production for the lifetime of the PV system. The total energy production for the lifetime of the PV system requires to consider for the energy production degradation over the lifetime of the PV system. With the annual energy degradation of 1% for the PV system is considered, the total energy production for 20 years is determined. From a part of the cost analysis, a comparison of the monthly cost spends for non-PV user and PV user with the schemes to determine the overall cost benefits of the schemes.

$$LCOE = \frac{\sum_{t=0}^{T} NPV}{\sum_{t=0}^{T} E_t} \tag{3.5}$$

Where,

NPV is total net present value cost

E_t is total energy produced over PV system lifespan

$$Payback\ period\ (years) = \frac{\sum_{t=0}^{T} NPV}{ROI} \tag{3.6}$$

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Energy Load Profile

The obtained hourly energy consumption for weekdays and weekend as shown below:

Table 4.1: Weekday Hourly Energy Consumption

Weekday	Energy usage (kWh)				
Time	House A	House B	House C	House D	House E
12am to 1am	1	1	1	2	2
1am to 2am	1	1	1	2	2
2am to 3am	1	1	1	2	2
3am to 4am	1	1	1	2	2
4am to 5am	1	1	1	2	2
5am to 6am	1	1	1	2	2
6am to 7am	1	3	1	2	2
7am to 8am	1	0	3	2	1
8am to 9am	0	0	2	2	0
9am to 10am	0	0	1	0	0
10am to 11am	0	1	0	0	1
11am to 12pm	0	0	1	1	0
12pm to 1pm	0	0	0	0	0
1pm to 2pm	0	1	1	1	1
2pm to 3pm	0	0	0	1	0
3pm to 4pm	0	0	0	0	0
4pm to 5pm	0	1	1	1	1
5pm to 6pm	0	0	1	1	1
6pm to 7pm	1	1	3	2	2
7pm to 8pm	2	3	4	6	6
8pm to 9pm	1	3	5	6	5
9pm to 10pm	1	3	3	4	6
10pm to 11pm	2	2	2	3	3
11pm to 12am	1	1	1	2	2

Table 4.2: Weekend Hourly Energy Consumption

Weekday	Energy usage (kWh)				
Time	House A	House B	House C	House D	House E
12am to 1am	1	1	1	2	2
1am to 2am	1	1	1	2	2
2am to 3am	1	1	1	2	2
3am to 4am	1	1	1	2	2
4am to 5am	1	1	1	2	2
5am to 6am	1	1	1	2	2
6am to 7am	1	3	3	2	2
7am to 8am	1	2	3	1	1
8am to 9am	0	1	3	2	0
9am to 10am	1	1	1	2	1
10am to 11am	1	1	1	2	0
11am to 12pm	0	1	1	1	1
12pm to 1pm	1	1	1	1	0
1pm to 2pm	1	1	1	1	1
2pm to 3pm	1	1	1	1	0
3pm to 4pm	0	1	1	2	1
4pm to 5pm	1	1	1	2	1
5pm to 6pm	1	1	1	2	1
6pm to 7pm	1	1	2	2	2
7pm to 8pm	2	3	3	6	6
8pm to 9pm	2	3	3	6	5
9pm to 10pm	1	3	3	4	5
10pm to 11pm	2	3	3	4	4
11pm to 12am	1	1	1	2	2

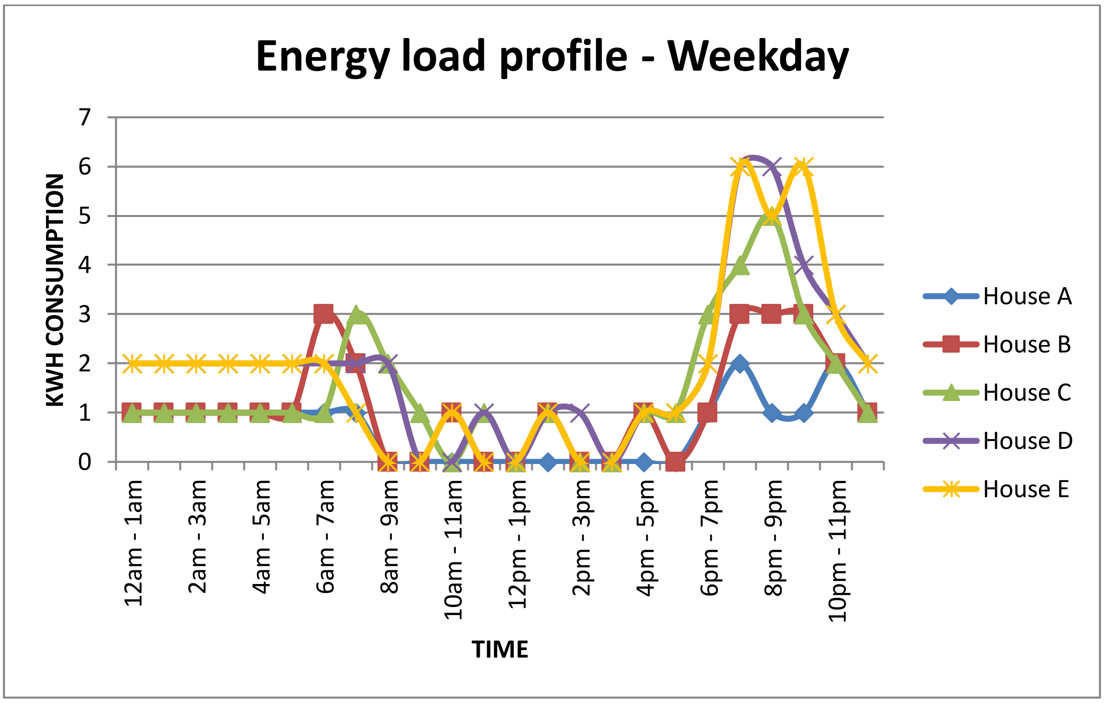


Figure 5: Weekday Energy Load Profile

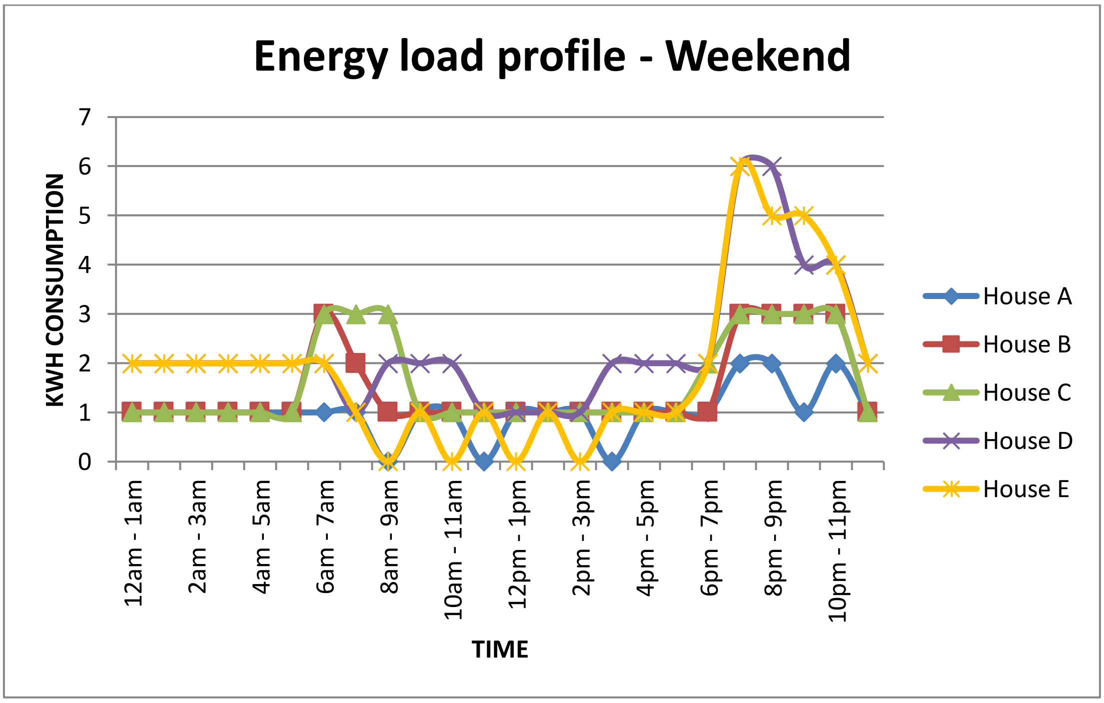


Figure 6: Weekend Energy Load Profile

From the figure shown, the energy demand is higher during morning hour starting 6 am and after 6 pm in both weekday and weekend energy load profile. The higher energy consumption house appliances likely to operate frequently during this hour compared to other hours.

Higher energy consumption on house D and E are because the numbers of house occupant are higher and the tendency to switch on more electrical appliances is higher, hence contribute to higher energy consumption especially in the between 6 pm to 10 pm period.

From the figure, it shows that the energy consumption during daytime between 8 am to 6 pm is lower compare to other time is because most of the house occupant is working and not in the house. With lesser occupant in the house, the tendency of the household appliance running is lower, which leads to the lower energy consumption at that period time as well.

4.2 Load Details

Table 4.3 shows the household load, which can have different energy consumption at one periodic time. Figure 7 to Figure 26 shows the load details and the hourly profile set at the PVSYST software to simulate the household load based on the energy load profile obtained on Section 4.1. However, it is unable to imitate the household load energy profile exactly 100%, there is minimal differences around 10% between the household load energy profile obtained from Section 4.1 and the imitation of the energy profile in PVSYST.

Table 4.3: Household Load

	Number of Ownerships				
Load	House A	House B	House C	House D	House E
Lights	20	26	28	30	30
TV / PC	1	2	2	3	3
Iron	1	1	1	1	1
Refrigerator	1	1	1	1	1
Washing machine	1	1	1	1	1
Instant water heater	1	1	2	2	1
Air conditioner	2	3	3	6	6

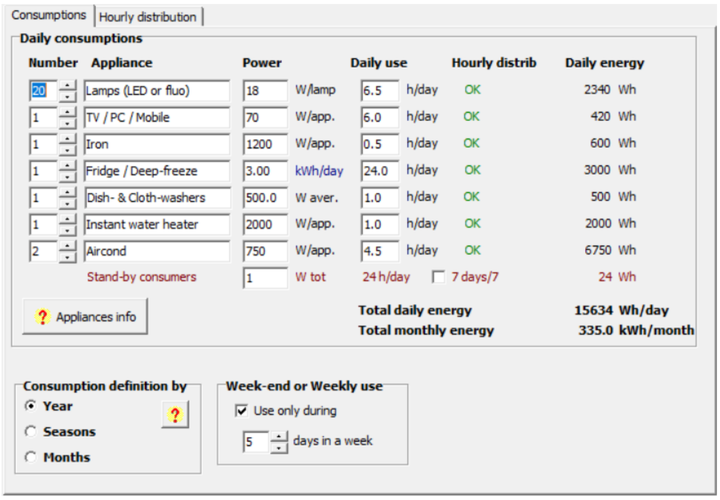


Figure 7: House A Weekday Consumption

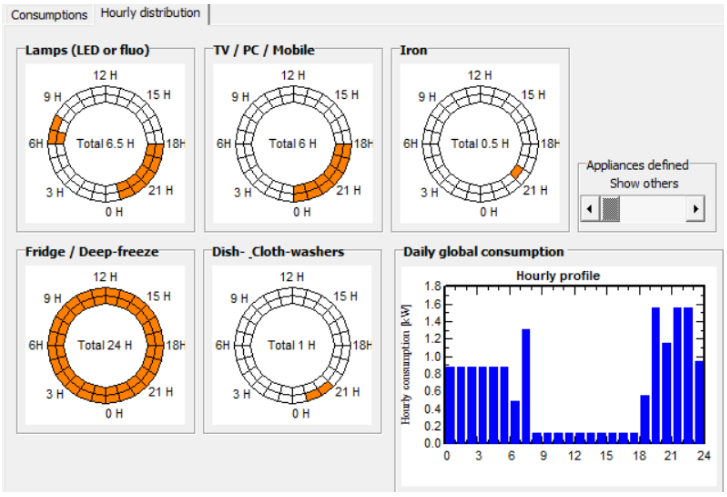


Figure 8: House A Weekday Hourly Load Profile

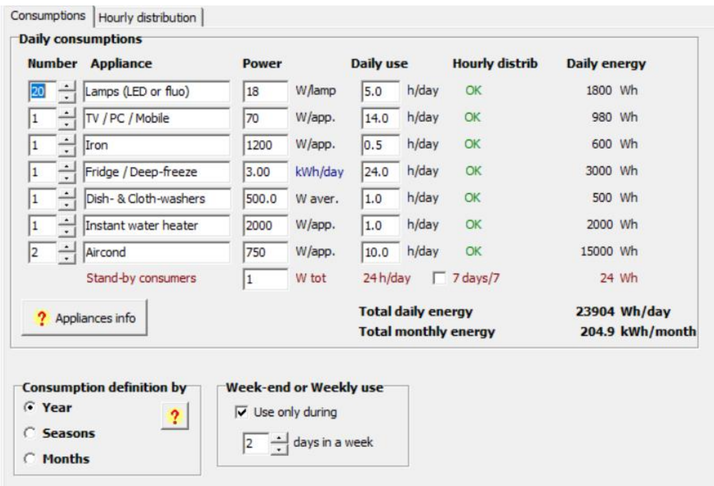


Figure 9: House A Weekend Load Consumption

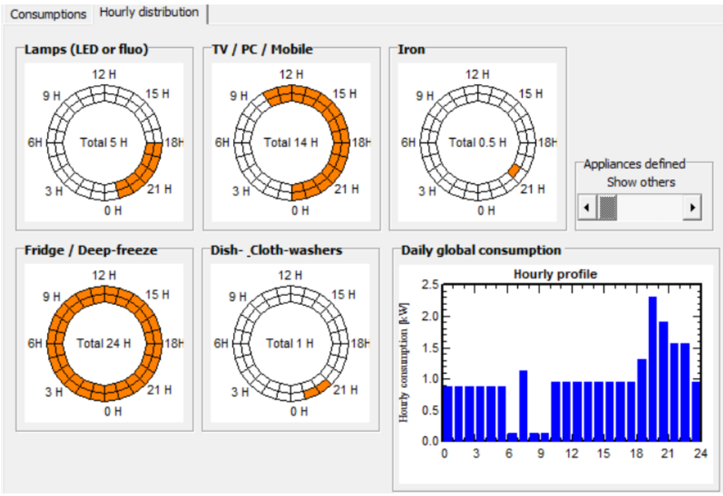


Figure 10: House A Weekend Hourly Load Profile

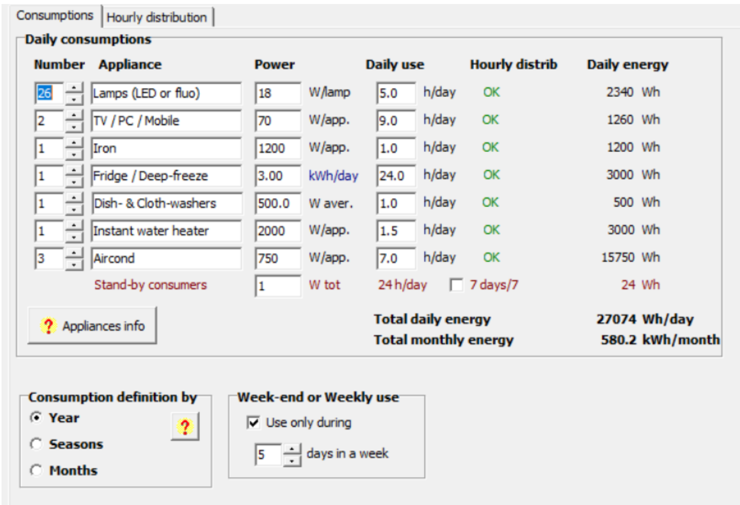


Figure 11: House B Weekday Load Consumption

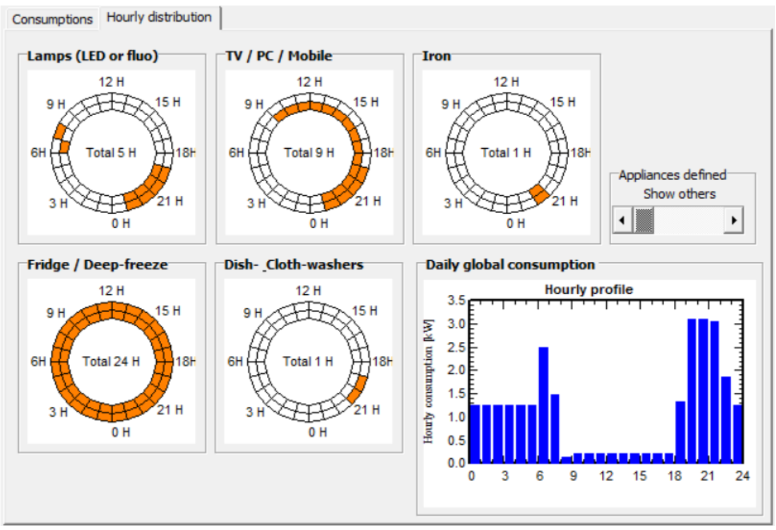


Figure 12: House B Weekday Hourly Load Profile

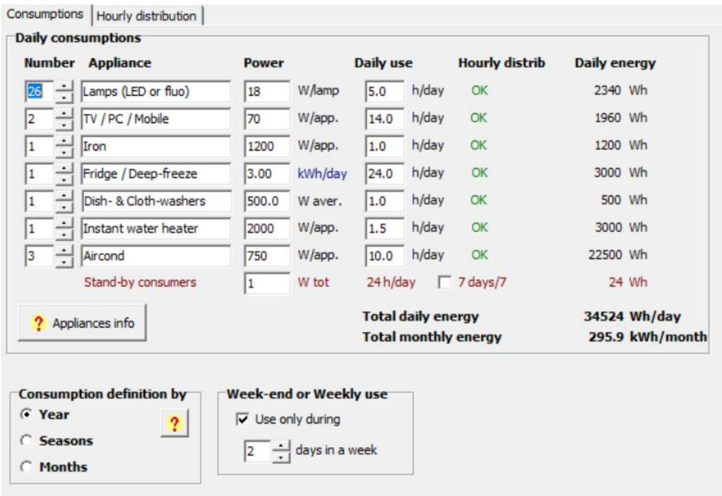


Figure 13: House B Weekend Load Consumption

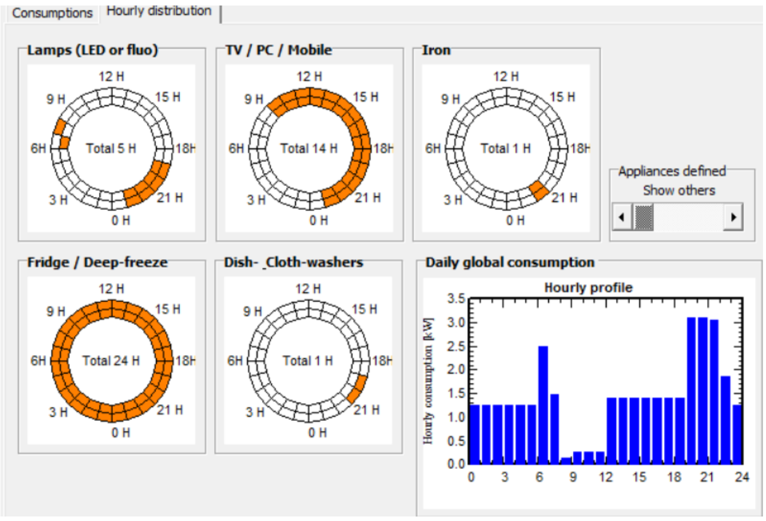


Figure 14: House B Weekend Hourly Load Profile

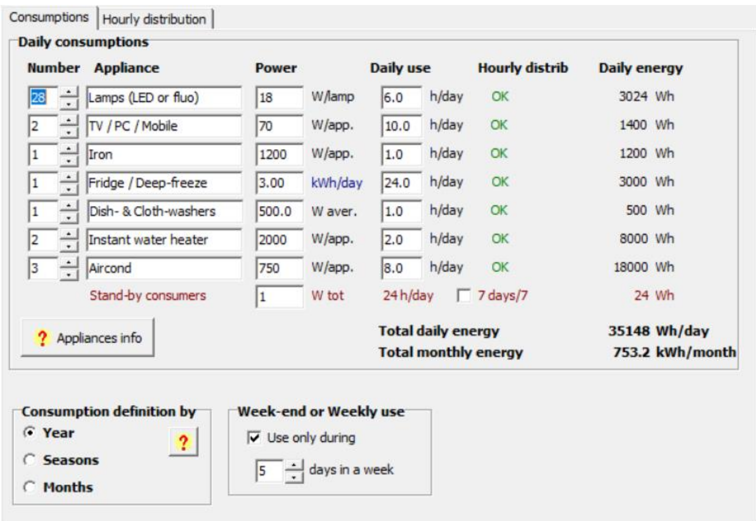


Figure 15: House C Weekday Load Consumption

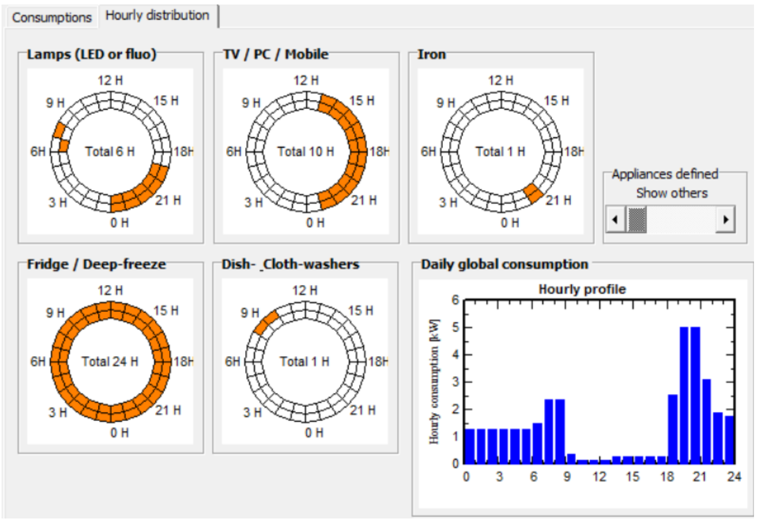
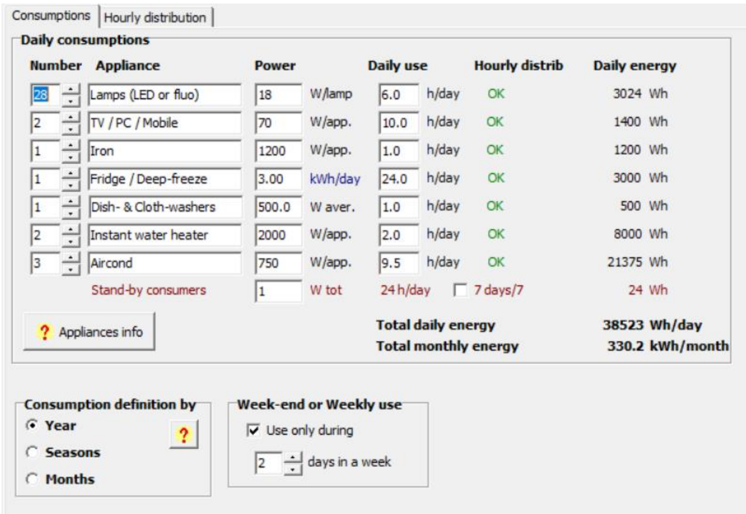


Figure 16: House C Weekday Hourly Load Profile



Consumptions | Hourly distribution

Daily consumptions

Number	Appliance	Power		Daily use		Hourly distrib	Daily energy
28	Lamps (LED or fluo)	18	W/lamp	6.0	h/day	OK	3024 Wh
2	TV / PC / Mobile	70	W/app.	10.0	h/day	OK	1400 Wh
1	Iron	1200	W/app.	1.0	h/day	OK	1200 Wh
1	Fridge / Deep-freeze	3.00	kWh/day	24.0	h/day	OK	3000 Wh
1	Dish- & Cloth-washers	500.0	W aver.	1.0	h/day	OK	500 Wh
2	Instant water heater	2000	W/app.	2.0	h/day	OK	8000 Wh
3	Aircond	750	W/app.	9.5	h/day	OK	21375 Wh
	Stand-by consumers	1	W tot	24 h/day		7 days/7	24 Wh

Appliances info

Total daily energy 38523 Wh/day
Total monthly energy 330.2 kWh/month

Consumption definition by: Year / Seasons / Months

Week-end or Weekly use: Use only during 2 days in a week

Figure 17: House C Weekend Load Consumption

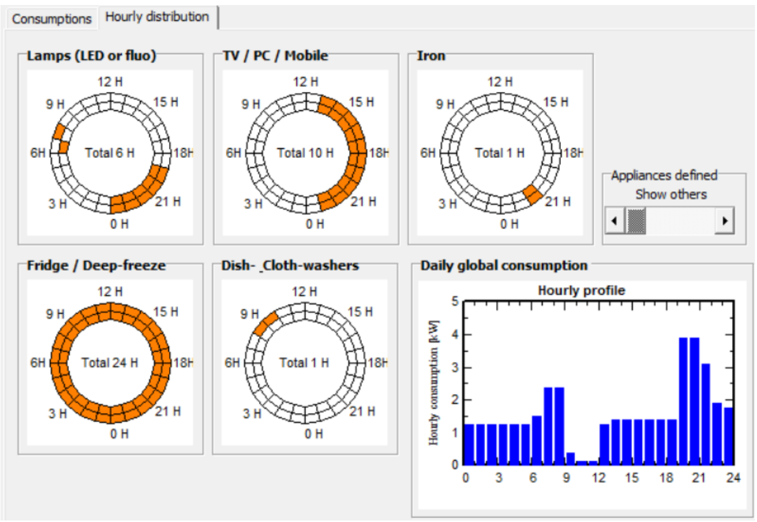


Figure 18: House C Weekend Hourly Load Profile

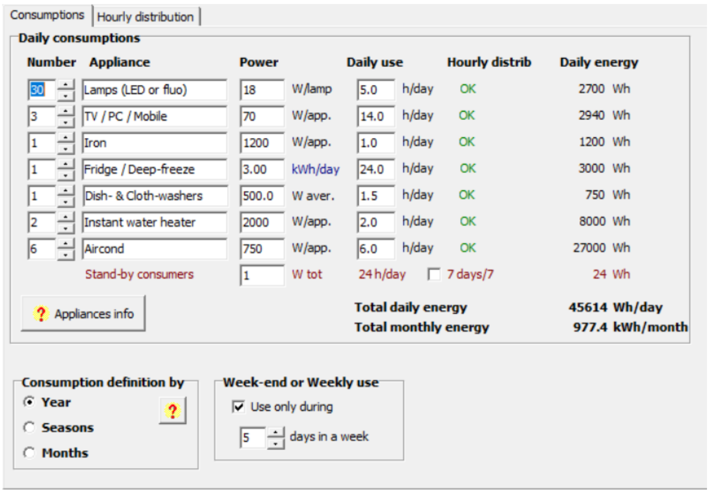


Figure 19: House D Weekday Load Consumption

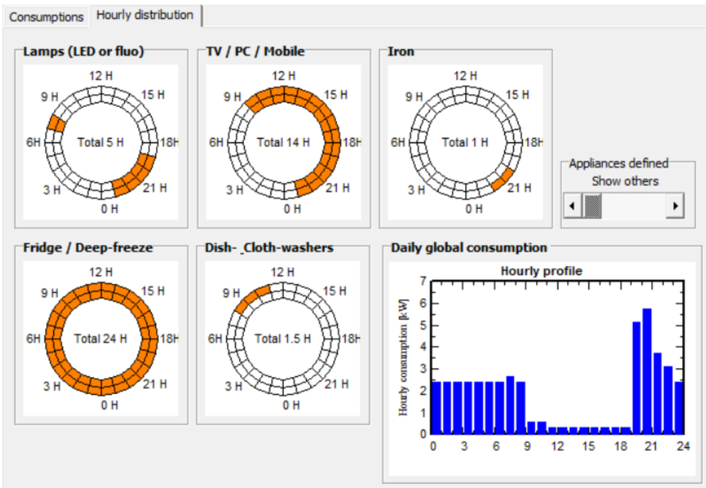


Figure 20: House D Weekday Hourly Load Profile

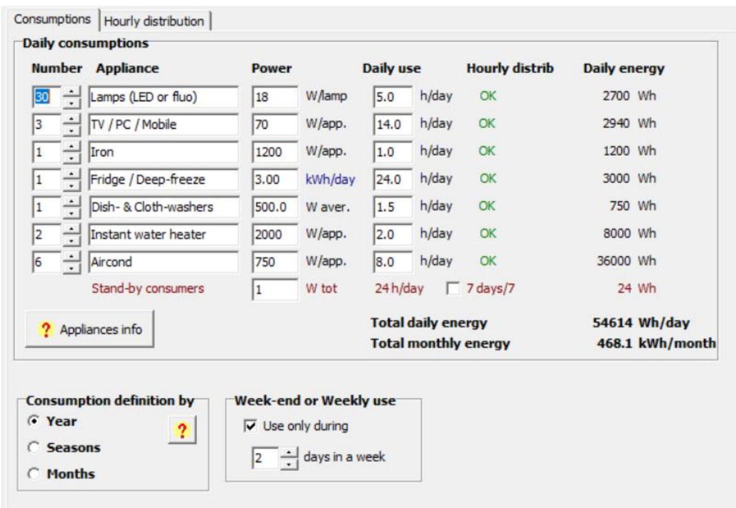


Figure 21: House D Weekend Load Consumption

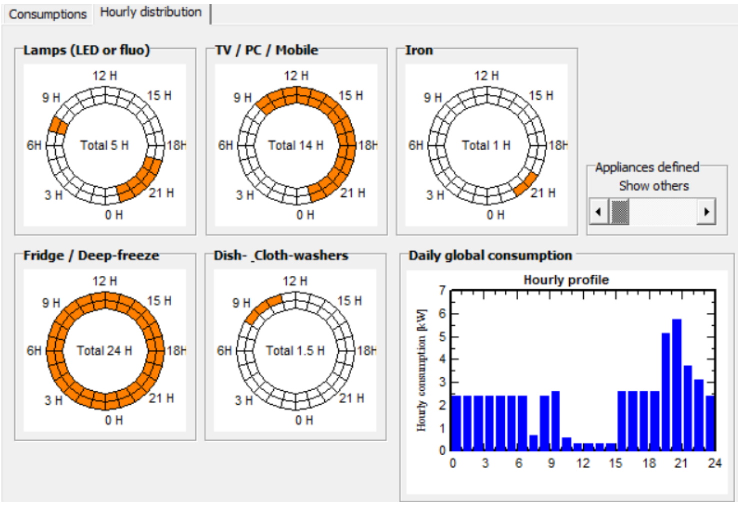


Figure 22: House D Weekend Hourly Load Profile

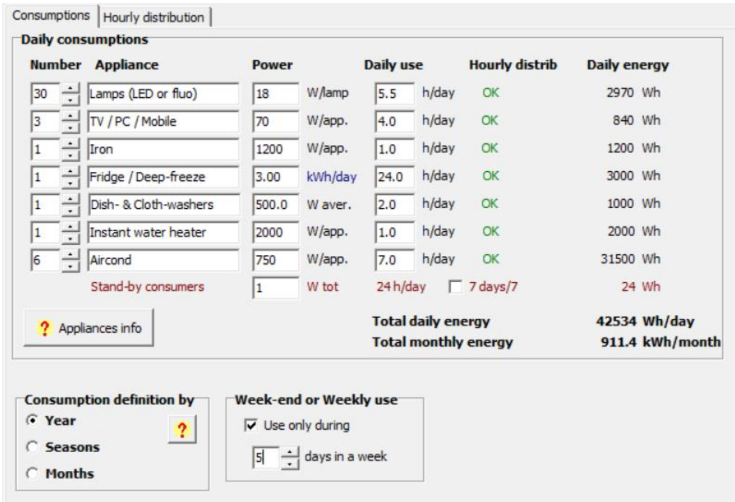


Figure 23: House E Weekday Load Consumption

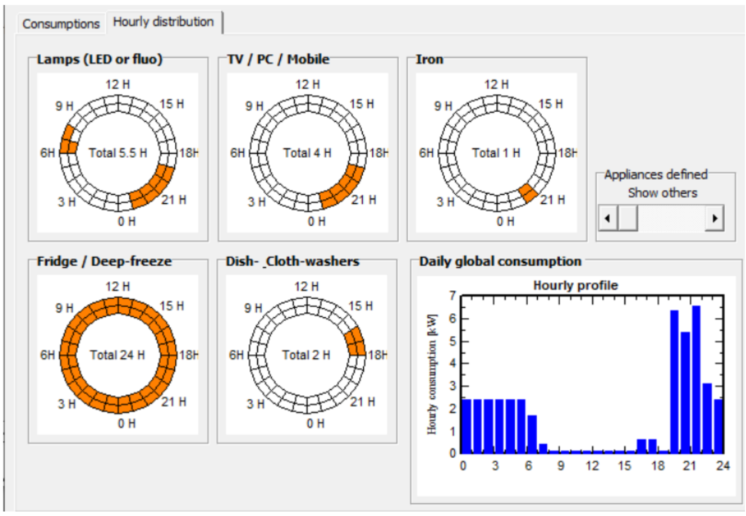


Figure 24: House E Weekday Hourly Load Profile

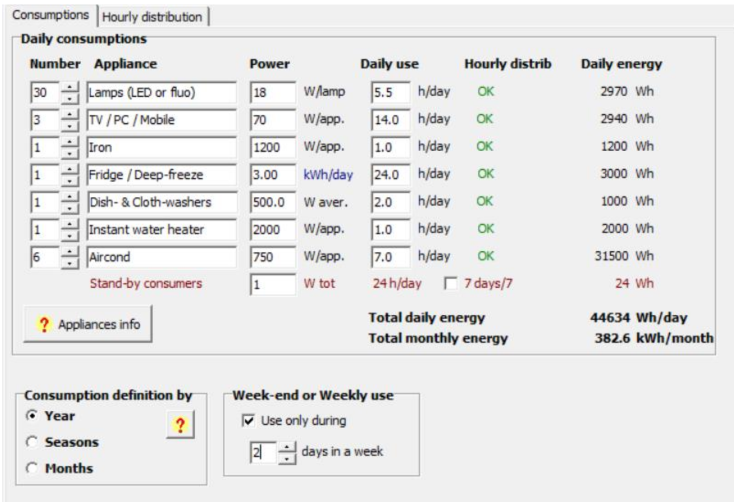


Figure 25: House E Weekend Load Consumption

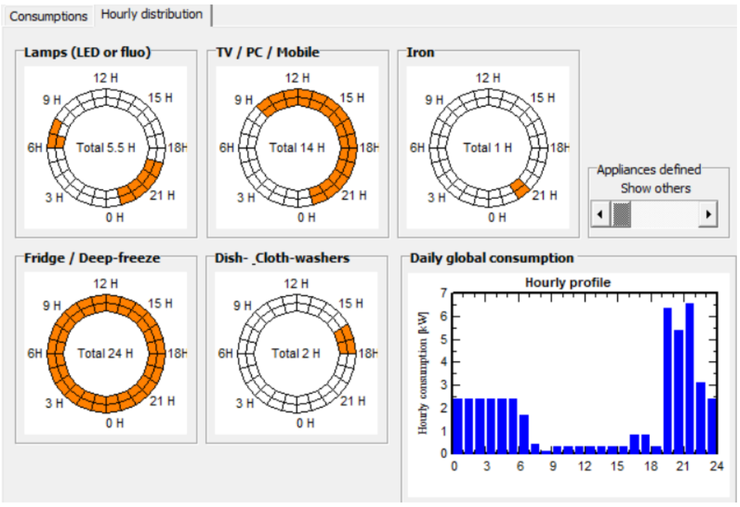


Figure 26: House E Weekend Hourly Load Profile

4.3 Energy Analysis

Energy analysis is required to analyse each information obtained to determine the total energy required from PV system and the grid to sustain the load consumption. In the energy analysis, the results obtained from the PVSYST tool are analysed and discussed.

Table 4.4: Results from PVSYST with 6 kW PV System for NEM scheme

Description	Simulation Result (MWh) over the year				
	House A	House B	House C	House D	House E
Annual energy production	8.41	8.41	8.41	8.41	8.41
Energy consumption from PV (weekday)	0.42	0.59	0.86	1.19	0.59
Energy consumption from grid (weekday)	3.66	6.47	8.32	10.72	10.51
Energy consumption from PV (weekend)	0.82	0.91	0.96	1.03	0.44
Energy consumption from grid (weekend)	1.69	2.71	3.09	4.71	4.25

From Table 4.4, it shows that with 6 kW PV system able to produce 8.41 MWh over the whole year. Monthly average energy consumption can be calculated for each house to be able to integrate with NEM scheme. Based on the NEM policy, the excessive energy produced after consumed by the house load can be export to the grid to be offset "one on one" basis with the energy consumed from the grid.

For house A, the total energy consumption for a whole year is 6.59 MWh. With the total energy production of 8.41 MWh, there is excessive of 1.82 MWh for a whole year. With monthly average energy production of 700 kWh and the monthly average consumption around 549 kWh. There are remaining of 151 kWh to export to the grid every month to be offset with the energy required from the grid. The result shows that the PV system of 6 kW capable of fully supply energy to the house A.

For the house B to house E, the energy consumption is higher than annual energy production. After deduct with NEM scheme "one on one" offset basis, remaining energy consumed from the grid is still charged by the utility company at a lower rate. Table 4.5 shows the remaining monthly energy required from the grid after offset with NEM scheme.

Table 4.5: Monthly Energy Analysis with NEM scheme

Description	House A	House B	House C	House D	House E
Annual energy production (MWh)	8.41	8.41	8.41	8.41	8.41
Annual energy consumption (MWh)	6.59	10.68	13.23	17.65	15.79
Monthly energy production (kWh)	700	700	700	700	700
Monthly load consumption (kWh)	549	890	1103	1470	1316
Remaining monthly energy required from grid (kWh)	-152 (excessive)	189	402	770	615

Table 4.6: Results from PVSYST with 9 kW PV System for NEM scheme

Description	Simulation Result (MWh) over the year			
	House B	House C	House D	House E
Annual energy production	11.78	11.78	11.78	11.78
Energy consumption from PV (weekday)	0.64	0.99	1.29	0.61
Energy consumption from grid (weekday)	6.43	8.19	10.62	10.49
Energy consumption from PV (weekend)	0.97	1.05	1.05	0.45
Energy consumption from grid (weekend)	2.66	3.0	4.69	4.24

Table 4.7:Monthly Energy Analysis with NEM scheme

Description	House B	House C	House D	House E
Annual energy production (MWh)	11.78	11.78	11.78	11.78
Annual energy consumption (MWh)	10.67	13.23	17.65	15.79
Monthly energy production (kWh)	983	983	983	983
Monthly load consumption (kWh)	890	1103	1471	1316
Remaining monthly energy required from grid (kWh)	-93 (excessive)	120	488	333

Table 4.6 show the energy production with 9 kW PV system for house B to house E. House A is not included for 9 kW PV system because from Table 4.5, it can see that the energy production from 6 kW PV system is supply excessive energy to the grid. It can see that the annual energy consumption for the house B is lesser than annual energy production, meanwhile the annual energy consumption for house C to house E are higher than their annual energy production. The study case for house B is similar with house A, where the energy produced by the PV system able to cope the total energy needed by the household load.

Table 4.7 shows the remaining of the energy required from the grid after NEM scheme offset to sustain the household load consumption. The result show that house B is oversupply 93 kWh monthly after NEM "one on one" offset with 9 kW PV system. Remaining energy consumption that required by house C to house E greatly reduced compared with the results shown on table 4.5. From the results shown, it can see that with higher capacity PV system with NEM scheme, the reduction of energy required from the grid is greatly reduced.

Table 4.8: Results from PVSYST with 6 kW PV System for SELCO scheme

Description	Simulation Result (MWh) over the year				
	House A	House B	House C	House D	House E
Maximum annual energy production (MWh)	8.41	8.41	8.41	8.41	8.41
Energy consumption from PV (weekday)	3.04	3.27	3.45	3.69	3.12
Energy consumption from grid (weekday)	1.04	3.80	5.72	8.22	7.98
Energy consumption from PV (weekend)	1.99	2.17	2.2	2.18	1.71
Energy consumption from grid (weekend)	0.52	1.45	1.85	3.56	2.98

Table 4.8 shows that the energy consumption directly from the PV system is higher compare with the results from Table 4.4. This is because of integration of battery system that required for SELCO scheme. In the event of no energy production occur, the battery system able to continue to supply to the house load until the depth of discharge reaches at 50% and switch into grid energy to be consume for house load.

Table 4.9: Monthly Energy Analysis of SELCO Scheme

Description	House A	House B	House C	House D	House E
Annual energy produced based on load (MWh)	5.03	5.44	5.65	5.87	4.83
Annual energy consumption from PV (MWh)	5.03	5.44	5.65	5.87	4.83
Monthly energy production (kWh)	419	453	470	489	402
Monthly load consumption (kWh)	549	890	1102	1470	1316
Remaining monthly energy required from grid (kWh)	130	437	632	981	914

Table 4.10: Results from PVSYST with 9 kW PV System for SELCO Scheme

Description	Simulation Result (MWh) over the year			
	House B	House C	House D	House E
Maximum annual energy production (MWh)	11.78	11.78	11.78	11.78
Energy consumption from PV (weekday)	4.64	4.91	5.18	4.53
Energy consumption from grid (weekday)	2.43	4.26	6.72	6.58
Energy consumption from PV (weekend)	2.83	2.94	3.01	2.43
Energy consumption from grid (weekend)	0.8	1.11	2.73	2.26

Table 4.11: Monthly Energy Analysis of SELCO Scheme

Description	House B	House C	House D	House E
Annual energy produced based on load (MWh)	7.47	7.85	8.19	6.96
Annual energy consumption from PV (MWh)	7.47	7.85	8.19	6.96
Monthly energy production (kWh)	622	654	682	580
Monthly load consumption (kWh)	890	1102	1470	1316
Remaining monthly energy required from grid (kWh)	268	448	788	736

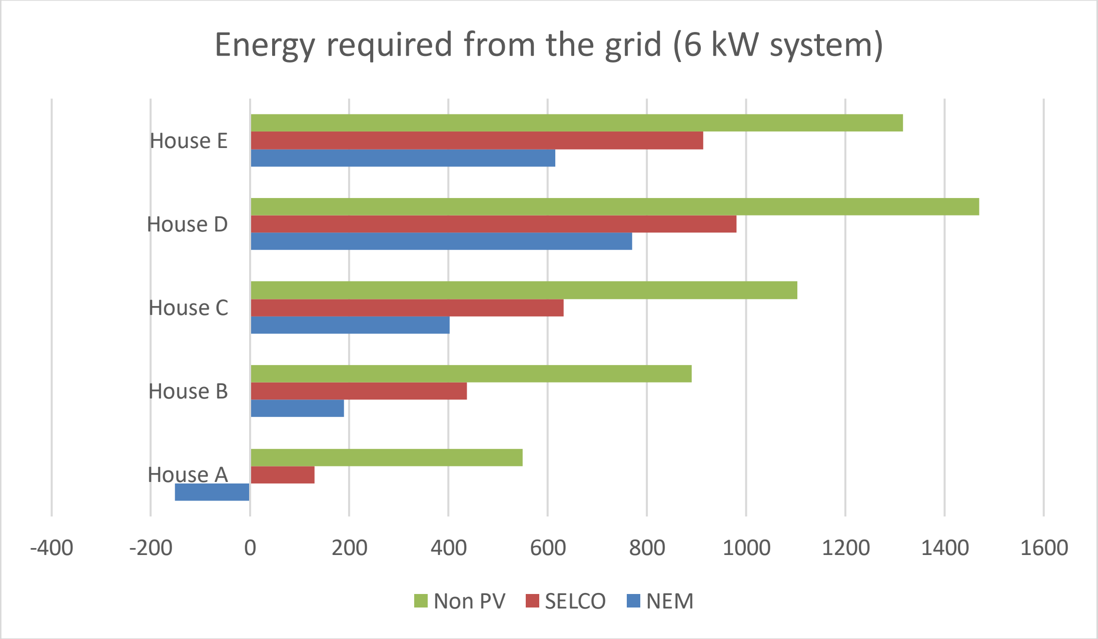


Figure 27: Comparison among the schemes and non-PV system with 6 kW system

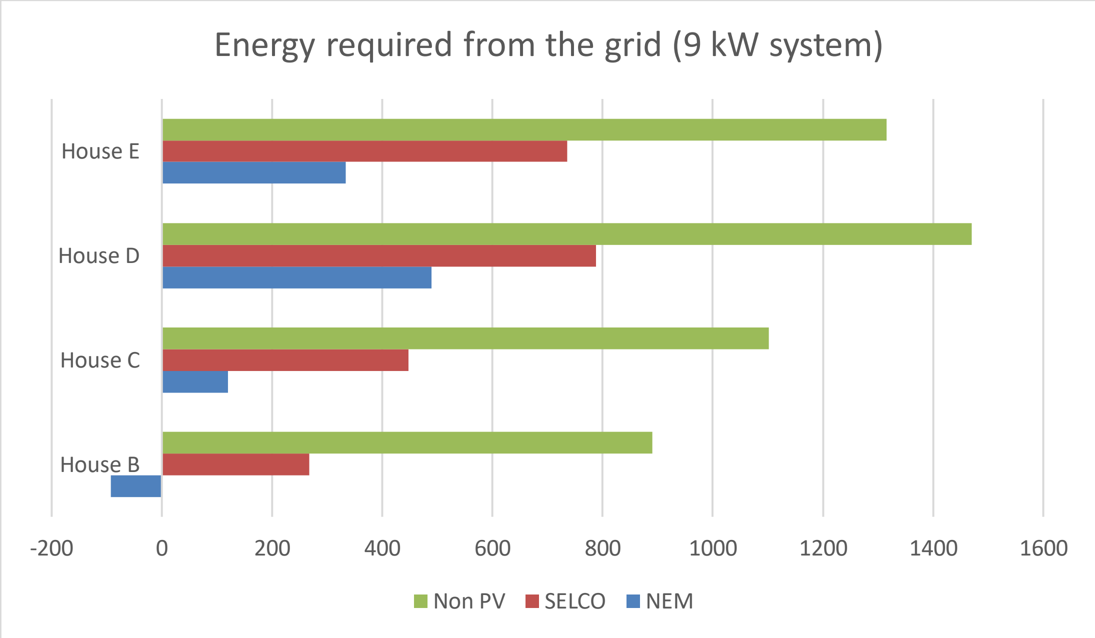


Figure 28: Comparison among the schemes and non-PV system with 9 kW system

From Figure 27 and Figure 28, it shows that with PV system running with NEM and SELCO schemes reduces the energy required from the grid to support the house load usage. Each house show reduction more than 50% on energy required from the grid for NEM scheme except house D on using 6 kW system shows 47% reduction on energy required from the grid. For NEM scheme case, there is a point where the energy produced are higher than the monthly consumption leads to zero energy require from the grid and supply the extra energy produced to the grid. This result can be seen on house A using 6 kW system and house B using 9 kW system. The excessive energy produced by the PV system can be export to the grid considering as energy storage and offset "one on one" energy consumed from the grid. This exchange enables the total energy generated by the PV system to be fully utilized.

For SELCO scheme, the reduction energy consumption from the grid shown on Figure 27 varies between 33% to 77% and Figure 28 varies between 45% to 70% among the houses. The variation of the reduction percentage is affected by the differences on the usage load during daytime, where the energy produced directly use for the house load usage. On the daytime where there is high energy consumption by the load, is beneficial because the energy produced can directly use for the load. On the contrast, during the daytime, where the energy consumption is low, the produced energy will charge the battery until full and stop produce the energy. The energy stored in the battery will be consumed once the PV module gain no sunlight to produce energy.

4.4 Cost Analysis

Cost analysis being carried out using the data obtained from the Section 4.3. The data of remaining energy required from the grid is used to calculate the electricity bill based on the residential electricity tariff.

Table 4.12: Electricity Bill Comparison Among Scheme

	Electricity Bill Comparison (RM)				
	House A	House B	House C	House D	House E
Without PV system	205.48	390.14	511.51	721.07	633.14
NEM (6 kW)	3.00	41.20	129.63	324.62	239.99
NEM (9 kW)	NA	3.00	26.16	174.52	94.54
SELCO (6 kW)	28.34	147.70	249.27	441.85	403.59
SELCO (9 kW)	NA	66.31	153.37	334.45	306.60

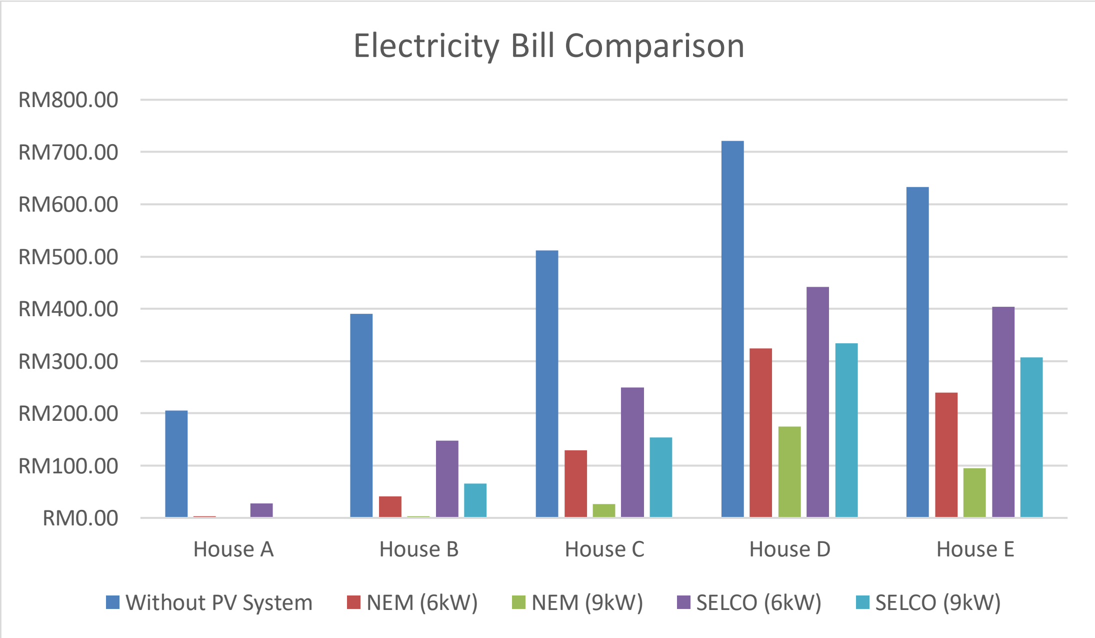


Figure 29: Electricity Bill Comparison Chart

Figure 29 shows the comparison electricity bill among the scheme with non-PV system installed. From the comparison, it shows that the highest reduction charges on the electricity bill is on NEM scheme with 9 kW system. Higher reduction effects on 9 kW system compared with 6 kW system is because of the higher energy produced by the larger capacity system. From the results shown, NEM scheme able to bring higher reduction on the electricity bill compared with SELCO scheme. Overall, both NEM and SELCO scheme capable to lower the electricity bill.

Table 4.13: NPV Cost for 20 years

System Size	NPV Total Cost (RM)
6 kW system without battery	31 520.69
6 kW system with 24 V 784 AH battery	47 520.69
9 kW system without battery	42 520.69
9 kW system with 36 V 784 AH battery	66 520.69

Table 4.14: Total Energy Production with NEM scheme for 20 years

System Size	Total Energy Production (KWh)
6 kW system without battery	153 140
9 kW system without battery	214 506

Table 4.15: Total Energy Production with SELCO scheme for 20 years

Sample House Load	Total Energy Production (kWh)	
	6 kW with battery system	9 kW with battery system
House A	91 593	-
House B	99 059	136 024
House C	102 700	142 907
House D	106 889	149 134
House E	87 951	126 737

From Table 4.14 and 4.15, it shows that the total energy produced for 20 years from both different schemes are different. For NEM scheme, the total energy production for 20 years entirely depends on the maximum energy that able to produce by the PV system. This is because the excessive energy produced after consumed by the house load, will directly feed into the grid and be offset “one on one” basis if the house load usage requires any additional energy from the grid.

For SELCO scheme, the total energy production for 20 years entirely depends the energy load profile. This can be seen on the results obtained in the table 4.15, the total energy production for house D is higher than house E, regardless the total energy consumption for house D is higher than house E. This is because the daytime energy consumption for house E is lower compared to house D, therefore the excessive energy produced will be stored on the battery storage sooner. At the period, where there is very low energy consumption during daytime, the PV system inverter will terminate the energy production to the house load when the battery storage is fully charge. In contrast with the house D, the scenario where the energy consumption during daytime is higher, the excessive energy produced after consumed by the higher house load will be stored at the battery storage with slower rate. This overall can fully utilized the maximum energy production of the PV system.

Table 4.16: Levelized Cost of Electricity

PV system with type of scheme	Levelized Cost of Electricity (RM / kWh)				
	A	B	C	D	E
6 kW system (NEM)	0.21	0.21	0.21	0.21	0.21
9 kW system (NEM)	-	0.20	0.20	0.20	0.20
6 kW system (SELCO)	0.52	0.48	0.46	0.44	0.54
9 kW system (SELCO)	-	0.49	0.47	0.45	0.52

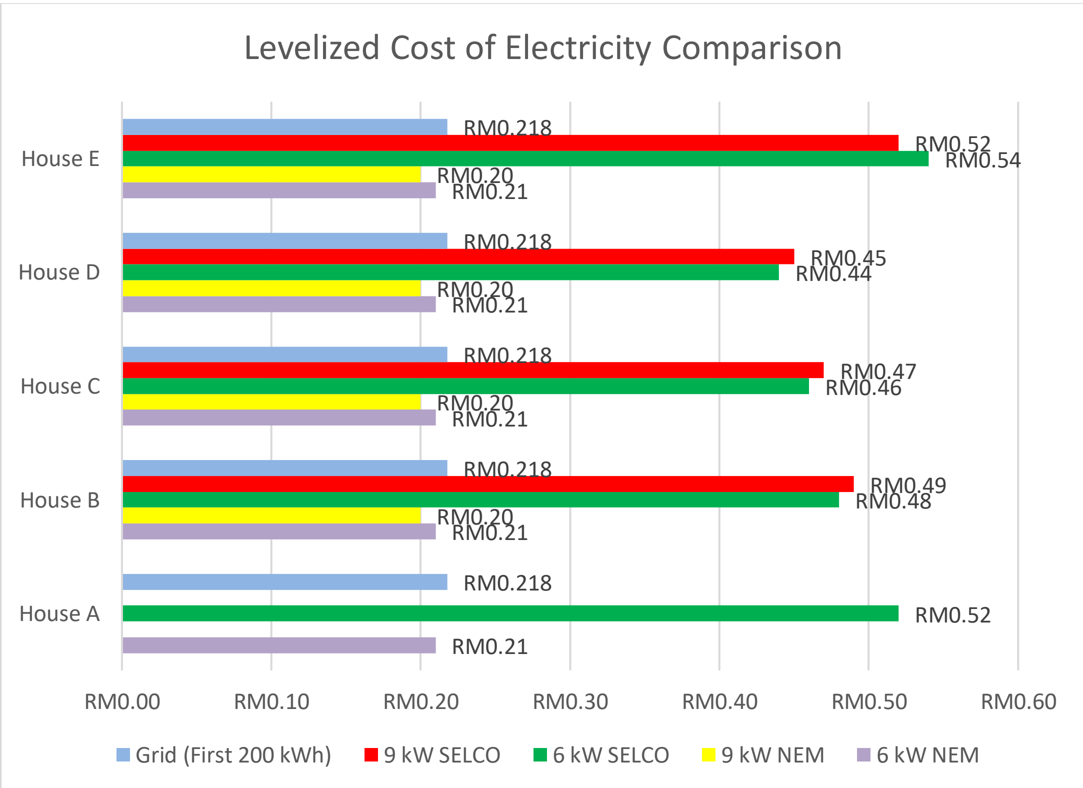


Figure 30: LCOE Comparison Chart

From the Table 4.16 and Figure 30, it shows each levelized cost of electricity for the both schemes comparing with the conventional grid user tariff. The comparison results shown that the levelized cost of electricity for NEM scheme is consistent for all five houses at RM 0.21 / kWh for 6 kW PV system and RM 0.20 / kWh for 9 kW PV system, which are lower than the cheapest block charges offer by the utility provider. This shows that with NEM scheme, the levelized cost of electricity is entirely depends on the PV system capacity size installed. As long as the PV system capacity size determined, the total amount of energy production able to predicted, the system able to fully produce the energy to be consume by the load and export the excess energy to the grid to be offset “one on one” basis if any energy usage taken from the grid.

The levelized cost of electricity for SELCO scheme is not consistent for all five houses. The results shown the levelized cost of electricity obtained for five houses in the range between RM 0.44 / kWh and RM 0.54 / kWh. The levelized cost of electricity obtained for SELCO scheme, is higher compared to the first block charges by the utility provider at the rate of RM 0.218 / kWh but is lower compared to the fourth block charges by the utility provider at the rate of RM 0.546 / kWh. The reason of this inconsistency of levelized cost of electricity is because of the differences of total energy consumption for different house load during daytime leading to the amount of excessive energy that able to store in the battery system. At the period, where battery is fully charged and no excessive energy allowable to export to the grid, the PV system will cut off the energy production, leading to total energy production is lesser as shown in Table 4.15.

Table 4.17: Comparison of The Cost on Specific Month

PV system with scheme on a specific month	Monthly costing (RM)				
	A	B	C	D	E
Without PV system	205.48	390.14	511.51	721.07	633.14
6 kW system (NEM) on 1^{st} month	136.33	174.53	262.96	457.95	373.32
6 kW system (NEM) on 240^{th} month	136.33	216.01	325.40	524.02	439.93
9 kW system (NEM) on 1^{st} month	-	182.16	205.32	353.68	273.70
9 kW system (NEM) on 240^{th} month	-	196.38	253.16	443.17	361.94
6 kW system (SELCO) on 1^{st} month	228.34	347.70	449.27	641.85	603.59
6 kW system (SELCO) on 240^{th} month	244.60	388.46	494.04	690.39	643.56
9 kW system (SELCO) on 1^{st} month	-	345.47	432.53	613.61	585.76
9 kW system (SELCO) on 240^{th} month	-	395.38	491.35	678.19	640.36

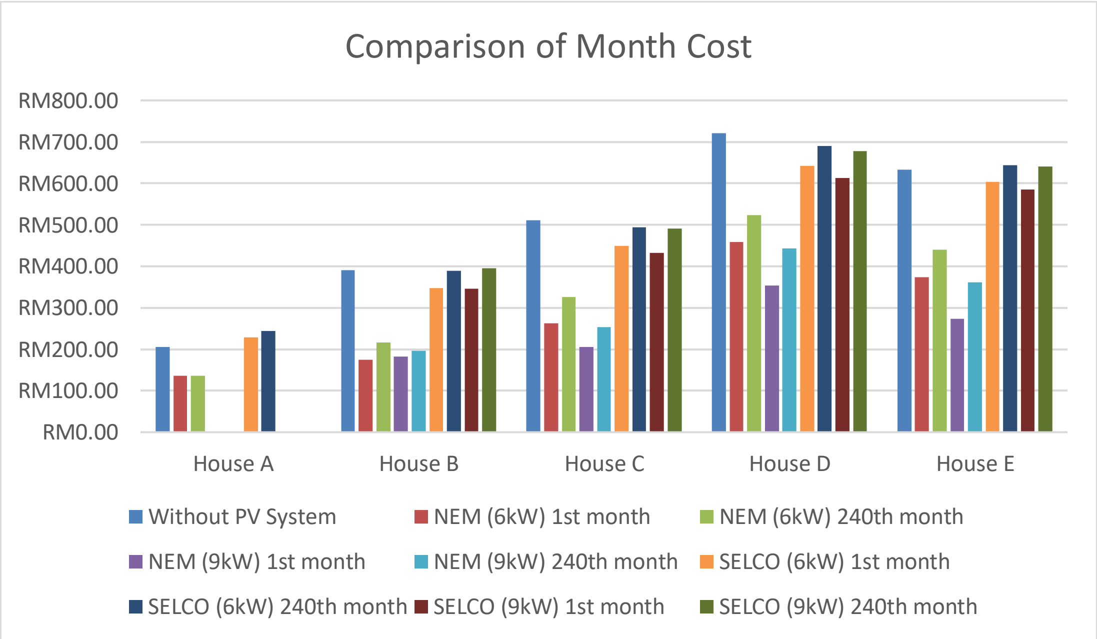


Figure 31: Comparison of Total Cost

The comparison of different month cost is needed because of energy degradation would affect the overall energy production over long time period. From results obtained at Table 4.17 and Figure 31, it shows that PV system with available schemes able to reduce the cost spend on electricity for the first month after implementing PV system. It is noticeable that the cost spends on the 240th month, which equal to 20 years after implementing the PV system, the 240th month cost is higher compare to the first month of implementing the PV system.

For the NEM scheme, the cost of the 240th month is still lower compare with the non-PV system user. Overall reduction of the cost on the 240th month able to achieve in the between 27% to 51% for NEM scheme depending on the household load comparing with the non-PV system user. The reduction of the cost for the first month is expected to be higher because of the highest energy efficiency without any degradation.

For the SELCO scheme, the cost on the 240th month is varying depending on the household load. It is noticeable that the cost on the 240th month for household B and E are higher than the non-PV system user. With the energy degradation happens over long time period, the cost to operate PV system with SELCO scheme getting higher which may bring cost losses to the user.

Table 4.18: ROI and Payback Period

Sample house load	Scheme	Monthly Savings	Annual ROI (RM)	Payback period (Years)
House A	6 kW system (NEM)	98.54%	2 429.76	13
	6 kW system (SELCO)	86.21%	2 125.68	22.4
House B	6 kW system (NEM)	89.44%	4 187.28	7.5
	9 kW system (NEM)	99.23%	4 645.68	9.2
	6 kW system (SELCO)	62.14%	2 909.28	16.3
	9 kW system (SELCO)	83.00%	3 885.96	17.1
House C	6 kW system (NEM)	74.66%	4 582.56	6.9
	9 kW system (NEM)	94.89%	5 824.20	7.3
	6 kW system (SELCO)	51.27%	3 146.88	15.1
	9 kW system (SELCO)	70.02%	4 297.68	15.5
House D	6 kW system (NEM)	54.98%	4 757.40	6.6
	9 kW system (NEM)	75.80%	6 558.60	6.5
	6 kW system (SELCO)	38.72%	3 350.64	14.2
	9 kW system (SELCO)	53.62%	4 693.44	14.3
House E	6 kW system (NEM)	62.10%	4 717.80	6.7
	9 kW system (NEM)	85.07%	6 463.20	6.6
	6 kW system (SELCO)	36.26%	2 754.60	17.3
	9 kW system (SELCO)	51.57%	3 918.48	17

Table 4.18 shows the return of investment and payback period for the five houses with both NEM and SELCO scheme. From the results obtained, it can see that investment of PV system with NEM scheme able to have payback period in the range of 6.5 years to 7.5 years for the monthly load consumption from 830 kWh onwards. However, for the monthly load consumption of 549 kWh for house A have a longer payback period of 13 years regardless the monthly saving achieved 98.54%. This shows that for NEM scheme, there is a minimum limit of monthly energy consumption in order to have cost beneficial to the investment made. If the minimum limit of monthly energy consumption is not meet, the investment made will have longer payback period even with high monthly reduction electricity bill achieved.

From the table 4.18, it shows that PV system with SELCO scheme have a payback period between 14.2 years to 22.4 years. This is mainly because of the investment amount for the PV with battery system is very high while having a lower rate on total energy that can be consumed by the load. With the long duration payback period, the investment for the PV with battery system for SELCO unlikely brings any cost benefits.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Energy household behaviour affects the total energy consumption for the household. Total energy consumption for a household can be affected by household appliances usage duration, total number of household appliances running at a time and total number of occupants in the house. As the time usage of the appliances increases, the total energy consumed increases as well. The total number of appliances running at the same time, increases the demand of the energy required to run multiple loads at the same. The total number of occupants in the house leads to higher tendency to use any household appliances at any time, which leads to possibility of energy consumption.

The energy load profile is important to study the overall energy consumption of the load. The assumption made from this study is that the energy load profile on the monthly basis are assumed to be the same to ease the study, where in the real-world scenario the monthly energy load profile shall be slightly varies. The information of high and low energy demand at specific time can be obtained and analysed to ensure energy production of the PV system able to cope with the overall energy demand of the load. The energy load profile on weekday and weekend are different due to the different routine of household appliances usage. The energy consumption during the weekend tends to be higher due to the duration hour of the house occupant staying in the house is longer compared during the weekday.

NEM scheme allows the remaining excessive energy after consumed by the household can be export to the grid and offset “one on one” with the energy consumed from the grid. This exchange enables the total energy generated by the PV system belongs to the household to be fully utilized. With the PV system that is sufficient to supply the energy required for the load, it can reduce the energy consumption from the grid. It is noticeable that high reduction on the energy consumption required from the grid greatly reduce by integrate NEM scheme, hence leading to lower electricity bill charges.

SELCO scheme mainly for the household to fully consume own energy production without export any energy to the grid. SELCO scheme relies heavily on the battery size to store high capacity of energy to be consumed by the household load. During the daytime where there is household load consuming energy, the energy produced from the PV system can cater for the household load. During this operation, any remaining excessive energy after consumed by the household load, will be stored into the battery system until fully charged. At the period of time, where there is very low energy demand by the load and the battery storage is fully charged, the inverter of the PV system will cut off the energy production due to the regulation of no energy allowable to export to the grid. This leads to the reduction of the potential total amount of energy able to produce by the PV system. Overall, the reduction of energy consumption from the grid is lesser compared to the NEM scheme due to the limitation from the battery capacity.

For the cost analysis, it is noticeable that NEM scheme able to bring lower levelized cost of electricity compared to the tariff offered by the utility provider. This is greatly beneficial to the household as this can helps in reducing electricity bill charges. Meanwhile for SELCO scheme, the levelized cost of electricity is not as low as compared to NEM scheme, it can achieve at RM 0.44 / kWh depending on the household load consumption is in the range of the tariff charges by the utility provider, starting from RM 0.218 / kWh to RM 0.571 / kWh depending on the block. Overall, investment made for PV system with NEM scheme have shorter payback period from 6.5years to 7.5 years compared to SELCO scheme that have payback period from 14.2 years to 22.4 years. However, for NEM scheme, it is needed to have minimum limit of monthly energy consumption in order to achieve short payback period.

5.2 Recommendations for future work

For the recommendations, the data of energy load profile and the irradiance data can be obtained for a twelve month to gain the overall changes of the household load that can bring closer results to the study. Besides that, the monthly energy production from the twelve-month information of irradiance data can be simulated using PVSYST software to have accurate monthly energy production.

Another recommendation that is worth to consider is to simulate PV system with different capacity from 2 kW to 12 kW with 1 kW interval for NEM scheme to determine whether the levelized cost of electricity able to remain at low cost. Theoretically, with higher power rated PV system, higher reduction of energy consumption from the grid can be achieve, which can lead to low electricity bill charges. However, study on different power rated PV system is needed to determine whether the levelized cost of electricity can be remain low.

Another recommendation is that the battery depth of discharge for SELCO scheme can be increase to higher value to see the effect on the reduction energy from the grid. Theoretically, with higher battery depth of discharge, the energy that can be supply to the load from the battery is higher as well, which lead to reduction of energy consumption from the grid. However, study on this is required to determine whether the levelized cost of electricity for SELCO scheme can be further reduced.

REFERENCES

Aris, H., Dollah, R., & Jamalludin, K. N. (2019). An Analysis on the Effect of Consumers Behaviour Towards Household Electricity Consumption. *2018 IEEE Conference on Big Data and Analytics, ICBDA 2018*, 16–22. https://doi.org/10.1109/ICBDAA.2018.8629738

Branker, K., Pathak, M. J. M., & Pearce, J. M. (2011). A review of solar photovoltaic levelized cost of electricity. *Renewable and Sustainable Energy Reviews*, *15*(9), 4470–4482. https://doi.org/10.1016/j.rser.2011.07.104

Gan, C., Lau, C., & Tan, P. (2014). Evaluation Of Solar Photovoltaic Levelized Cost Of Energy For PV Grid Parity Analysis In Malaysia. *International Journal of Renewable Energy Resources*, *4*(1), 28–34.

Gomez-gonzalez, M., Hernandez, J. C., Vera, D., & Jurado, F. (2020). Optimal sizing and power schedule in PV household-prosumers for improving PV self-consumption and providing frequency containment reserve. *Energy*, *191*, 116554. https://doi.org/10.1016/j.energy.2019.116554

Hlal, M. I., Ramachandaramurthy, V. K., Sarhan, A., Pouryekta, A., & Subramaniam, U. (2019). Optimum battery depth of discharge for off-grid solar PV/battery system. *Journal of Energy Storage*, *26*(June), 100999. https://doi.org/10.1016/j.est.2019.100999

NEM – Renewable Energy Malaysia. (n.d.). Retrieved May 3, 2020, from http://www.seda.gov.my/reportal/nem/

Razali, A. H., Abdullah, M. P., Hassan, M. Y., & Hussin, F. (2019). Comparison of New and Previous Net Energy Metering (NEM) Scheme in Malaysia. *ELEKTRIKA- Journal of Electrical Engineering*, *18*(1), 36–42. https://doi.org/10.11113/elektrika.v18n1.141

Zhou, K., & Yang, S. (2016). Understanding household energy consumption behavior: The contribution of energy big data analytics. *Renewable and Sustainable Energy Reviews*, *56*, 810–819. https://doi.org/10.1016/j.rser.2015.12.001

APPENDICES

APPENDIX A: PVSYST Simulation Reports

Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **working couple (6kw)**

Simulation date 21/04/20 17h34

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	11.2 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

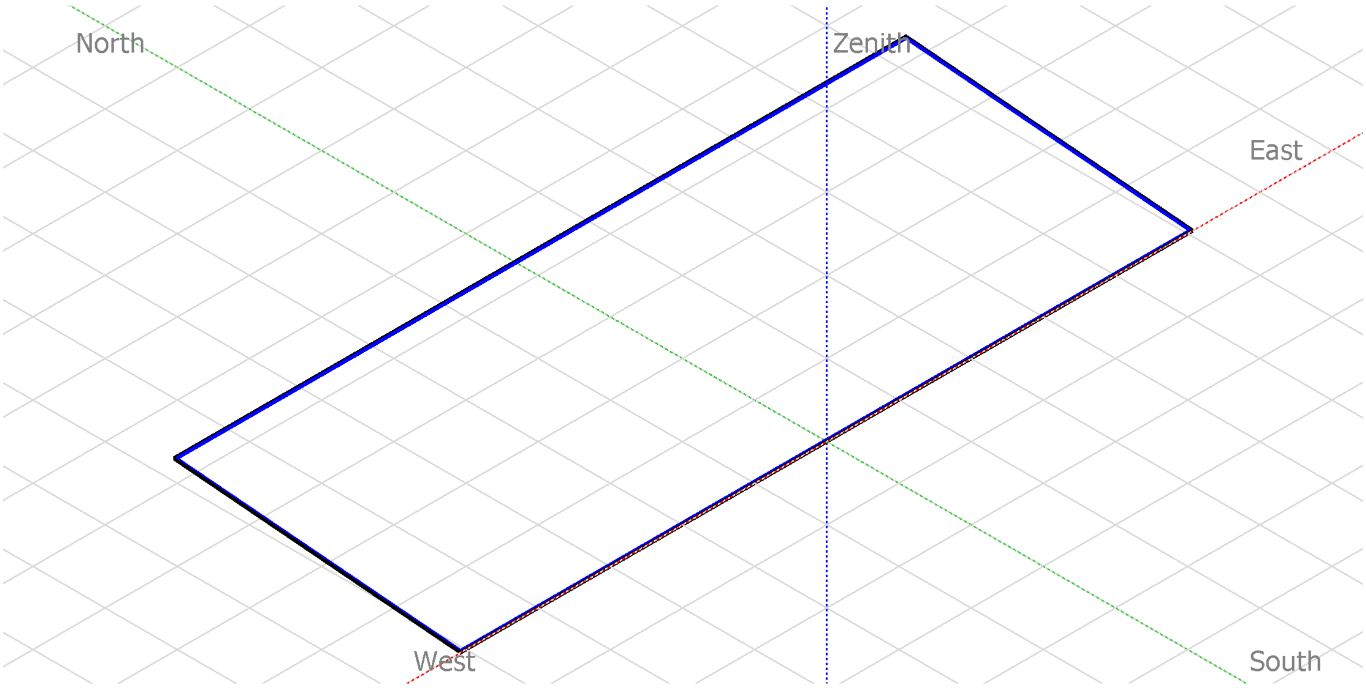
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

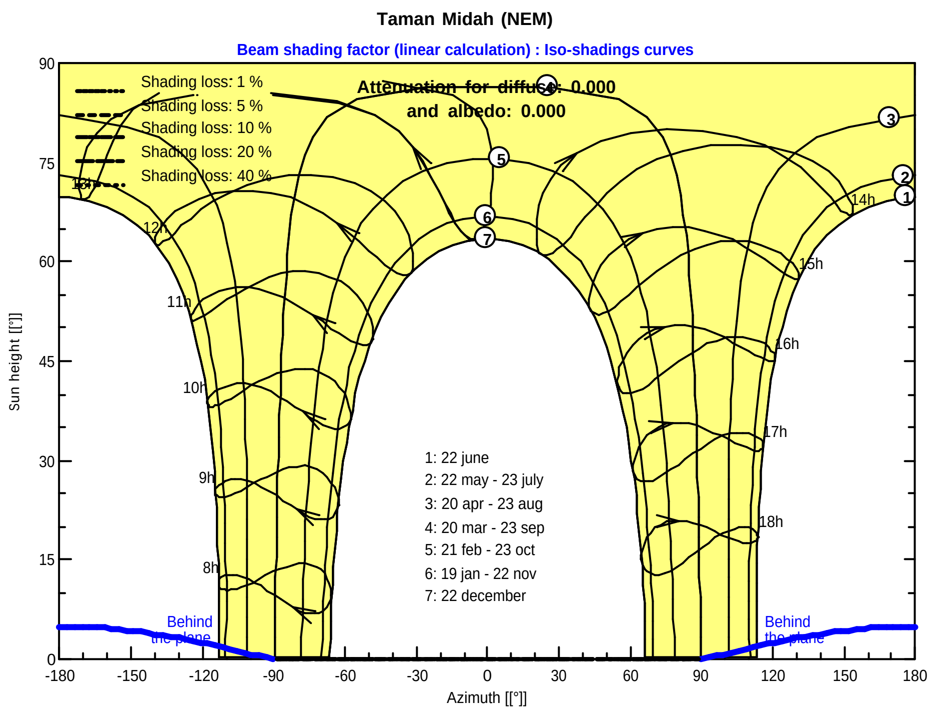
Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

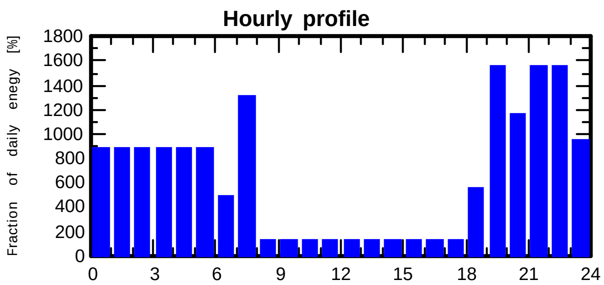
Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Daily household consumers, Constant over the year, average = 11.2 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	20	18 W/lamp	7 h/day	2340 Wh/day
TV / PC / Mobile	1	70 W/app	6 h/day	420 Wh/day
Iron	1	1200 W/app	1 h/day	600 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	2	750 W tot	5 h/day	6750 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				15634 Wh/day



Grid-Connected System: Main results

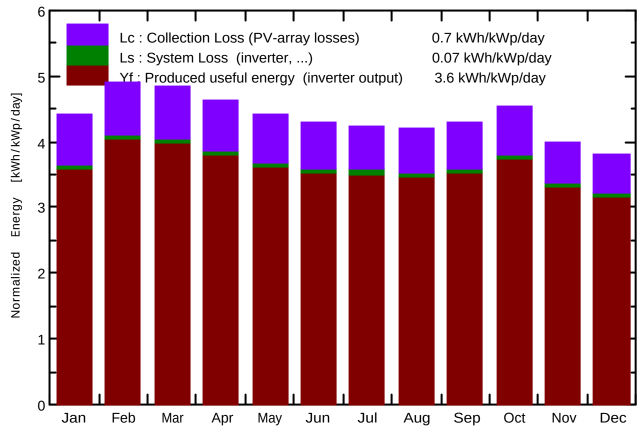
Project : **Taman Midah (NEM)**

Simulation variant : **working couple (6kw)**

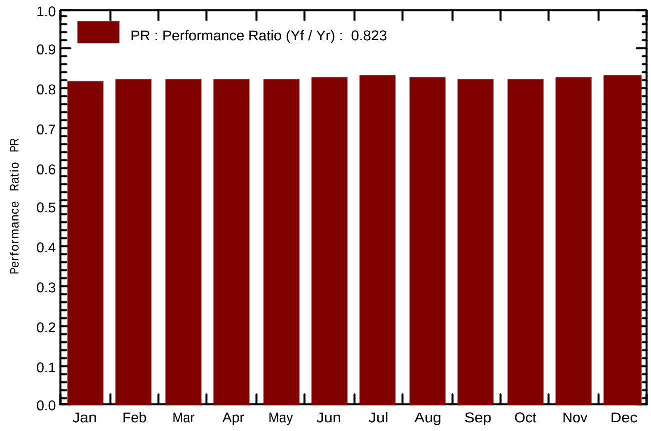
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	10.23 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



working couple (6kw)

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	133.0	82.20	28.10	136.3	131.2	0.726	0.360	0.039	0.673	0.321
February	134.6	67.90	27.70	137.4	132.8	0.737	0.313	0.033	0.690	0.279
March	149.8	88.20	28.00	150.3	144.9	0.804	0.344	0.038	0.751	0.306
April	140.3	70.50	27.70	138.8	133.9	0.742	0.328	0.035	0.693	0.294
May	140.3	78.60	28.60	136.9	131.7	0.734	0.360	0.039	0.680	0.320
June	132.0	77.80	27.80	128.3	123.5	0.691	0.328	0.034	0.643	0.295
July	134.4	87.20	27.80	131.1	125.8	0.710	0.344	0.037	0.660	0.307
August	132.2	87.20	27.80	130.1	125.2	0.700	0.360	0.038	0.649	0.322
September	129.2	79.00	27.10	128.8	124.0	0.691	0.313	0.033	0.645	0.280
October	138.8	82.60	27.40	140.4	135.5	0.754	0.360	0.033	0.706	0.326
November	117.6	79.20	26.70	119.8	115.4	0.648	0.344	0.030	0.605	0.314
December	115.0	73.20	26.29	118.1	113.6	0.640	0.328	0.030	0.597	0.298
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	4.080	0.417	7.992	3.663

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

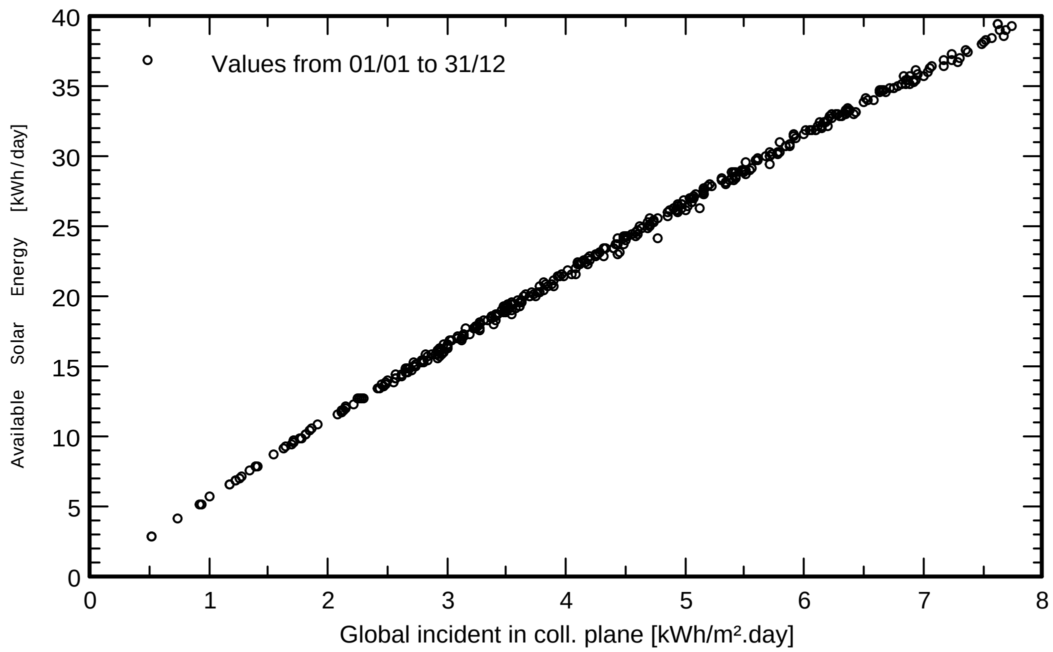
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

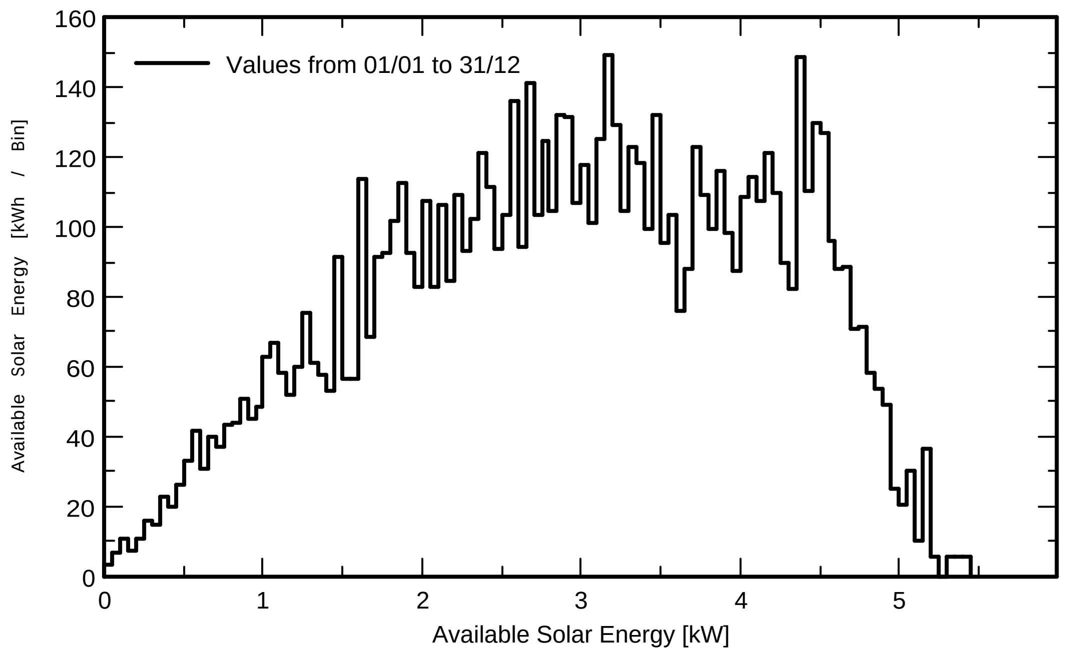
Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Daily Input/Output diagram



System Output Power Distribution



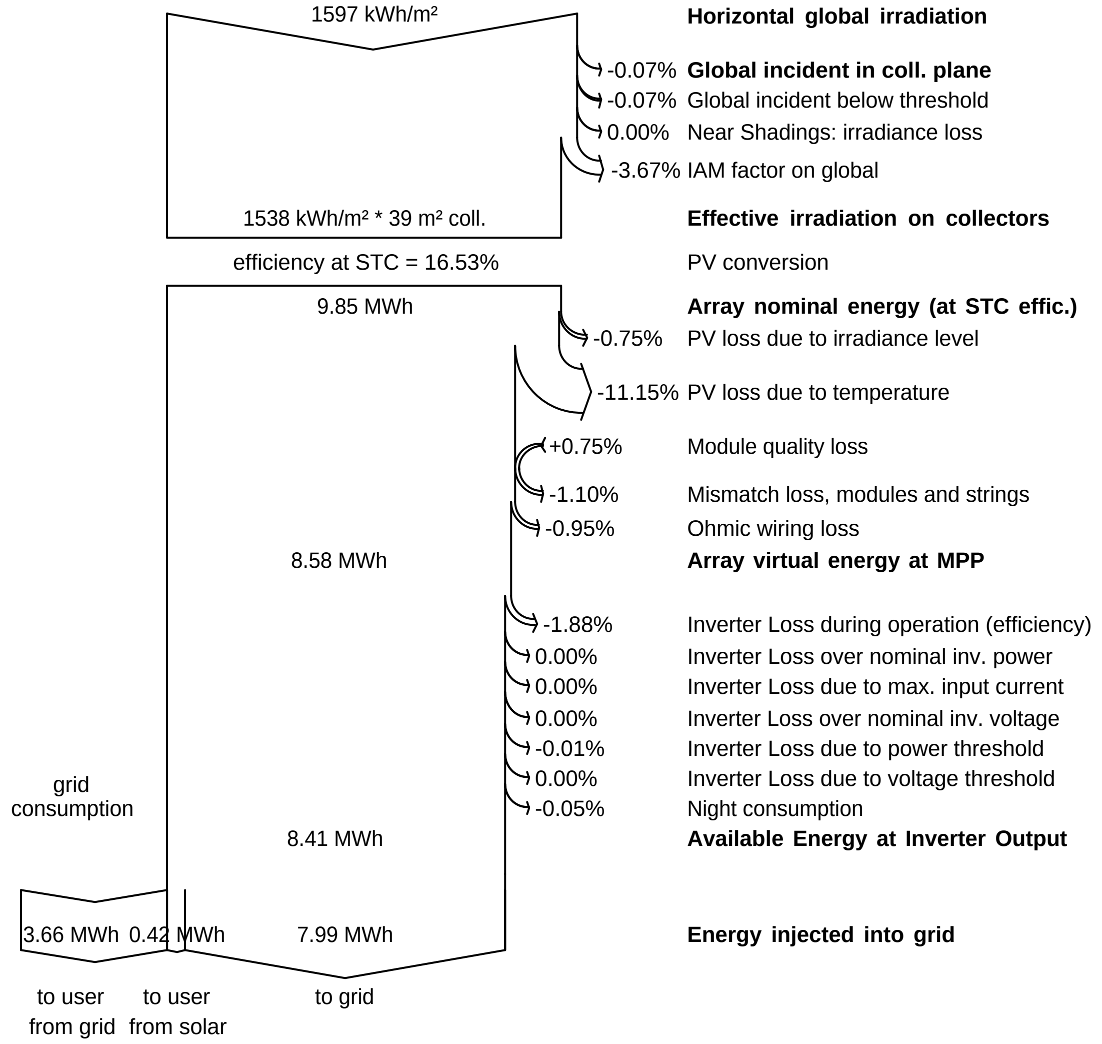
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

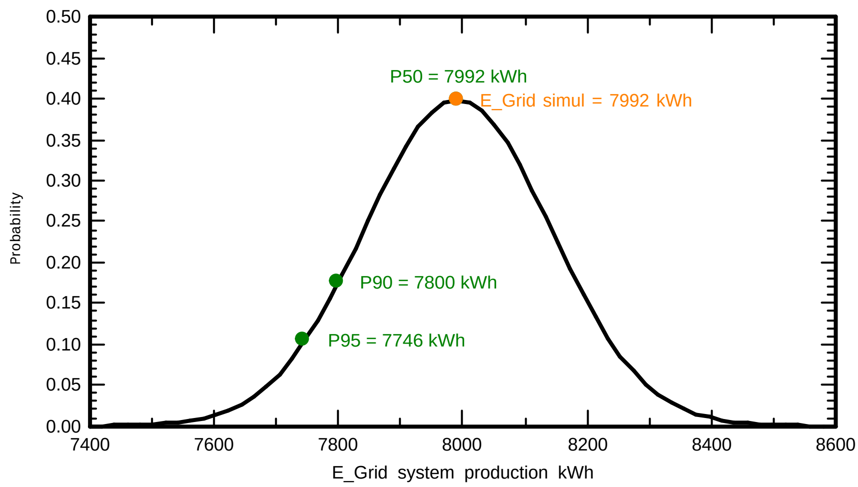
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.15 MWh**
	P50	**7.99 MWh**
	P90	**7.80 MWh**
	P95	**7.75 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : working couple (6kw)

Simulation date	21/04/20 17h39	

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	6.9 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²

Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

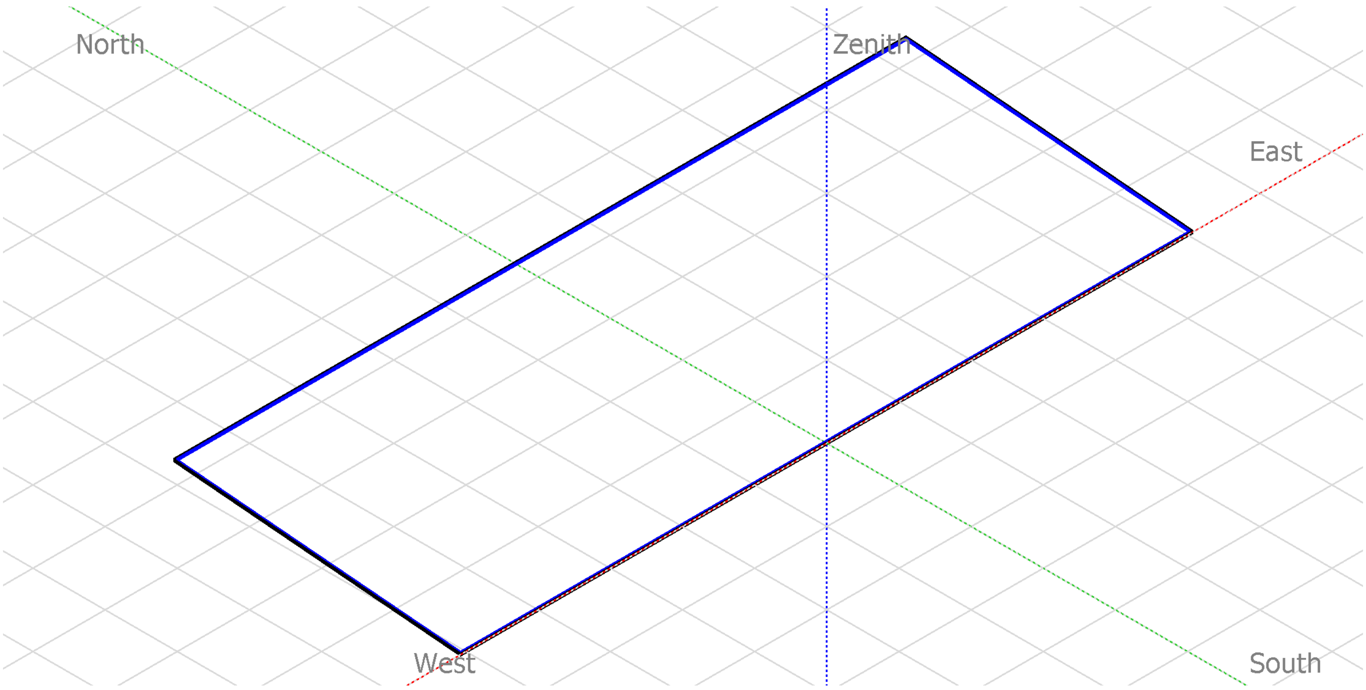
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

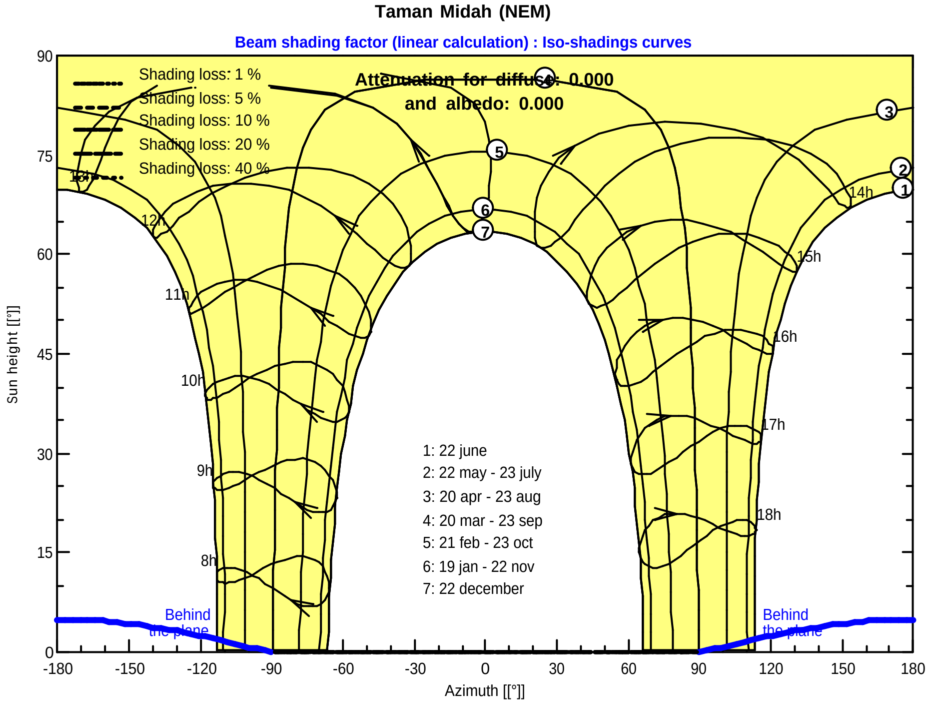
Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

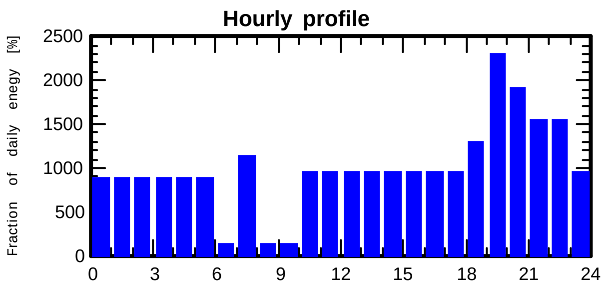
Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Daily household consumers, Constant over the year, average = 6.9 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	20	18 W/lamp	5 h/day	1800 Wh/day
TV / PC / Mobile	1	70 W/app	14 h/day	980 Wh/day
Iron	1	1200 W/app	1 h/day	600 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	2	750 W tot	10 h/day	15000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				23904 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

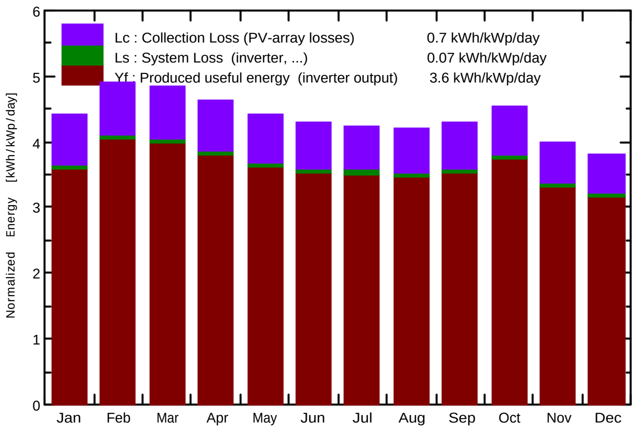
Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

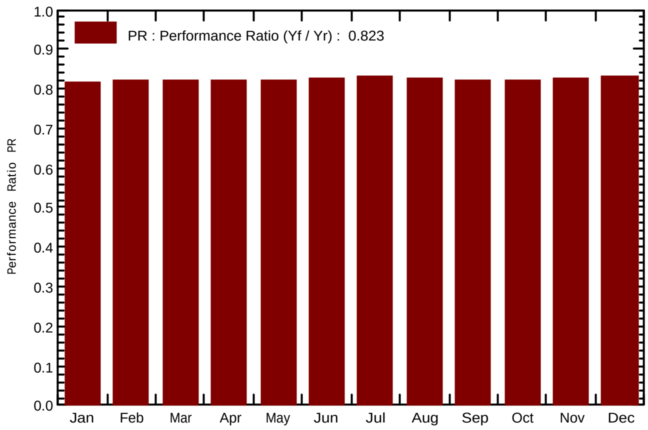
Main simulation results

System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	32.49 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



working couple (6kw)

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	133.0	82.20	28.10	136.3	131.2	0.726	0.239	0.080	0.632	0.159
February	134.6	67.90	27.70	137.4	132.8	0.737	0.191	0.067	0.656	0.124
March	149.8	88.20	28.00	150.3	144.9	0.804	0.191	0.066	0.723	0.125
April	140.3	70.50	27.70	138.8	133.9	0.742	0.215	0.072	0.656	0.143
May	140.3	78.60	28.60	136.9	131.7	0.734	0.215	0.069	0.651	0.146
June	132.0	77.80	27.80	128.3	123.5	0.691	0.191	0.060	0.617	0.131
July	134.4	87.20	27.80	131.1	125.8	0.710	0.239	0.081	0.615	0.158
August	132.2	87.20	27.80	130.1	125.2	0.700	0.191	0.056	0.630	0.136
September	129.2	79.00	27.10	128.8	124.0	0.691	0.191	0.061	0.616	0.130
October	138.8	82.60	27.40	140.4	135.5	0.754	0.239	0.079	0.660	0.160
November	117.6	79.20	26.70	119.8	115.4	0.648	0.191	0.058	0.577	0.134
December	115.0	73.20	26.29	118.1	113.6	0.640	0.215	0.067	0.560	0.148
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	2.510	0.816	7.593	1.694

Legends:

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

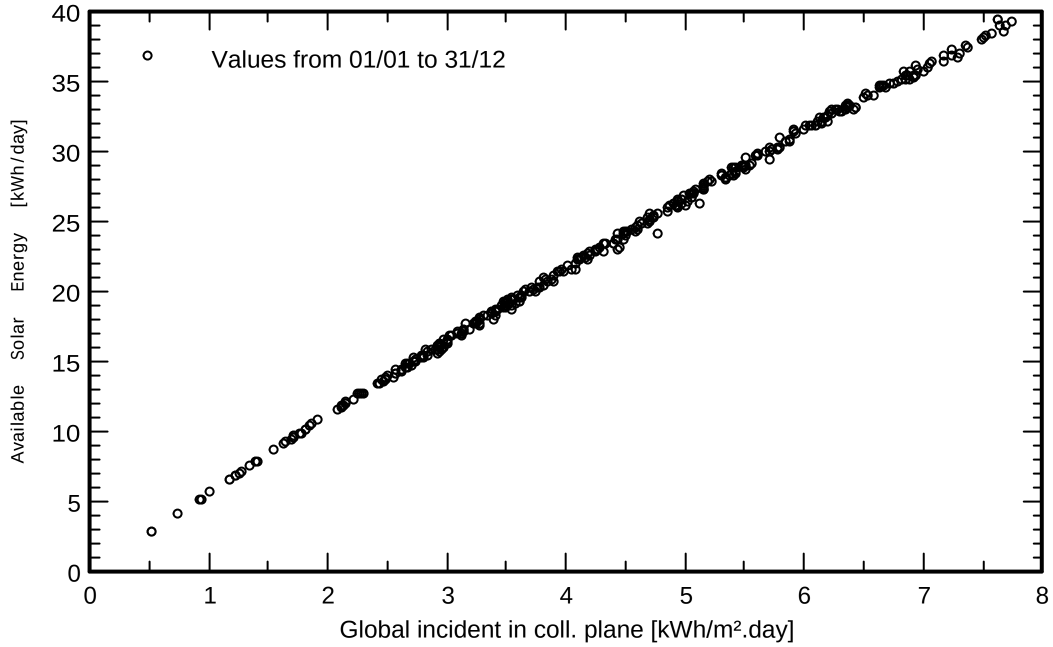
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

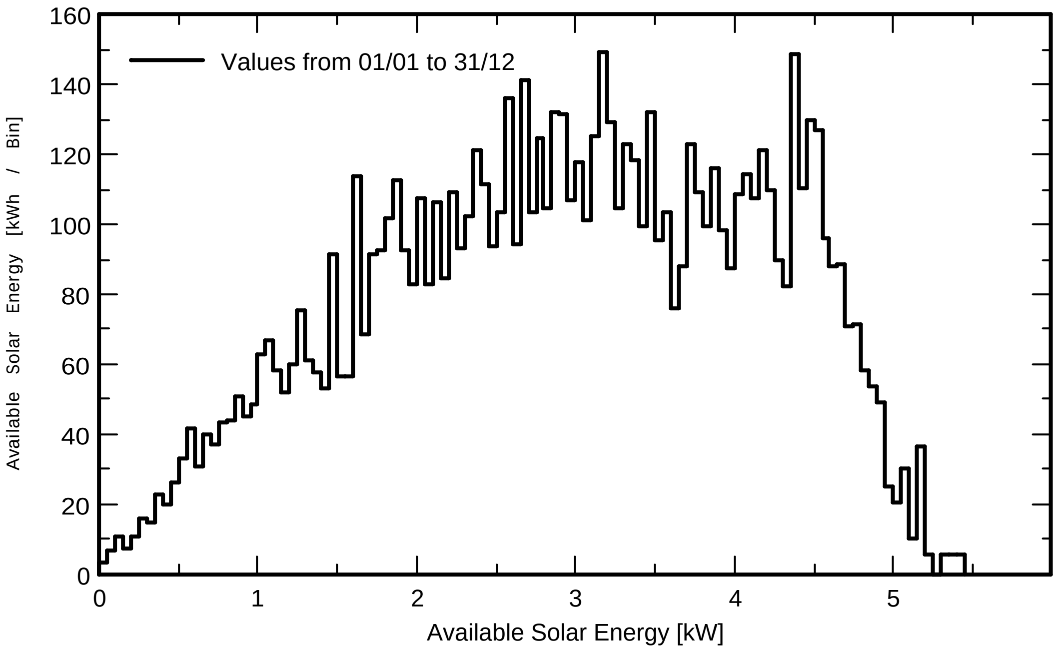
Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Daily Input/Output diagram



System Output Power Distribution



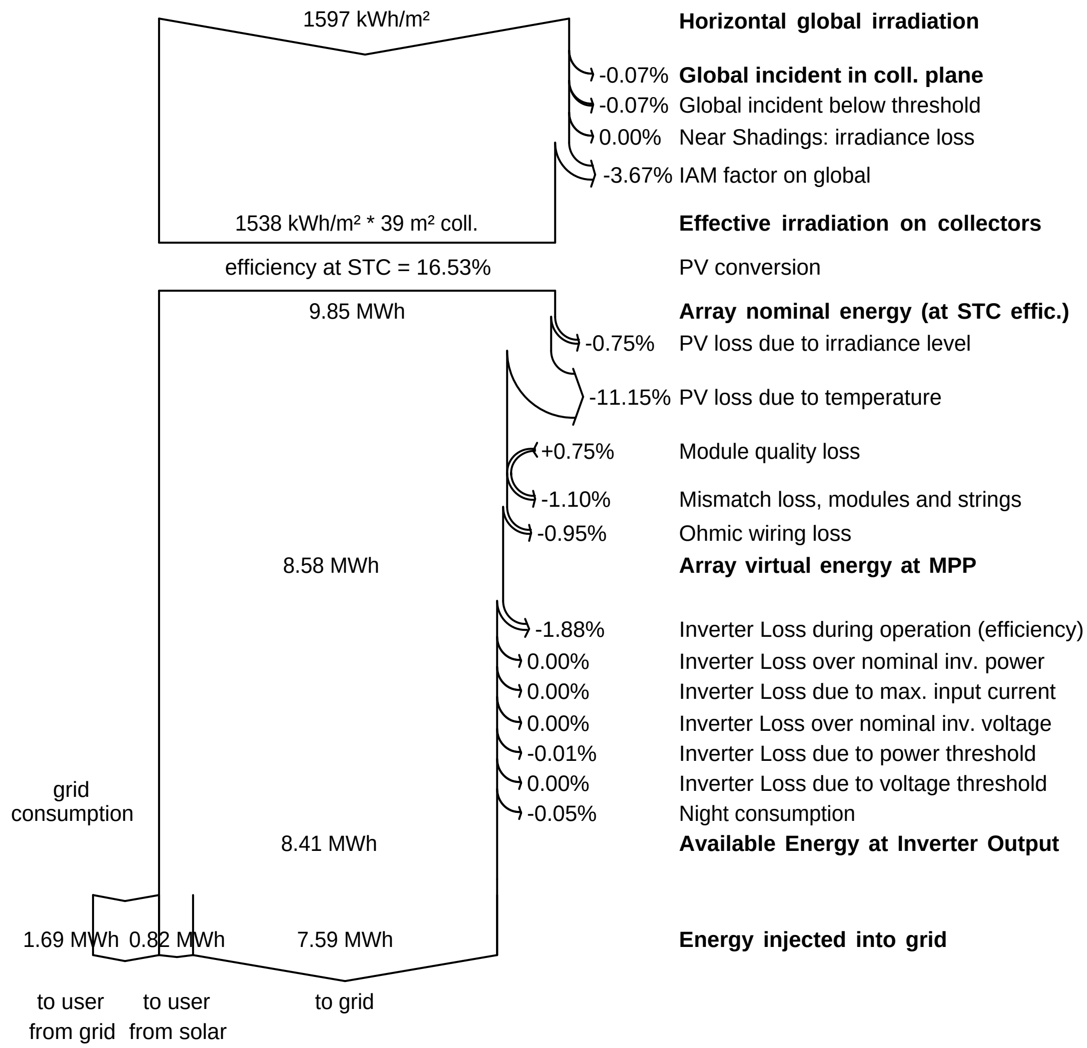
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

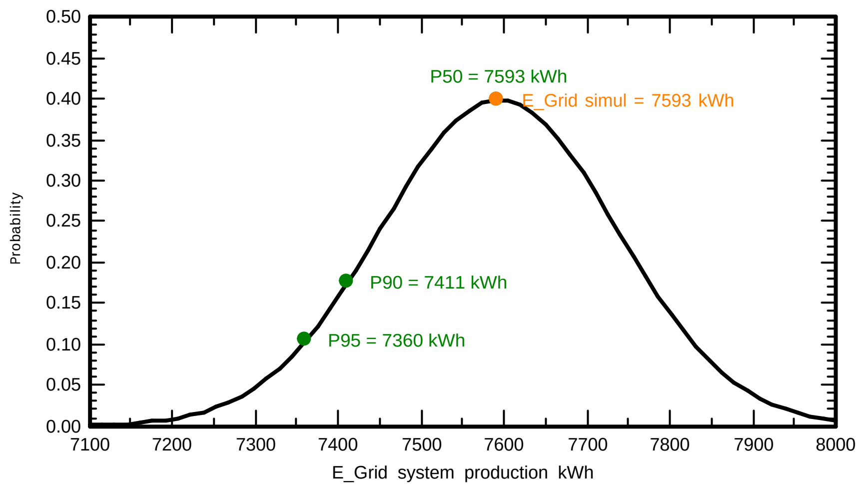
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.14 MWh**
	P50	**7.59 MWh**
	P90	**7.41 MWh**
	P95	**7.36 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **Small family - 6kw**

Simulation date 21/04/20 17h17

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	19.4 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

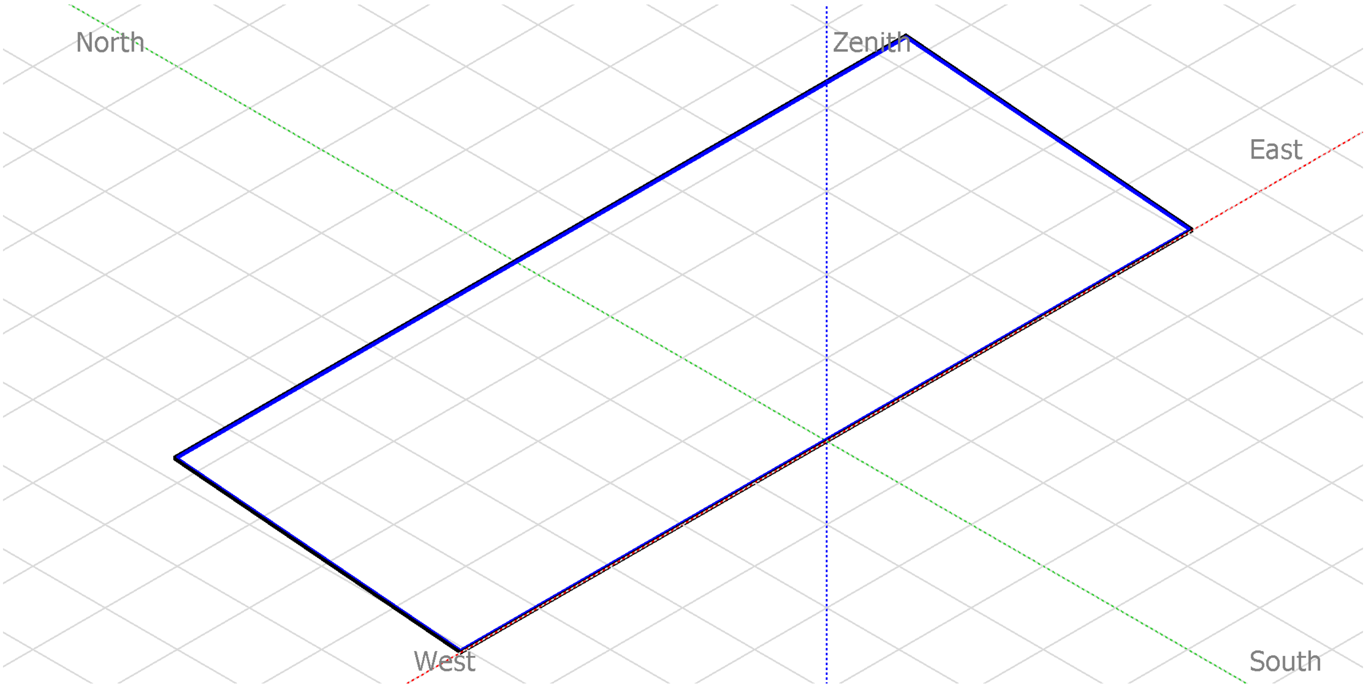
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

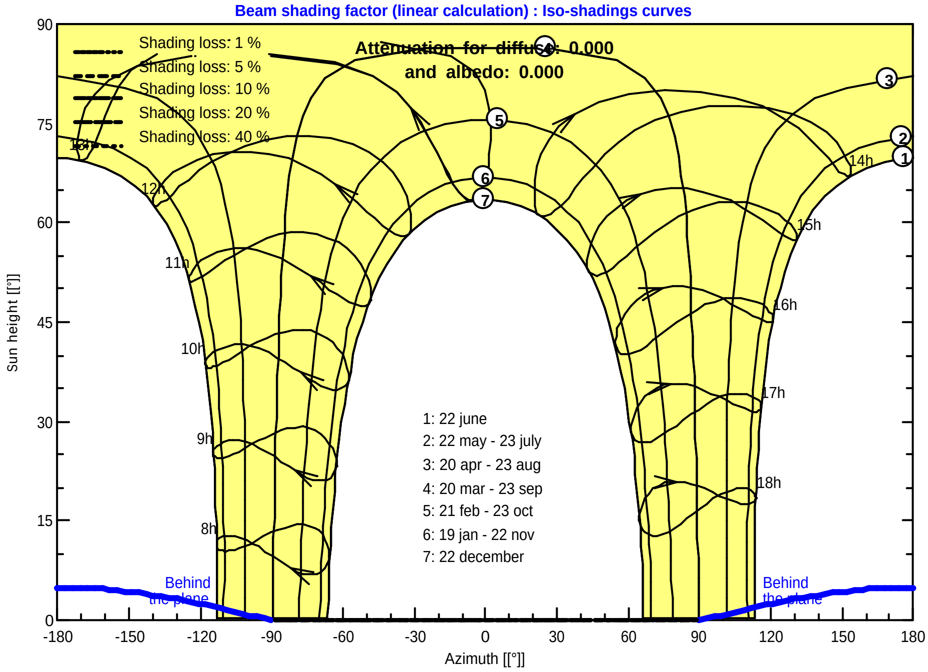
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Taman Midah (NEM)

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



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

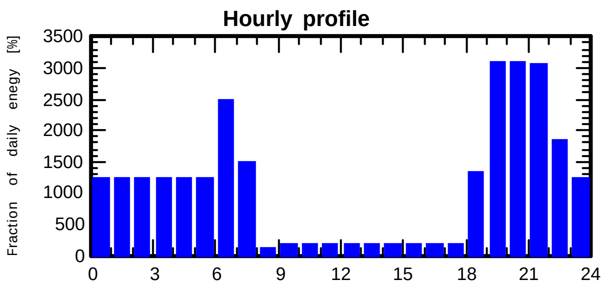
Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Daily household consumers, Constant over the year, average = 19.4 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	26	18 W/lamp	5 h/day	2340 Wh/day
TV / PC / Mobile	2	70 W/app	9 h/day	1260 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	2 h/day	3000 Wh/day
Aircond	3	750 W tot	7 h/day	15750 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				27074 Wh/day



Grid-Connected System: Main results

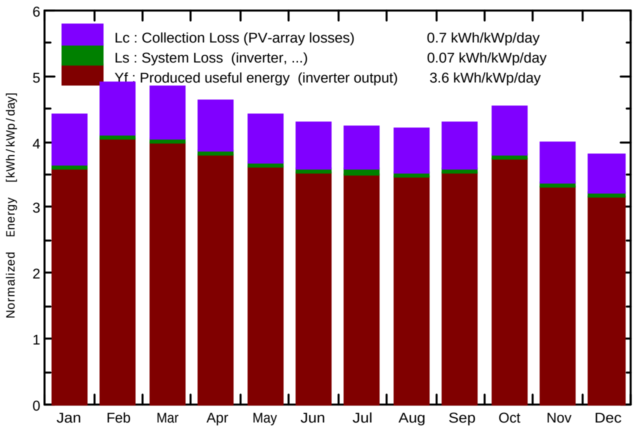
Project : **Taman Midah (NEM)**

Simulation variant : **Small family - 6kw**

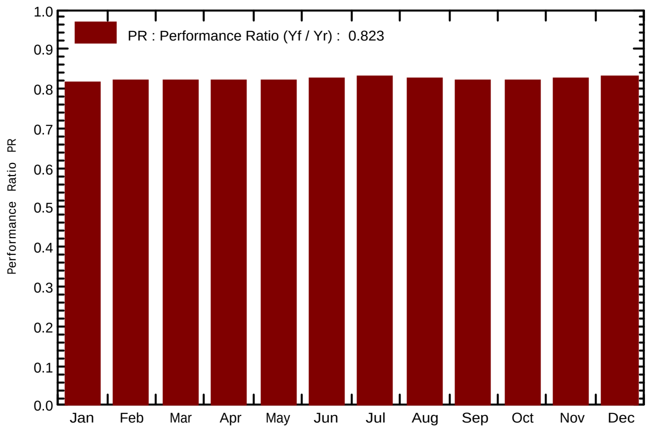
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	8.37 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



Small family - 6kw

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	133.0	82.20	28.10	136.3	131.2	0.726	0.623	0.055	0.656	0.567
February	134.6	67.90	27.70	137.4	132.8	0.737	0.541	0.048	0.675	0.493
March	149.8	88.20	28.00	150.3	144.9	0.804	0.596	0.054	0.734	0.541
April	140.3	70.50	27.70	138.8	133.9	0.742	0.569	0.049	0.679	0.520
May	140.3	78.60	28.60	136.9	131.7	0.734	0.623	0.054	0.665	0.569
June	132.0	77.80	27.80	128.3	123.5	0.691	0.569	0.047	0.630	0.522
July	134.4	87.20	27.80	131.1	125.8	0.710	0.596	0.051	0.645	0.544
August	132.2	87.20	27.80	130.1	125.2	0.700	0.623	0.053	0.634	0.570
September	129.2	79.00	27.10	128.8	124.0	0.691	0.541	0.046	0.632	0.496
October	138.8	82.60	27.40	140.4	135.5	0.754	0.623	0.048	0.692	0.575
November	117.6	79.20	26.70	119.8	115.4	0.648	0.596	0.043	0.591	0.552
December	115.0	73.20	26.29	118.1	113.6	0.640	0.569	0.043	0.584	0.525
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	7.066	0.592	7.817	6.475

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

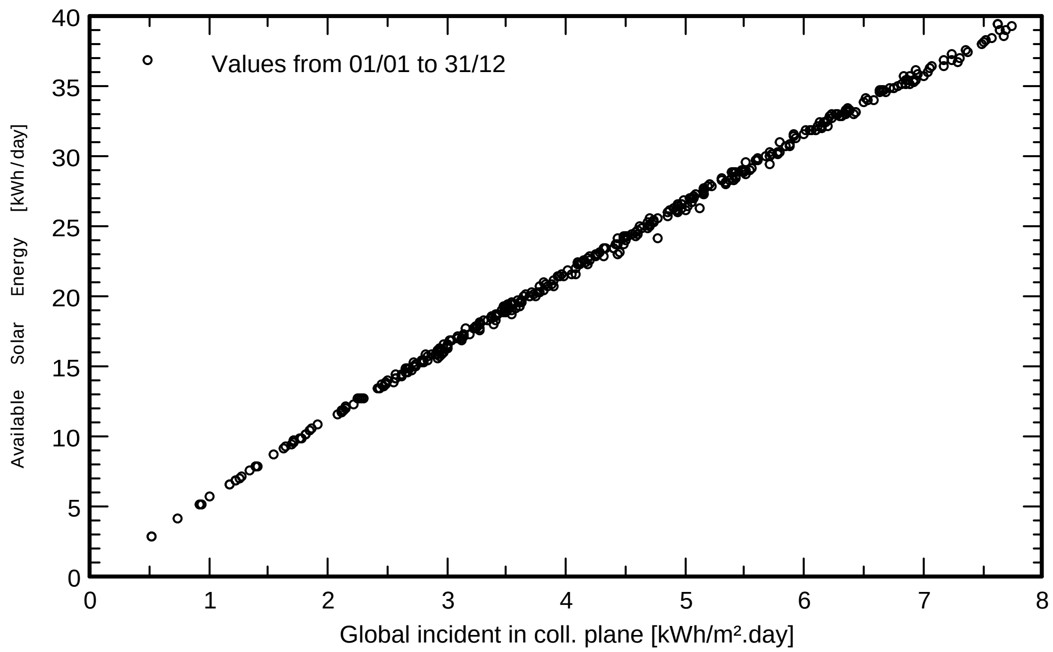
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

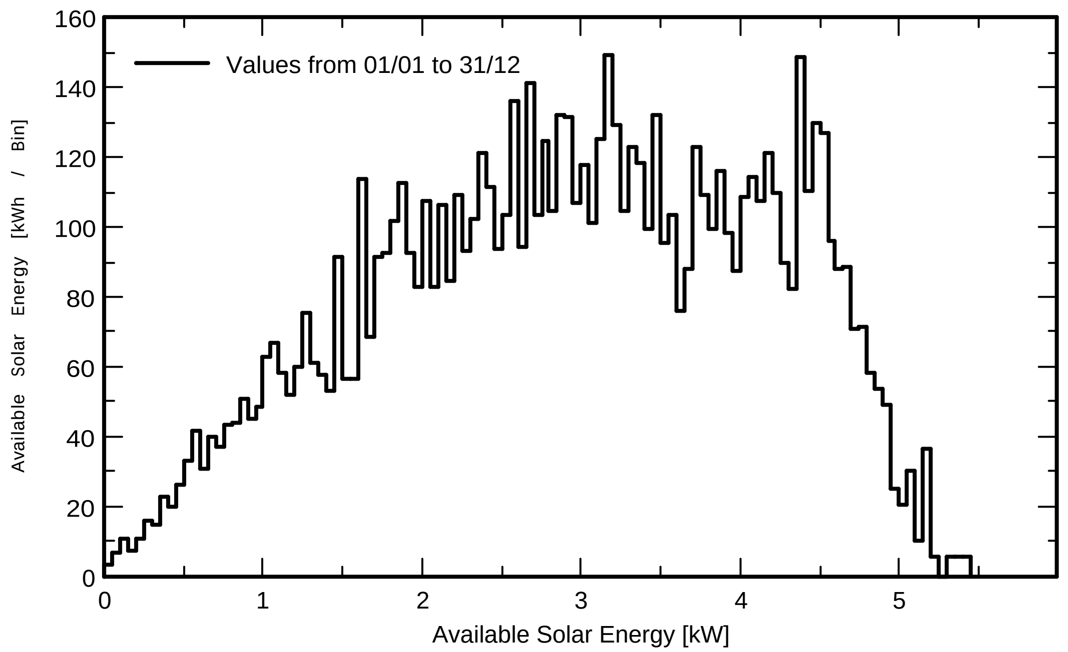
Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Daily Input/Output diagram



System Output Power Distribution



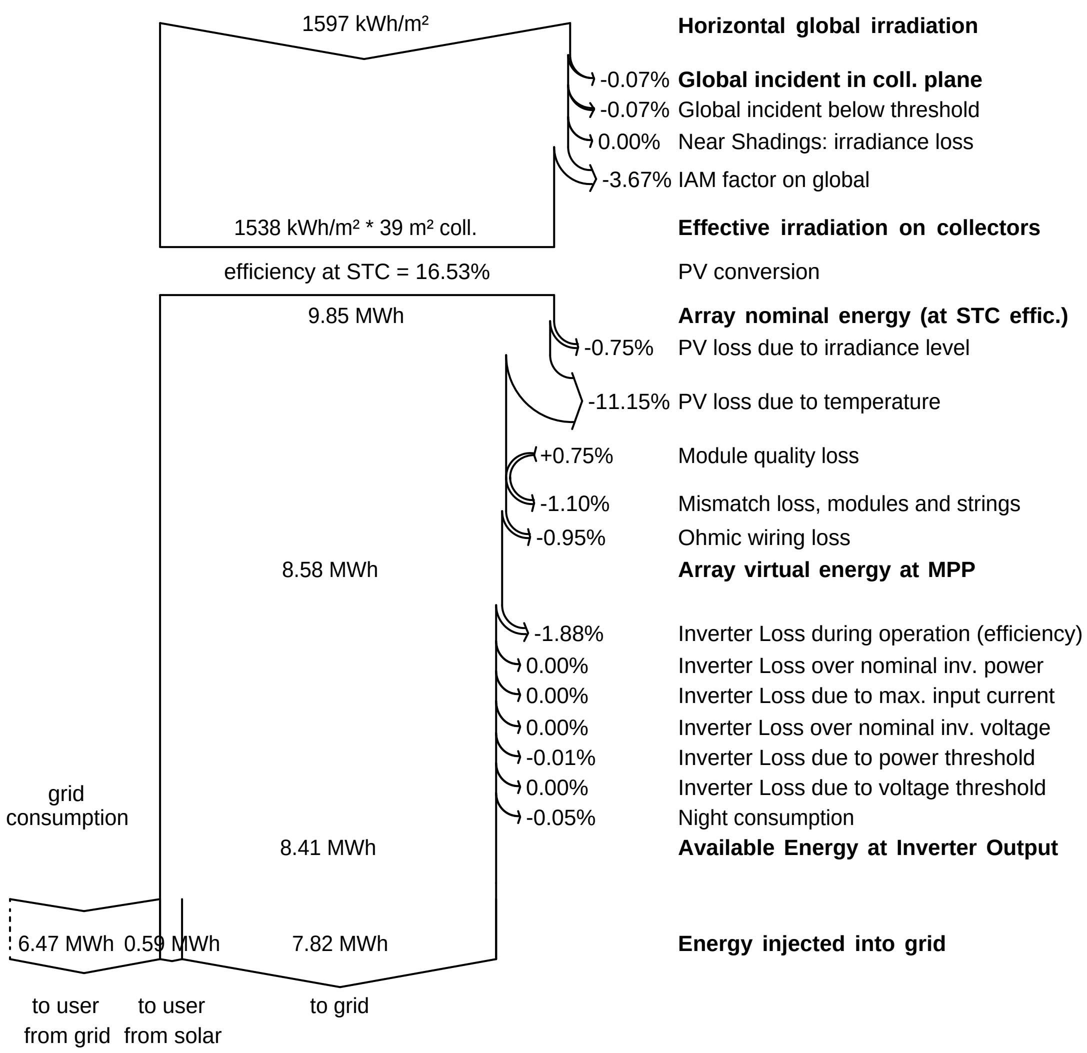
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

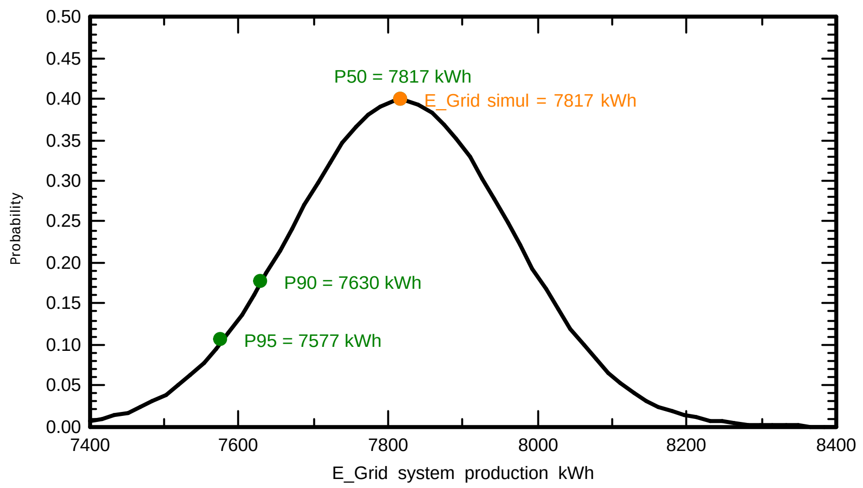
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.15 MWh**
	P50	**7.82 MWh**
	P90	**7.63 MWh**
	P95	**7.58 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **Small family - 6kw**

	Simulation date	21/04/20 17h21

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	9.9 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	10 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	20	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)		U mpp	336 V	I mpp	17 A
Total area		Module area	**38.8 m²**	Cell area	34.4 m²

Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

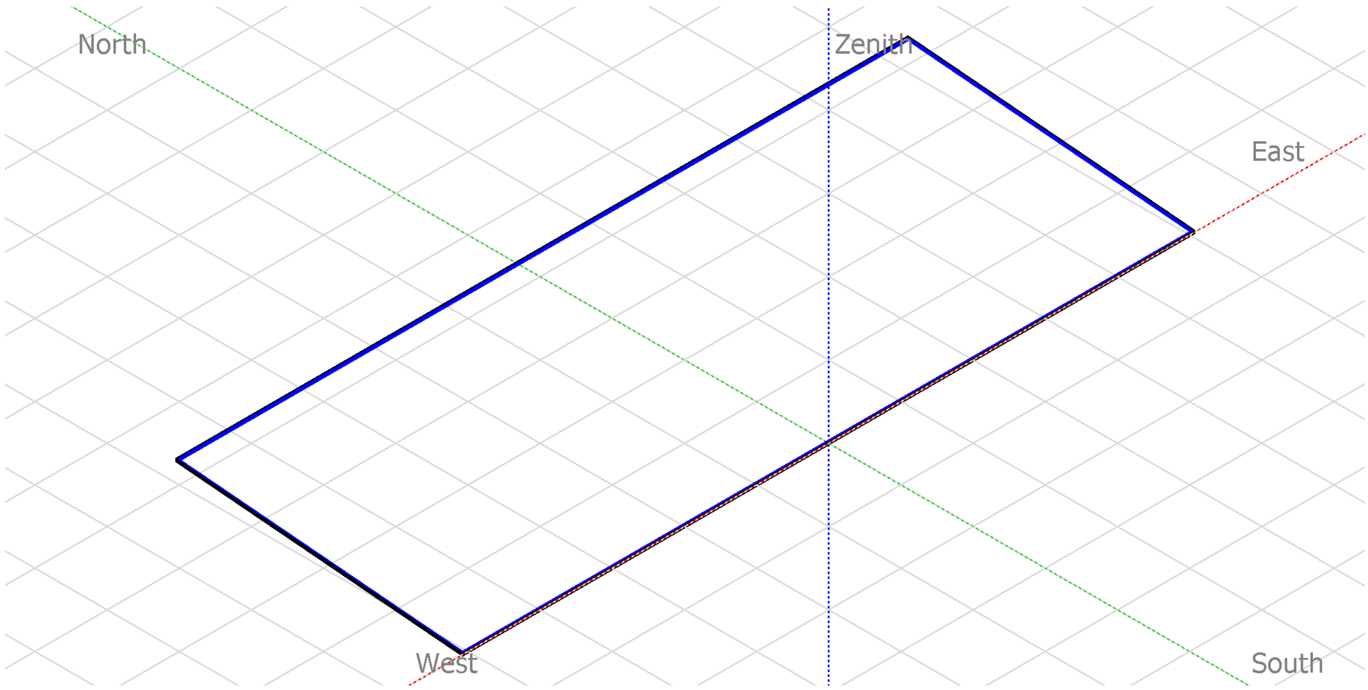
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

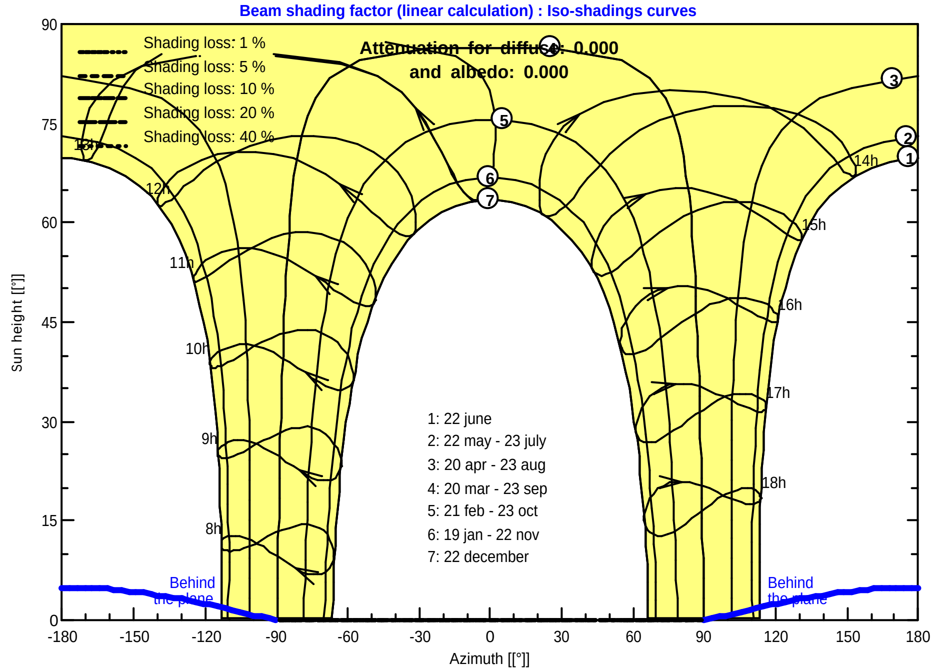
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Taman Midah (NEM)

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



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

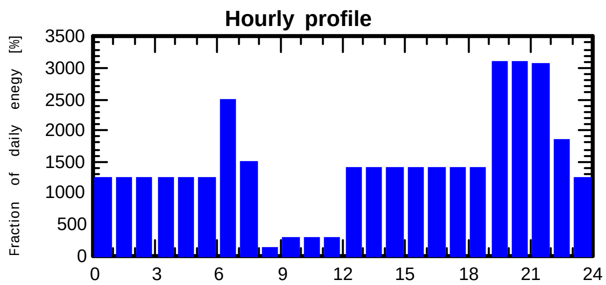
Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Daily household consumers, Constant over the year, average = 9.9 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	26	18 W/lamp	5 h/day	2340 Wh/day
TV / PC / Mobile	2	70 W/app	14 h/day	1960 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	2 h/day	3000 Wh/day
Aircond	3	750 W tot	10 h/day	22500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				34524 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

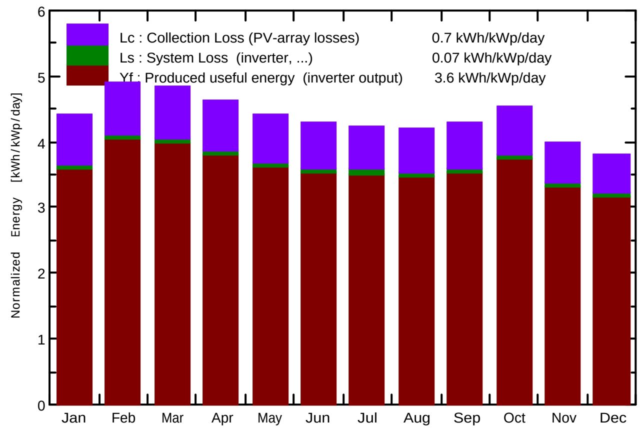
Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

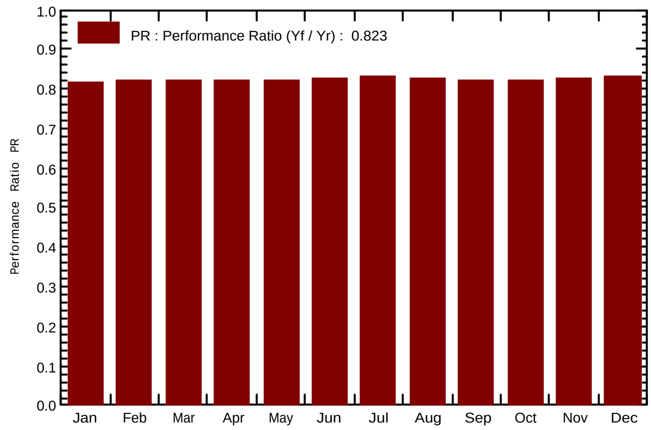
Main simulation results

System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	25.20 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



Small family - 6kw

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	133.0	82.20	28.10	136.3	131.2	0.726	0.345	0.090	0.622	0.255
February	134.6	67.90	27.70	137.4	132.8	0.737	0.276	0.078	0.645	0.198
March	149.8	88.20	28.00	150.3	144.9	0.804	0.276	0.076	0.712	0.200
April	140.3	70.50	27.70	138.8	133.9	0.742	0.311	0.080	0.648	0.231
May	140.3	78.60	28.60	136.9	131.7	0.734	0.311	0.075	0.644	0.236
June	132.0	77.80	27.80	128.3	123.5	0.691	0.276	0.066	0.611	0.210
July	134.4	87.20	27.80	131.1	125.8	0.710	0.345	0.092	0.604	0.253
August	132.2	87.20	27.80	130.1	125.2	0.700	0.276	0.062	0.624	0.214
September	129.2	79.00	27.10	128.8	124.0	0.691	0.276	0.067	0.610	0.209
October	138.8	82.60	27.40	140.4	135.5	0.754	0.345	0.091	0.649	0.255
November	117.6	79.20	26.70	119.8	115.4	0.648	0.276	0.062	0.572	0.214
December	115.0	73.20	26.29	118.1	113.6	0.640	0.311	0.073	0.554	0.237
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	3.625	0.914	7.495	2.712

Legends:

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

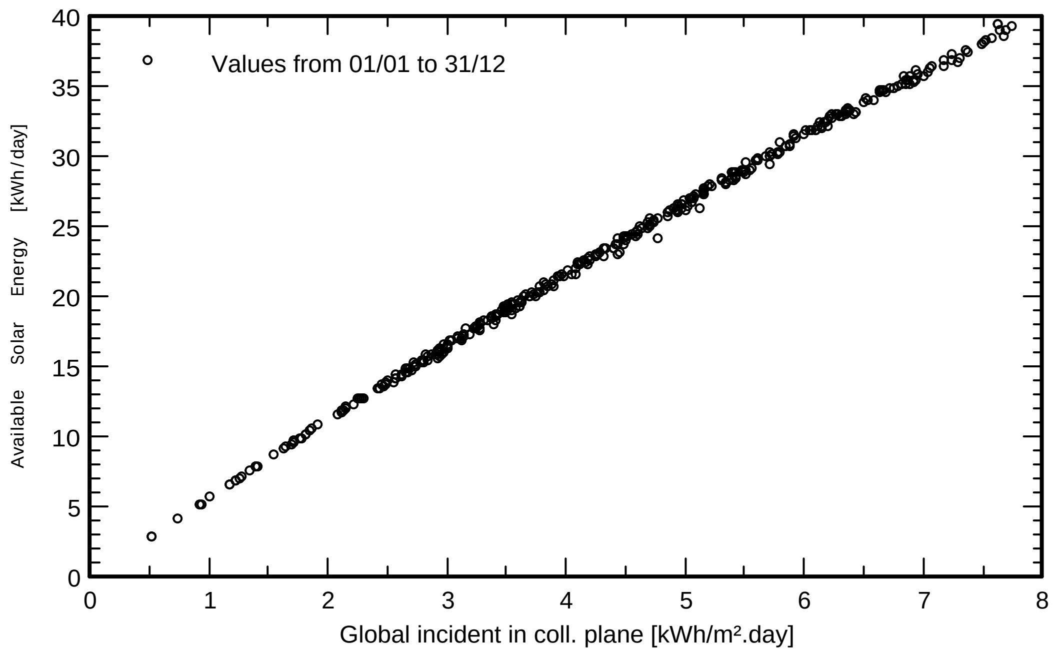
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

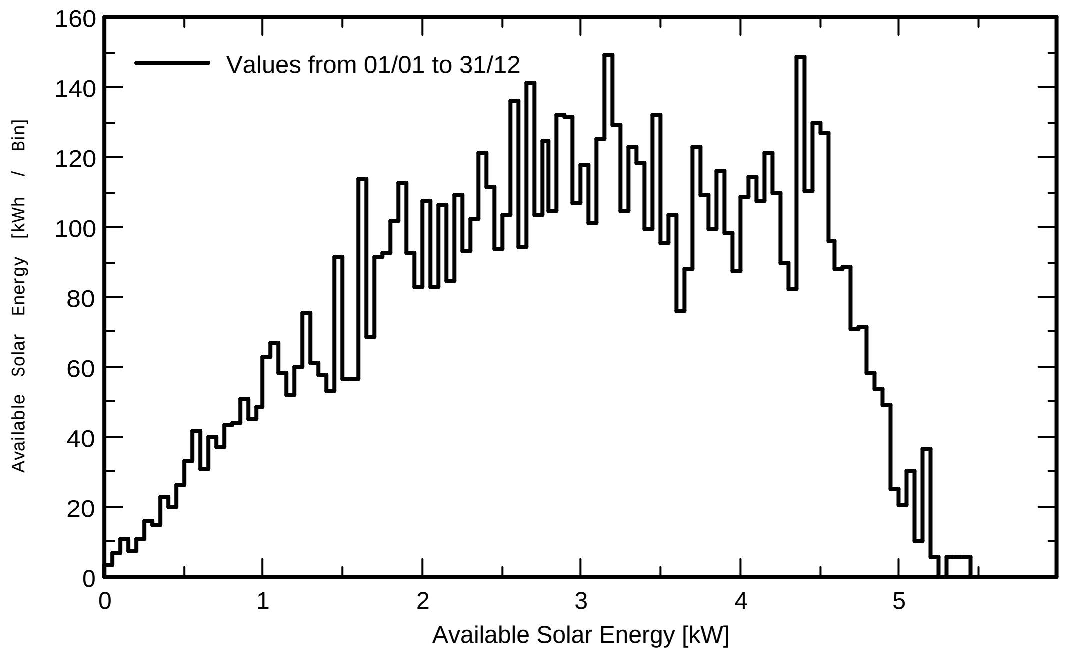
Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Daily Input/Output diagram



System Output Power Distribution



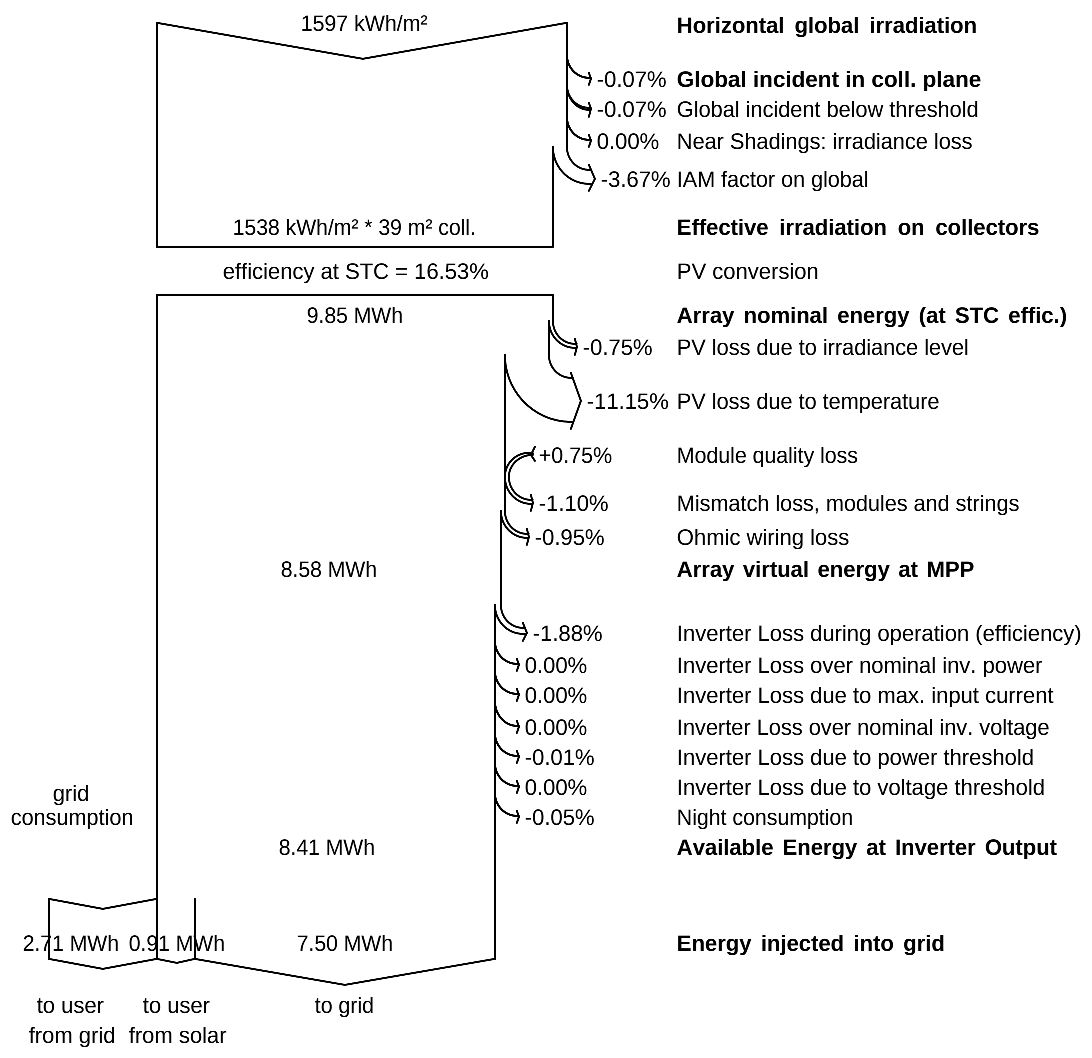
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

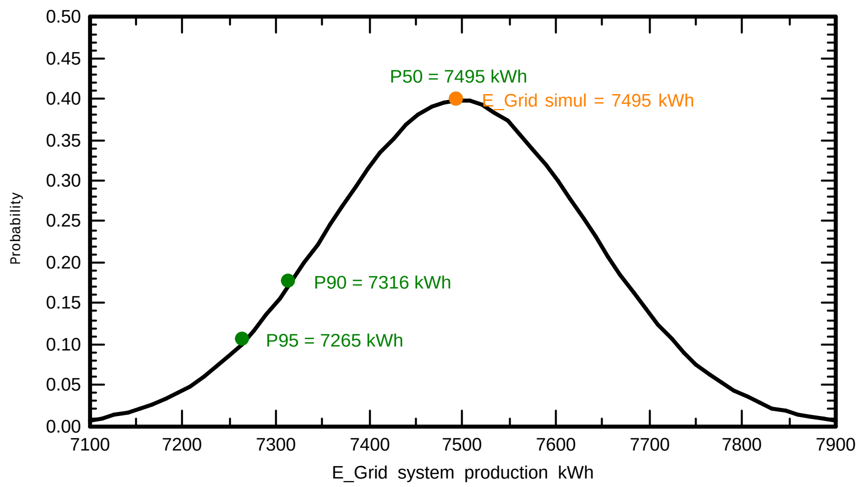
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.14 MWh**
	P50	**7.50 MWh**
	P90	**7.32 MWh**
	P95	**7.27 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **small family - 9kw**

	Simulation date	21/04/20 17h22

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	19.4 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

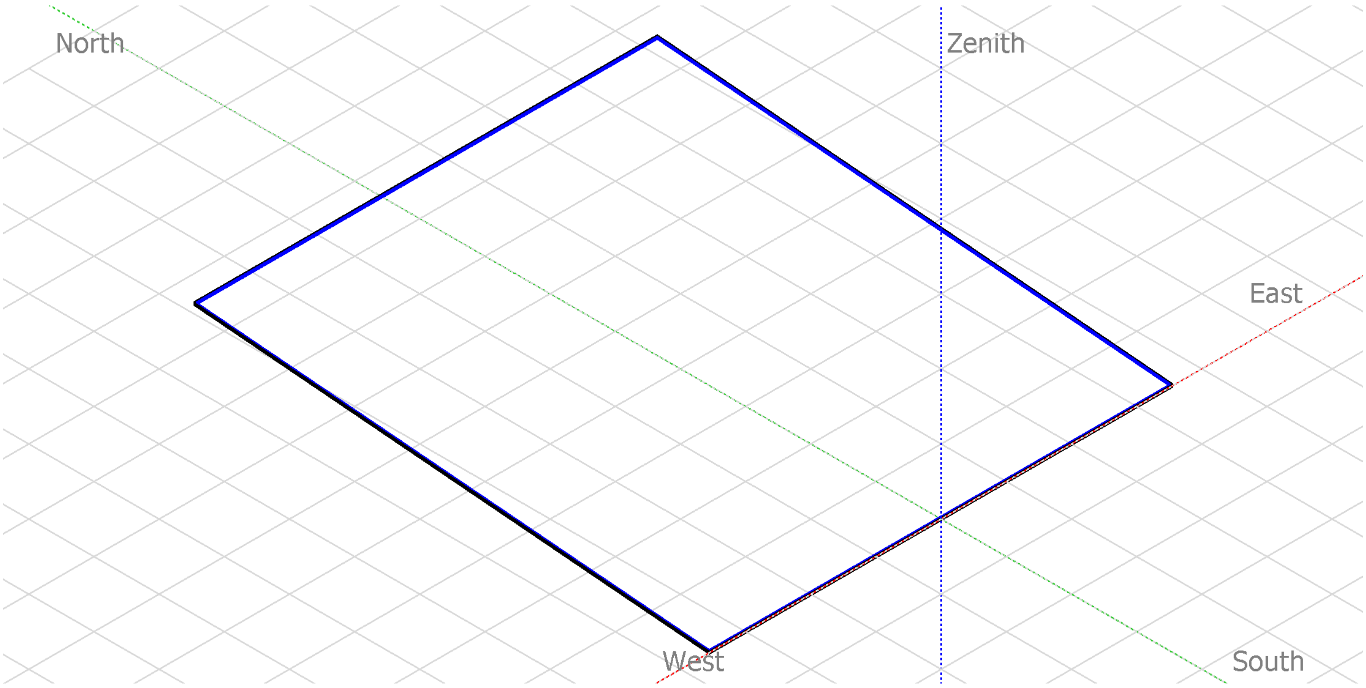
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

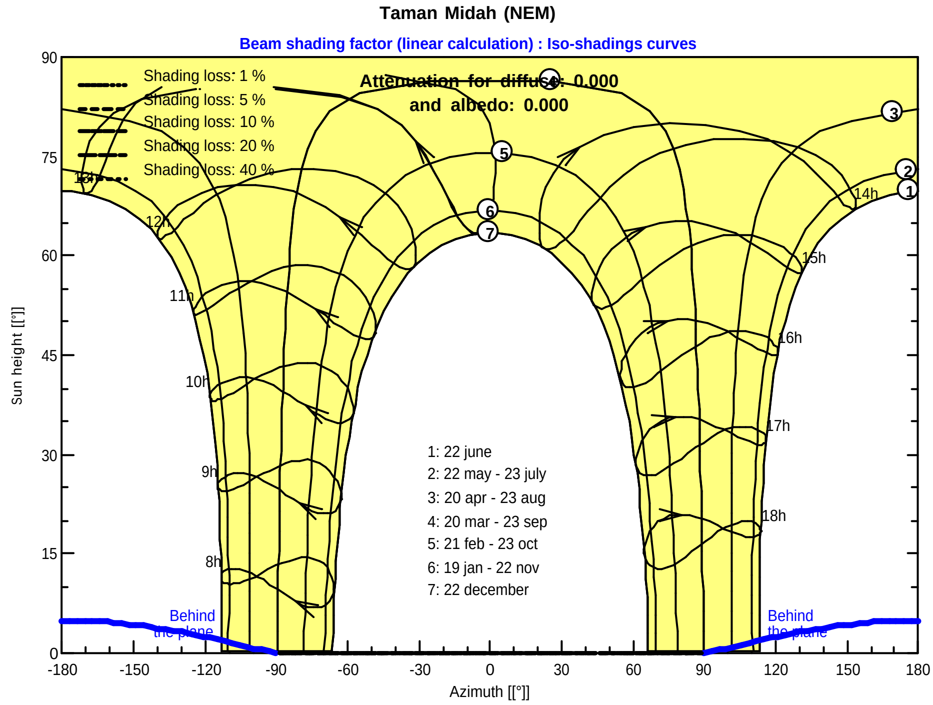
Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

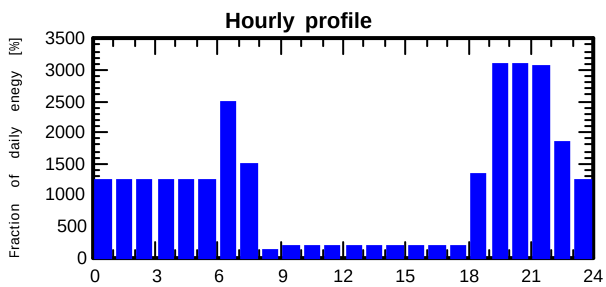
Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Daily household consumers, Constant over the year, average = 19.4 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	26	18 W/lamp	5 h/day	2340 Wh/day
TV / PC / Mobile	2	70 W/app	9 h/day	1260 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	2 h/day	3000 Wh/day
Aircond	3	750 W tot	7 h/day	15750 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				27074 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

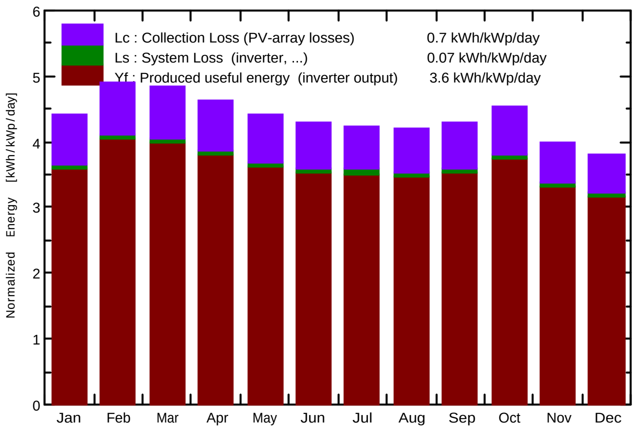
Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

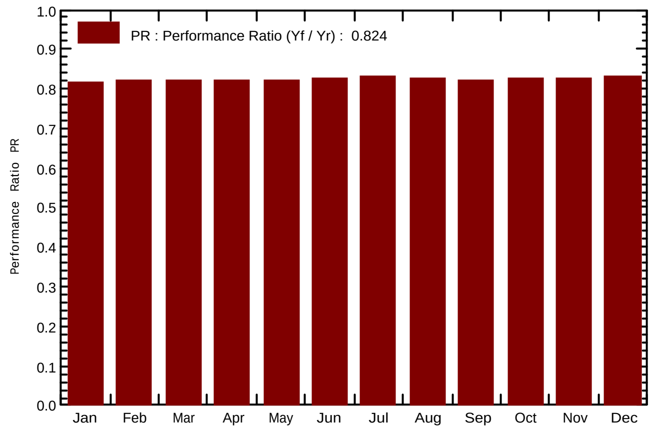
Main simulation results

System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	82.40 %	Solar Fraction SF	8.99 %

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



small family - 9kw

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	133.0	82.20	28.10	136.3	131.2	1.016	0.623	0.061	0.937	0.562
February	134.6	67.90	27.70	137.4	132.8	1.031	0.541	0.053	0.961	0.489
March	149.8	88.20	28.00	150.3	144.9	1.125	0.596	0.060	1.046	0.536
April	140.3	70.50	27.70	138.8	133.9	1.039	0.569	0.053	0.967	0.516
May	140.3	78.60	28.60	136.9	131.7	1.027	0.623	0.058	0.950	0.564
June	132.0	77.80	27.80	128.3	123.5	0.967	0.569	0.050	0.899	0.518
July	134.4	87.20	27.80	131.1	125.8	0.994	0.596	0.055	0.920	0.540
August	132.2	87.20	27.80	130.1	125.2	0.980	0.623	0.057	0.905	0.566
September	129.2	79.00	27.10	128.8	124.0	0.968	0.541	0.050	0.900	0.492
October	138.8	82.60	27.40	140.4	135.5	1.056	0.623	0.050	0.987	0.573
November	117.6	79.20	26.70	119.8	115.4	0.907	0.596	0.044	0.845	0.551
December	115.0	73.20	26.29	118.1	113.6	0.896	0.569	0.045	0.834	0.523
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	7.066	0.635	11.149	6.431

Legends:

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

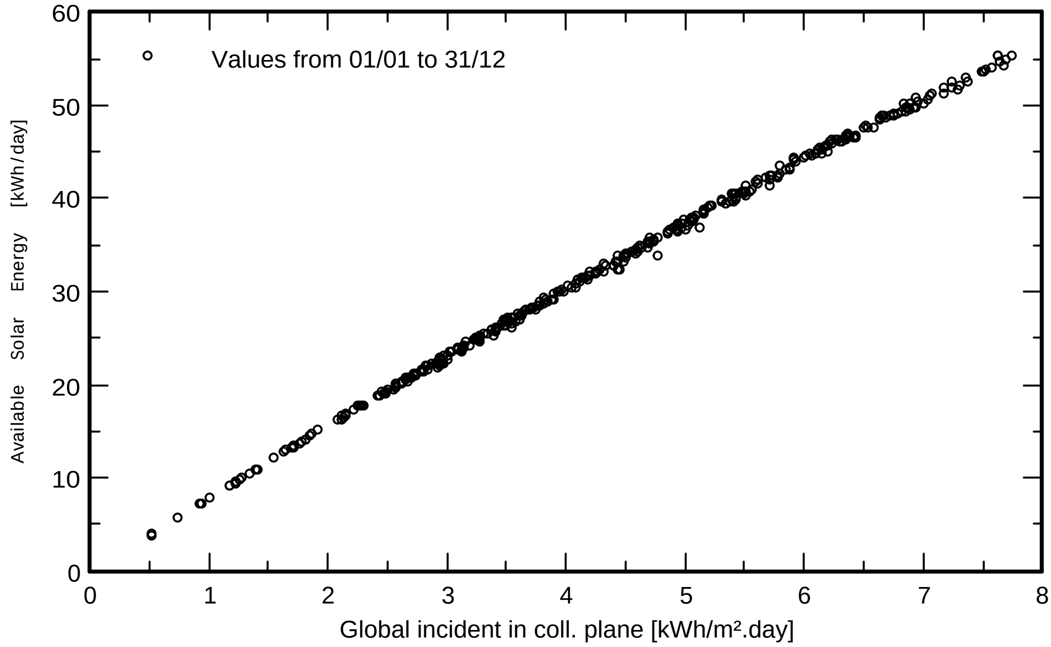
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

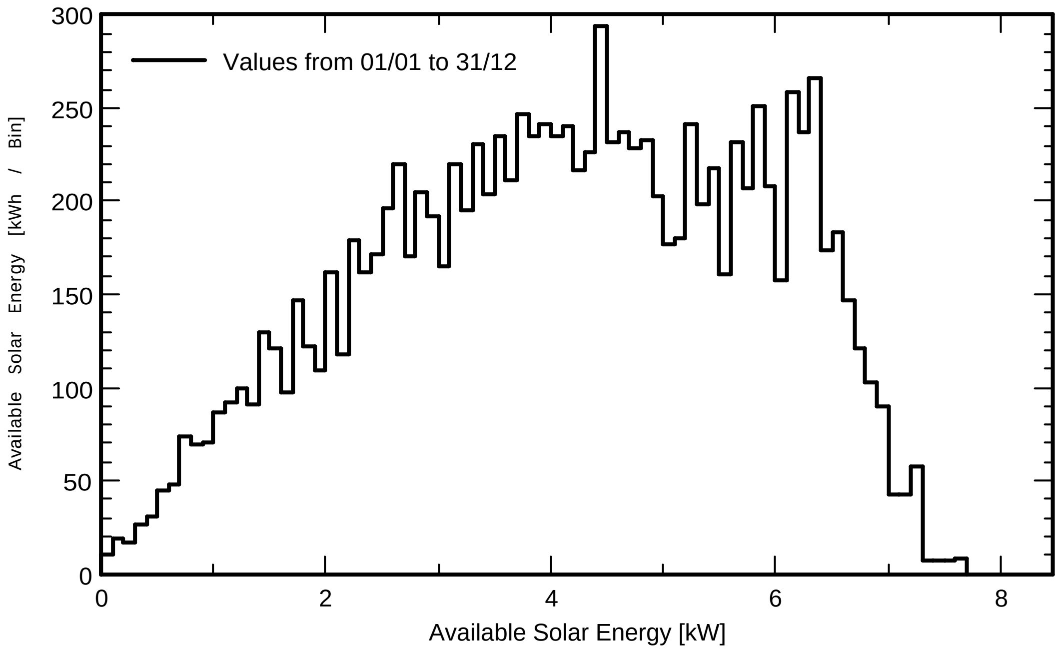
Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Daily Input/Output diagram



System Output Power Distribution



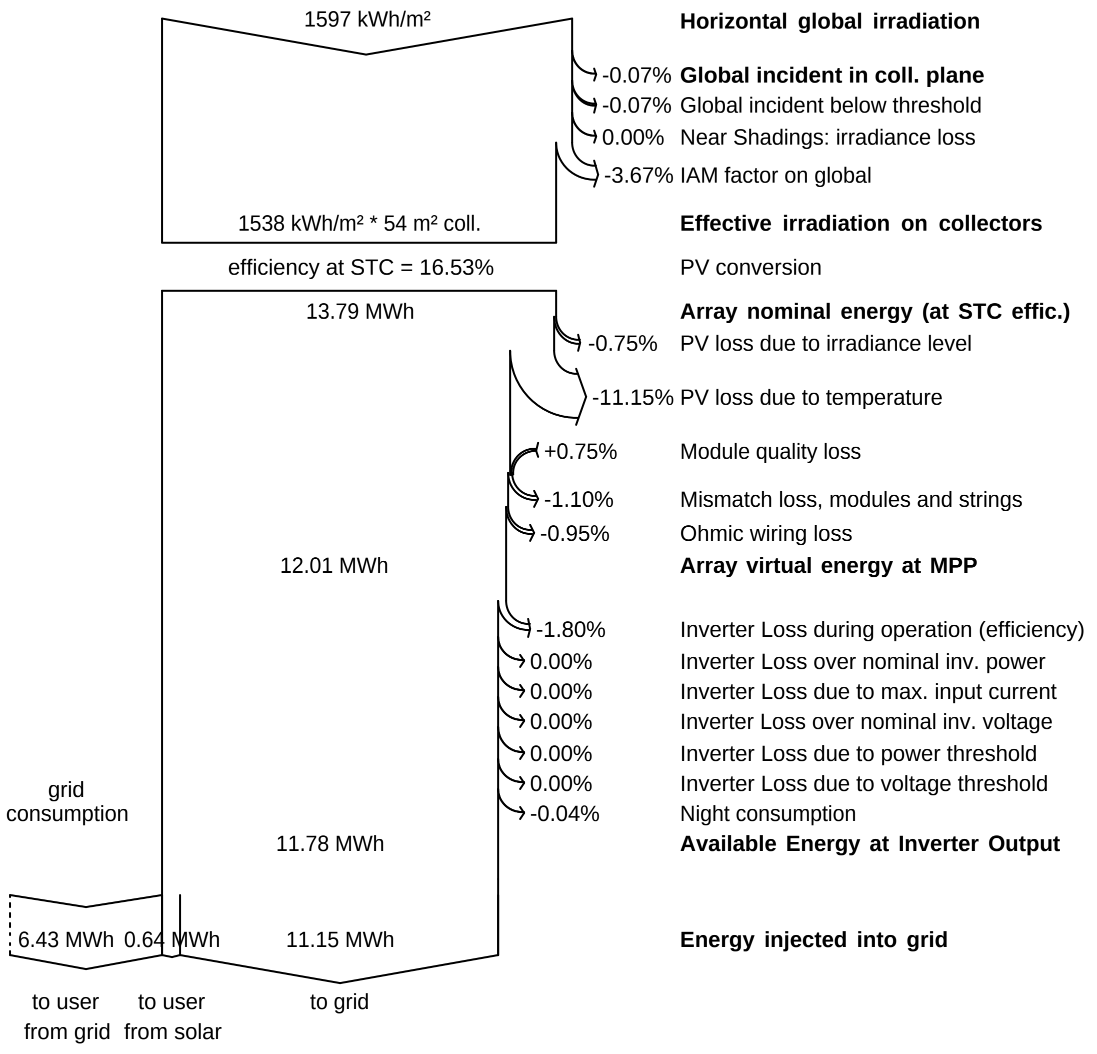
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

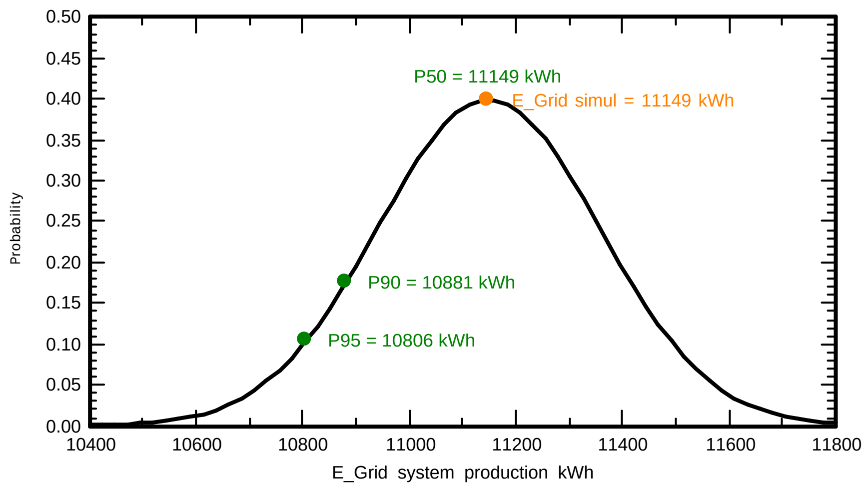
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.21 MWh**
	P50	**11.15 MWh**
	P90	**10.88 MWh**
	P95	**10.81 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project :	**Taman Midah (NEM)**			
Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant :	**small family - 9kw**	
	Simulation date	21/04/20 17h24

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	9.9 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	14 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	28	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)		U mpp	470 V	I mpp	17 A
Total area		Module area	**54.3 m²**	Cell area	48.2 m²

Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

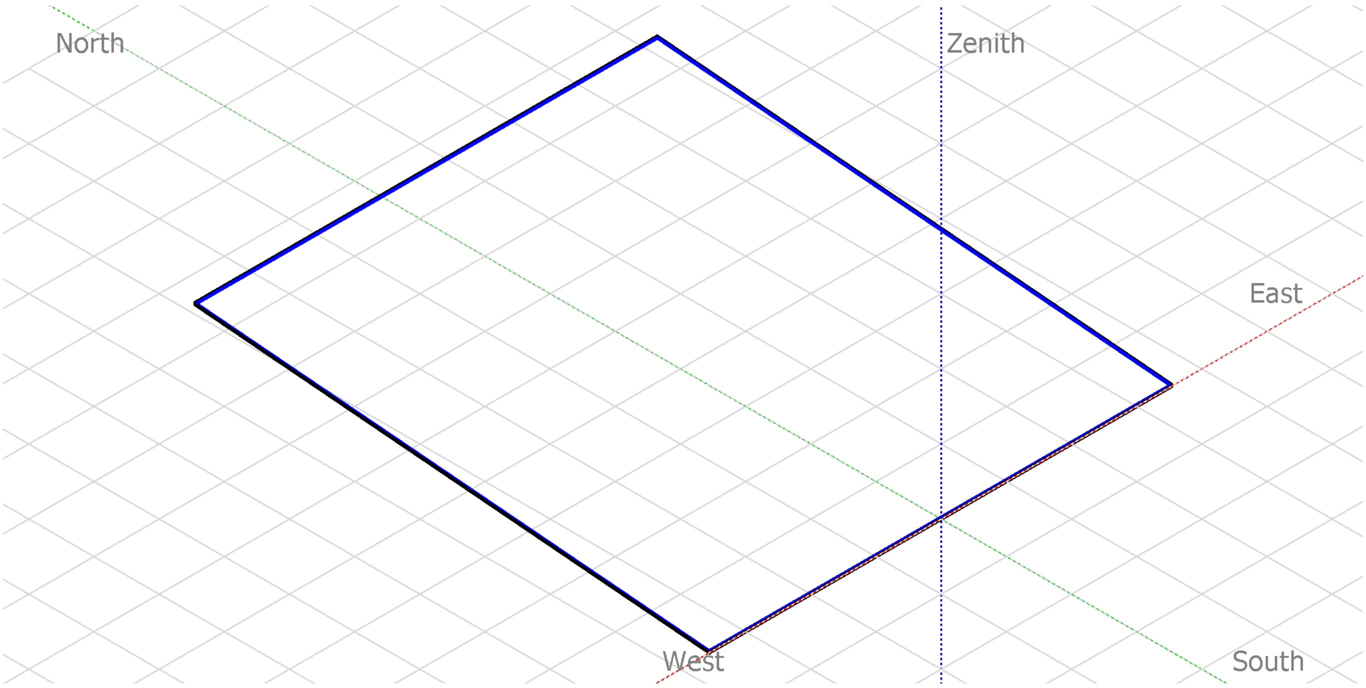
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

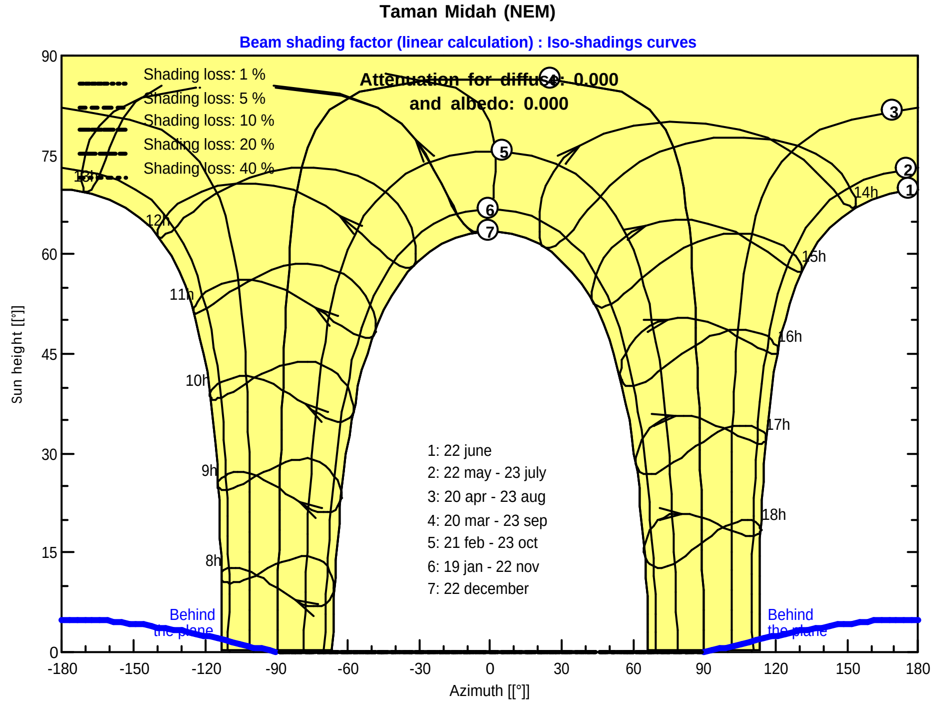
Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

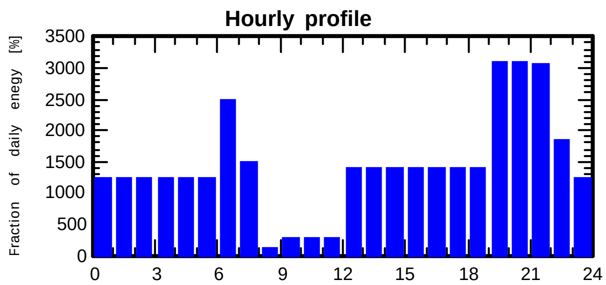
Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Daily household consumers, Constant over the year, average = 9.9 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	26	18 W/lamp	5 h/day	2340 Wh/day
TV / PC / Mobile	2	70 W/app	14 h/day	1960 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	2 h/day	3000 Wh/day
Aircond	3	750 W tot	10 h/day	22500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				34524 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

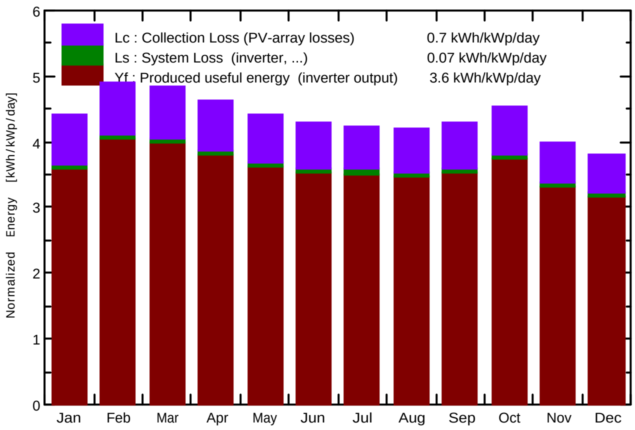
Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

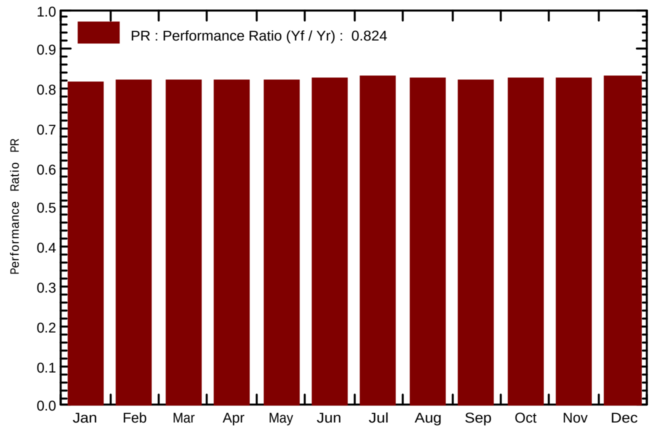
Main simulation results

System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	82.40 %	Solar Fraction SF	26.68 %

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



small family - 9kw

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	133.0	82.20	28.10	136.3	131.2	1.016	0.345	0.095	0.902	0.250
February	134.6	67.90	27.70	137.4	132.8	1.031	0.276	0.081	0.933	0.196
March	149.8	88.20	28.00	150.3	144.9	1.125	0.276	0.079	1.026	0.197
April	140.3	70.50	27.70	138.8	133.9	1.039	0.311	0.085	0.935	0.226
May	140.3	78.60	28.60	136.9	131.7	1.027	0.311	0.082	0.926	0.229
June	132.0	77.80	27.80	128.3	123.5	0.967	0.276	0.070	0.879	0.206
July	134.4	87.20	27.80	131.1	125.8	0.994	0.345	0.097	0.878	0.248
August	132.2	87.20	27.80	130.1	125.2	0.980	0.276	0.066	0.896	0.210
September	129.2	79.00	27.10	128.8	124.0	0.968	0.276	0.073	0.877	0.203
October	138.8	82.60	27.40	140.4	135.5	1.056	0.345	0.094	0.943	0.251
November	117.6	79.20	26.70	119.8	115.4	0.907	0.276	0.067	0.822	0.209
December	115.0	73.20	26.29	118.1	113.6	0.896	0.311	0.078	0.801	0.232
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	3.625	0.967	10.817	2.658

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

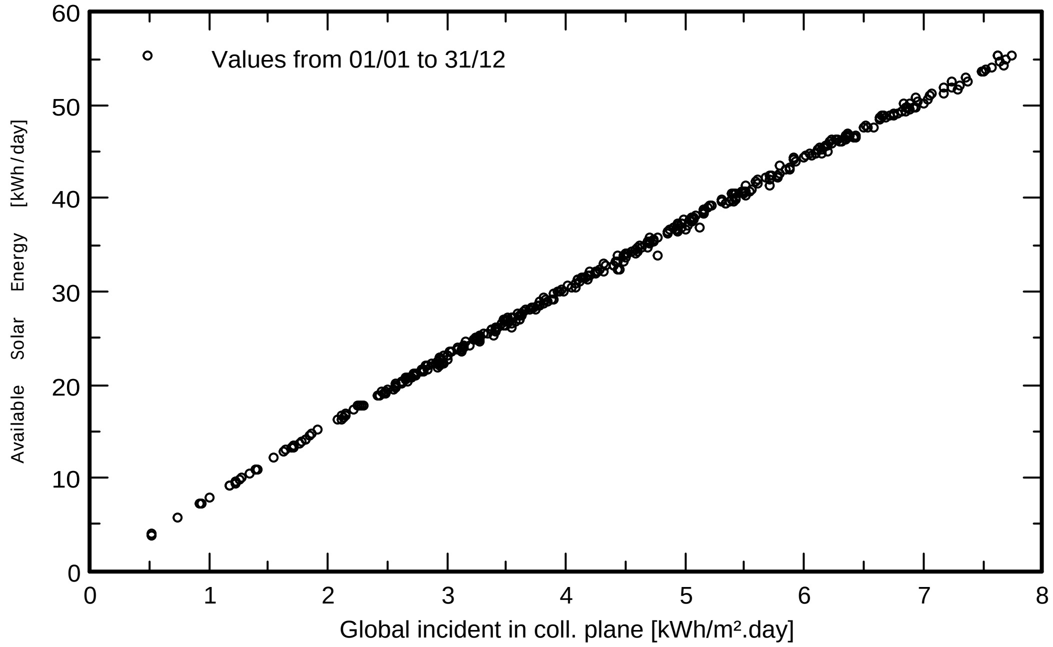
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

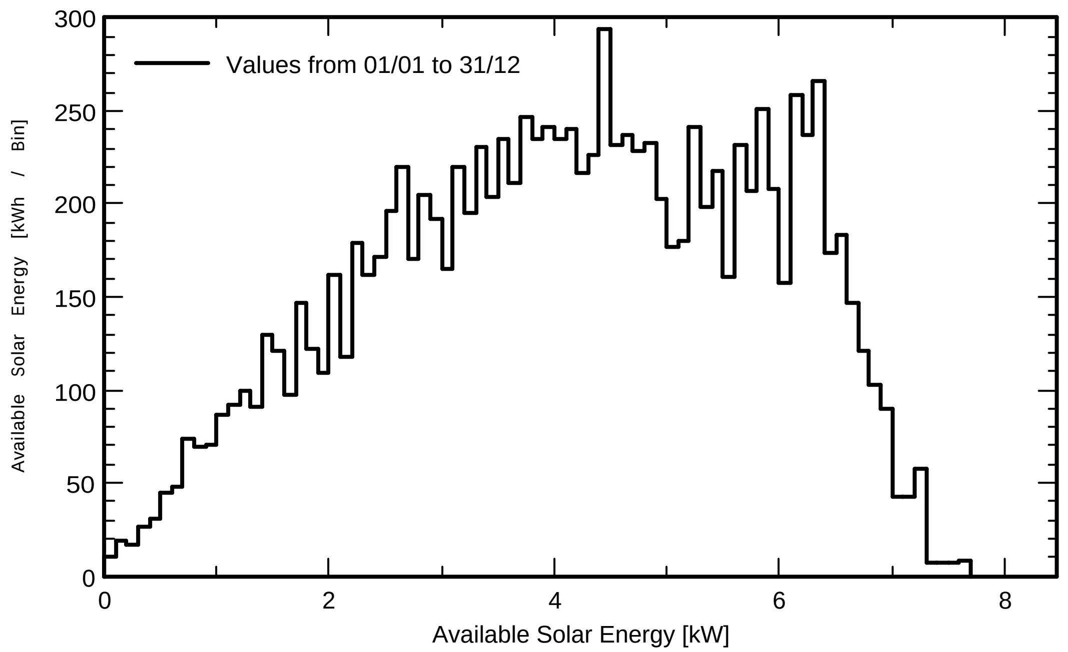
Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Daily Input/Output diagram



System Output Power Distribution



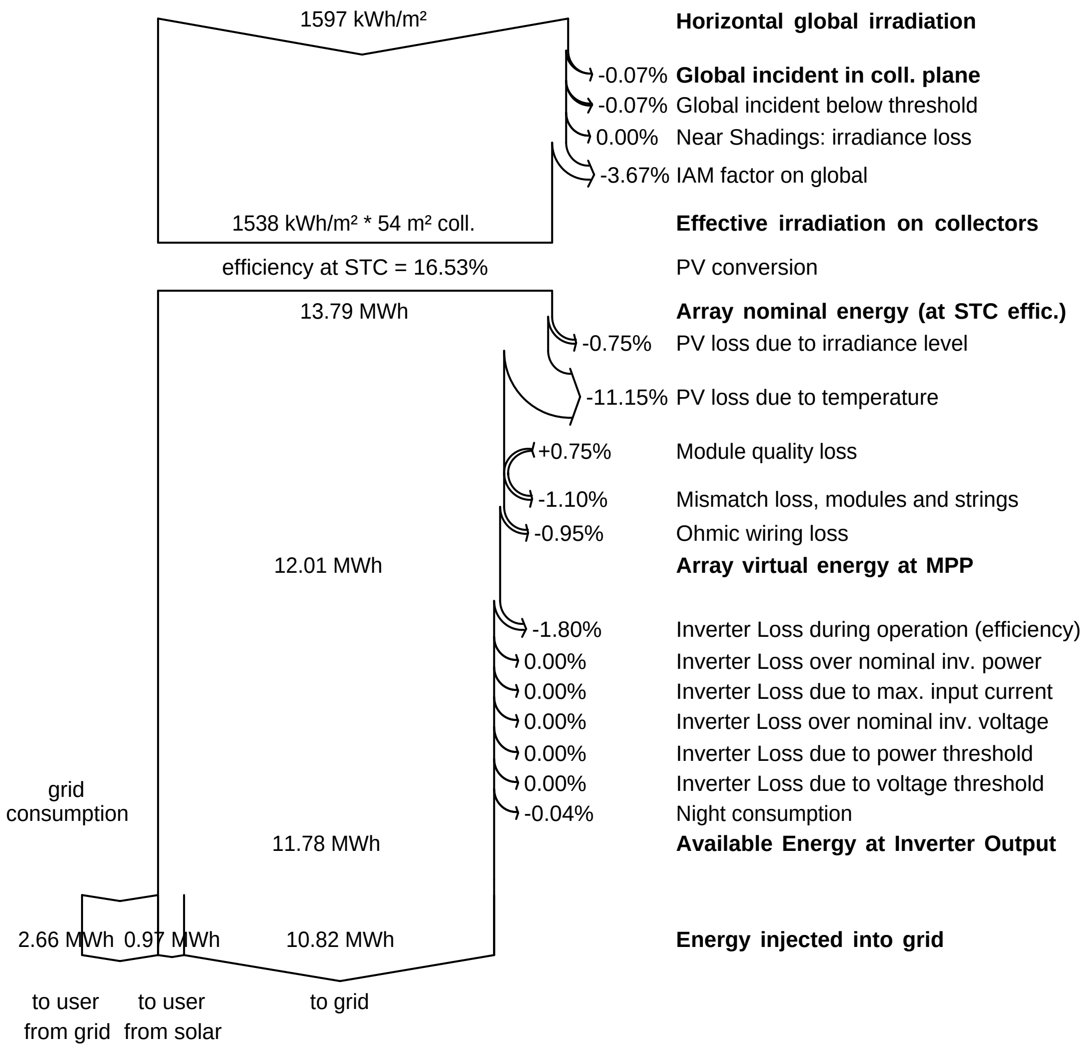
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

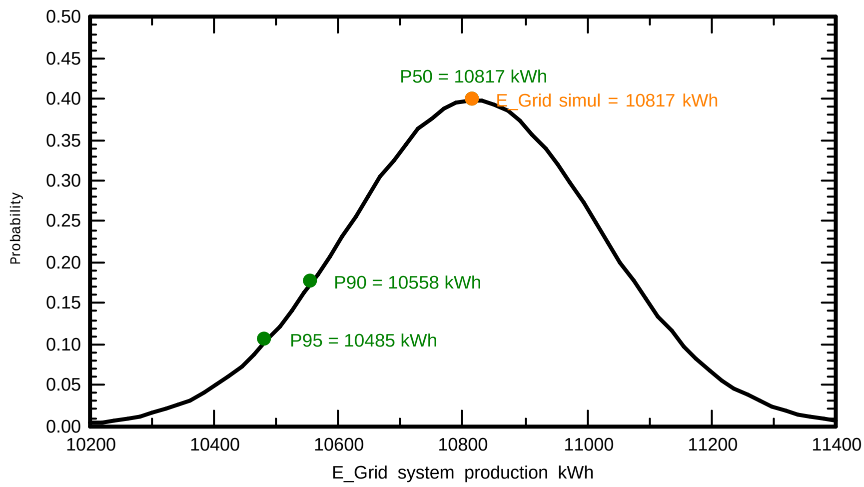
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.20 MWh**
	P50	**10.82 MWh**
	P90	**10.56 MWh**
	P95	**10.48 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **average family - 6kw**

Simulation date 21/04/20 15h58

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	25.1 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	10 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	20	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)		U mpp	336 V	I mpp	17 A
Total area		Module area	**38.8 m²**	Cell area	34.4 m²

Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

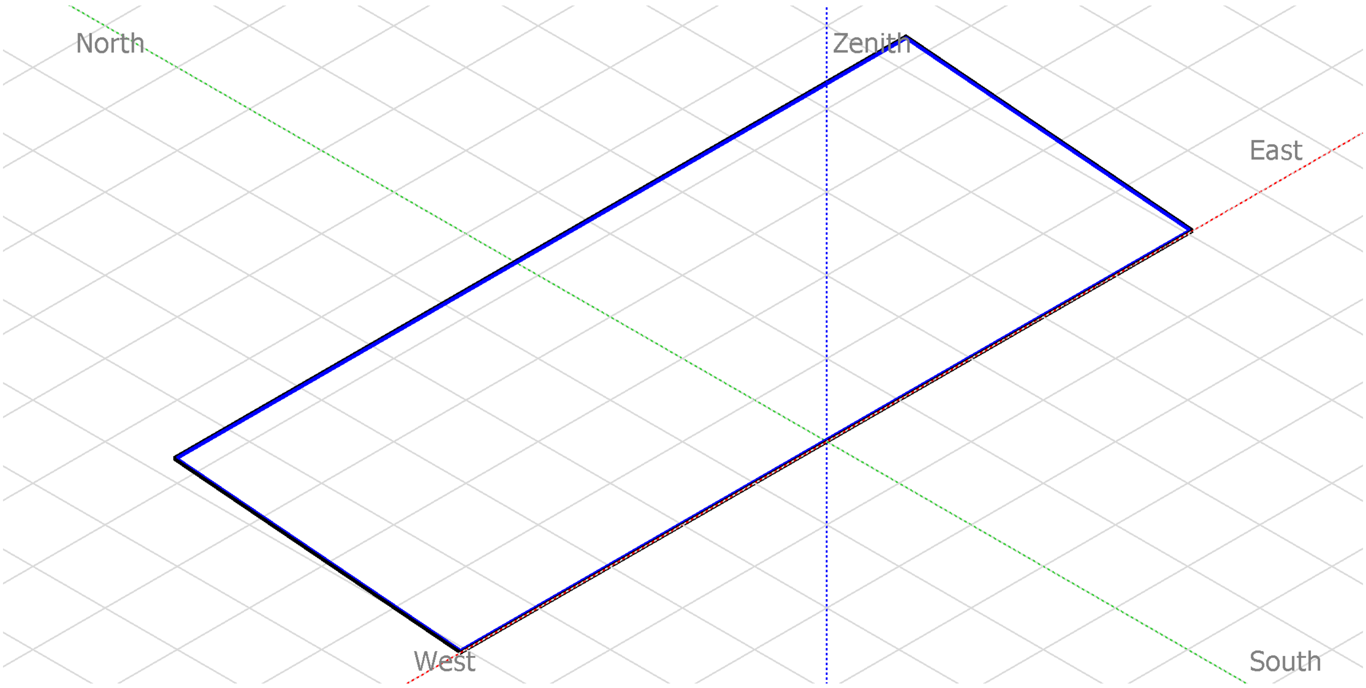
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

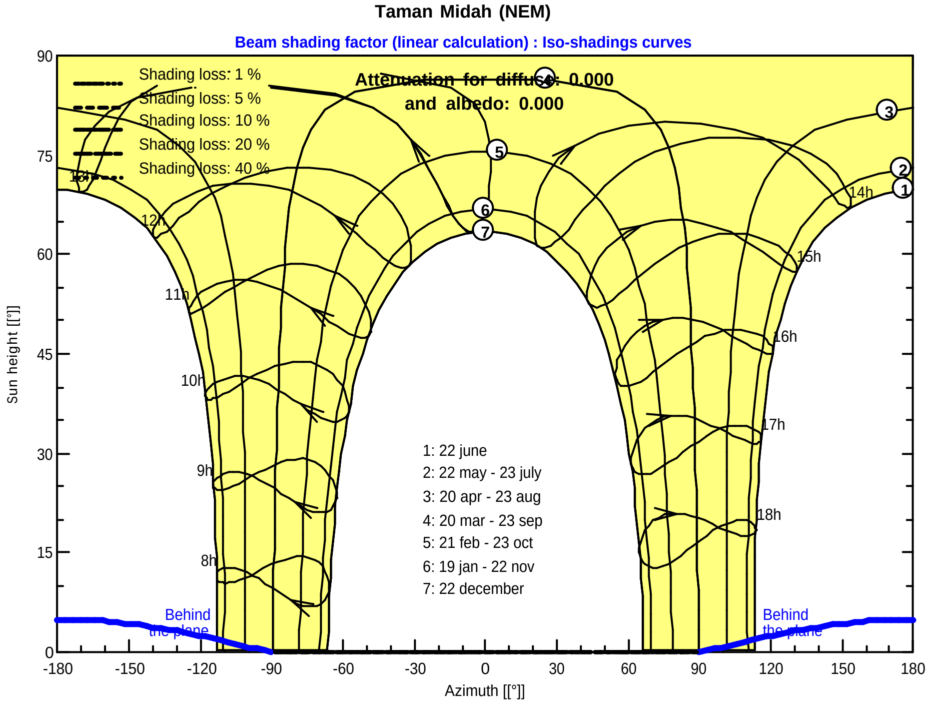
Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

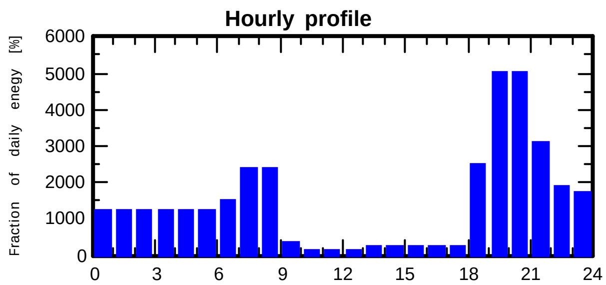
Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Daily household consumers, Constant over the year, average = 25.1 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	28	18 W/lamp	6 h/day	3024 Wh/day
TV / PC / Mobile	2	70 W/app	10 h/day	1400 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	3	750 W tot	8 h/day	18000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				35148 Wh/day



Grid-Connected System: Main results

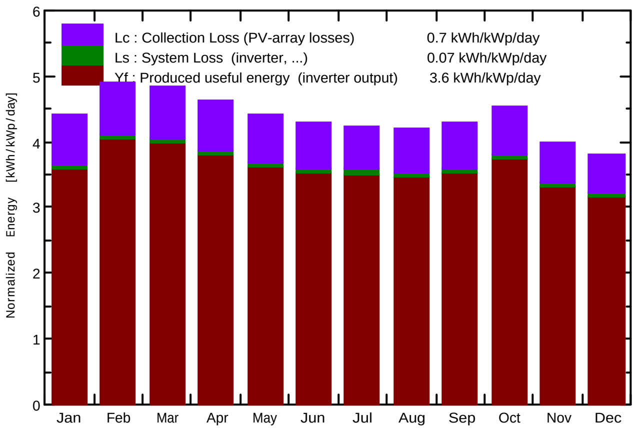
Project : **Taman Midah (NEM)**

Simulation variant : **average family - 6kw**

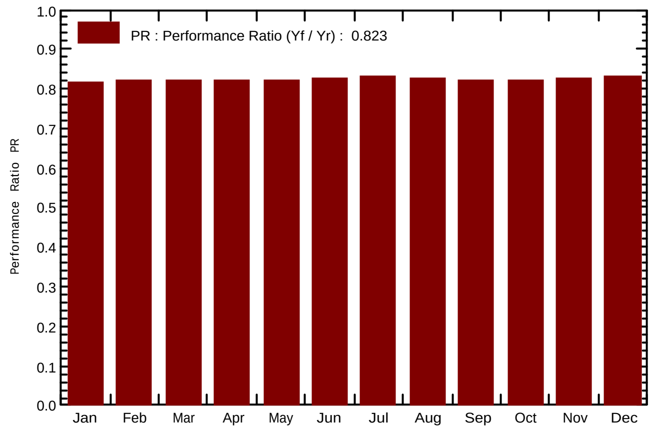
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	9.34 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



average family - 6kw

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	133.0	82.20	28.10	136.3	131.2	0.726	0.808	0.077	0.635	0.732
February	134.6	67.90	27.70	137.4	132.8	0.737	0.703	0.066	0.657	0.636
March	149.8	88.20	28.00	150.3	144.9	0.804	0.773	0.075	0.713	0.698
April	140.3	70.50	27.70	138.8	133.9	0.742	0.738	0.073	0.655	0.666
May	140.3	78.60	28.60	136.9	131.7	0.734	0.808	0.078	0.641	0.730
June	132.0	77.80	27.80	128.3	123.5	0.691	0.738	0.068	0.609	0.670
July	134.4	87.20	27.80	131.1	125.8	0.710	0.773	0.071	0.625	0.702
August	132.2	87.20	27.80	130.1	125.2	0.700	0.808	0.075	0.612	0.734
September	129.2	79.00	27.10	128.8	124.0	0.691	0.703	0.068	0.610	0.635
October	138.8	82.60	27.40	140.4	135.5	0.754	0.808	0.077	0.662	0.731
November	117.6	79.20	26.70	119.8	115.4	0.648	0.773	0.067	0.568	0.707
December	115.0	73.20	26.29	118.1	113.6	0.640	0.738	0.061	0.566	0.677
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	9.174	0.857	7.552	8.317

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

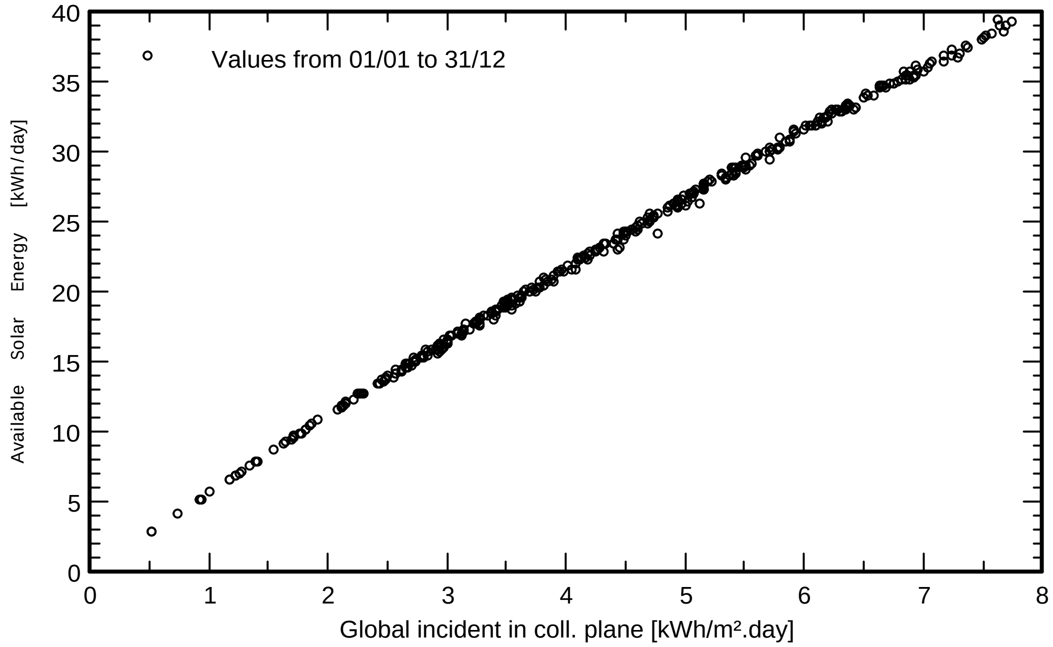
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

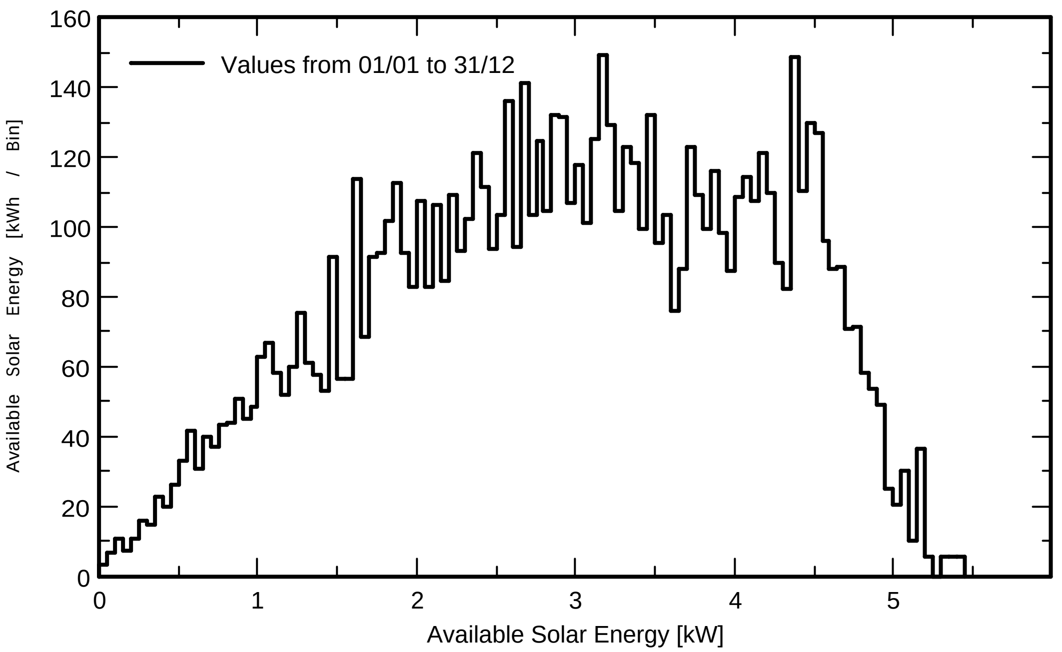
Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Daily Input/Output diagram



System Output Power Distribution



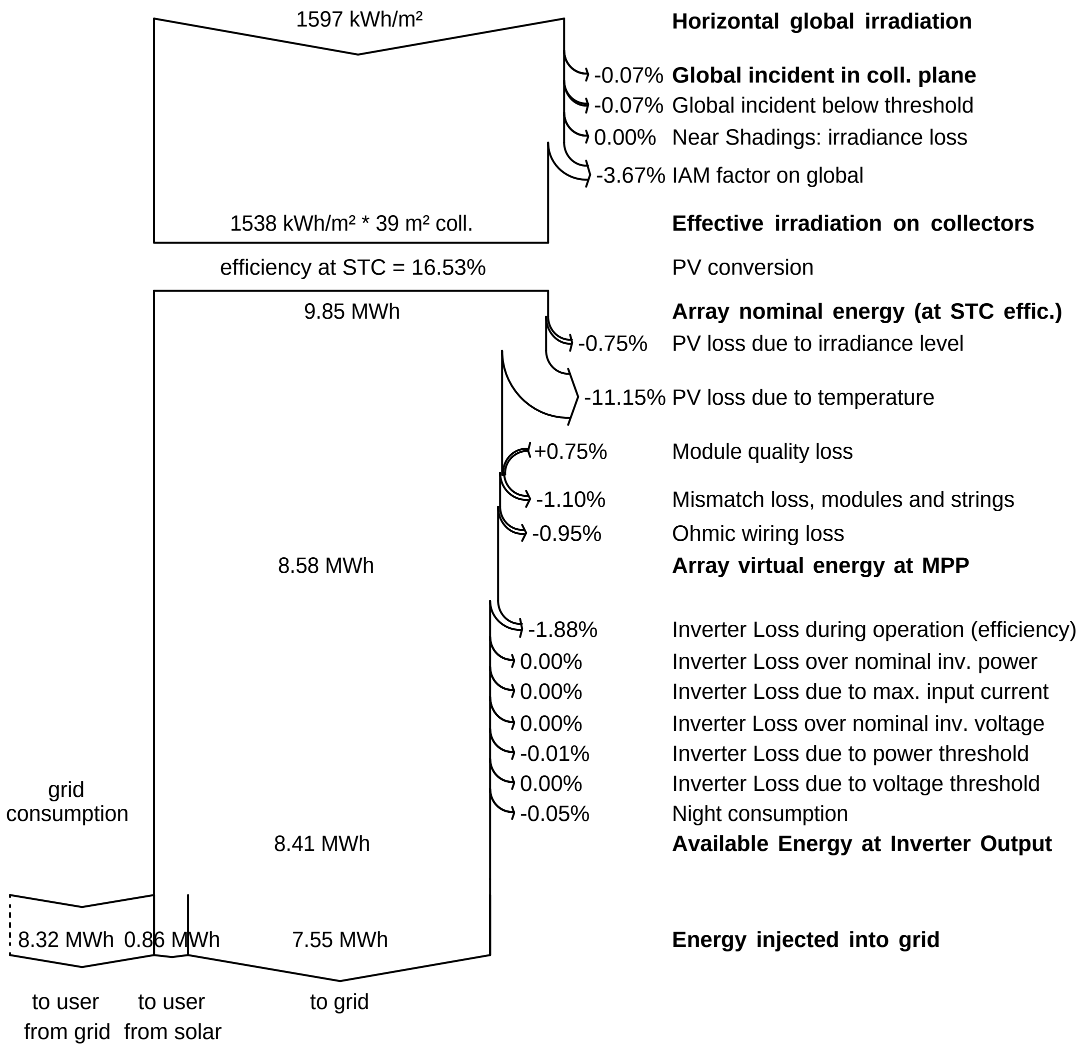
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

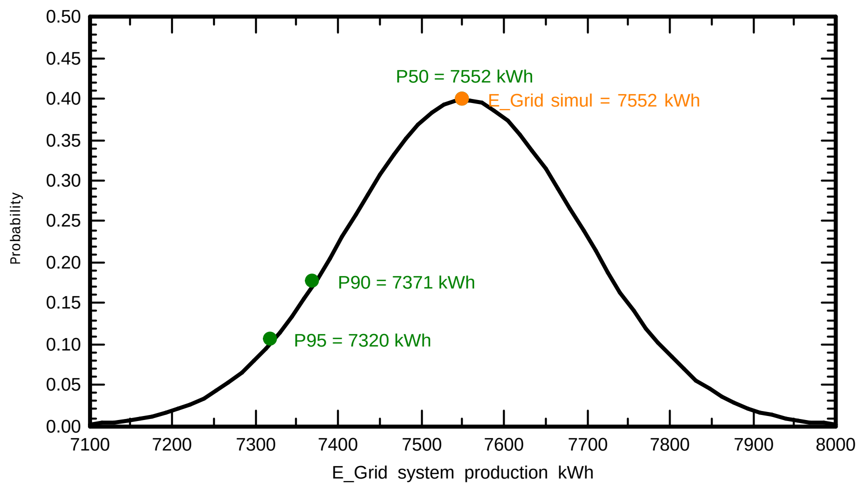
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.14 MWh**
	P50	**7.55 MWh**
	P90	**7.37 MWh**
	P95	**7.32 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **average family - 6kw**

Simulation date 21/04/20 16h02

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	11.1 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²

Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

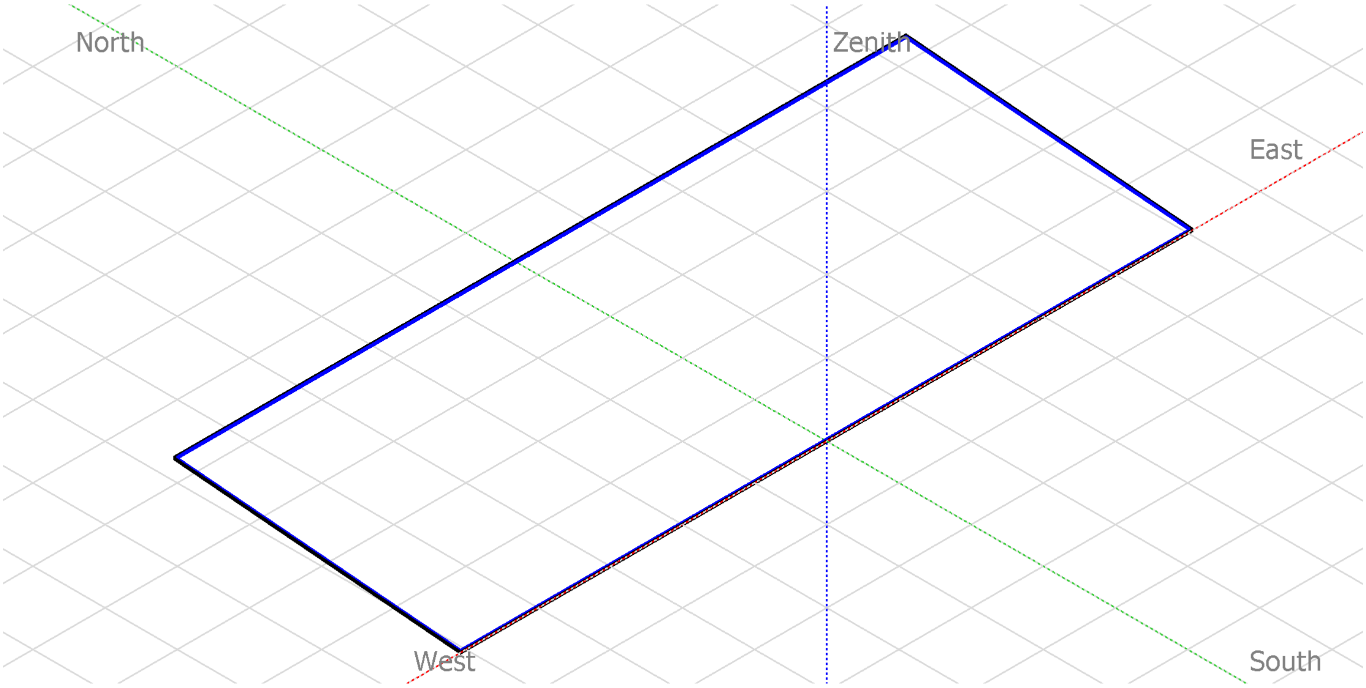
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

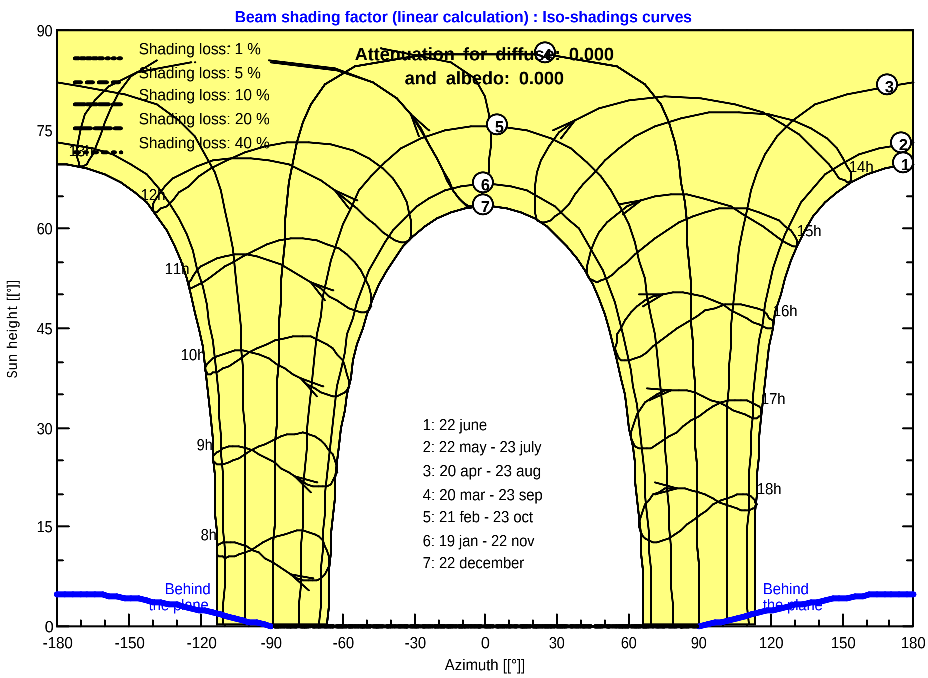
Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

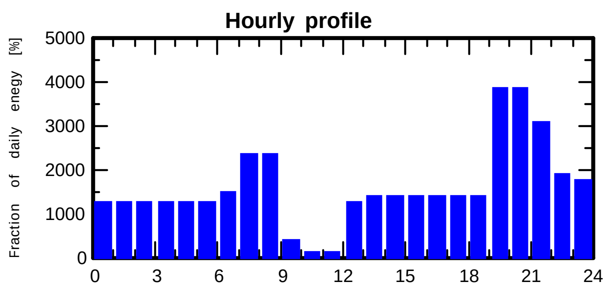
Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Daily household consumers, Constant over the year, average = 11.1 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	28	18 W/lamp	6 h/day	3024 Wh/day
TV / PC / Mobile	2	70 W/app	10 h/day	1400 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	3	750 W tot	10 h/day	21375 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				38523 Wh/day



Grid-Connected System: Main results

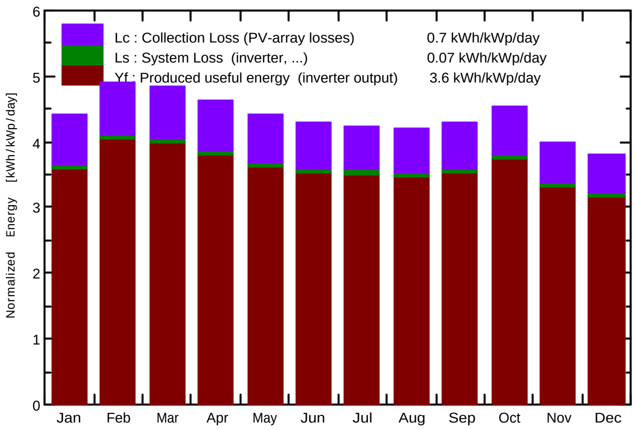
Project : **Taman Midah (NEM)**

Simulation variant : **average family - 6kw**

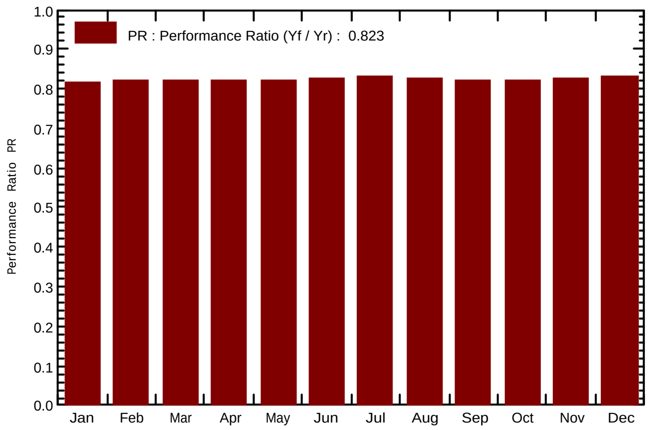
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	23.69 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



average family - 6kw

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	133.0	82.20	28.10	136.3	131.2	0.726	0.385	0.094	0.617	0.291
February	134.6	67.90	27.70	137.4	132.8	0.737	0.308	0.081	0.642	0.227
March	149.8	88.20	28.00	150.3	144.9	0.804	0.308	0.079	0.709	0.229
April	140.3	70.50	27.70	138.8	133.9	0.742	0.347	0.082	0.646	0.264
May	140.3	78.60	28.60	136.9	131.7	0.734	0.347	0.078	0.641	0.268
June	132.0	77.80	27.80	128.3	123.5	0.691	0.308	0.070	0.607	0.238
July	134.4	87.20	27.80	131.1	125.8	0.710	0.385	0.095	0.601	0.290
August	132.2	87.20	27.80	130.1	125.2	0.700	0.308	0.065	0.622	0.244
September	129.2	79.00	27.10	128.8	124.0	0.691	0.308	0.073	0.605	0.235
October	138.8	82.60	27.40	140.4	135.5	0.754	0.385	0.098	0.642	0.287
November	117.6	79.20	26.70	119.8	115.4	0.648	0.308	0.065	0.569	0.243
December	115.0	73.20	26.29	118.1	113.6	0.640	0.347	0.077	0.551	0.270
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	4.045	0.958	7.451	3.087

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

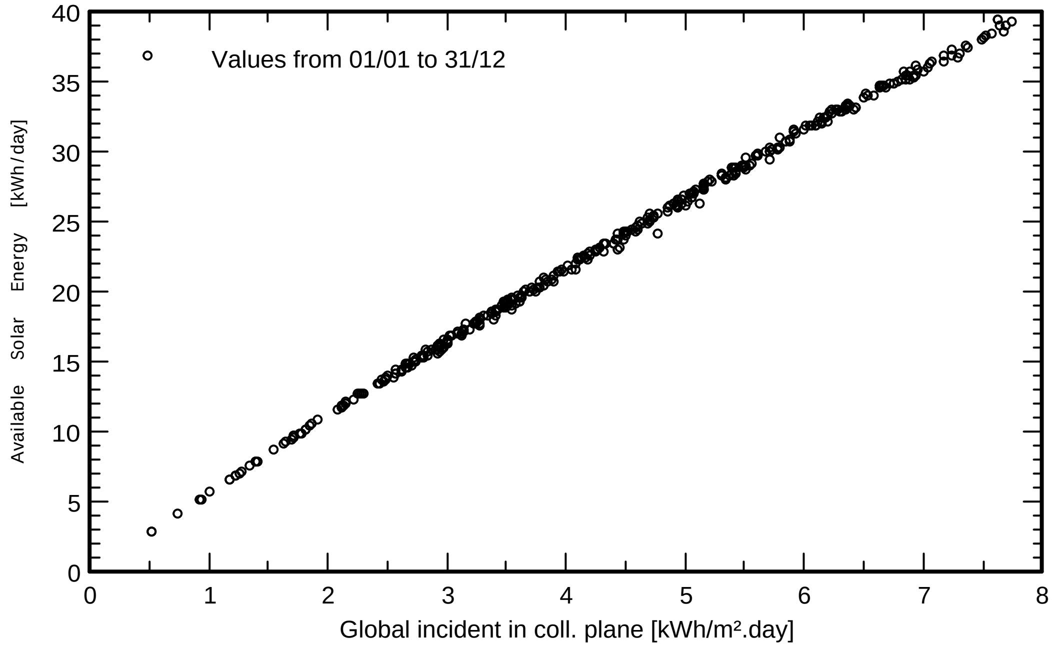
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

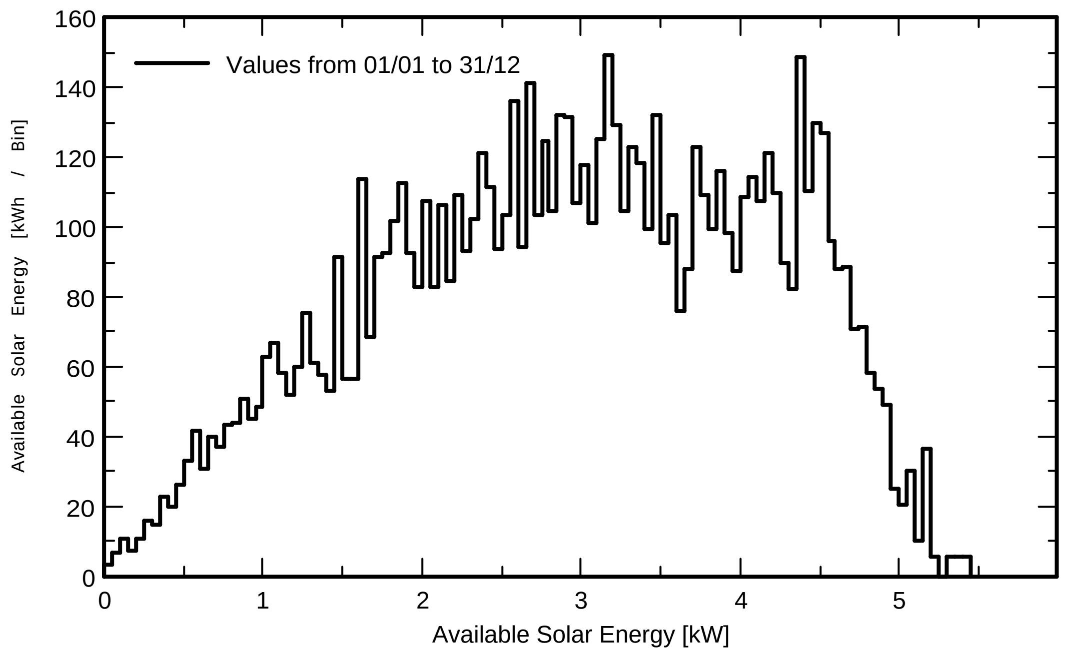
Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Daily Input/Output diagram



System Output Power Distribution



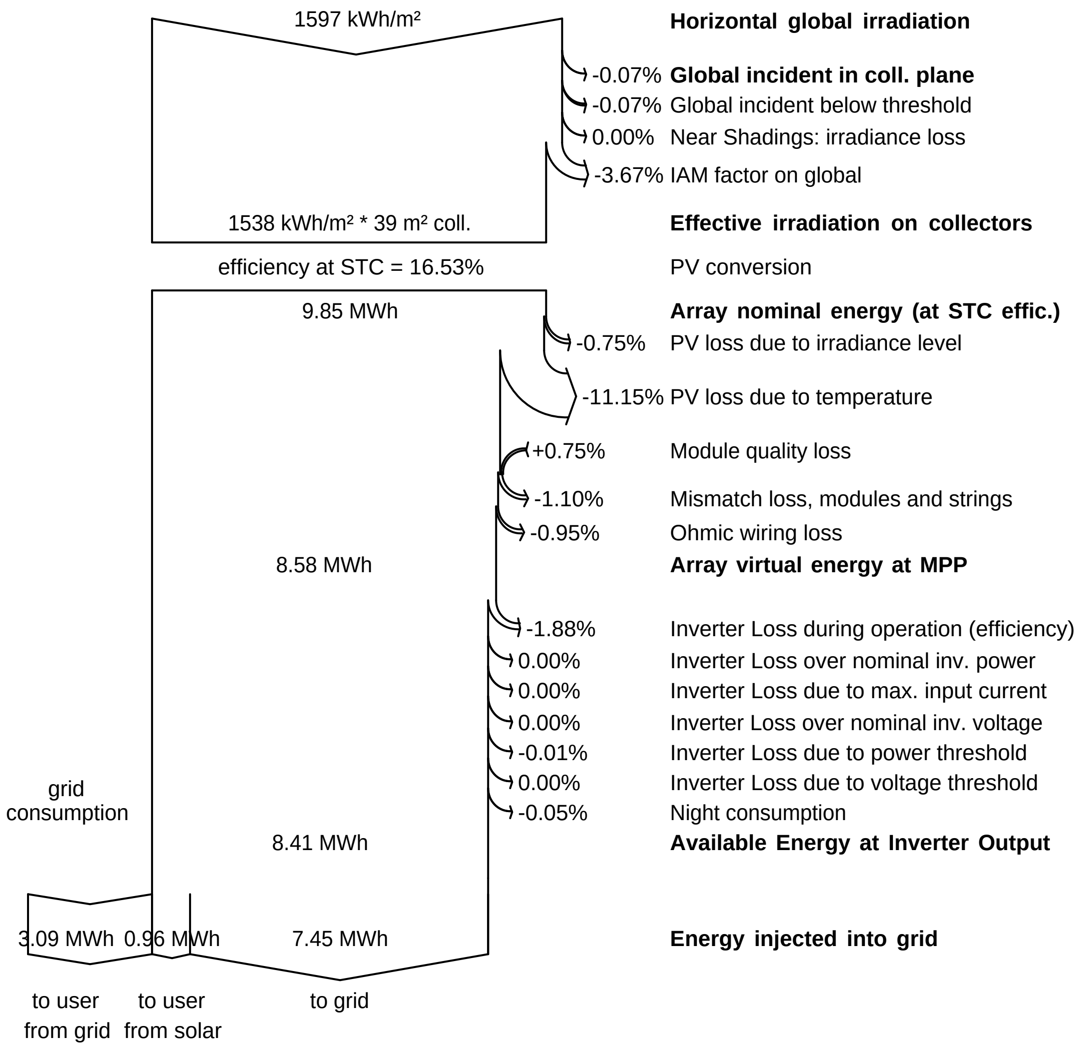
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

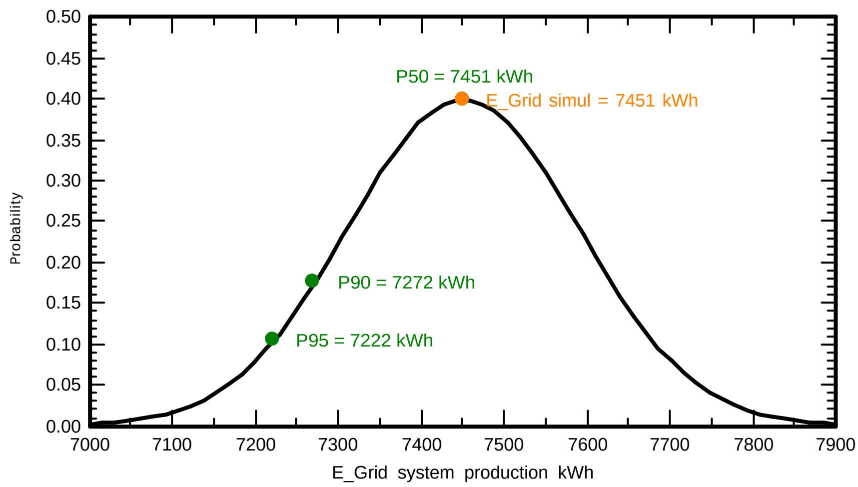
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.14 MWh**
	P50	**7.45 MWh**
	P90	**7.27 MWh**
	P95	**7.22 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **average family - 9kw**

Simulation date 21/04/20 16h07

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	25.1 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	14 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	28	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)		U mpp	470 V	I mpp	17 A
Total area		Module area	**54.3 m²**	Cell area	48.2 m²

Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

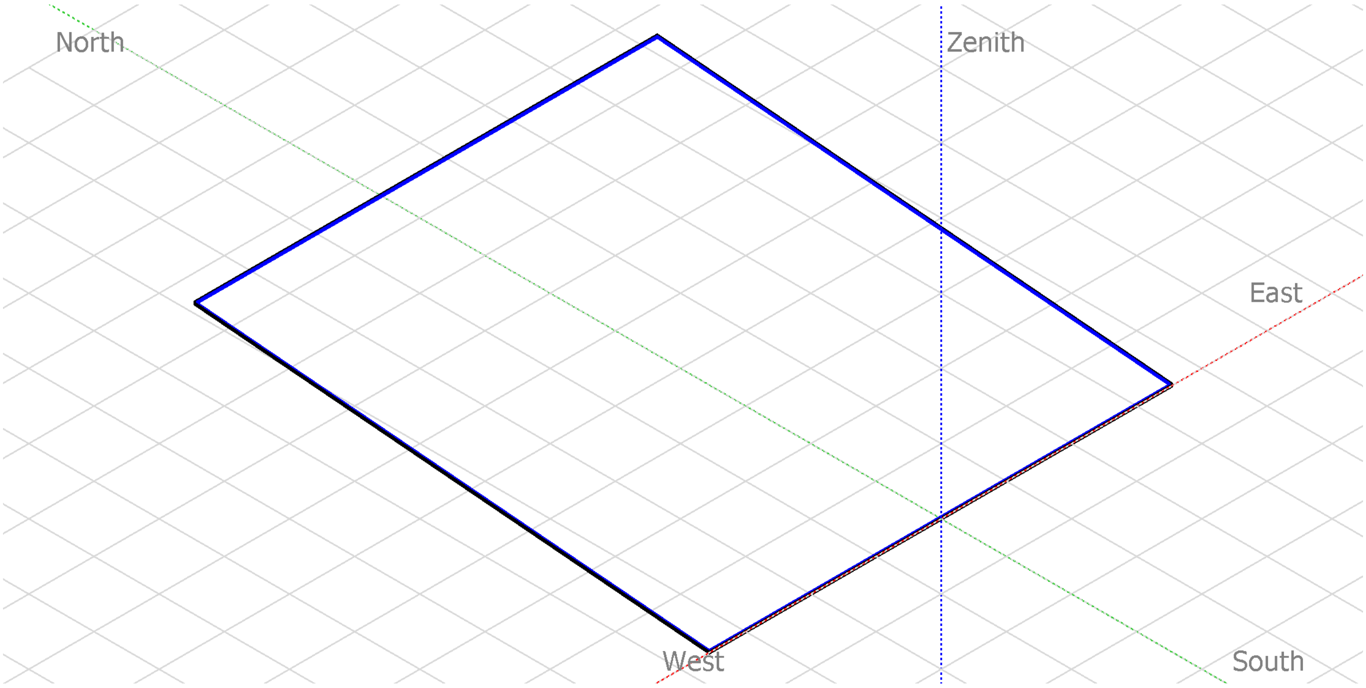
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

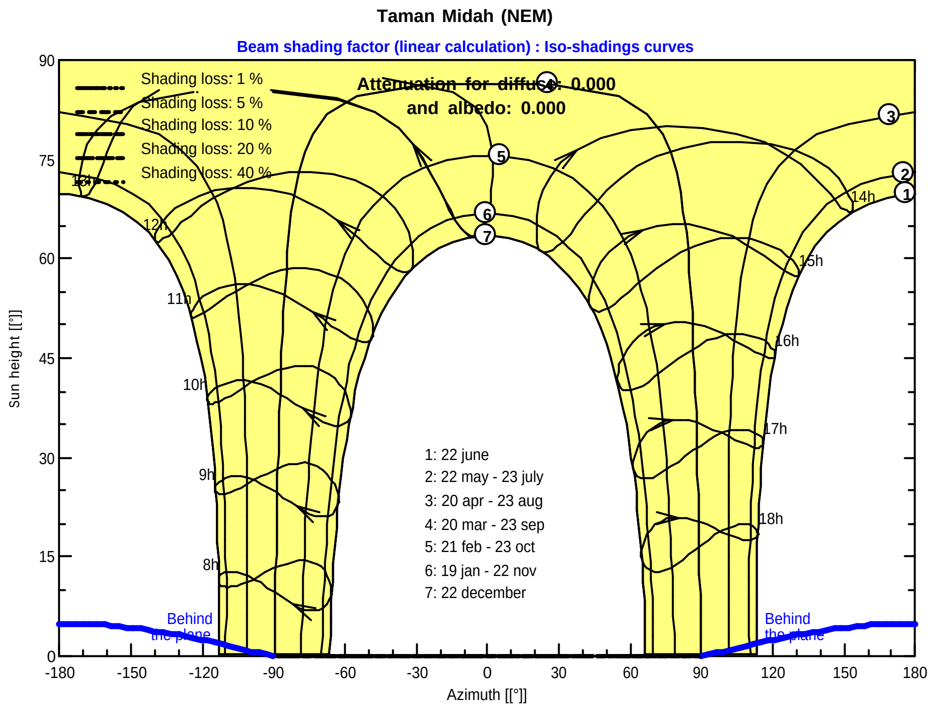
Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

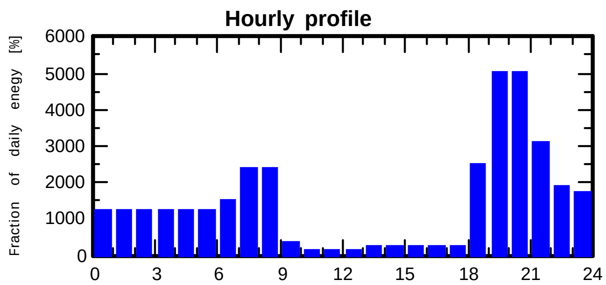
Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**			
Near Shadings	Linear shadings				
PV Field Orientation	tilt	5°	azimuth	0°	
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp	
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**	
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac	
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year	

Daily household consumers, Constant over the year, average = 25.1 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	28	18 W/lamp	6 h/day	3024 Wh/day
TV / PC / Mobile	2	70 W/app	10 h/day	1400 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	3	750 W tot	8 h/day	18000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				35148 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

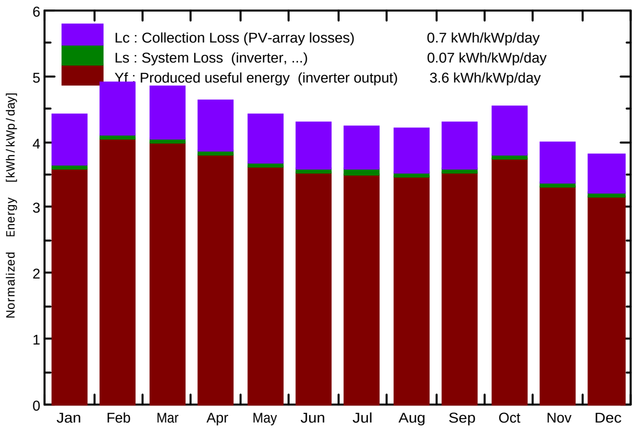
Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

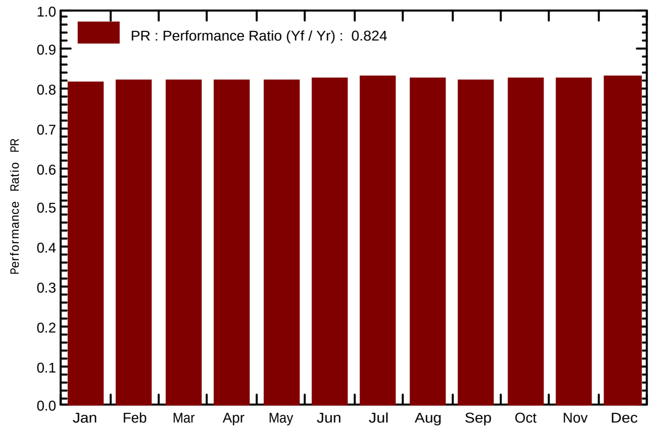
Main simulation results

System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	82.40 %	Solar Fraction SF	10.75 %

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



average family - 9kw

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	133.0	82.20	28.10	136.3	131.2	1.016	0.808	0.089	0.909	0.720
February	134.6	67.90	27.70	137.4	132.8	1.031	0.703	0.076	0.937	0.627
March	149.8	88.20	28.00	150.3	144.9	1.125	0.773	0.087	1.018	0.686
April	140.3	70.50	27.70	138.8	133.9	1.039	0.738	0.084	0.936	0.654
May	140.3	78.60	28.60	136.9	131.7	1.027	0.808	0.091	0.917	0.717
June	132.0	77.80	27.80	128.3	123.5	0.967	0.738	0.079	0.870	0.659
July	134.4	87.20	27.80	131.1	125.8	0.994	0.773	0.082	0.894	0.692
August	132.2	87.20	27.80	130.1	125.2	0.980	0.808	0.086	0.875	0.722
September	129.2	79.00	27.10	128.8	124.0	0.968	0.703	0.079	0.870	0.624
October	138.8	82.60	27.40	140.4	135.5	1.056	0.808	0.089	0.948	0.720
November	117.6	79.20	26.70	119.8	115.4	0.907	0.773	0.076	0.813	0.698
December	115.0	73.20	26.29	118.1	113.6	0.896	0.738	0.069	0.810	0.669
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	9.174	0.987	10.798	8.187

Legends:

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

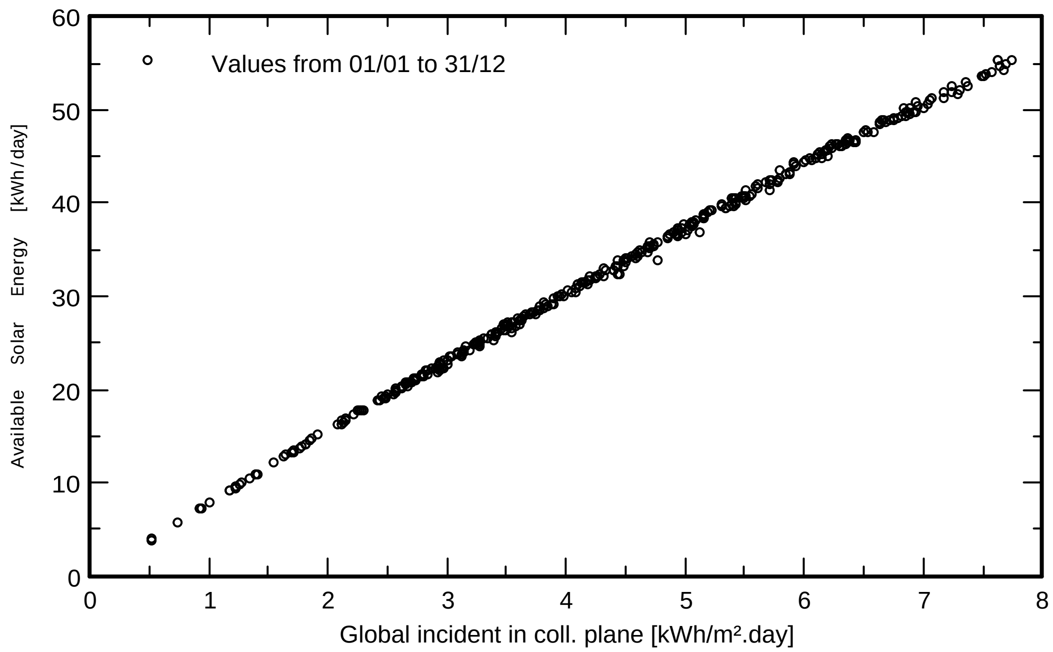
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

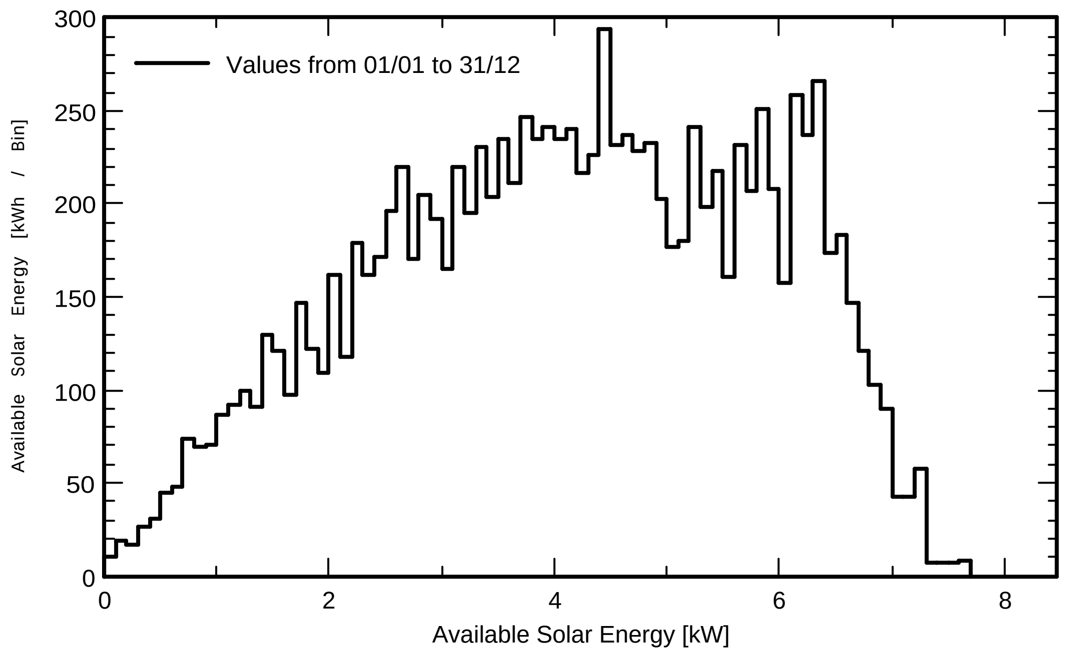
Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Daily Input/Output diagram



System Output Power Distribution



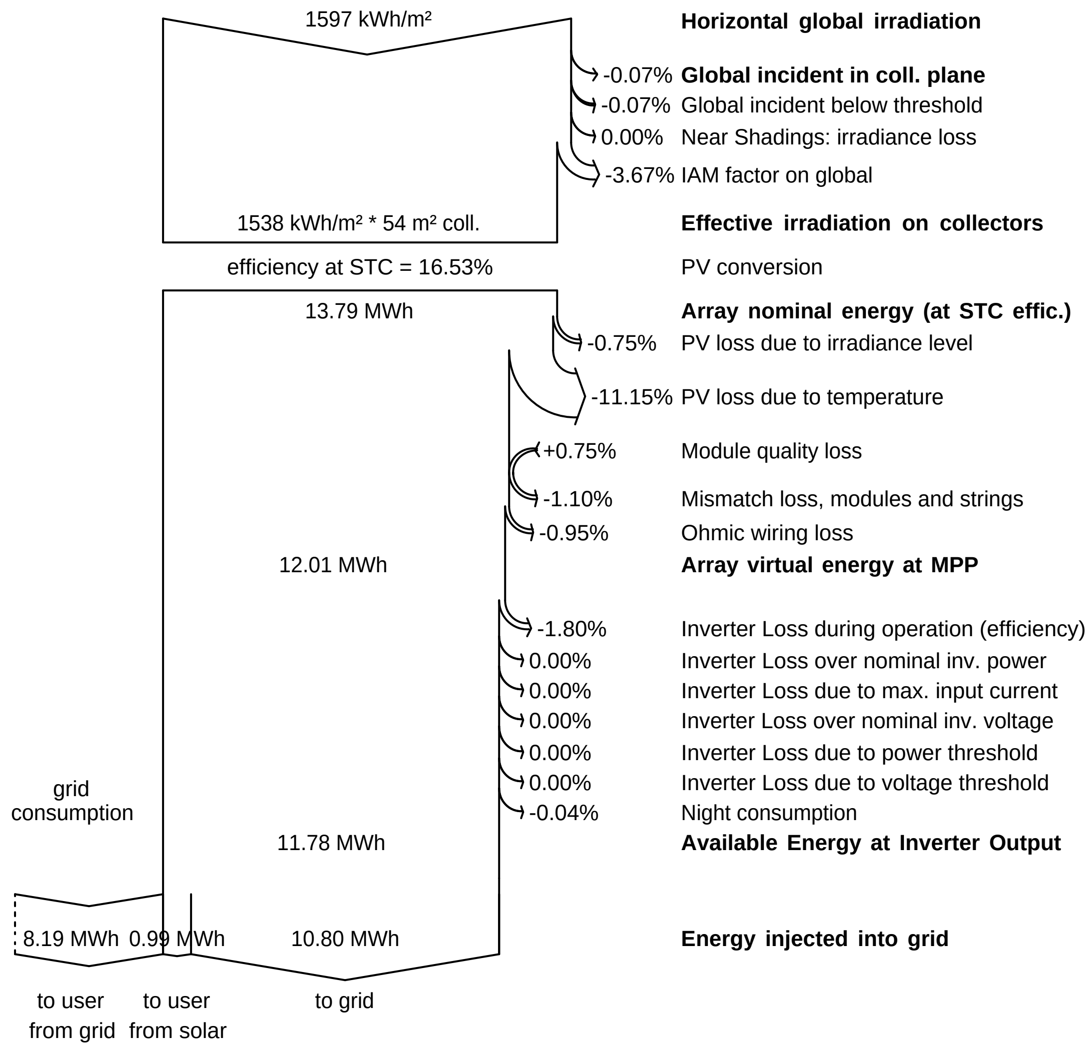
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

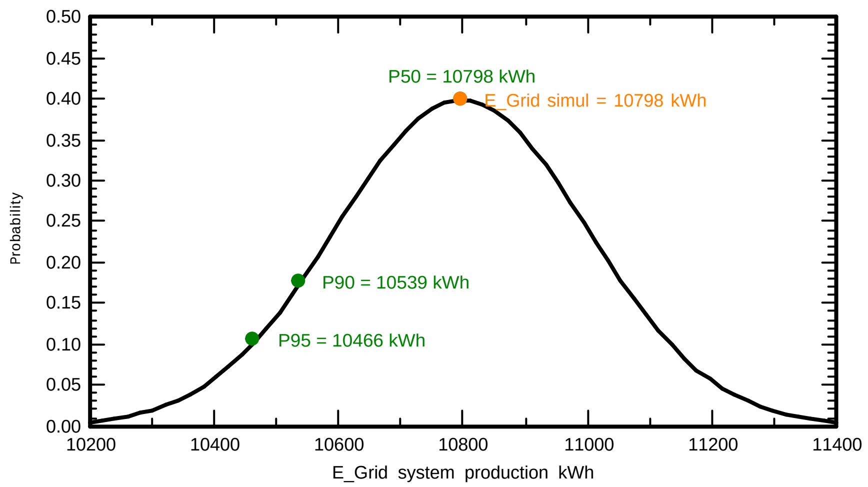
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.20 MWh**
	P50	**10.80 MWh**
	P90	**10.54 MWh**
	P95	**10.47 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project :	**Taman Midah (NEM)**			
Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : average family - 9kw

	Simulation date	21/04/20 16h08		
Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	11.1 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

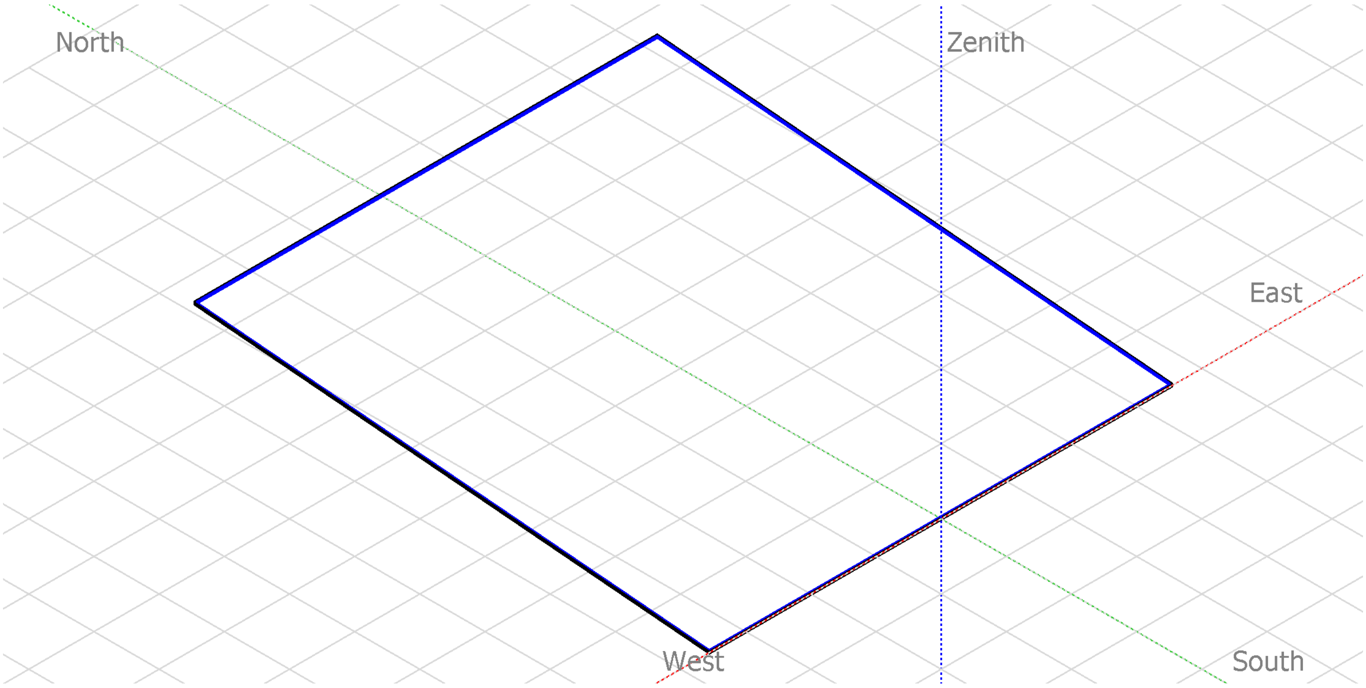
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

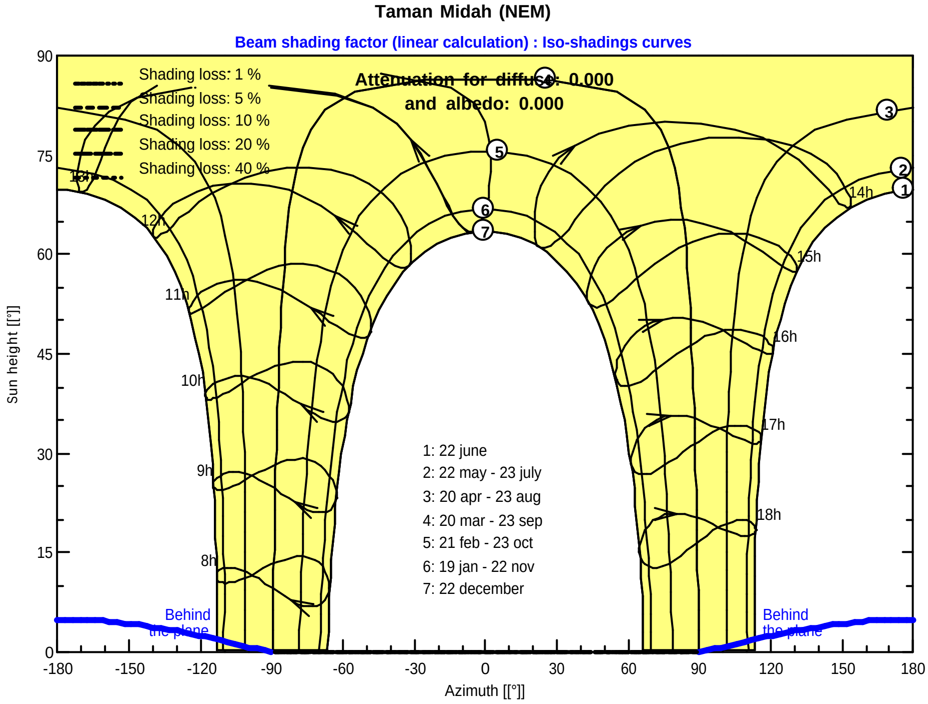
Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

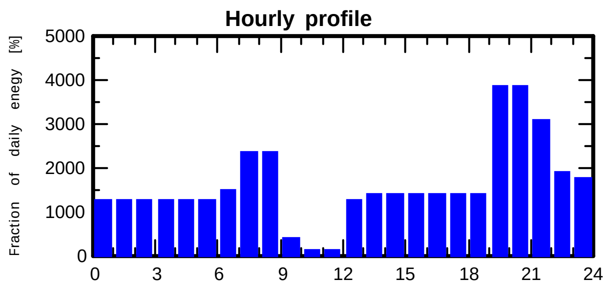
Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Daily household consumers, Constant over the year, average = 11.1 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	28	18 W/lamp	6 h/day	3024 Wh/day
TV / PC / Mobile	2	70 W/app	10 h/day	1400 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	3	750 W tot	10 h/day	21375 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				38523 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

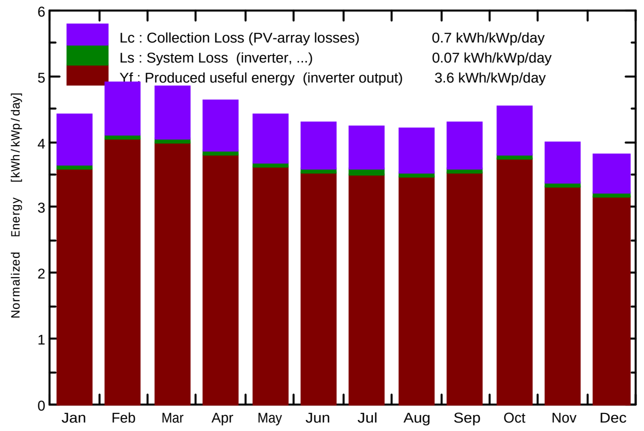
Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

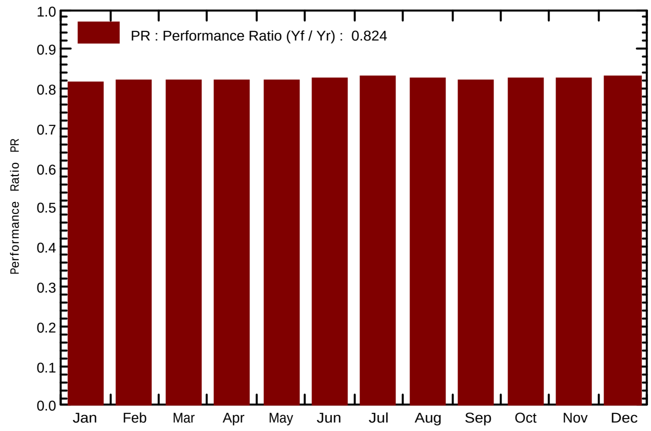
Main simulation results

System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	82.40 %	Solar Fraction SF	25.85 %

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



average family - 9kw

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	133.0	82.20	28.10	136.3	131.2	1.016	0.385	0.103	0.894	0.282
February	134.6	67.90	27.70	137.4	132.8	1.031	0.308	0.087	0.927	0.222
March	149.8	88.20	28.00	150.3	144.9	1.125	0.308	0.085	1.021	0.224
April	140.3	70.50	27.70	138.8	133.9	1.039	0.347	0.090	0.931	0.257
May	140.3	78.60	28.60	136.9	131.7	1.027	0.347	0.088	0.920	0.259
June	132.0	77.80	27.80	128.3	123.5	0.967	0.308	0.077	0.872	0.231
July	134.4	87.20	27.80	131.1	125.8	0.994	0.385	0.103	0.872	0.282
August	132.2	87.20	27.80	130.1	125.2	0.980	0.308	0.071	0.891	0.238
September	129.2	79.00	27.10	128.8	124.0	0.968	0.308	0.081	0.868	0.227
October	138.8	82.60	27.40	140.4	135.5	1.056	0.385	0.106	0.931	0.280
November	117.6	79.20	26.70	119.8	115.4	0.907	0.308	0.072	0.817	0.236
December	115.0	73.20	26.29	118.1	113.6	0.896	0.347	0.085	0.794	0.262
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	4.045	1.046	10.738	2.999

Legends:

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

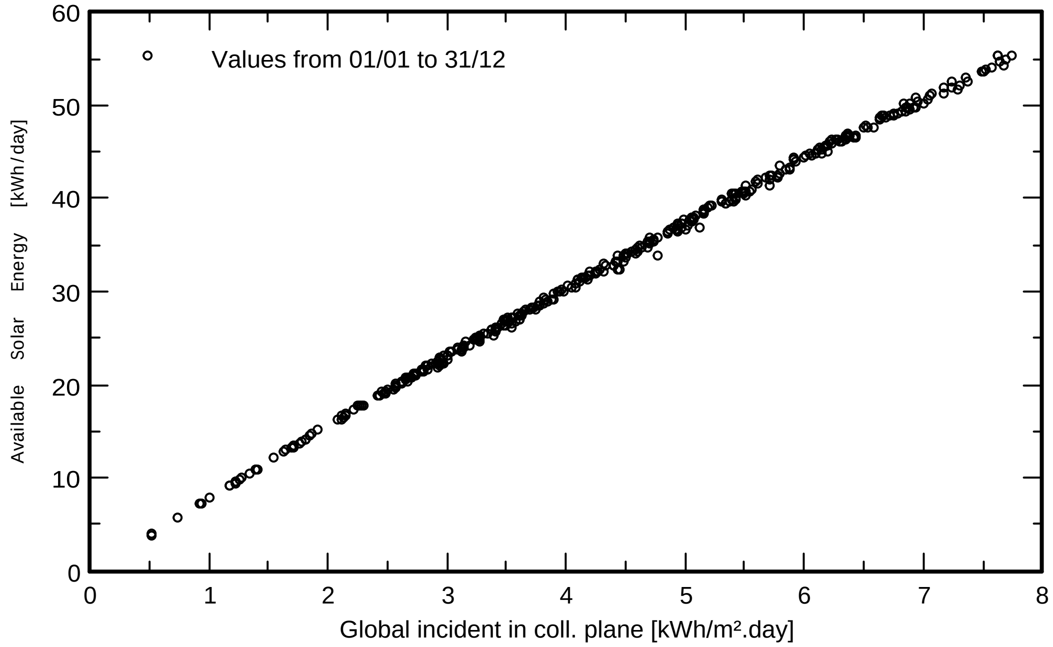
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

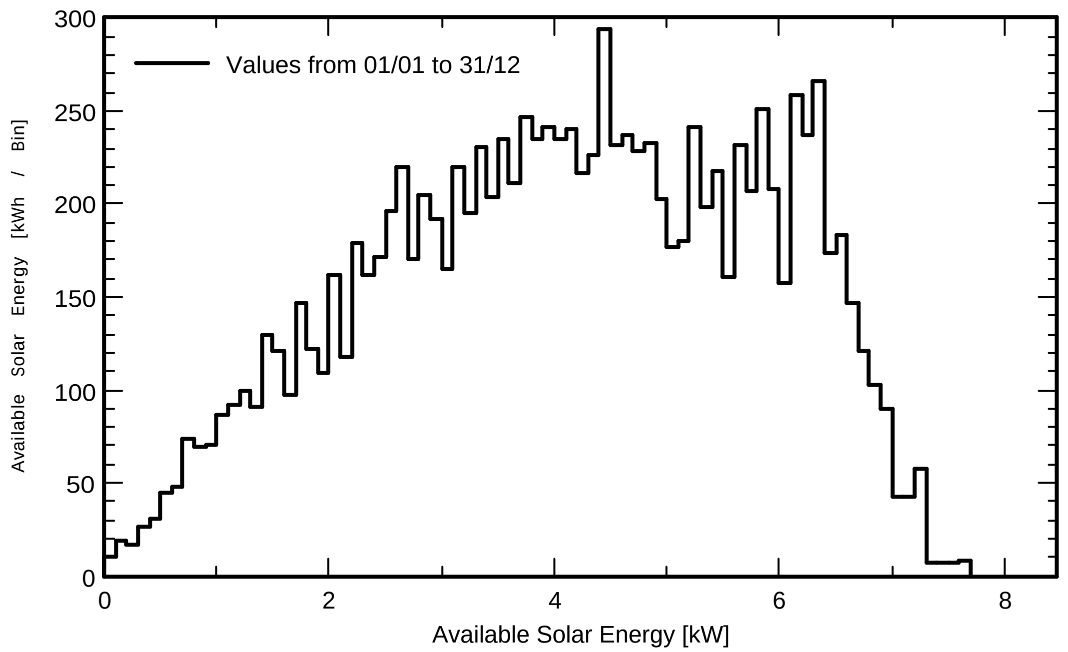
Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Daily Input/Output diagram



System Output Power Distribution



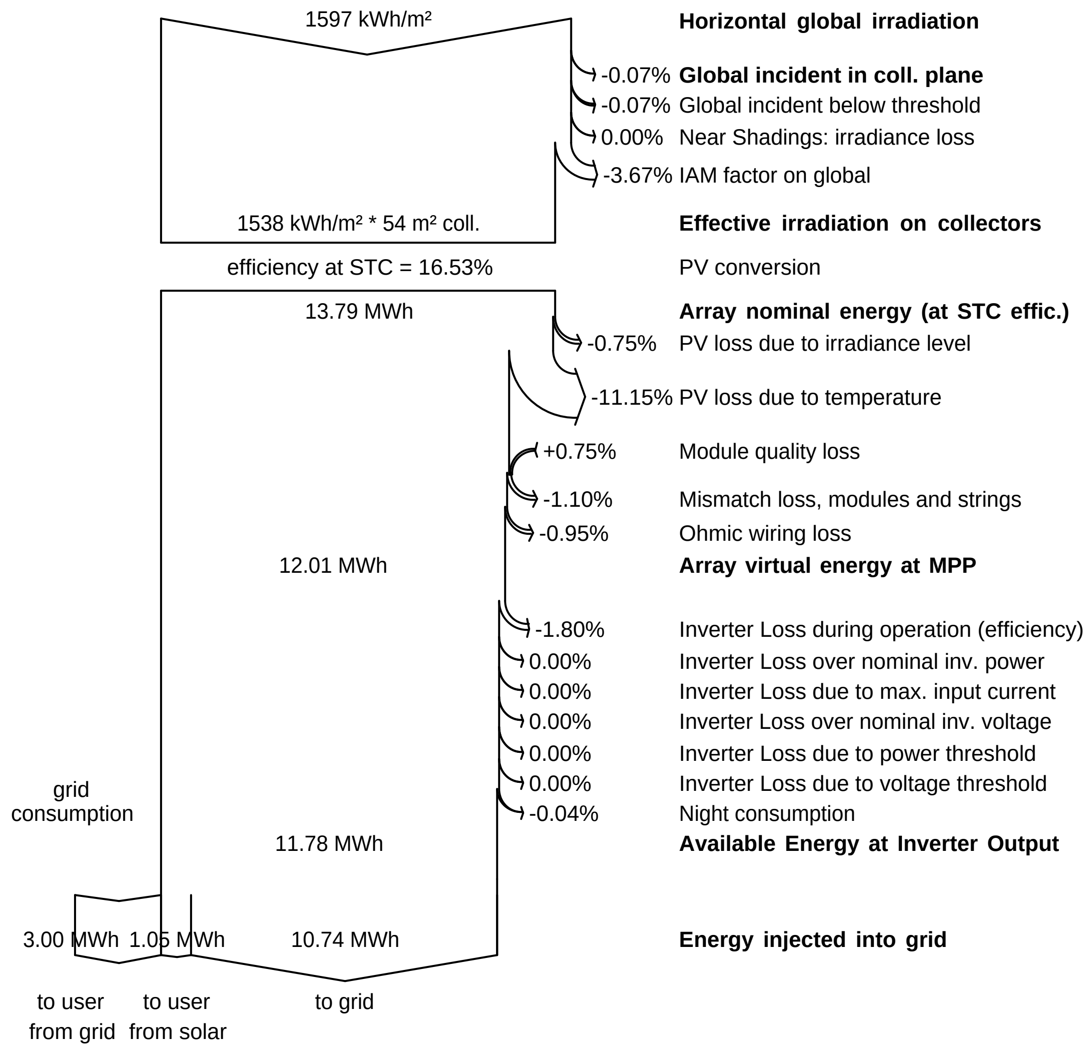
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

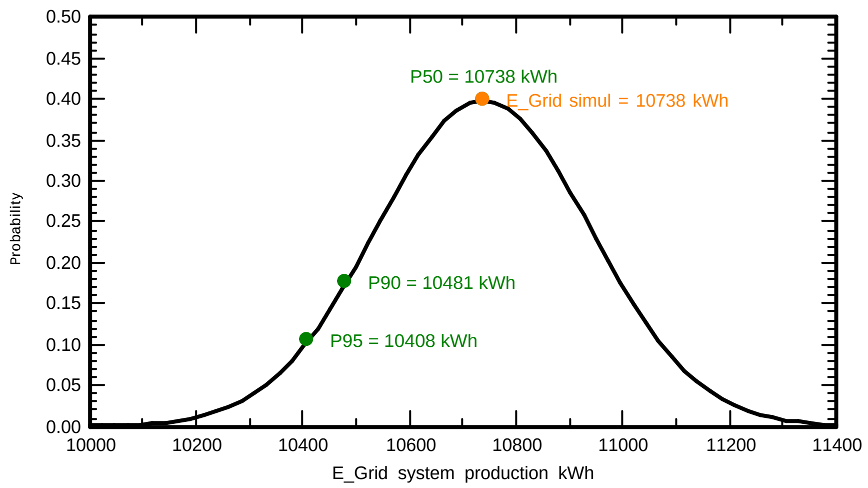
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.20 MWh**
	P50	**10.74 MWh**
	P90	**10.48 MWh**
	P95	**10.41 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **big family - 6kw**

Simulation date 21/04/20 15h29

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	32.6 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	10 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	20	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)		U mpp	336 V	I mpp	17 A
Total area		Module area	**38.8 m²**	Cell area	34.4 m²

Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

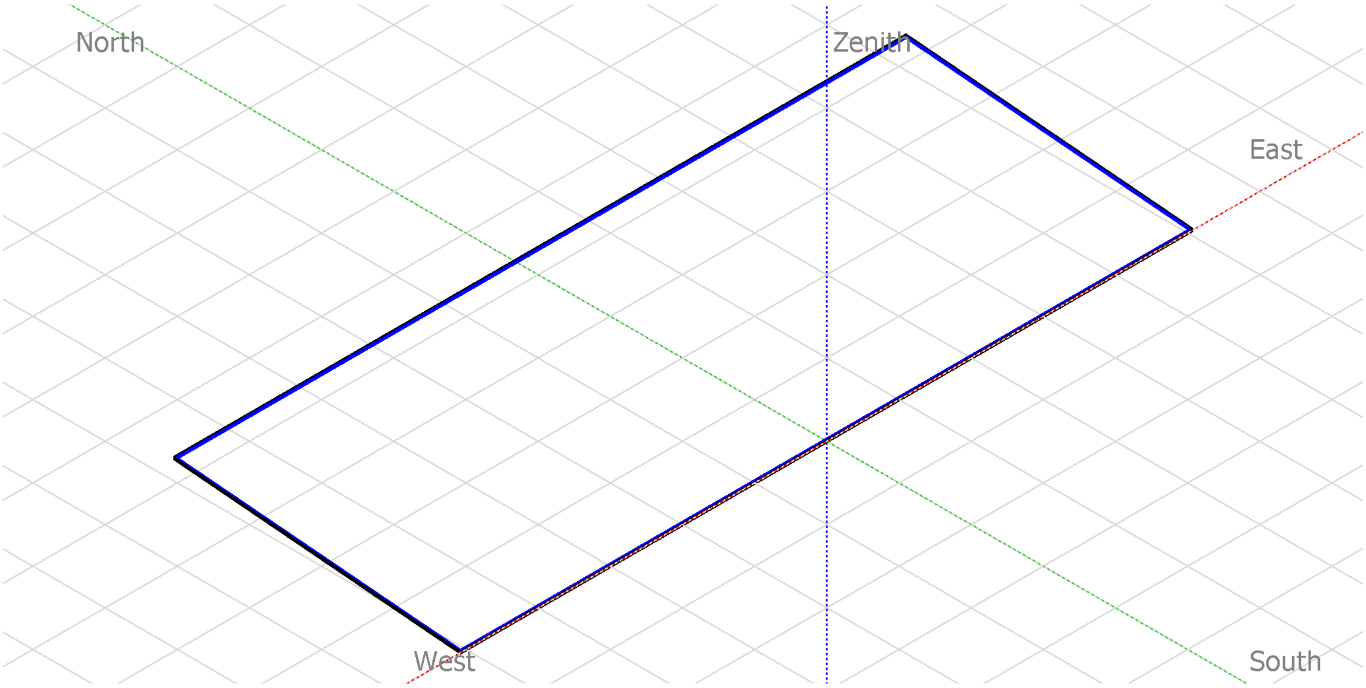
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

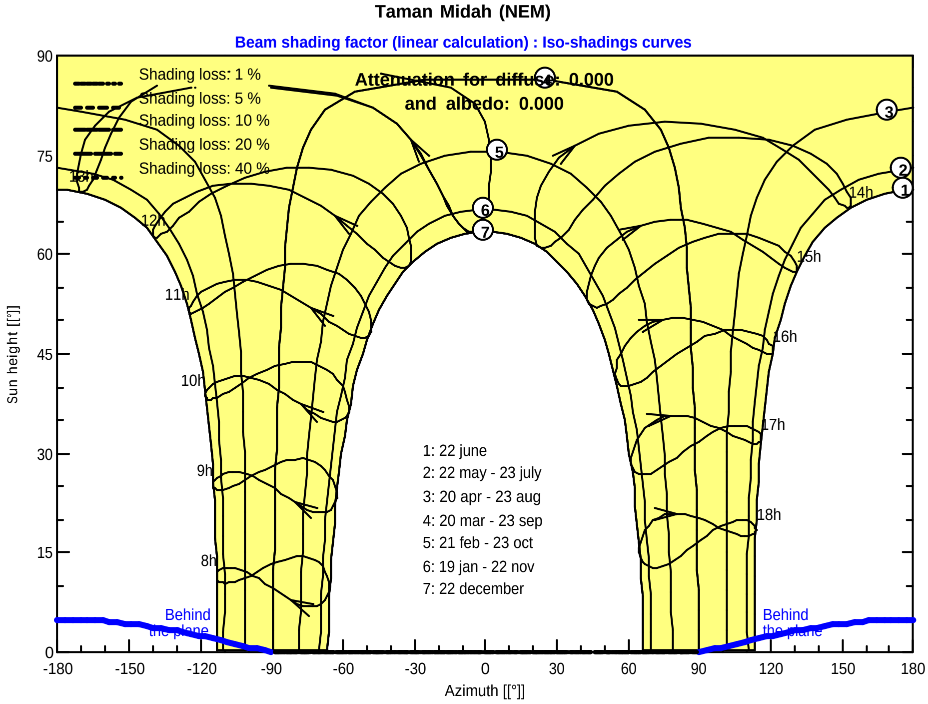
Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

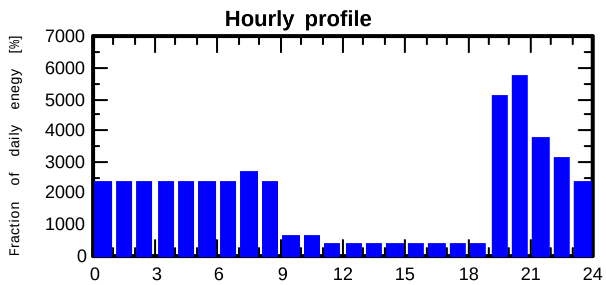
Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Daily household consumers, Constant over the year, average = 32.6 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	5 h/day	2700 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	750 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	6	750 W tot	6 h/day	27000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				45614 Wh/day



Grid-Connected System: Main results

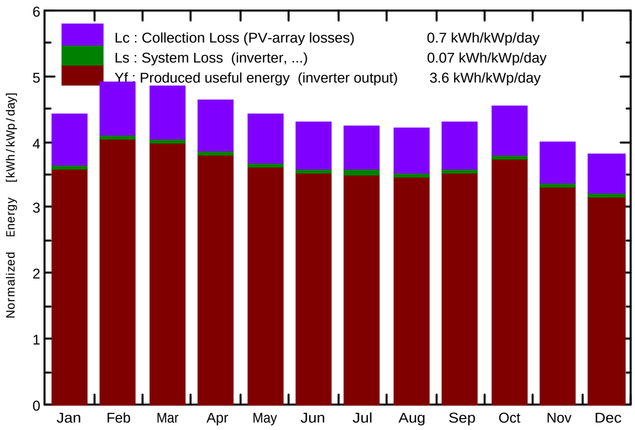
Project : **Taman Midah (NEM)**

Simulation variant : **big family - 6kw**

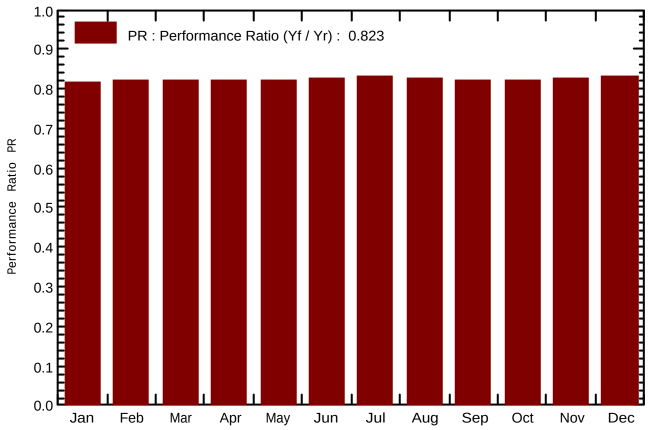
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	9.99 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



big family - 6kw

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	133.0	82.20	28.10	136.3	131.2	0.726	1.049	0.103	0.608	0.946
February	134.6	67.90	27.70	137.4	132.8	0.737	0.912	0.090	0.633	0.822
March	149.8	88.20	28.00	150.3	144.9	0.804	1.004	0.100	0.688	0.903
April	140.3	70.50	27.70	138.8	133.9	0.742	0.958	0.099	0.629	0.859
May	140.3	78.60	28.60	136.9	131.7	0.734	1.049	0.108	0.611	0.941
June	132.0	77.80	27.80	128.3	123.5	0.691	0.958	0.095	0.582	0.863
July	134.4	87.20	27.80	131.1	125.8	0.710	1.004	0.100	0.597	0.904
August	132.2	87.20	27.80	130.1	125.2	0.700	1.049	0.103	0.583	0.946
September	129.2	79.00	27.10	128.8	124.0	0.691	0.912	0.093	0.585	0.819
October	138.8	82.60	27.40	140.4	135.5	0.754	1.049	0.110	0.630	0.939
November	117.6	79.20	26.70	119.8	115.4	0.648	1.004	0.097	0.537	0.906
December	115.0	73.20	26.29	118.1	113.6	0.640	0.958	0.090	0.537	0.868
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	11.905	1.189	7.220	10.716

Legends:

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

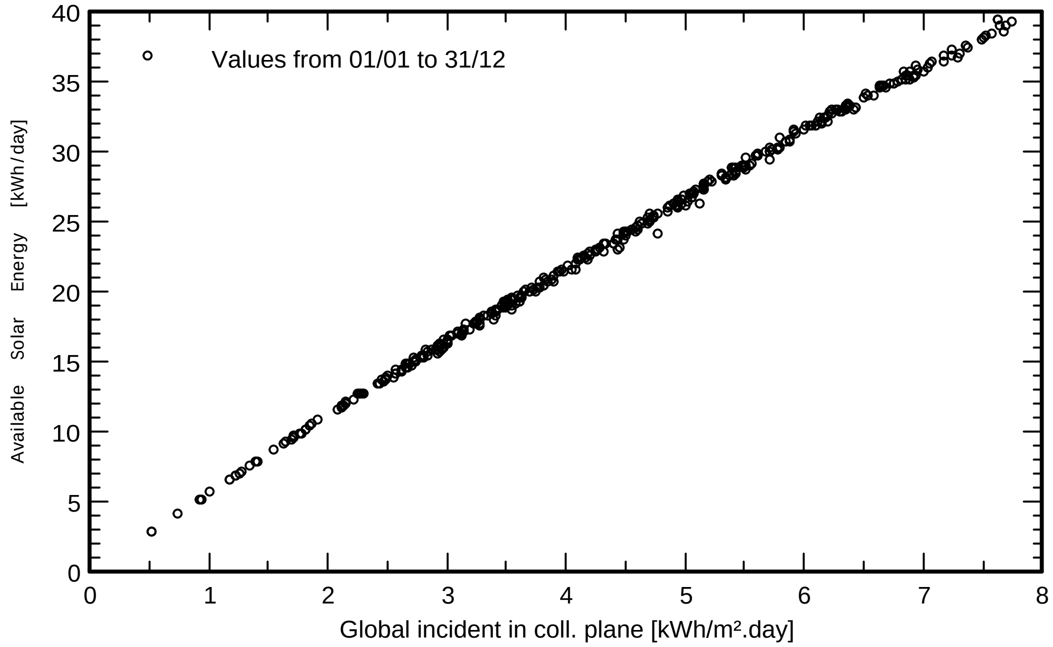
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

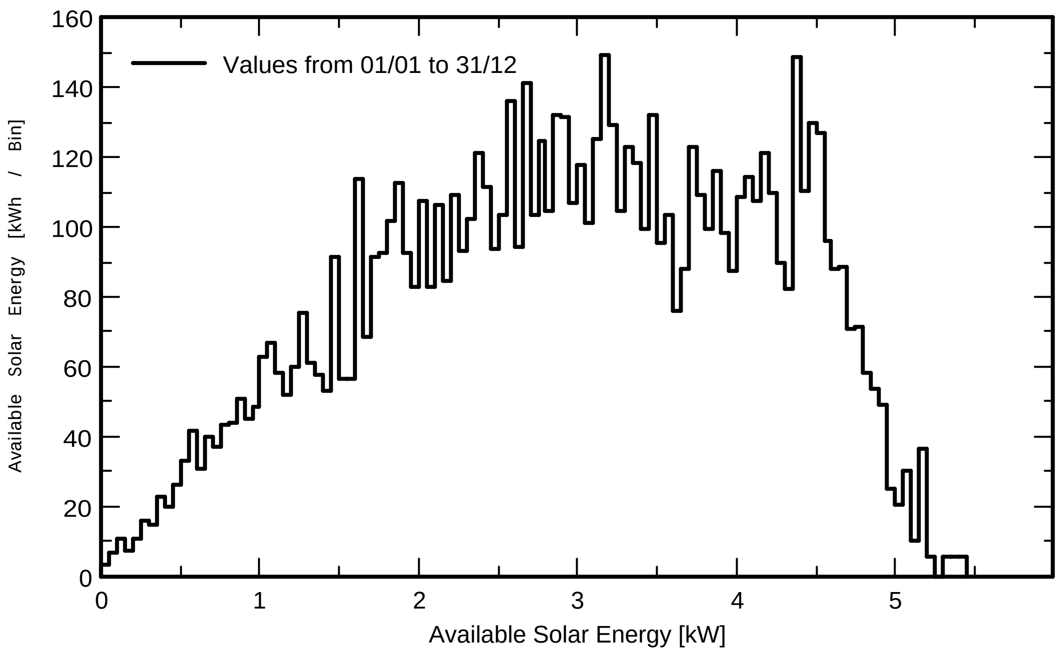
Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Daily Input/Output diagram



System Output Power Distribution



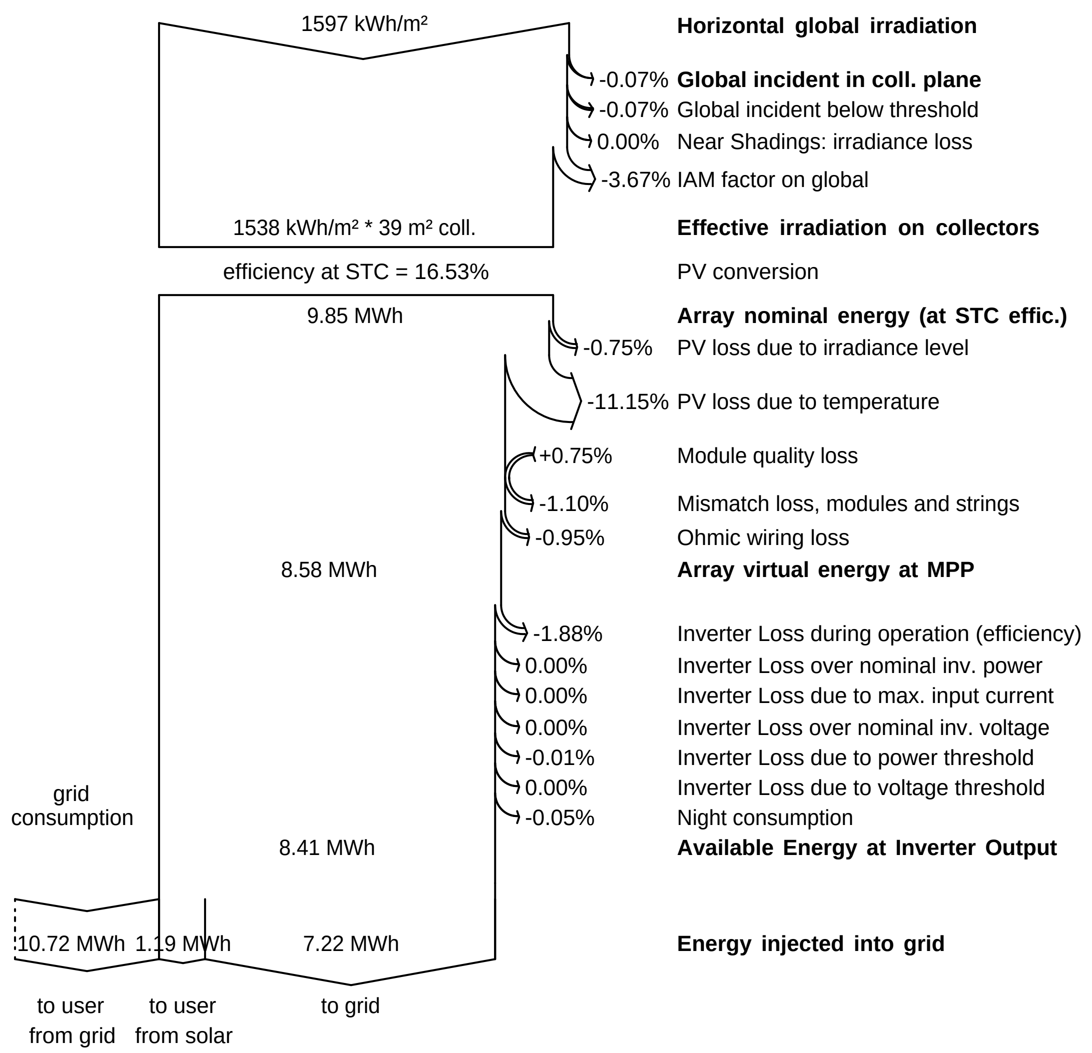
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

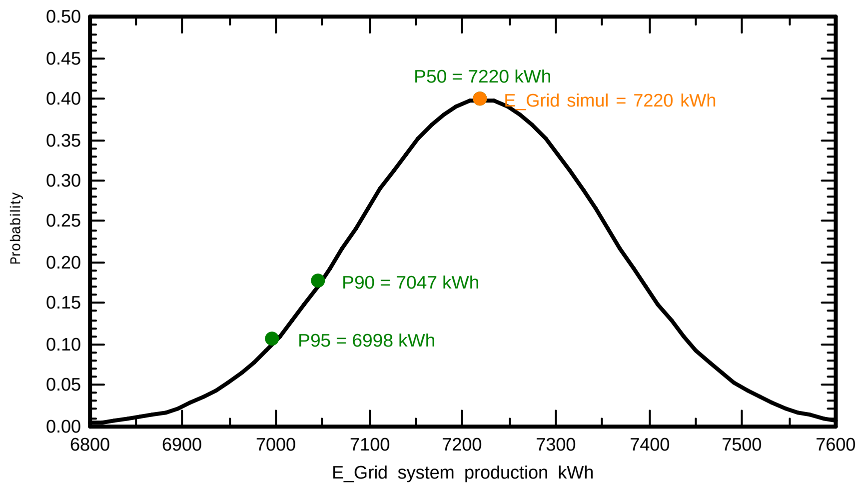
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.14 MWh**
	P50	**7.22 MWh**
	P90	**7.05 MWh**
	P95	**7.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **big family - 6kw**

Simulation date 21/04/20 15h35

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	15.7 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

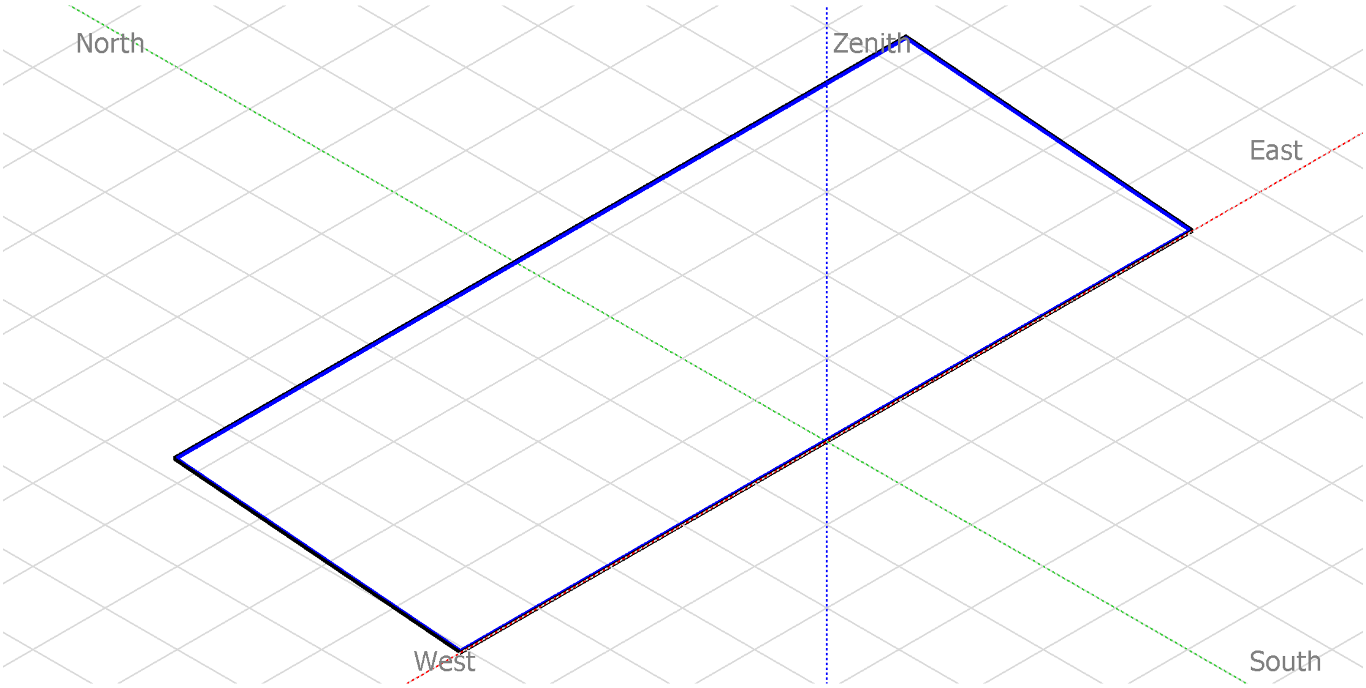
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

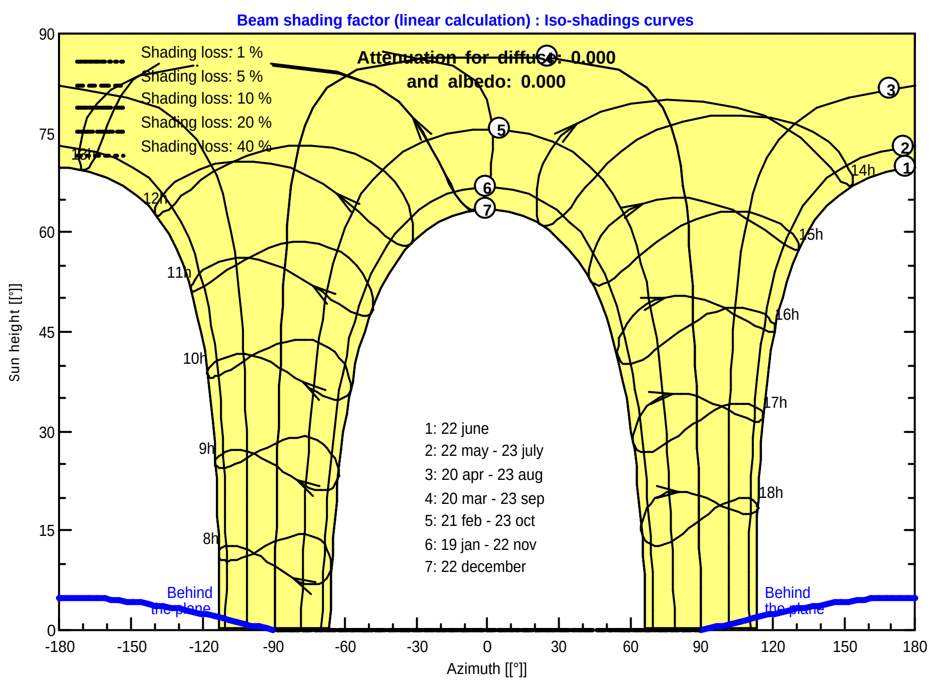
Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

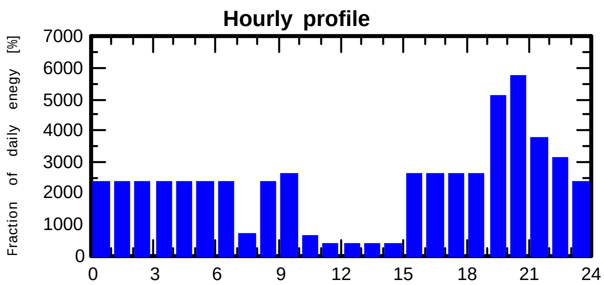
Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Daily household consumers, Constant over the year, average = 15.7 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	5 h/day	2700 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	750 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	6	750 W tot	8 h/day	36000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				54614 Wh/day



Grid-Connected System: Main results

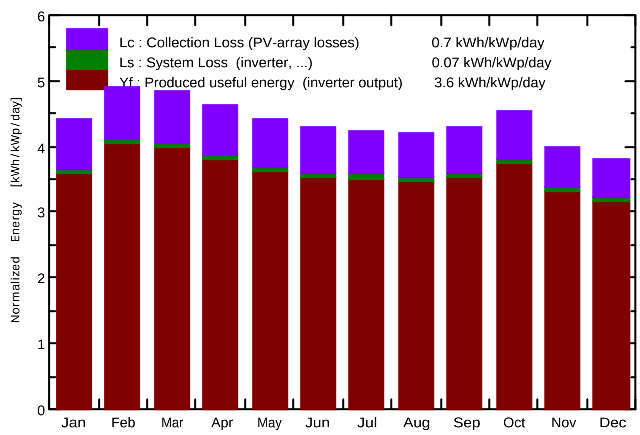
Project : **Taman Midah (NEM)**

Simulation variant : **big family - 6kw**

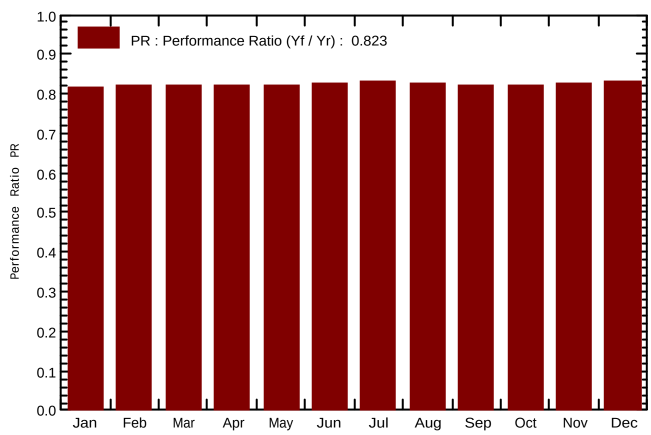
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	17.91 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



big family - 6kw

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	133.0	82.20	28.10	136.3	131.2	0.726	0.546	0.109	0.603	0.437
February	134.6	67.90	27.70	137.4	132.8	0.737	0.437	0.094	0.629	0.343
March	149.8	88.20	28.00	150.3	144.9	0.804	0.437	0.086	0.703	0.351
April	140.3	70.50	27.70	138.8	133.9	0.742	0.492	0.087	0.641	0.404
May	140.3	78.60	28.60	136.9	131.7	0.734	0.492	0.081	0.638	0.410
June	132.0	77.80	27.80	128.3	123.5	0.691	0.437	0.073	0.604	0.364
July	134.4	87.20	27.80	131.1	125.8	0.710	0.546	0.099	0.598	0.448
August	132.2	87.20	27.80	130.1	125.2	0.700	0.437	0.071	0.615	0.366
September	129.2	79.00	27.10	128.8	124.0	0.691	0.437	0.080	0.598	0.357
October	138.8	82.60	27.40	140.4	135.5	0.754	0.546	0.109	0.631	0.437
November	117.6	79.20	26.70	119.8	115.4	0.648	0.437	0.061	0.573	0.376
December	115.0	73.20	26.29	118.1	113.6	0.640	0.492	0.077	0.551	0.415
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	5.734	1.027	7.382	4.708

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

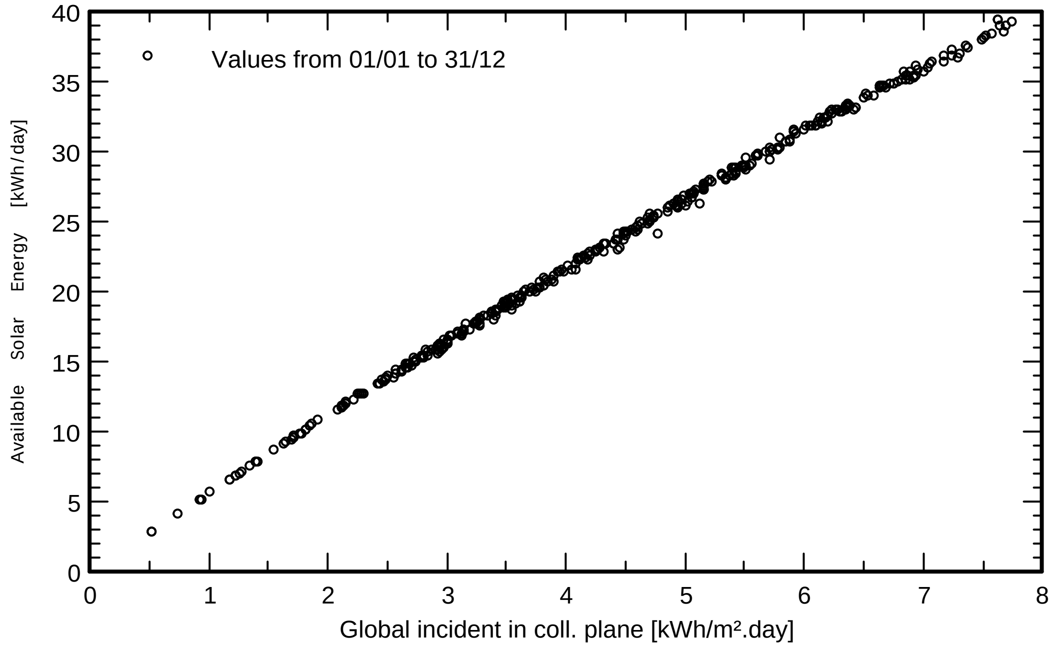
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

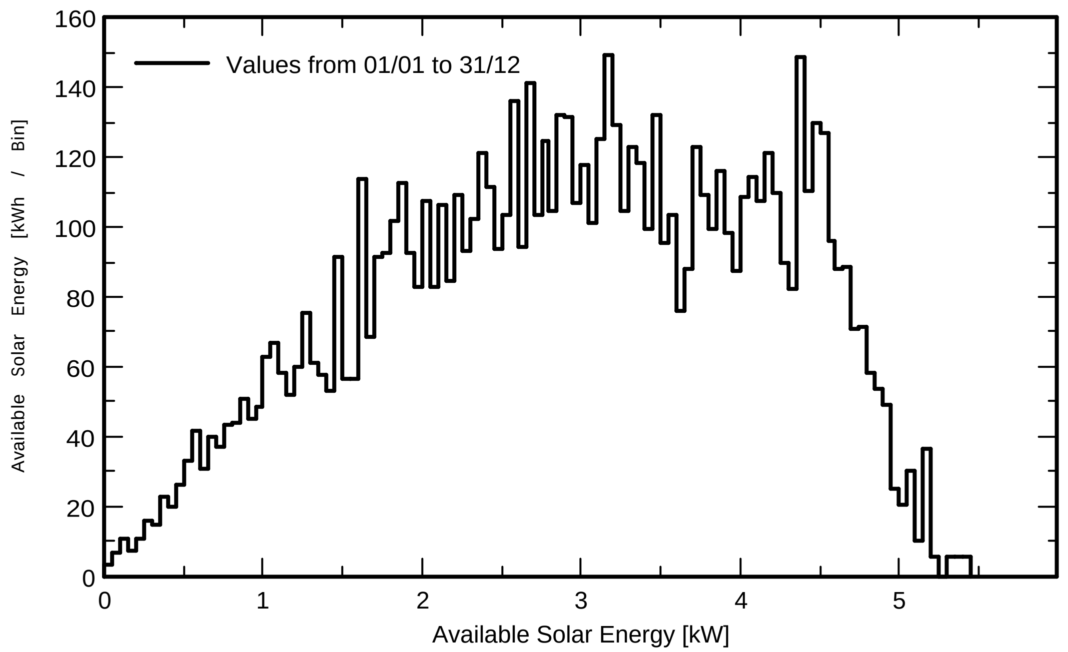
Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Daily Input/Output diagram



System Output Power Distribution



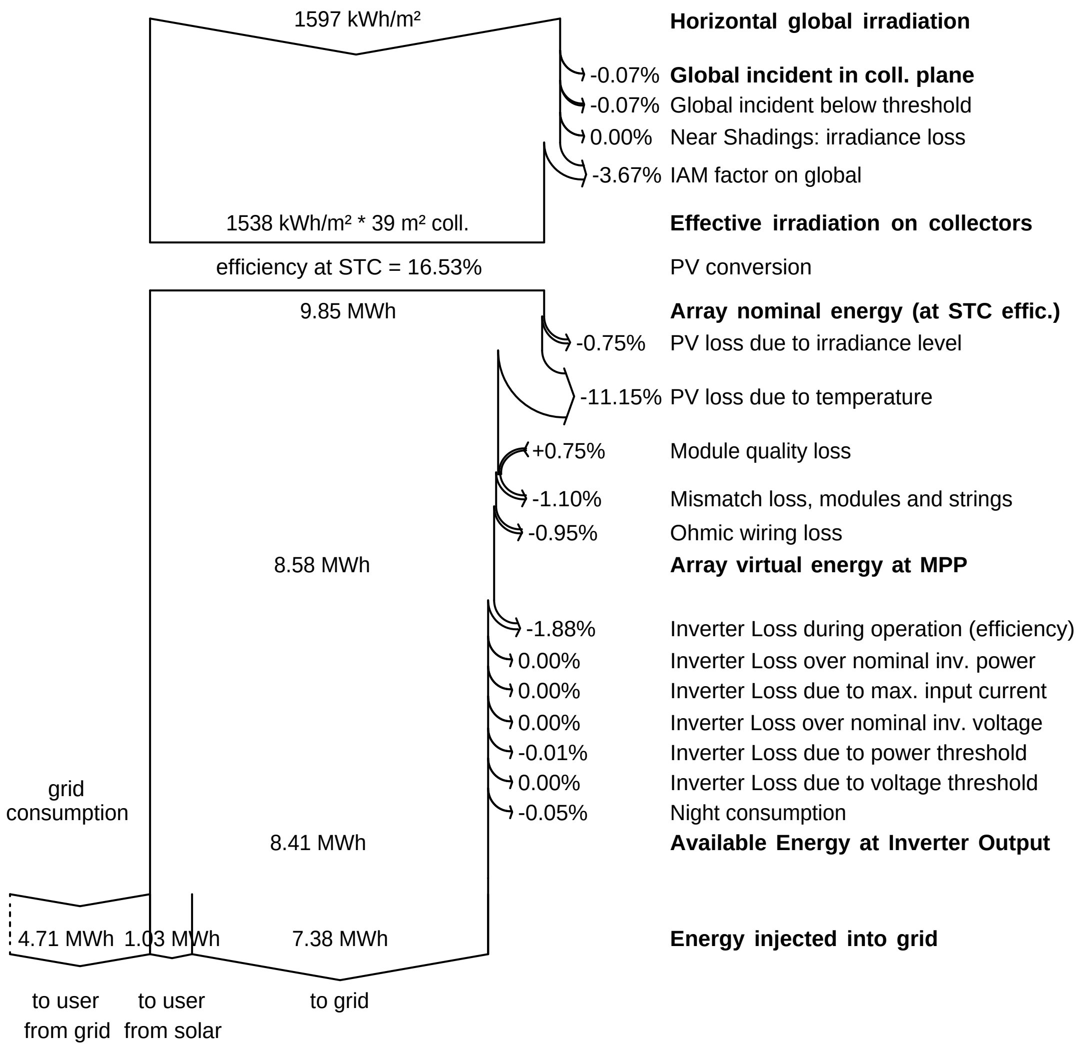
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

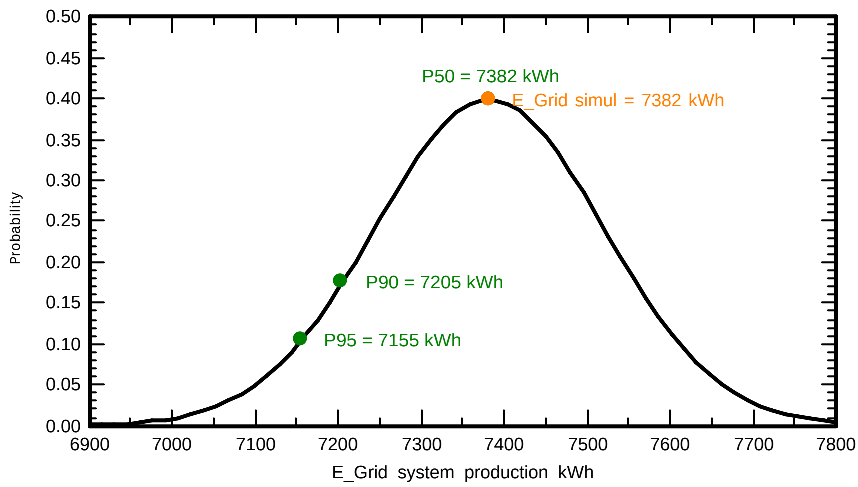
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.14 MWh**
	P50	**7.38 MWh**
	P90	**7.20 MWh**
	P95	**7.16 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **big family - 9kw**

	Simulation date	21/04/20 15h40

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	32.6 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

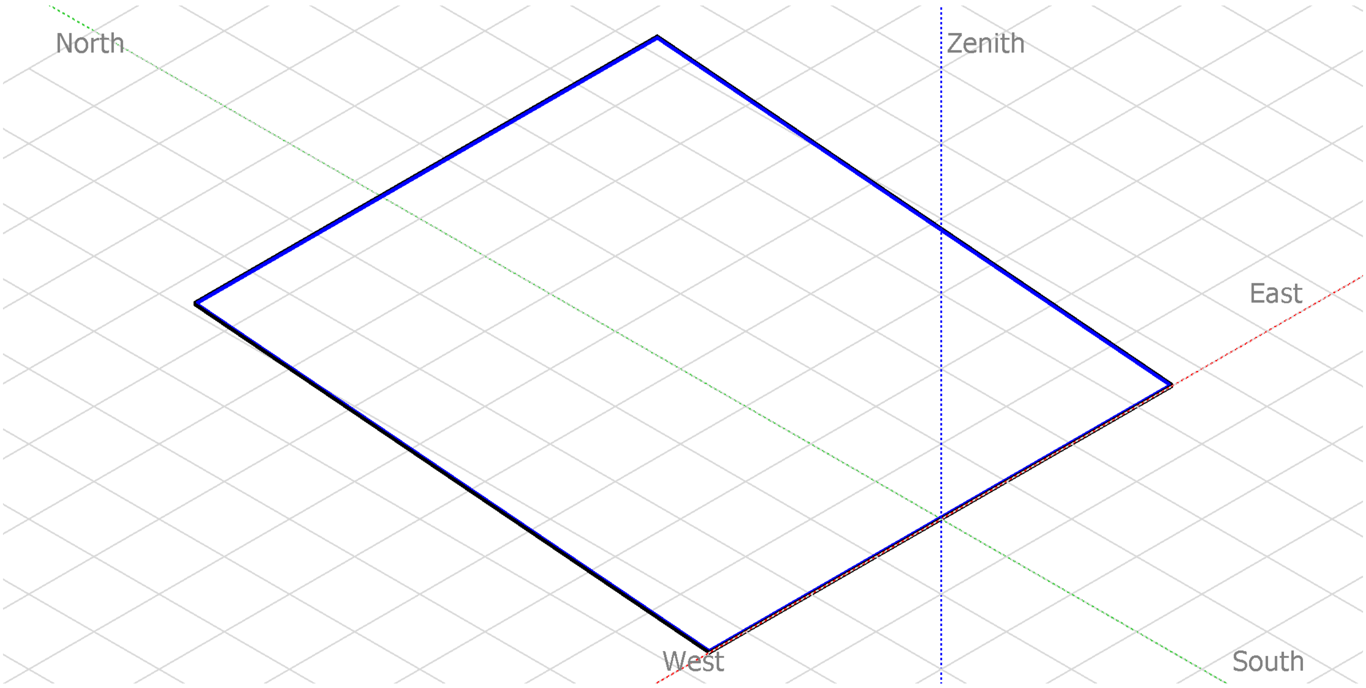
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

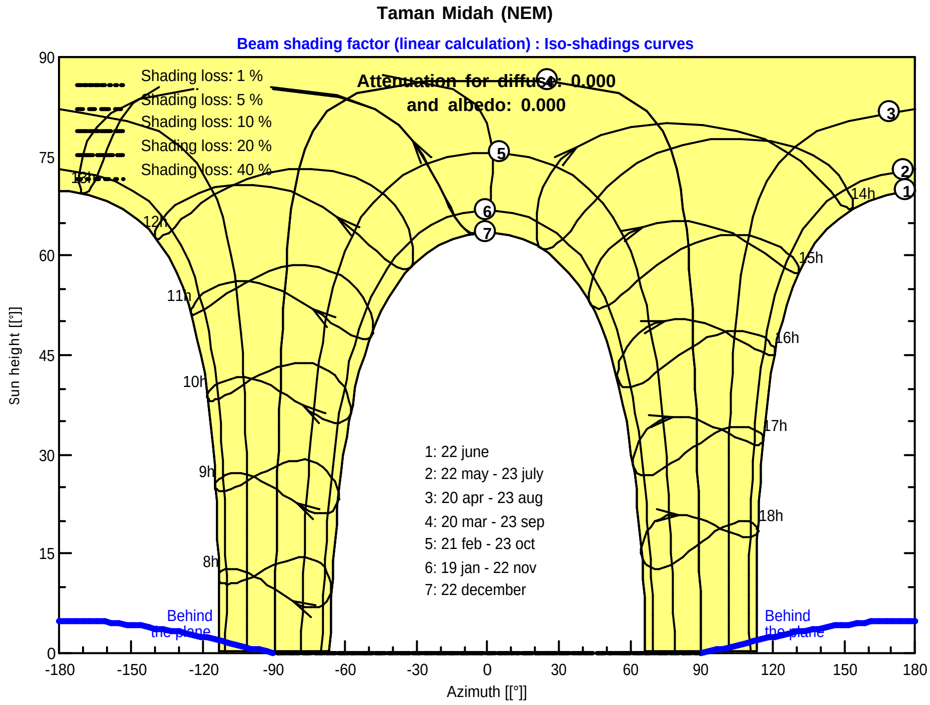
Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

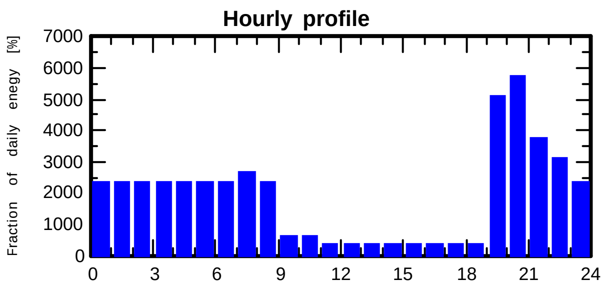
Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Daily household consumers, Constant over the year, average = 32.6 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	5 h/day	2700 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	750 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	6	750 W tot	6 h/day	27000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				45614 Wh/day



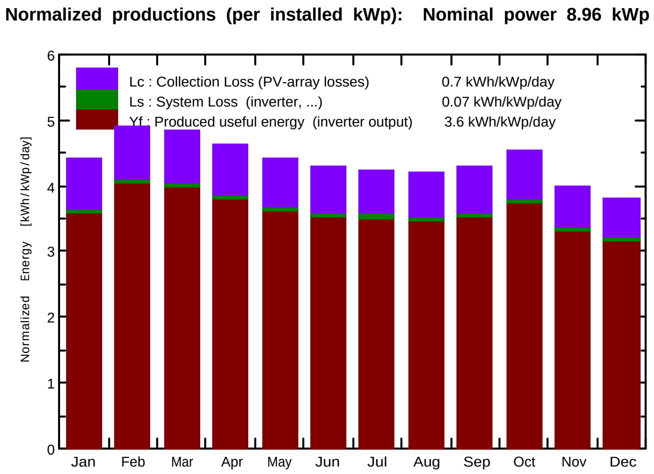
Grid-Connected System: Main results

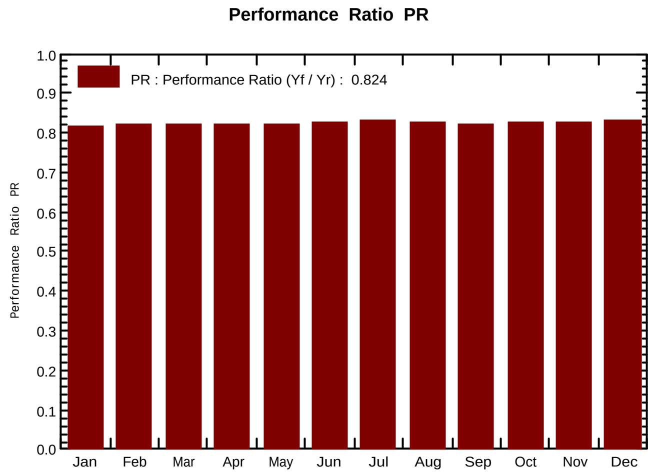
Project : **Taman Midah (NEM)**

Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	82.40 %	Solar Fraction SF	10.83 %





big family - 9kw

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	133.0	82.20	28.10	136.3	131.2	1.016	1.049	0.111	0.886	0.938
February	134.6	67.90	27.70	137.4	132.8	1.031	0.912	0.096	0.918	0.816
March	149.8	88.20	28.00	150.3	144.9	1.125	1.004	0.107	0.998	0.896
April	140.3	70.50	27.70	138.8	133.9	1.039	0.958	0.108	0.912	0.850
May	140.3	78.60	28.60	136.9	131.7	1.027	1.049	0.118	0.890	0.931
June	132.0	77.80	27.80	128.3	123.5	0.967	0.958	0.104	0.844	0.854
July	134.4	87.20	27.80	131.1	125.8	0.994	1.004	0.106	0.869	0.897
August	132.2	87.20	27.80	130.1	125.2	0.980	1.049	0.112	0.850	0.937
September	129.2	79.00	27.10	128.8	124.0	0.968	0.912	0.102	0.847	0.810
October	138.8	82.60	27.40	140.4	135.5	1.056	1.049	0.121	0.915	0.928
November	117.6	79.20	26.70	119.8	115.4	0.907	1.004	0.107	0.782	0.896
December	115.0	73.20	26.29	118.1	113.6	0.896	0.958	0.097	0.782	0.861
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	11.905	1.290	10.494	10.615

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

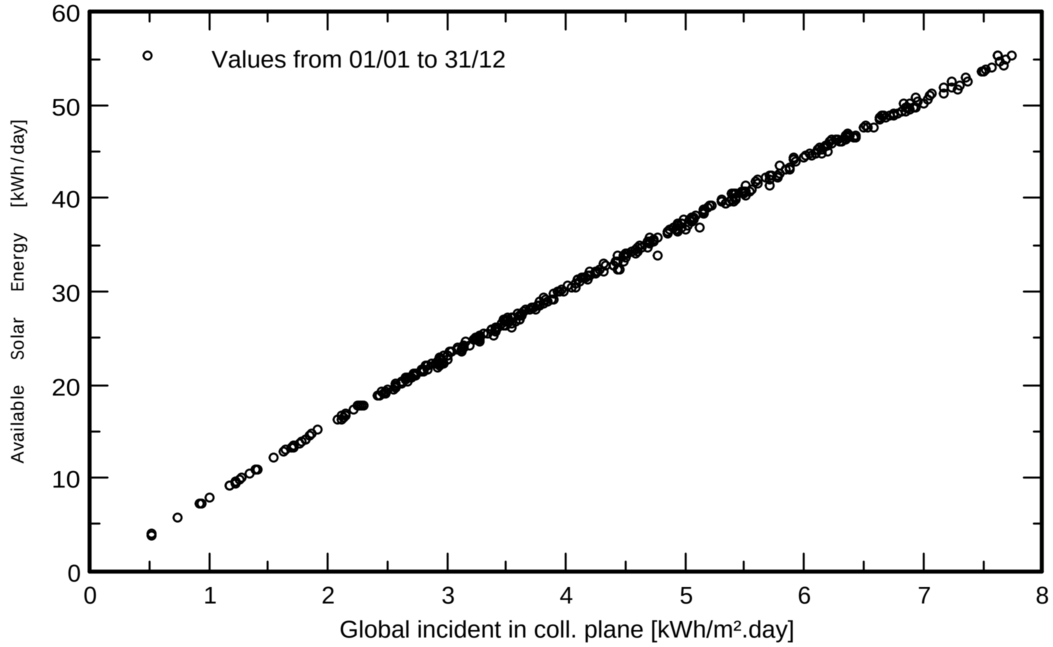
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

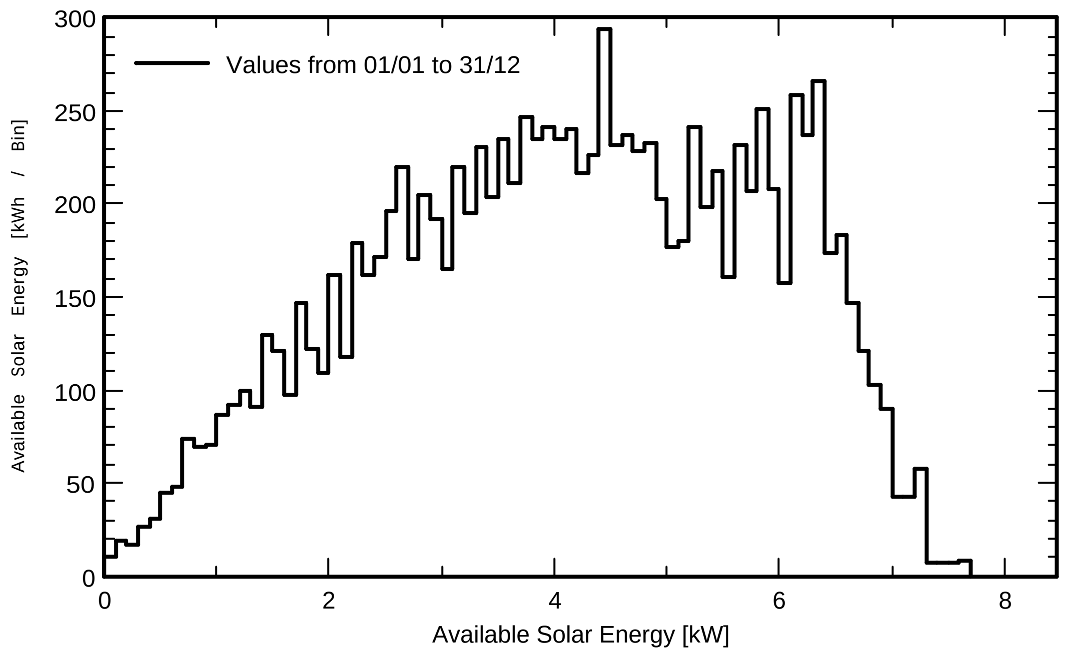
Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Daily Input/Output diagram



System Output Power Distribution



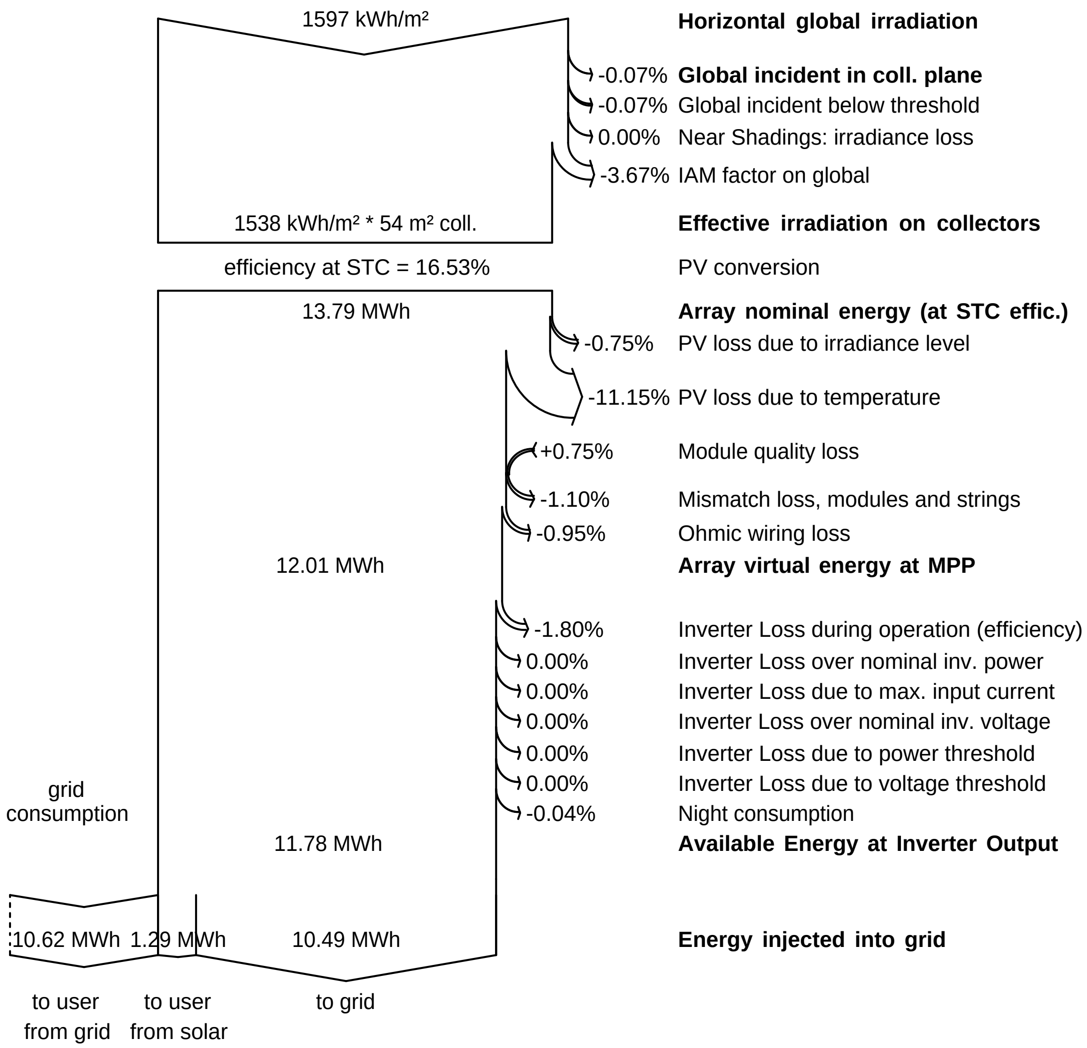
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

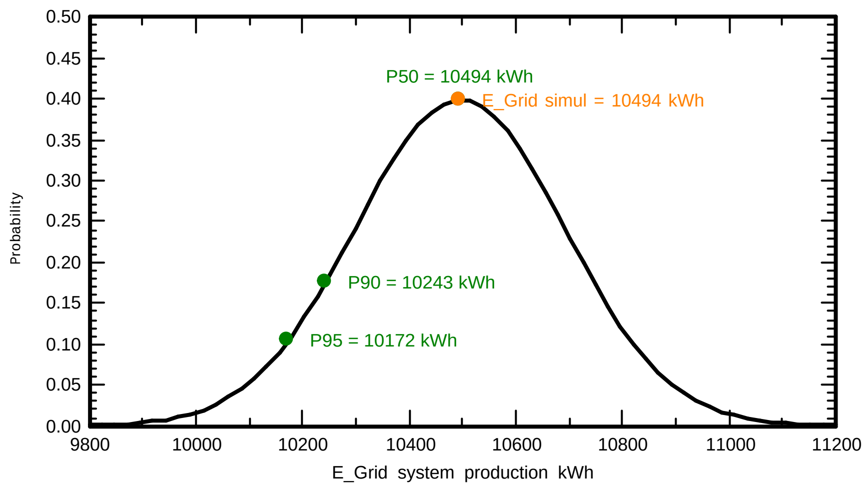
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.20 MWh**
	P50	**10.49 MWh**
	P90	**10.24 MWh**
	P95	**10.17 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **big family - 9kw**

	Simulation date	21/04/20 15h42

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	15.7 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	14 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	28	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)		U mpp	470 V	I mpp	17 A
Total area		Module area	**54.3 m²**	Cell area	48.2 m²

Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

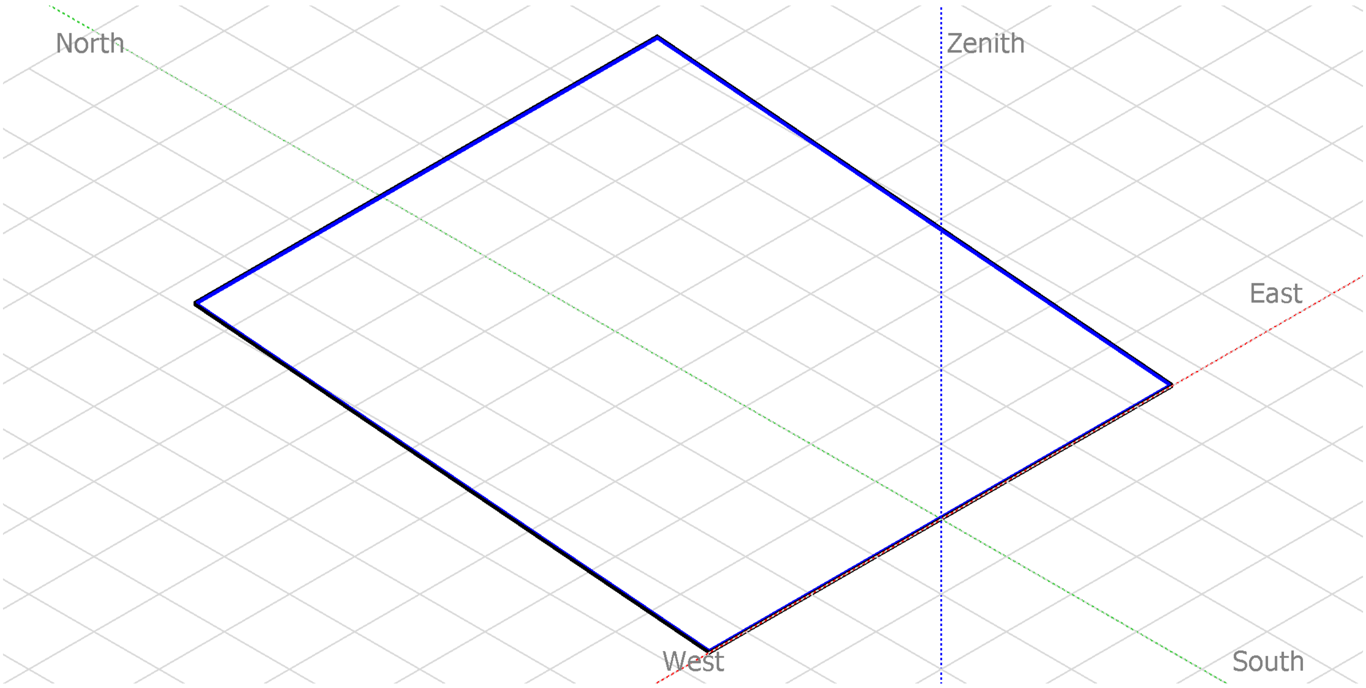
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

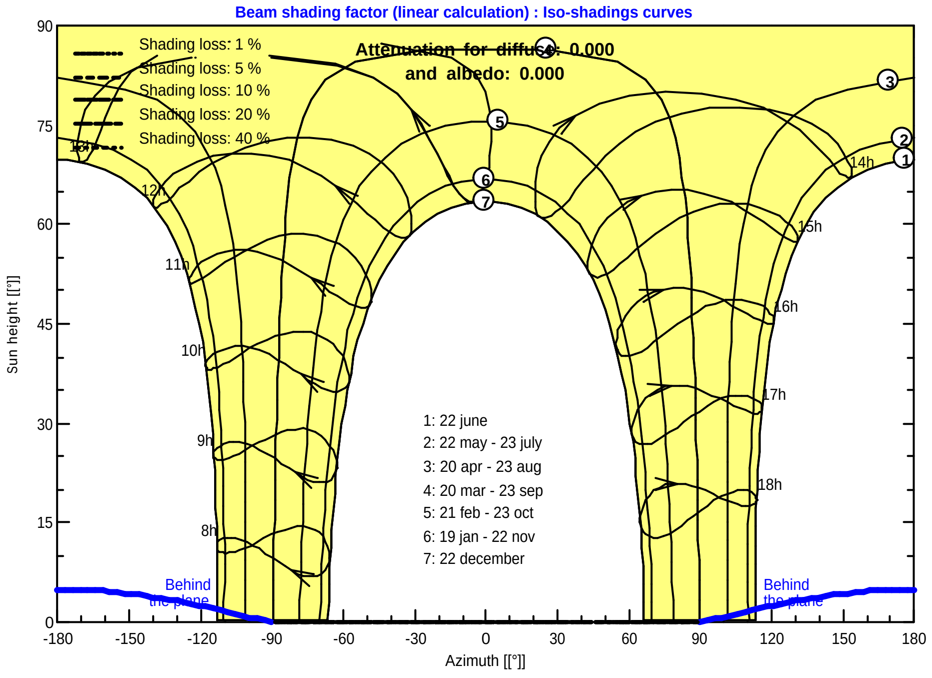
Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

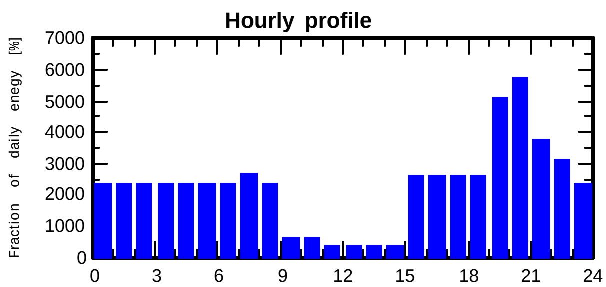
Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Daily household consumers, Constant over the year, average = 15.7 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	5 h/day	2700 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	750 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	6	750 W tot	8 h/day	36000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				54614 Wh/day



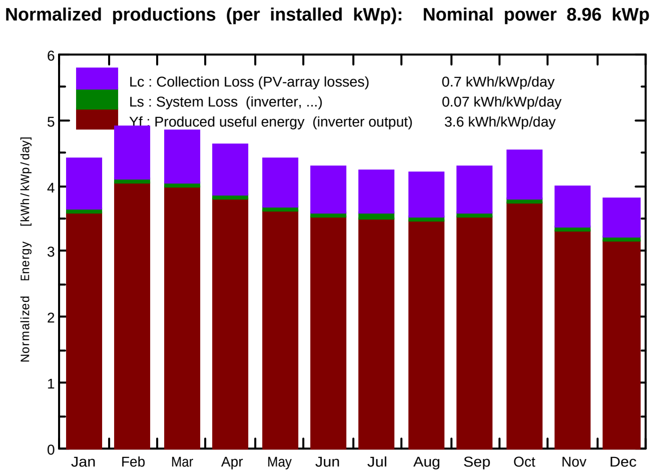
Grid-Connected System: Main results

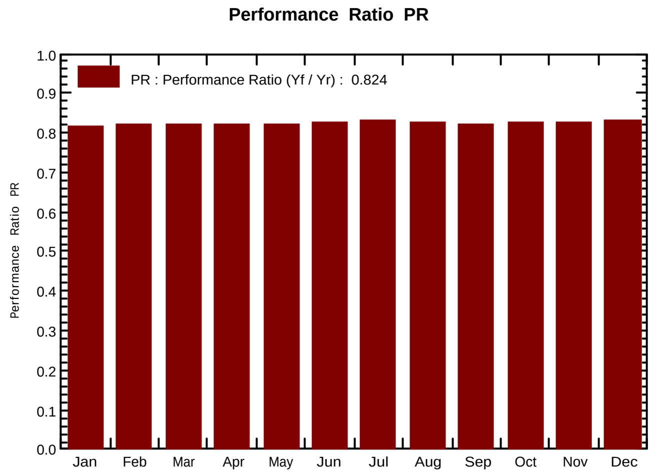
Project : **Taman Midah (NEM)**

Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	82.40 %	Solar Fraction SF	18.28 %





big family - 9kw

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	133.0	82.20	28.10	136.3	131.2	1.016	0.546	0.108	0.890	0.439
February	134.6	67.90	27.70	137.4	132.8	1.031	0.437	0.094	0.919	0.343
March	149.8	88.20	28.00	150.3	144.9	1.125	0.437	0.088	1.017	0.348
April	140.3	70.50	27.70	138.8	133.9	1.039	0.492	0.092	0.928	0.400
May	140.3	78.60	28.60	136.9	131.7	1.027	0.492	0.085	0.924	0.407
June	132.0	77.80	27.80	128.3	123.5	0.967	0.437	0.073	0.875	0.363
July	134.4	87.20	27.80	131.1	125.8	0.994	0.546	0.105	0.870	0.441
August	132.2	87.20	27.80	130.1	125.2	0.980	0.437	0.069	0.893	0.368
September	129.2	79.00	27.10	128.8	124.0	0.968	0.437	0.081	0.869	0.356
October	138.8	82.60	27.40	140.4	135.5	1.056	0.546	0.109	0.927	0.437
November	117.6	79.20	26.70	119.8	115.4	0.907	0.437	0.065	0.824	0.372
December	115.0	73.20	26.29	118.1	113.6	0.896	0.492	0.079	0.800	0.413
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	5.734	1.048	10.736	4.686

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

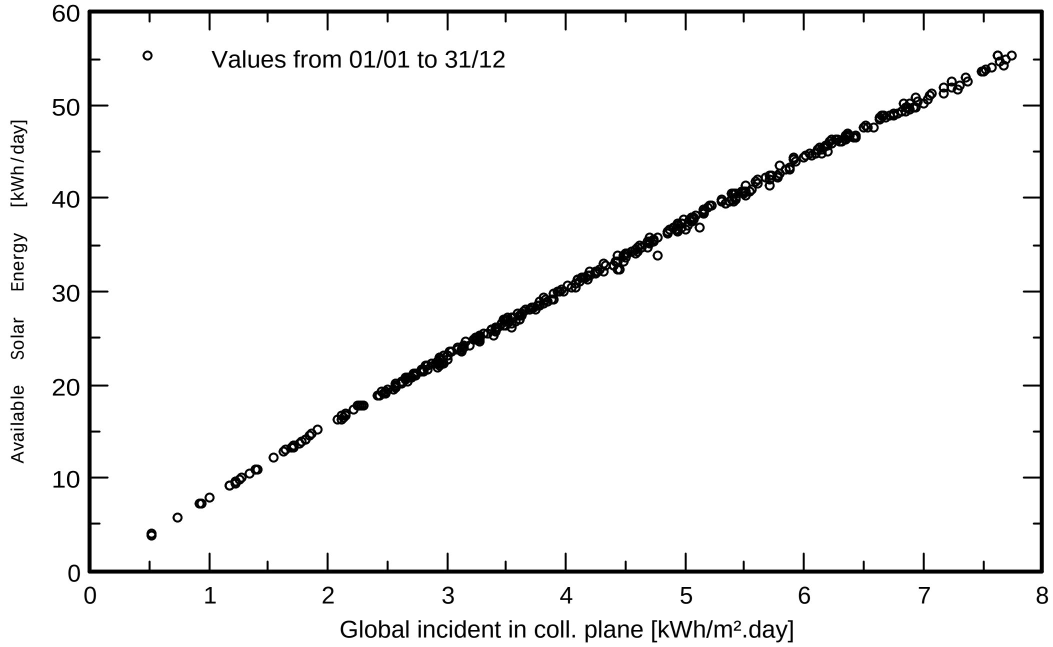
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

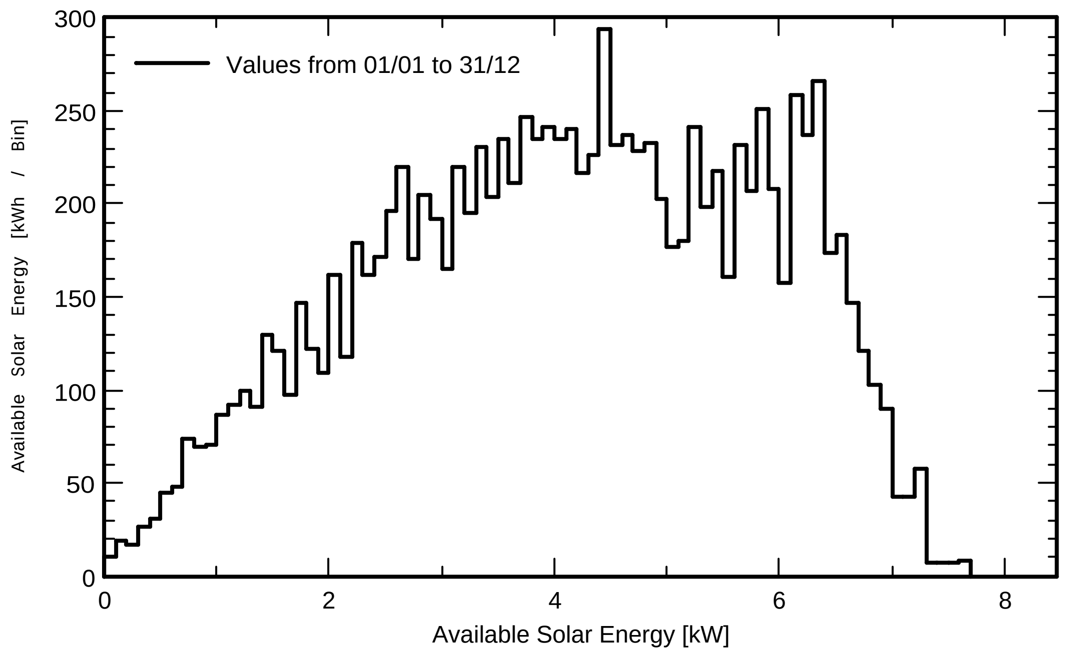
Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Daily Input/Output diagram



System Output Power Distribution



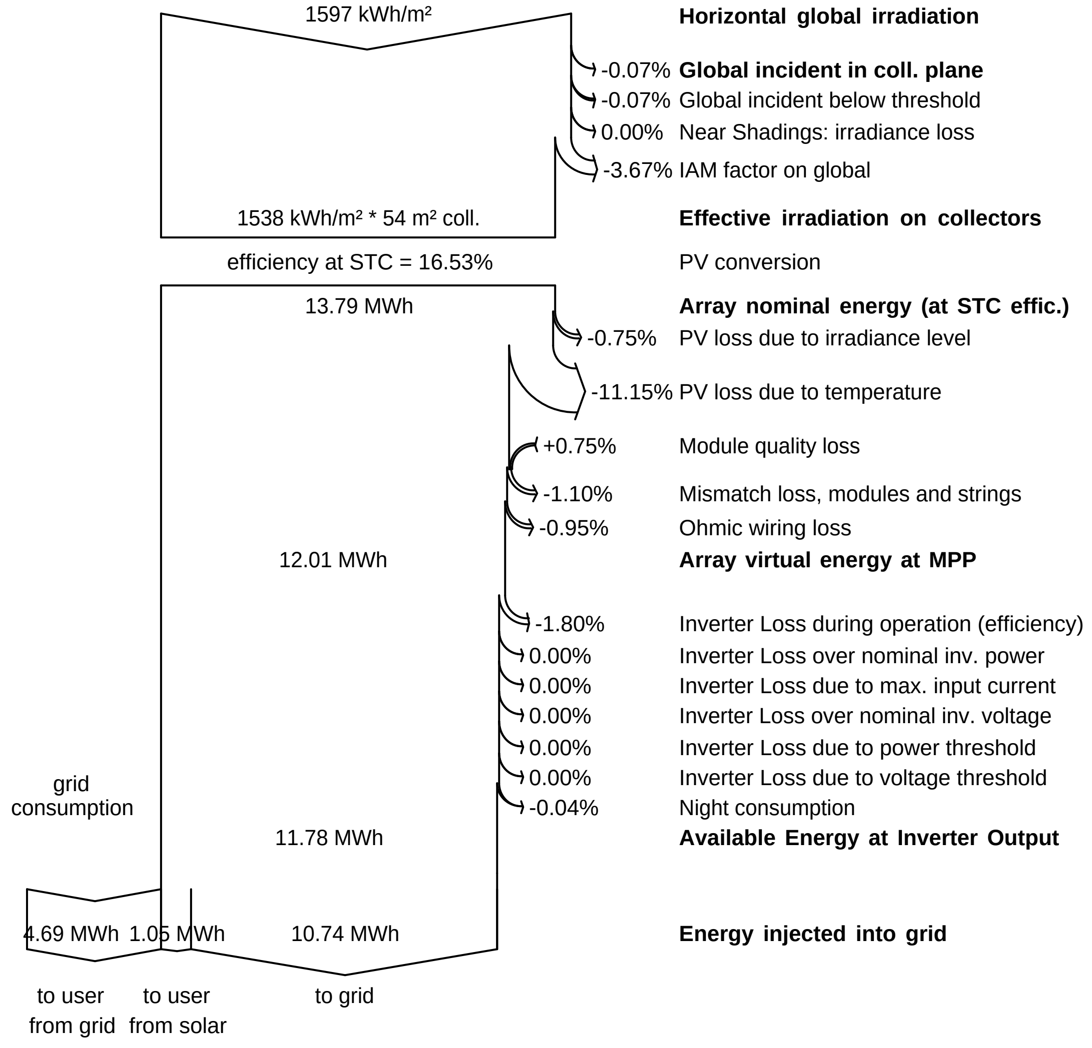
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

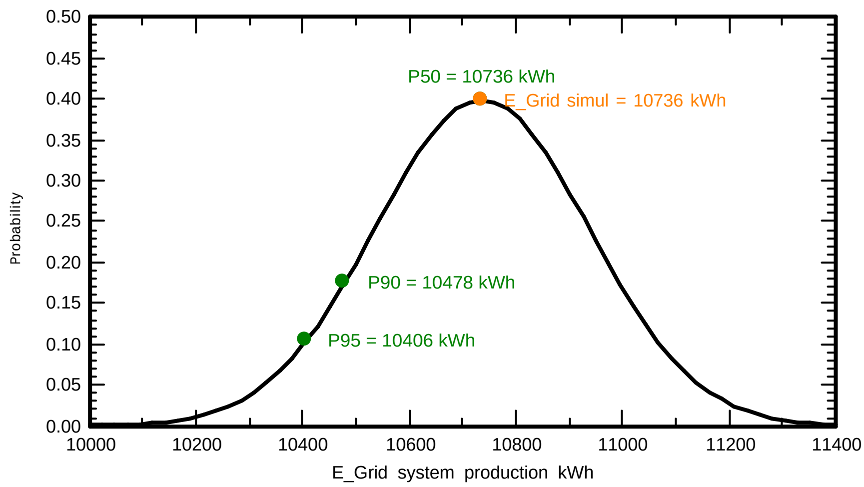
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.20 MWh**
	P50	**10.74 MWh**
	P90	**10.48 MWh**
	P95	**10.41 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project :	**Taman Midah (NEM)**			
Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant :	**Own house**	
	Simulation date	21/04/20 14h32

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	30.4 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	10 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	20	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)		U mpp	336 V	I mpp	17 A
Total area		Module area	**38.8 m²**	Cell area	34.4 m²

Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

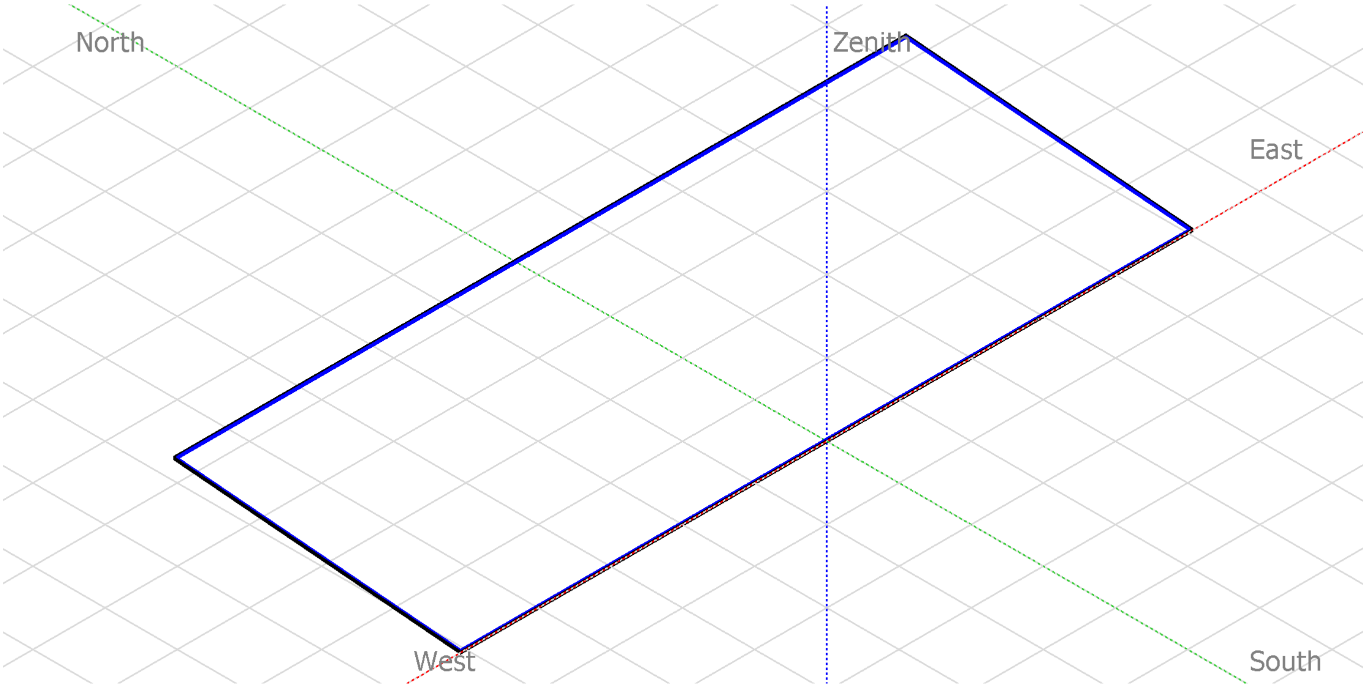
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

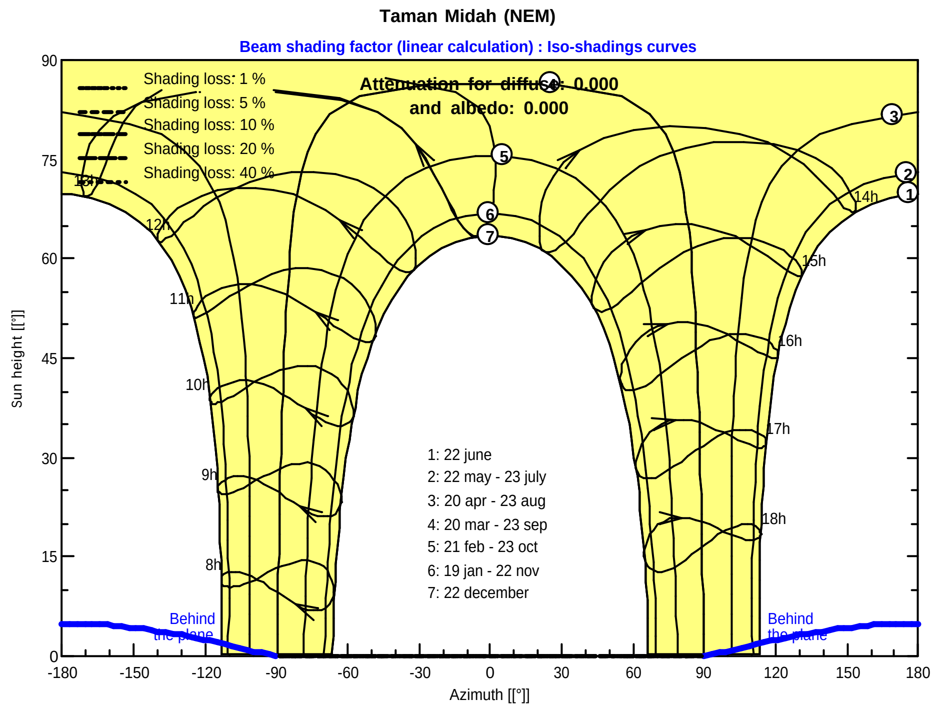
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

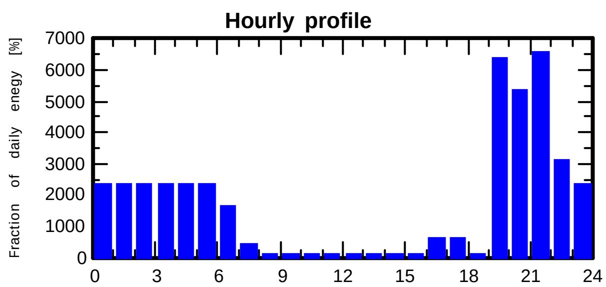
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Daily household consumers, Constant over the year, average = 30.4 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	6 h/day	2970 Wh/day
TV / PC / Mobile	3	70 W/app	4 h/day	840 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	1000 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	6	750 W tot	7 h/day	31500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				42534 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

Simulation variant : **Own house**

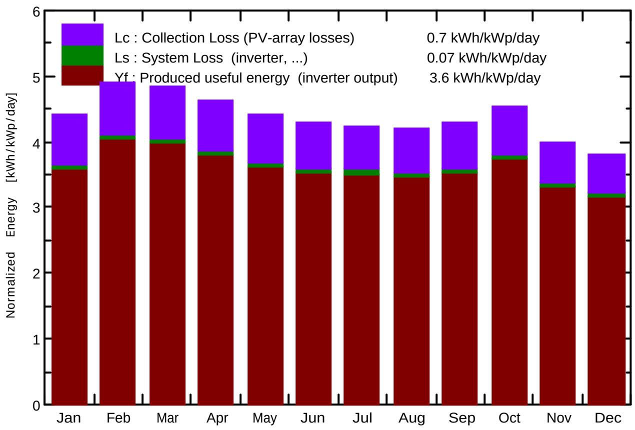
Main system parameters System type **Sheds on ground**

Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

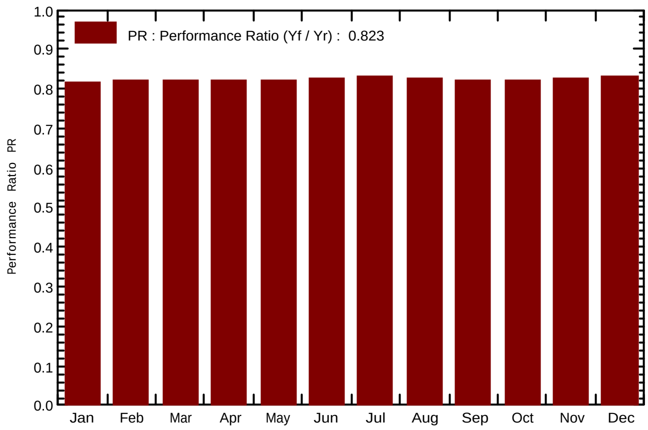
Main simulation results

System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	5.35 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



Own house

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	133.0	82.20	28.10	136.3	131.2	0.726	0.978	0.051	0.660	0.927
February	134.6	67.90	27.70	137.4	132.8	0.737	0.851	0.047	0.676	0.804
March	149.8	88.20	28.00	150.3	144.9	0.804	0.936	0.052	0.737	0.884
April	140.3	70.50	27.70	138.8	133.9	0.742	0.893	0.049	0.679	0.845
May	140.3	78.60	28.60	136.9	131.7	0.734	0.978	0.054	0.665	0.924
June	132.0	77.80	27.80	128.3	123.5	0.691	0.893	0.046	0.631	0.847
July	134.4	87.20	27.80	131.1	125.8	0.710	0.936	0.052	0.644	0.884
August	132.2	87.20	27.80	130.1	125.2	0.700	0.978	0.051	0.635	0.928
September	129.2	79.00	27.10	128.8	124.0	0.691	0.851	0.046	0.632	0.805
October	138.8	82.60	27.40	140.4	135.5	0.754	0.978	0.053	0.687	0.925
November	117.6	79.20	26.70	119.8	115.4	0.648	0.936	0.048	0.587	0.888
December	115.0	73.20	26.29	118.1	113.6	0.640	0.893	0.046	0.582	0.848
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	11.101	0.594	7.815	10.508

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

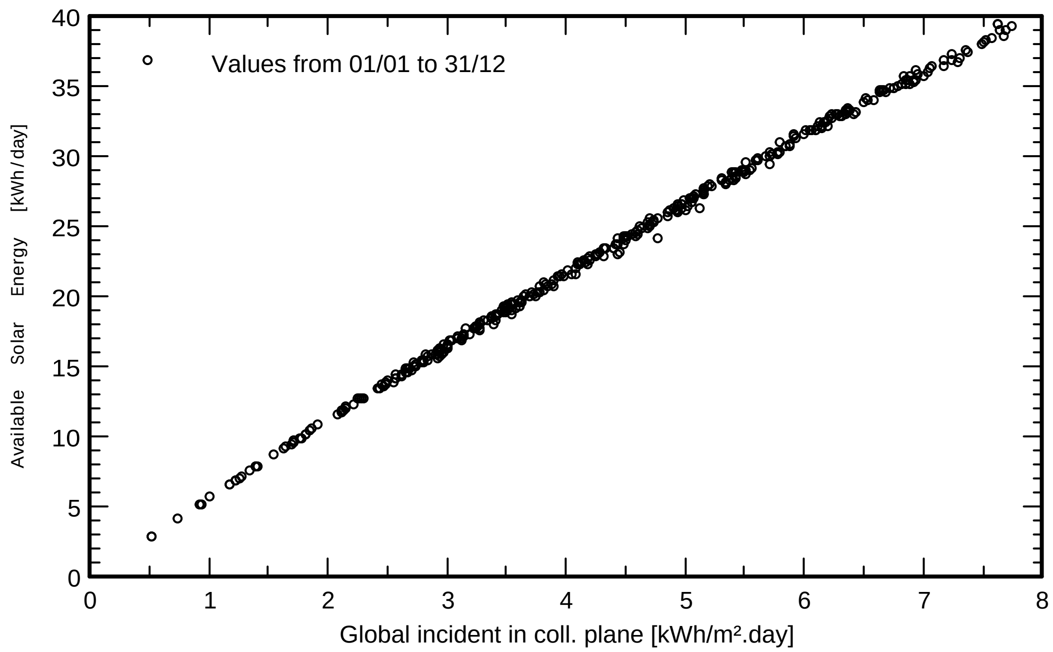
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

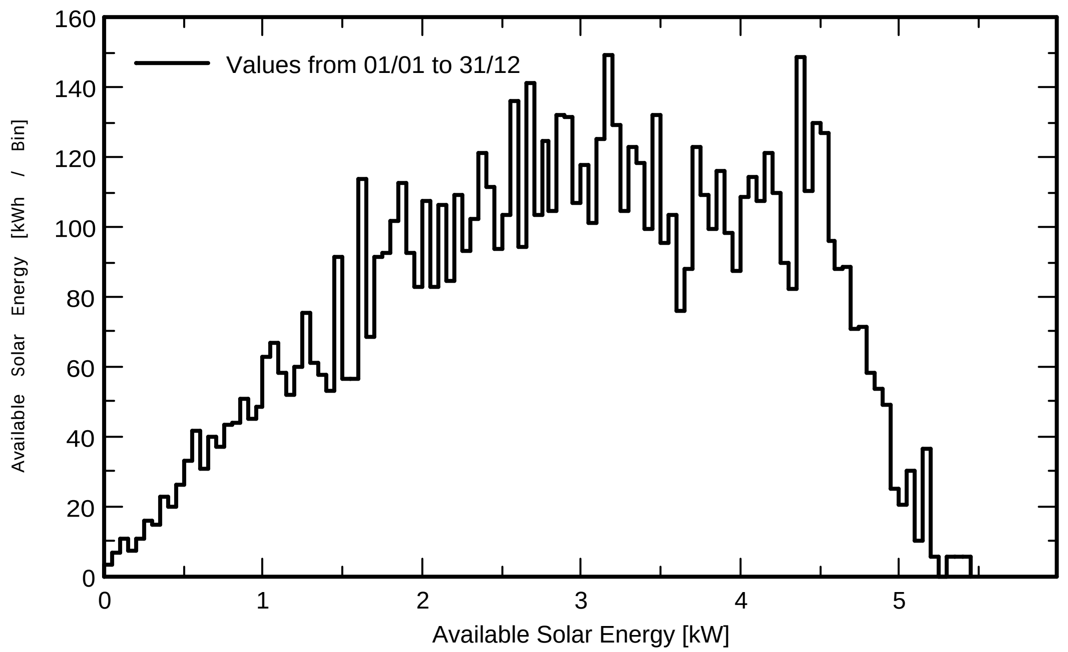
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Daily Input/Output diagram



System Output Power Distribution



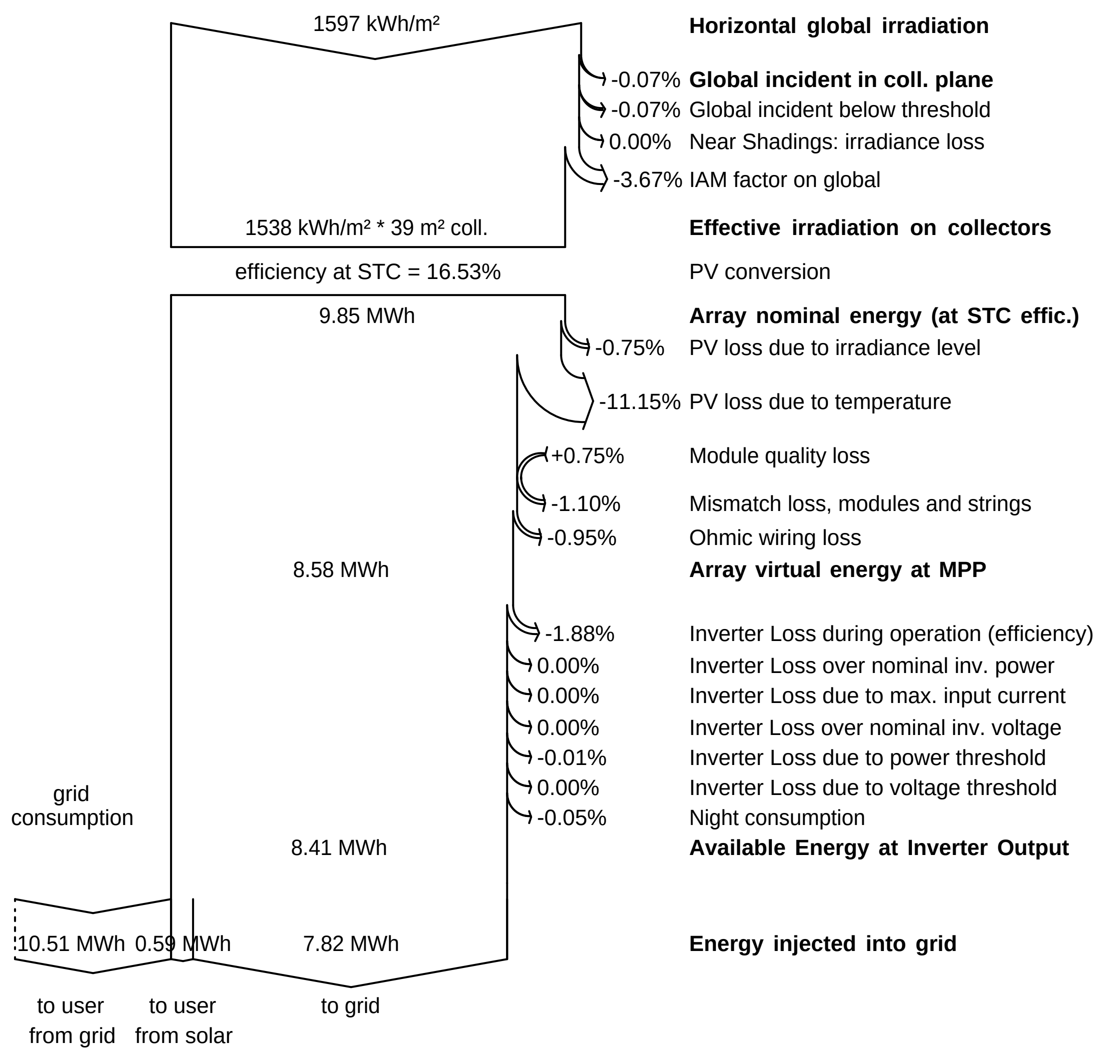
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

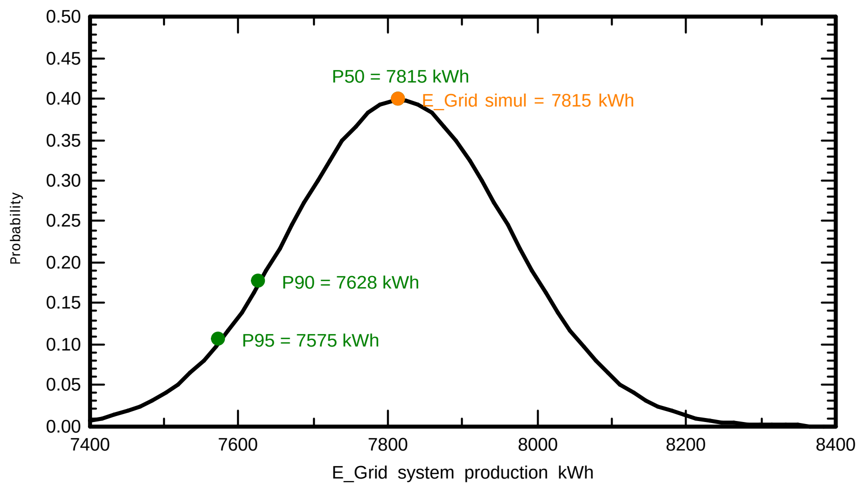
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.15 MWh**
	P50	**7.82 MWh**
	P90	**7.63 MWh**
	P95	**7.58 MWh**

Probability distribution



Grid-Connected System: CO2 Balance

Project : **Taman Midah (NEM)**

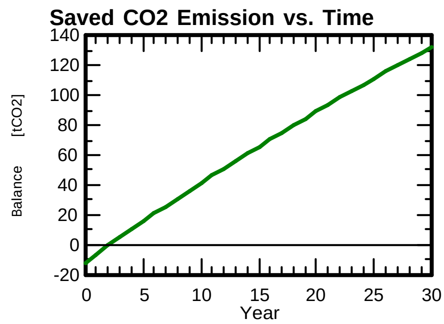
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Produced Emissions	**Total:**	**11.84 tCO2**		
	Source:	Detailed calculation from table below		
Replaced Emissions	**Total:**	**166.5 tCO2**		
	System production:	8408.96 kWh/yr	Lifetime:	30 years
			Annual Degradation:	1.0 %
	Grid Lifecycle Emissions:	660 gCO2/kWh		
	Source:	IEA List	Country:	Malaysia
CO2 Emission Balance	**Total:**	**132.6 tCO2**		

System Lifecycle Emissions Details:

Item	Modules	Supports
LCE	1713 kgCO2/kWp	4.40 kgCO2/kg
Quantity	6.40 kWp	200 kg
Subtotal [kgCO2]	10961	880



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **Own house**

Simulation date 21/04/20 14h34

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	12.8 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

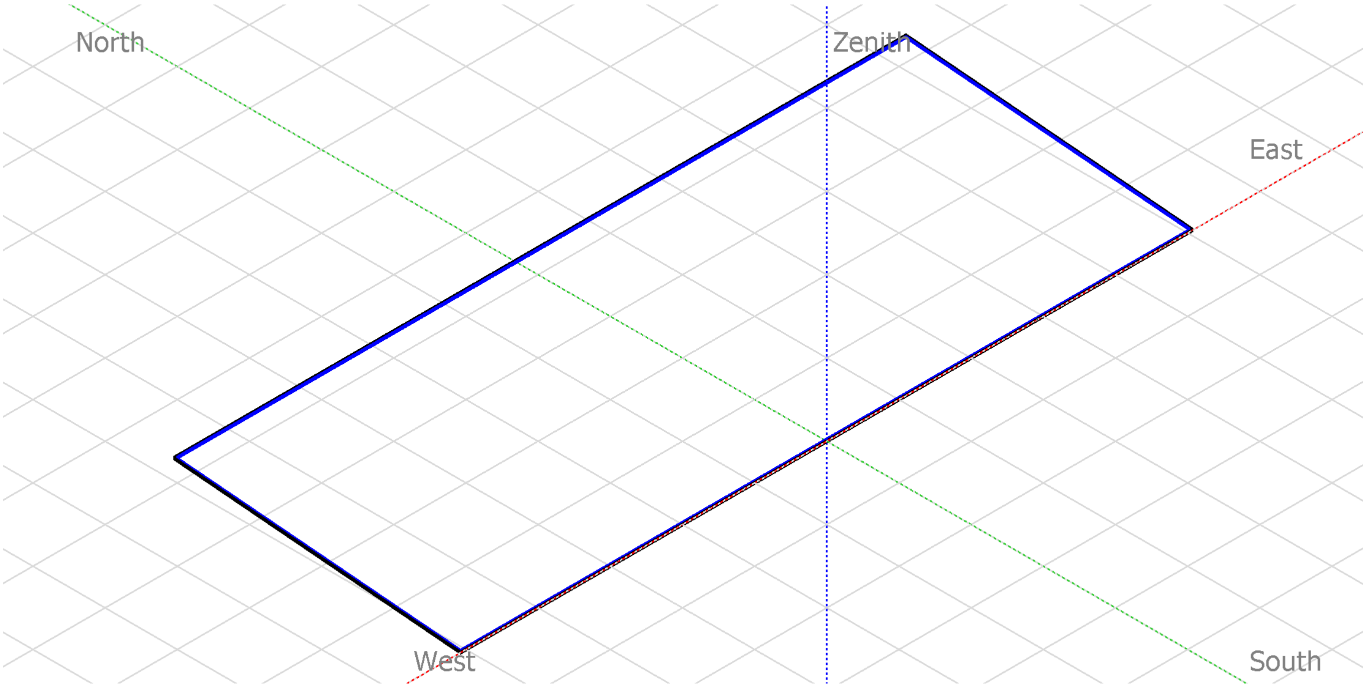
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

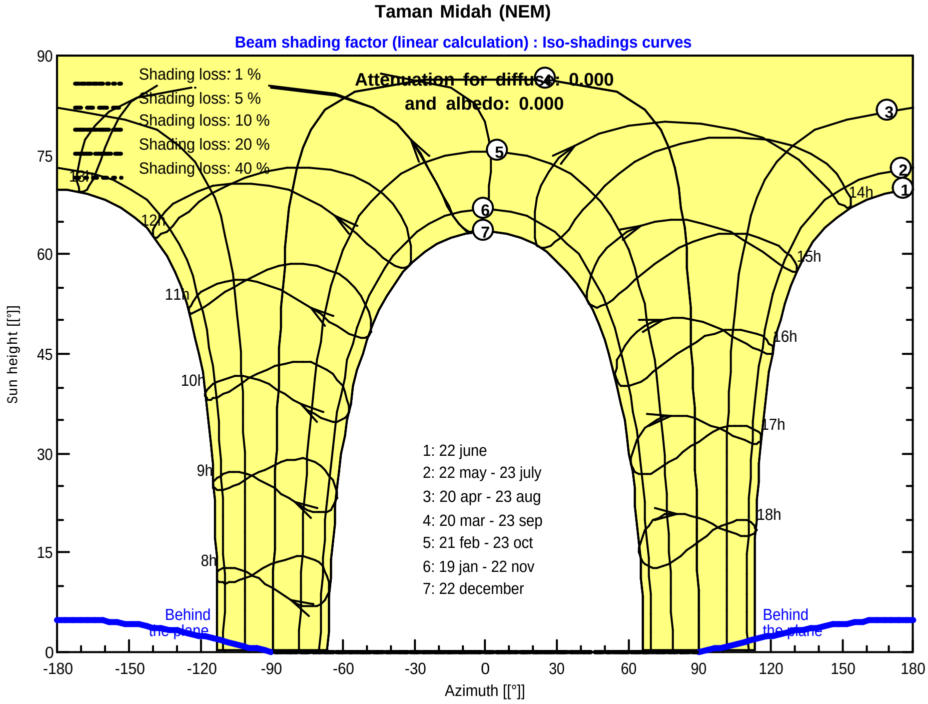
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

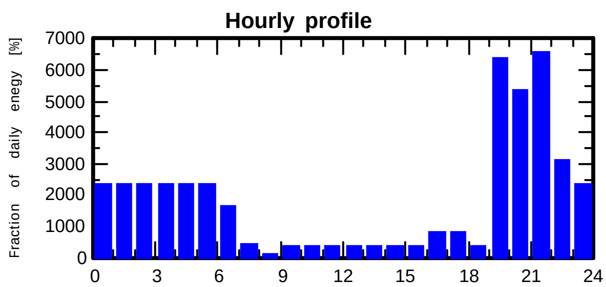
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Daily household consumers, Constant over the year, average = 12.8 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	6 h/day	2970 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	1000 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	6	750 W tot	7 h/day	31500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				44634 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

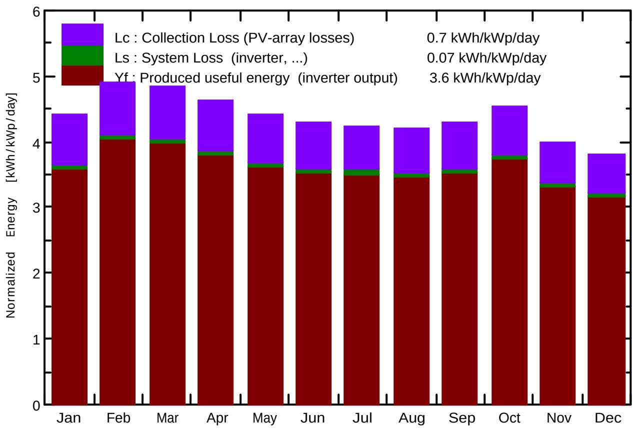
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

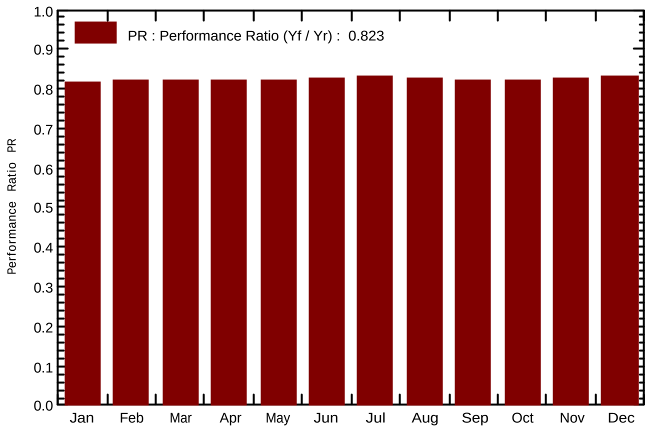
Main simulation results

System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	82.32 %	Solar Fraction SF	9.32 %

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



Own house

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	133.0	82.20	28.10	136.3	131.2	0.726	0.446	0.042	0.669	0.404
February	134.6	67.90	27.70	137.4	132.8	0.737	0.357	0.035	0.688	0.322
March	149.8	88.20	28.00	150.3	144.9	0.804	0.357	0.035	0.753	0.322
April	140.3	70.50	27.70	138.8	133.9	0.742	0.402	0.038	0.689	0.363
May	140.3	78.60	28.60	136.9	131.7	0.734	0.402	0.038	0.681	0.364
June	132.0	77.80	27.80	128.3	123.5	0.691	0.357	0.032	0.645	0.325
July	134.4	87.20	27.80	131.1	125.8	0.710	0.446	0.043	0.653	0.403
August	132.2	87.20	27.80	130.1	125.2	0.700	0.357	0.030	0.656	0.327
September	129.2	79.00	27.10	128.8	124.0	0.691	0.357	0.034	0.644	0.323
October	138.8	82.60	27.40	140.4	135.5	0.754	0.446	0.043	0.697	0.403
November	117.6	79.20	26.70	119.8	115.4	0.648	0.357	0.030	0.605	0.327
December	115.0	73.20	26.29	118.1	113.6	0.640	0.402	0.035	0.592	0.366
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	4.687	0.437	7.972	4.250

Legends:

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

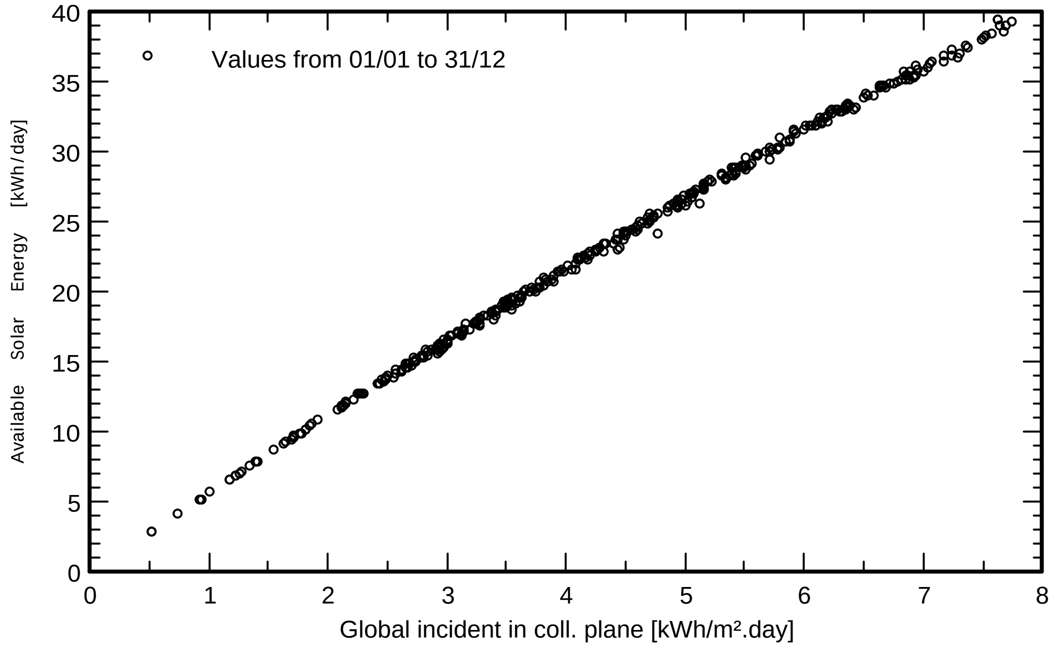
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

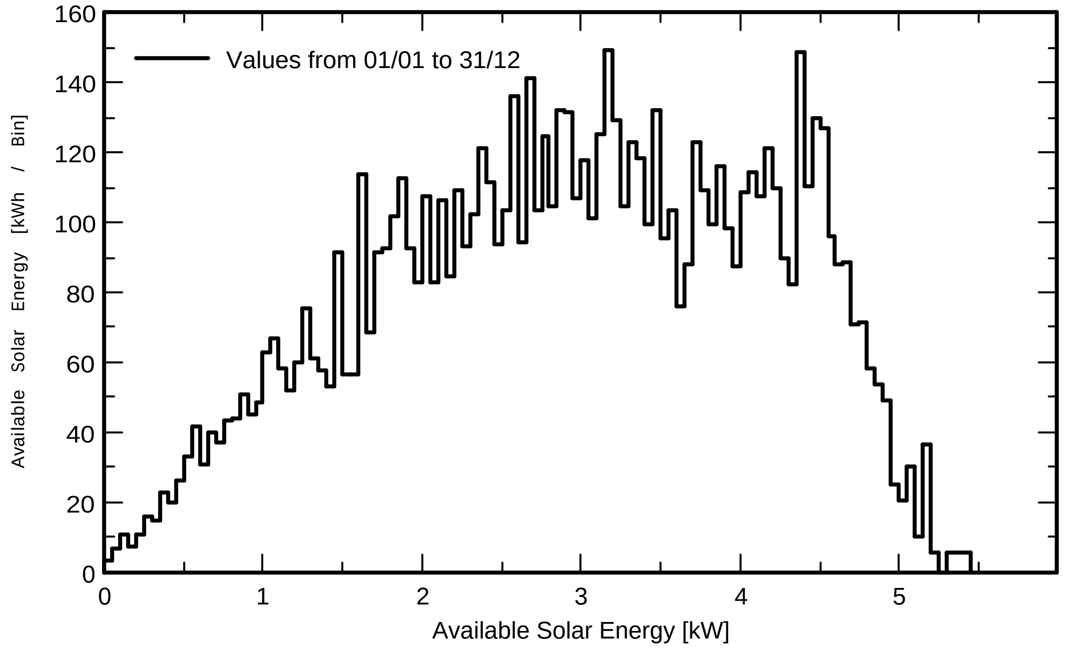
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Daily Input/Output diagram



System Output Power Distribution



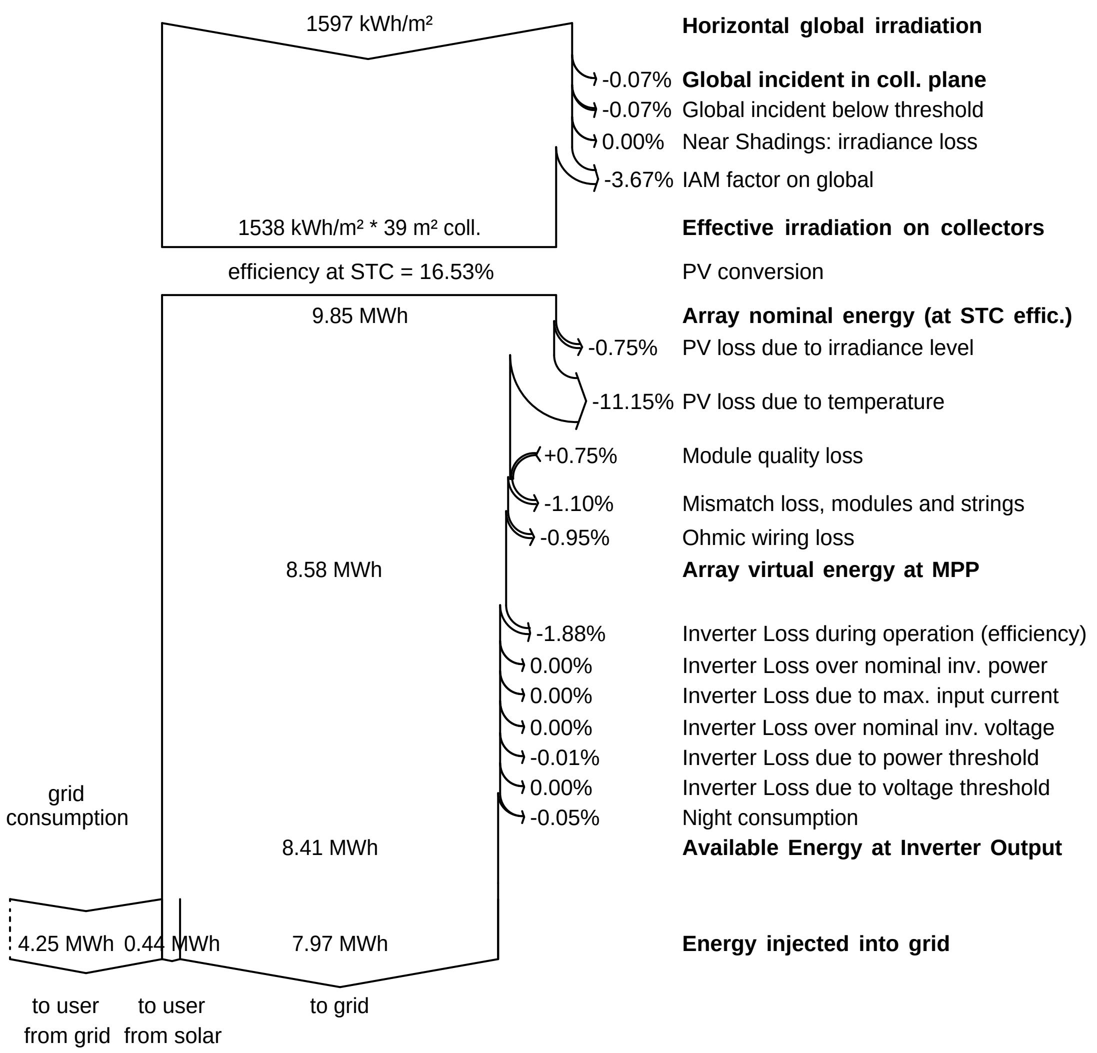
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

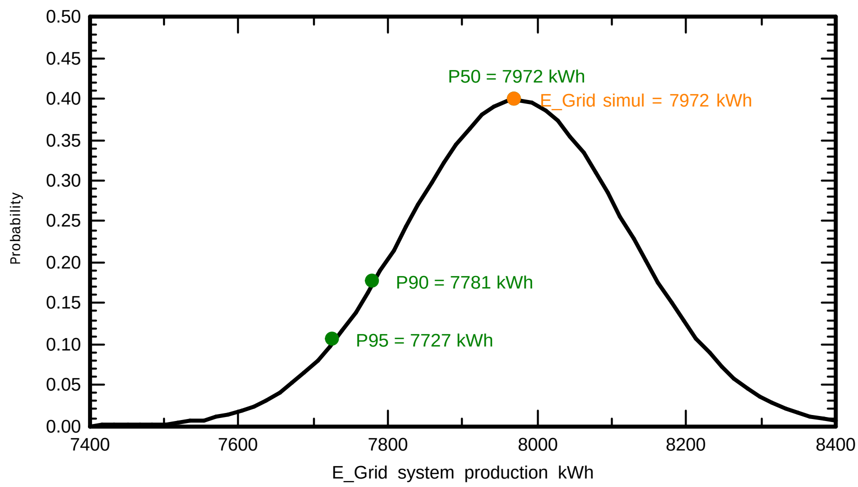
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.15 MWh**
	P50	**7.97 MWh**
	P90	**7.78 MWh**
	P95	**7.73 MWh**

Probability distribution



Grid-Connected System: CO_2 Balance

Project : **Taman Midah (NEM)**

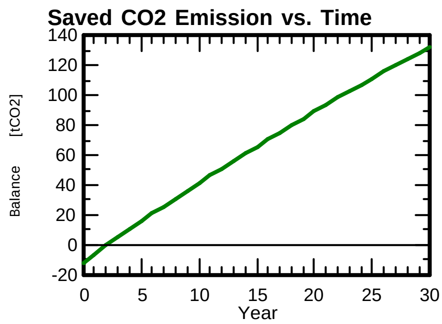
Simulation variant : **Own house**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Produced Emissions	**Total:**	**11.84 tCO2**		
	Source:	Detailed calculation from table below		
Replaced Emissions	**Total:**	**166.5 tCO2**		
	System production:	8408.96 kWh/yr	Lifetime:	30 years
			Annual Degradation:	1.0 %
	Grid Lifecycle Emissions:	660 gCO2/kWh		
	Source:	IEA List	Country:	Malaysia
CO2 Emission Balance	**Total:**	**132.6 tCO2**		

System Lifecycle Emissions Details:

Item	Modules	Supports
LCE	1713 kgCO2/kWp	4.40 kgCO2/kg
Quantity	6.40 kWp	200 kg
Subtotal [kgCO2]	10961	880



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **Own (9KW)**

Simulation date 21/04/20 14h27

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	30.4 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	14 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	28	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)		U mpp	470 V	I mpp	17 A
Total area		Module area	**54.3 m²**	Cell area	48.2 m²

Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

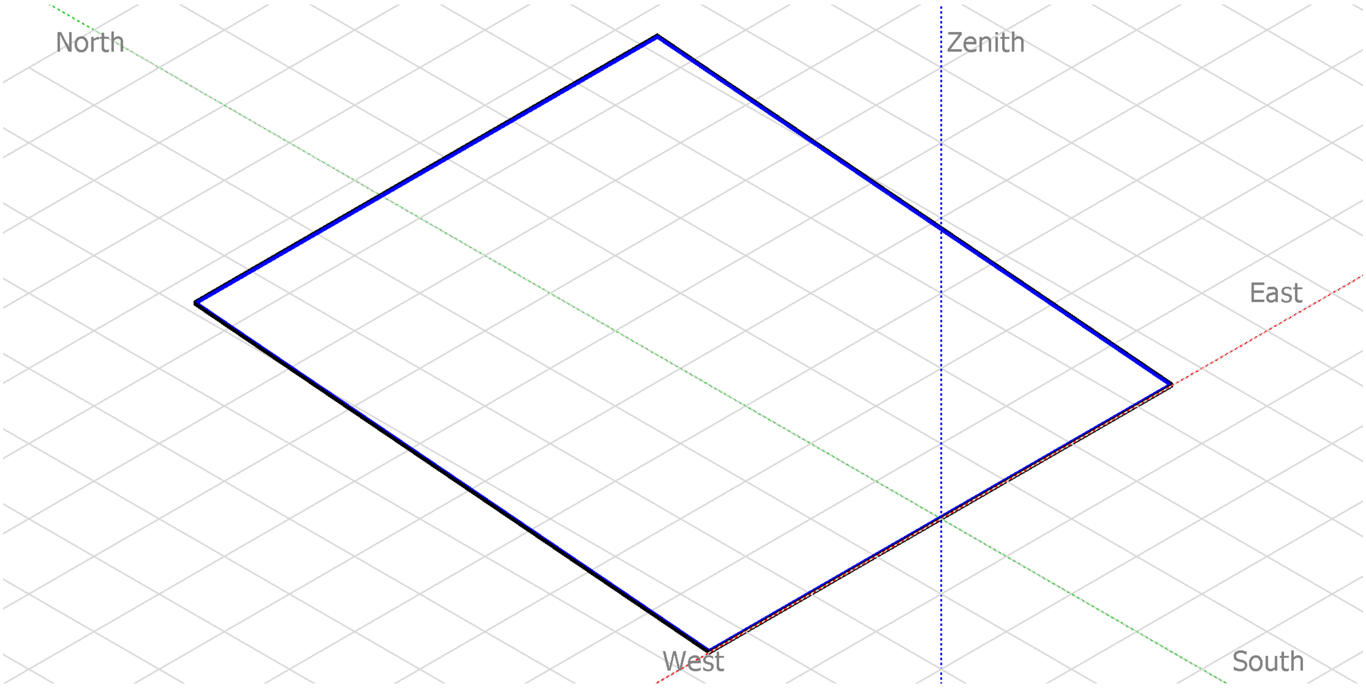
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

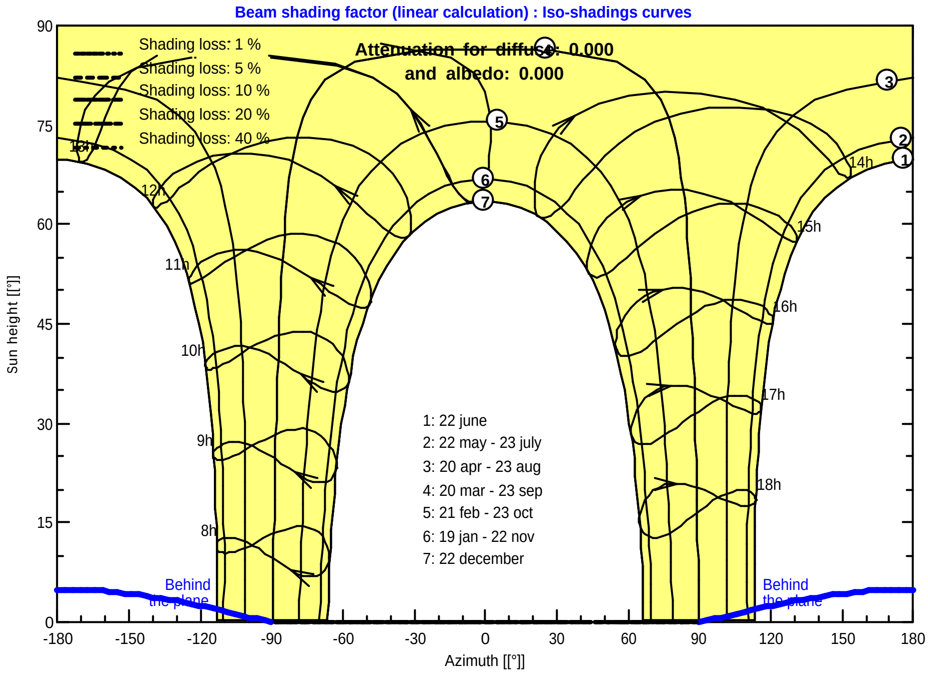
Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

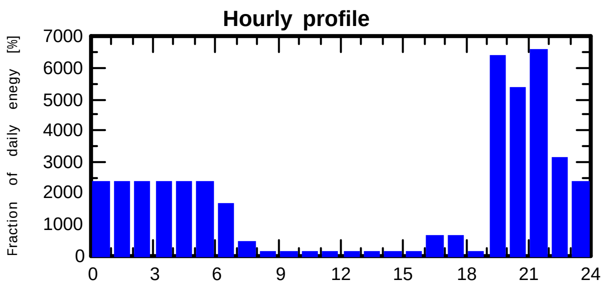
Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Daily household consumers, Constant over the year, average = 30.4 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	6 h/day	2970 Wh/day
TV / PC / Mobile	3	70 W/app	4 h/day	840 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	1000 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	6	750 W tot	7 h/day	31500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				42534 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

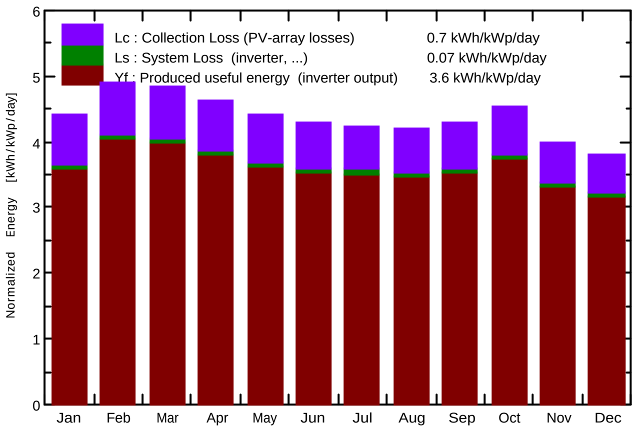
Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

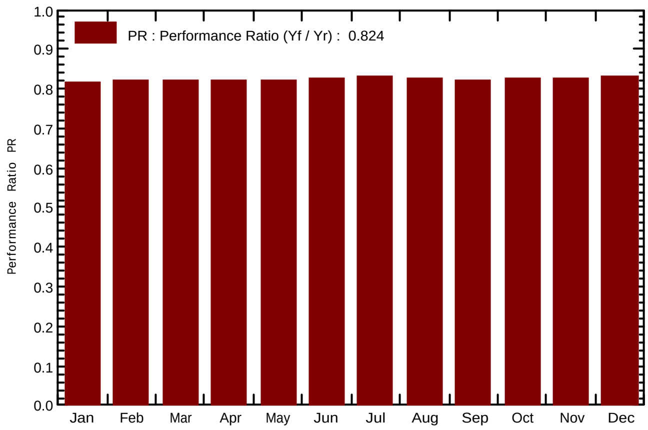
Main simulation results

System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	82.40 %	Solar Fraction SF	5.49 %

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



Own (9KW)

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	133.0	82.20	28.10	136.3	131.2	1.016	0.978	0.052	0.945	0.926
February	134.6	67.90	27.70	137.4	132.8	1.031	0.851	0.047	0.966	0.804
March	149.8	88.20	28.00	150.3	144.9	1.125	0.936	0.052	1.053	0.884
April	140.3	70.50	27.70	138.8	133.9	1.039	0.893	0.050	0.971	0.844
May	140.3	78.60	28.60	136.9	131.7	1.027	0.978	0.056	0.952	0.922
June	132.0	77.80	27.80	128.3	123.5	0.967	0.893	0.048	0.901	0.845
July	134.4	87.20	27.80	131.1	125.8	0.994	0.936	0.052	0.923	0.883
August	132.2	87.20	27.80	130.1	125.2	0.980	0.978	0.052	0.909	0.926
September	129.2	79.00	27.10	128.8	124.0	0.968	0.851	0.047	0.902	0.804
October	138.8	82.60	27.40	140.4	135.5	1.056	0.978	0.055	0.981	0.923
November	117.6	79.20	26.70	119.8	115.4	0.907	0.936	0.050	0.839	0.886
December	115.0	73.20	26.29	118.1	113.6	0.896	0.893	0.048	0.831	0.846
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	11.101	0.609	11.175	10.492

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

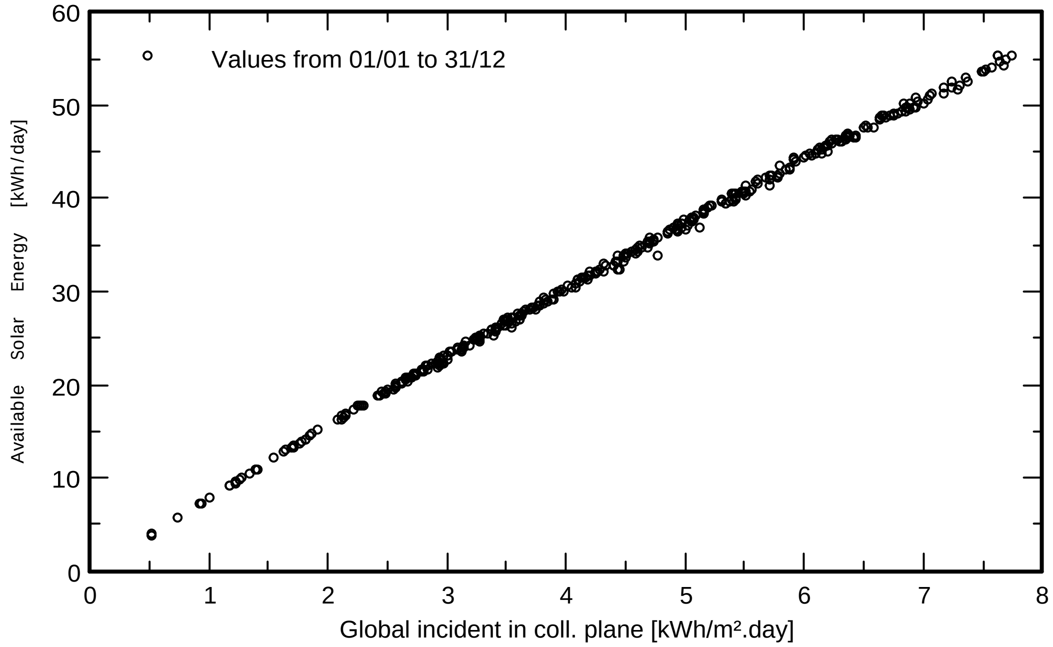
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

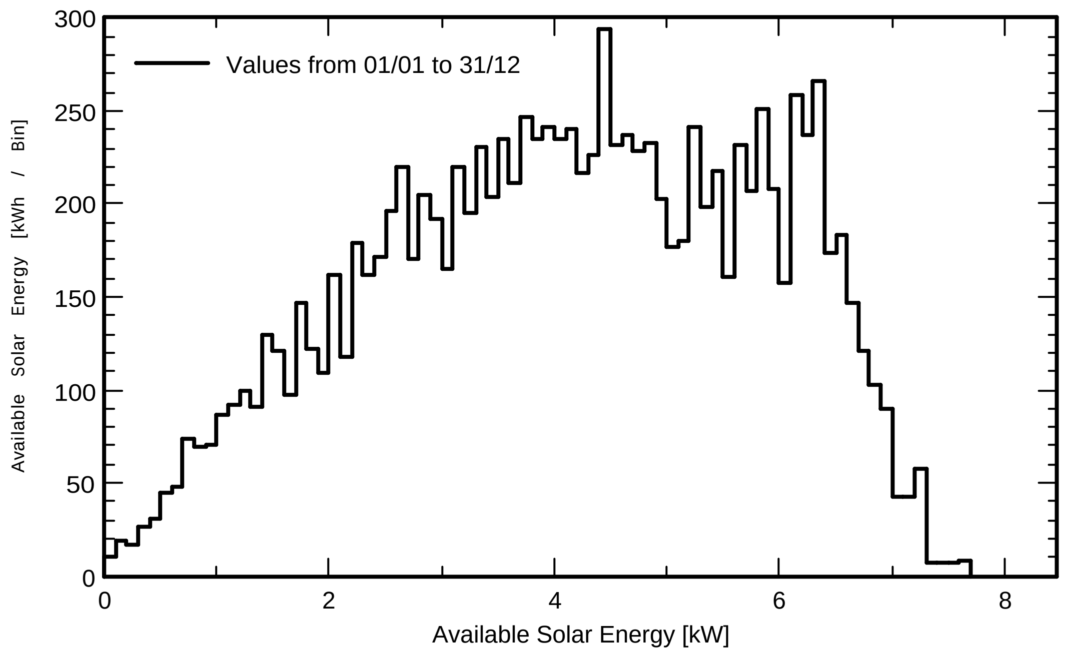
Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Daily Input/Output diagram



System Output Power Distribution



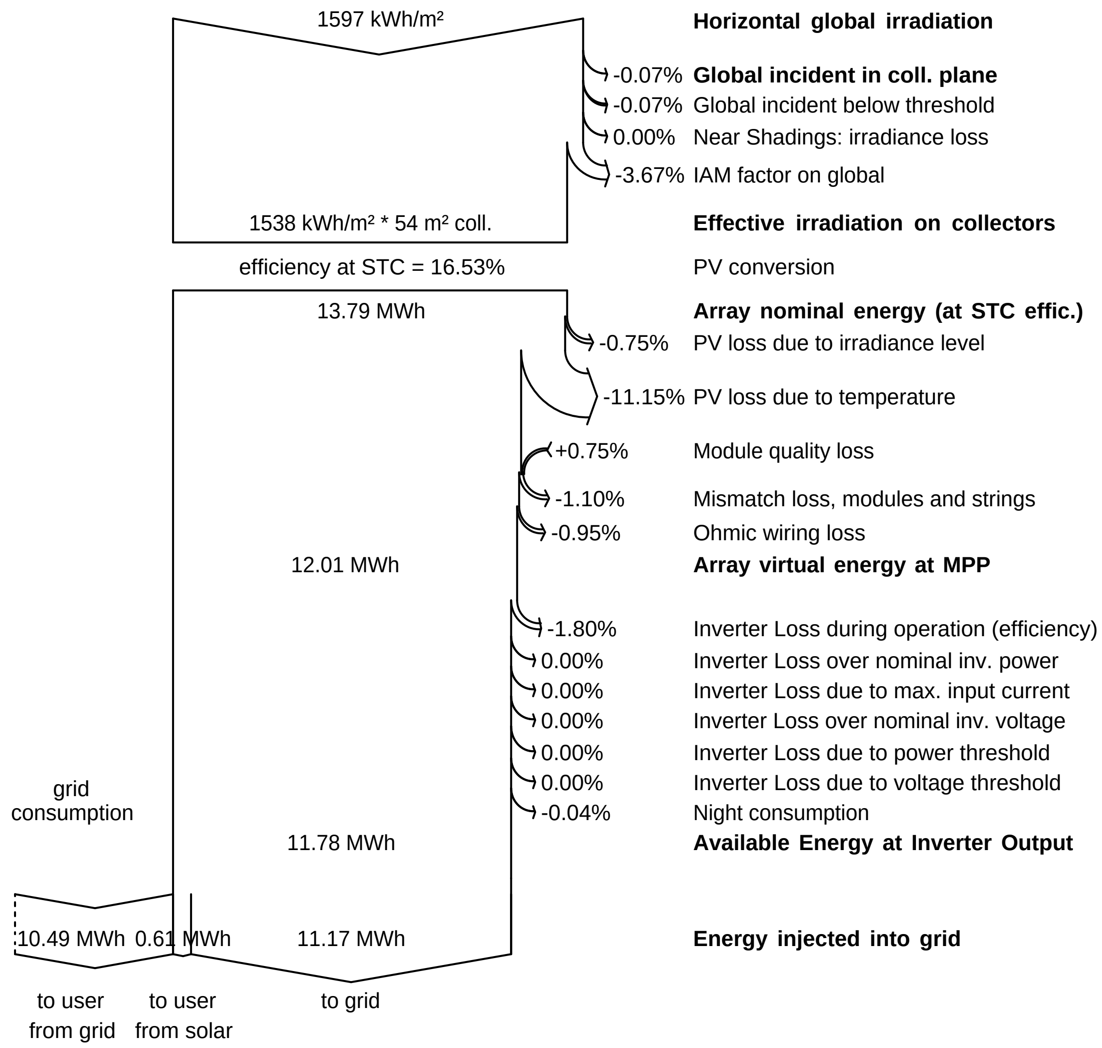
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Loss diagram over the whole year



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **Own (9KW)**

Simulation date 21/04/20 14h29

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
User's needs :	Daily household consumers	Constant over the year		
	average	12.8 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	14 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	28	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)		U mpp	470 V	I mpp	17 A
Total area		Module area	**54.3 m²**	Cell area	48.2 m²

Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

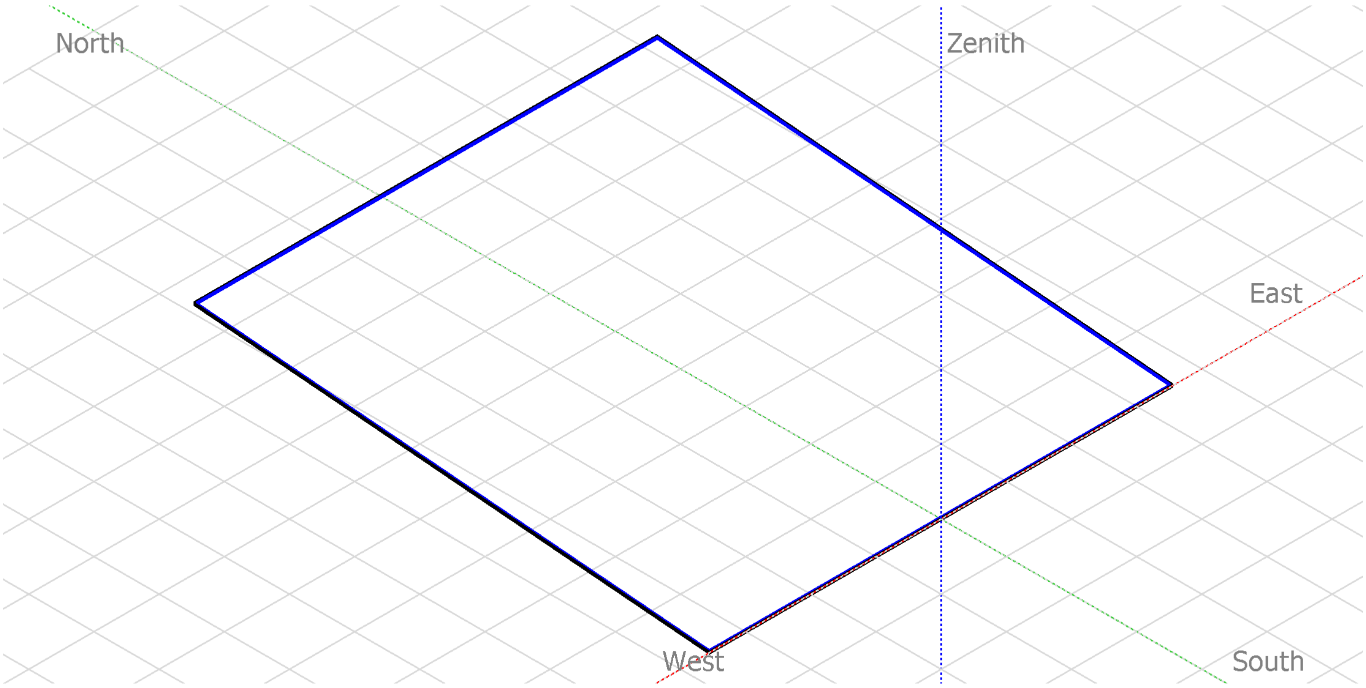
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

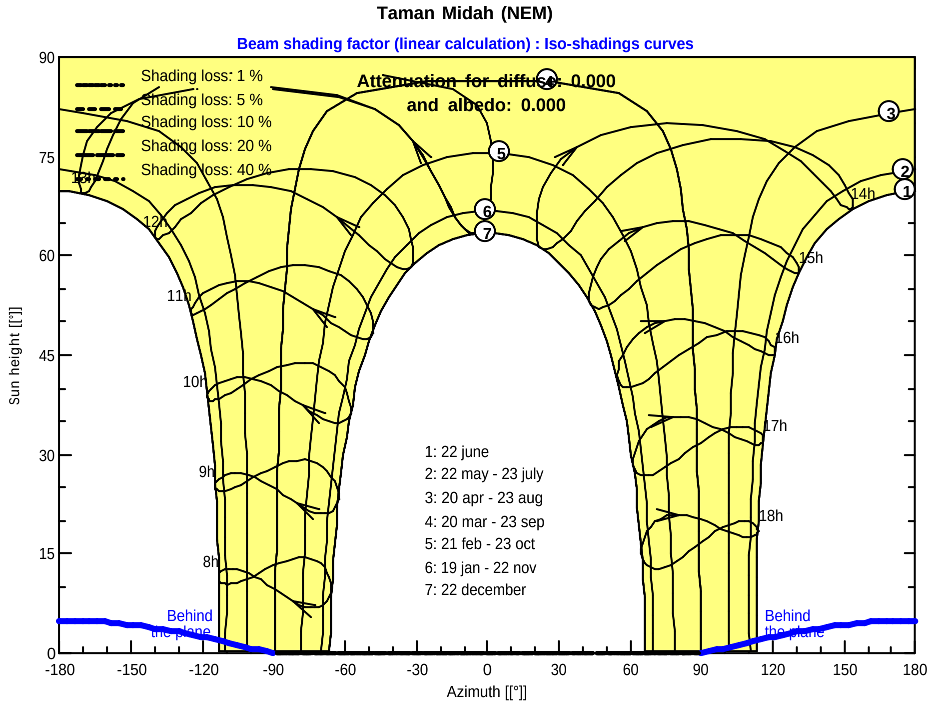
Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

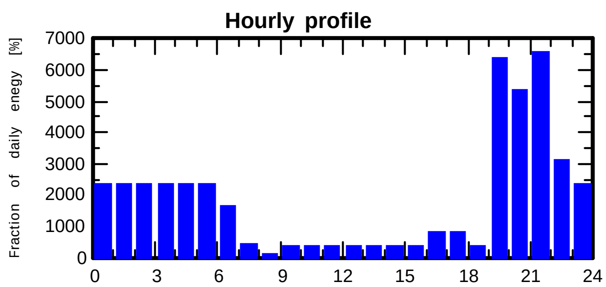
Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Daily household consumers, Constant over the year, average = 12.8 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	6 h/day	2970 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	1000 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	6	750 W tot	7 h/day	31500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				44634 Wh/day



Grid-Connected System: Main results

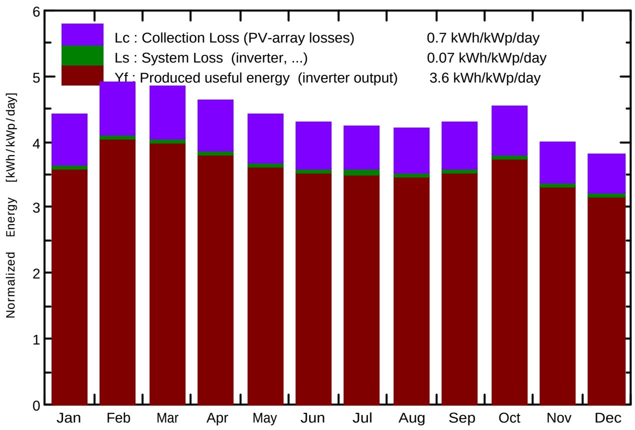
Project : **Taman Midah (NEM)**

Simulation variant : **Own (9KW)**

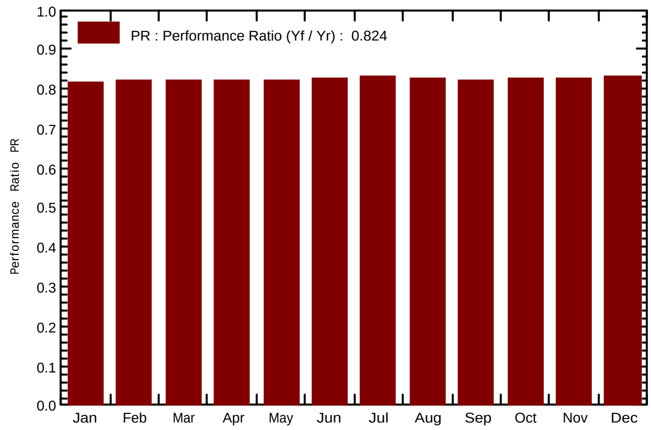
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	82.40 %	Solar Fraction SF	9.58 %

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



Own (9KW)

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	133.0	82.20	28.10	136.3	131.2	1.016	0.446	0.043	0.954	0.403
February	134.6	67.90	27.70	137.4	132.8	1.031	0.357	0.036	0.978	0.322
March	149.8	88.20	28.00	150.3	144.9	1.125	0.357	0.036	1.070	0.322
April	140.3	70.50	27.70	138.8	133.9	1.039	0.402	0.039	0.981	0.362
May	140.3	78.60	28.60	136.9	131.7	1.027	0.402	0.040	0.968	0.362
June	132.0	77.80	27.80	128.3	123.5	0.967	0.357	0.033	0.916	0.324
July	134.4	87.20	27.80	131.1	125.8	0.994	0.446	0.044	0.931	0.402
August	132.2	87.20	27.80	130.1	125.2	0.980	0.357	0.031	0.930	0.326
September	129.2	79.00	27.10	128.8	124.0	0.968	0.357	0.035	0.915	0.322
October	138.8	82.60	27.40	140.4	135.5	1.056	0.446	0.044	0.992	0.402
November	117.6	79.20	26.70	119.8	115.4	0.907	0.357	0.031	0.858	0.326
December	115.0	73.20	26.29	118.1	113.6	0.896	0.402	0.037	0.842	0.365
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	4.687	0.449	11.335	4.238

Legends:

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

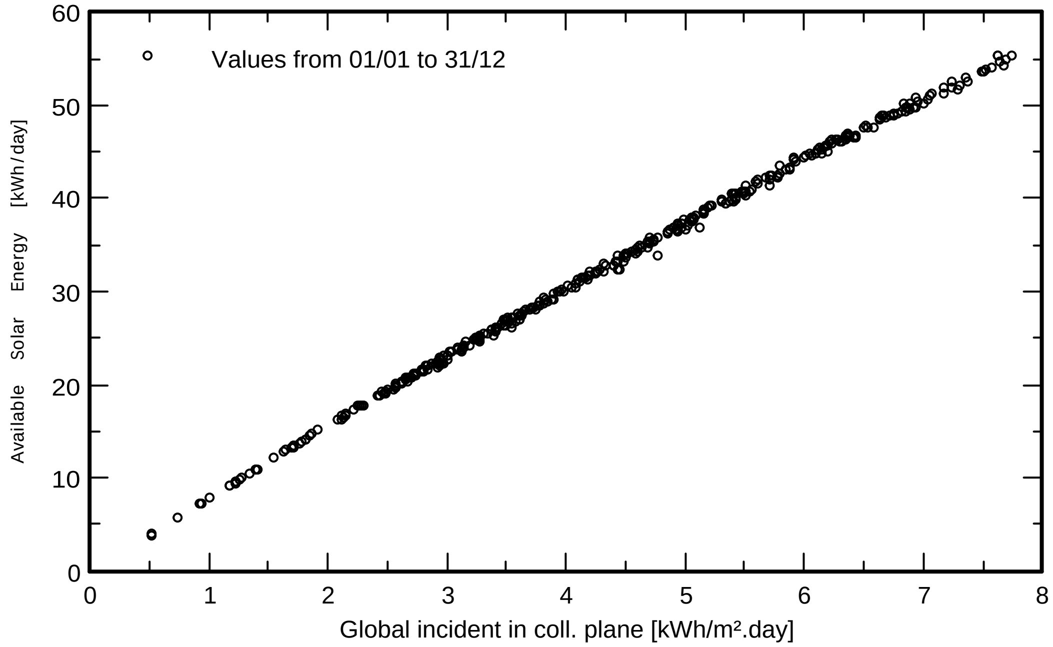
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

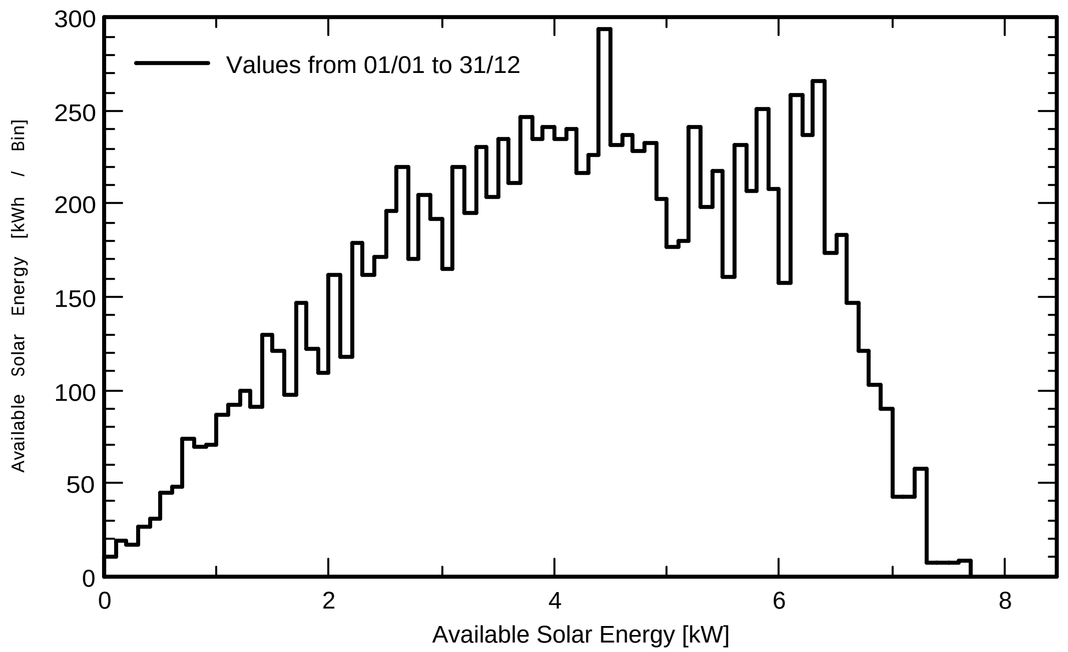
Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Daily Input/Output diagram



System Output Power Distribution



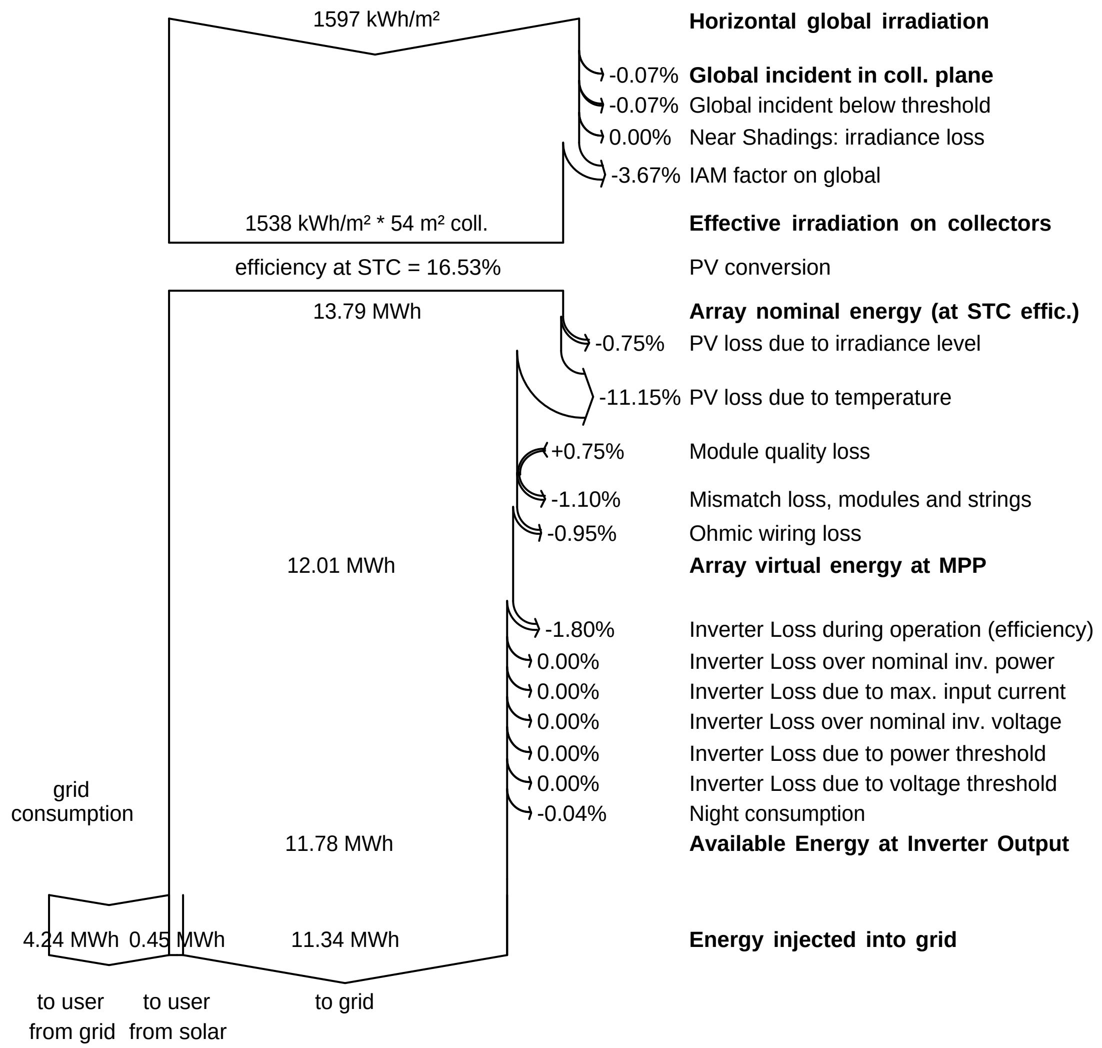
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Own (9KW)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Loss diagram over the whole year



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : SELCO - working couple (6kw)

	Simulation date	21/04/20 17h48

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	11.2 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	1.9 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

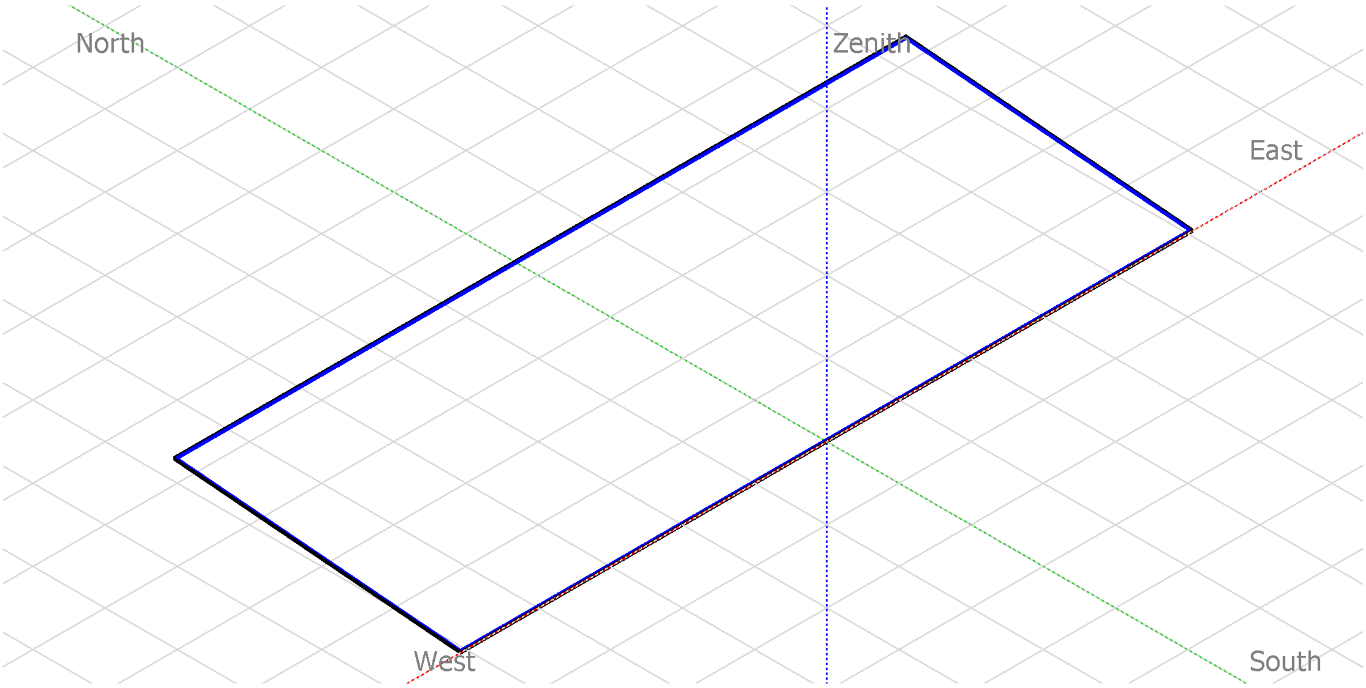
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

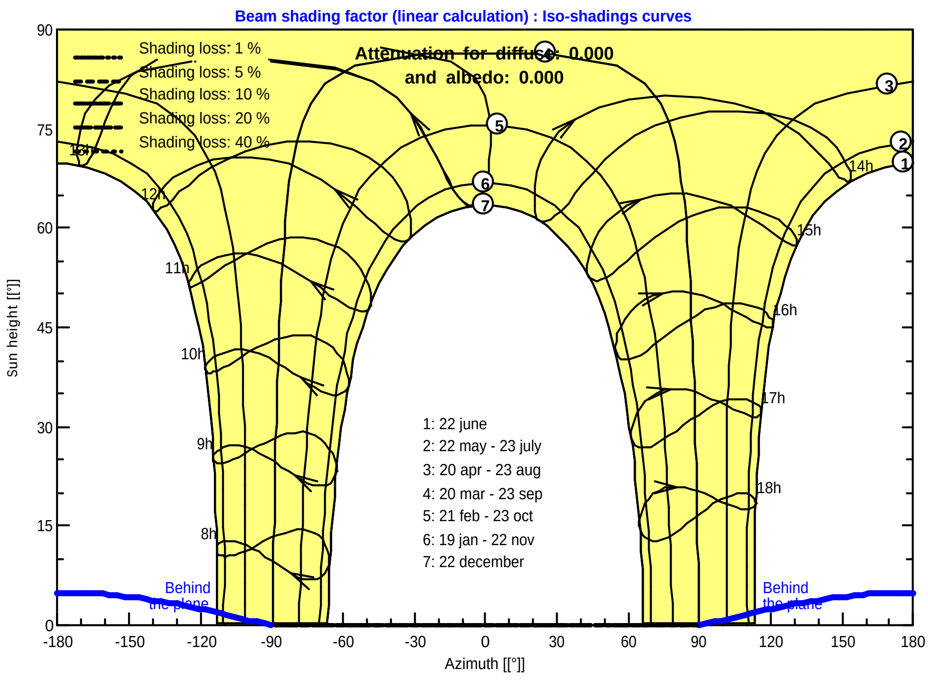
Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

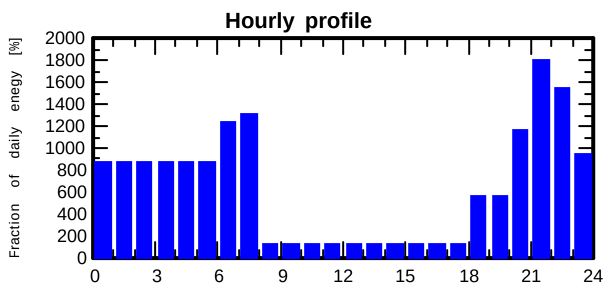
Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Daily household consumers, Constant over the year, average = 11.2 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	20	18 W/lamp	7 h/day	2340 Wh/day
TV / PC / Mobile	1	70 W/app	6 h/day	420 Wh/day
Iron	1	1200 W/app	1 h/day	600 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	2	750 W tot	5 h/day	6750 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				15634 Wh/day



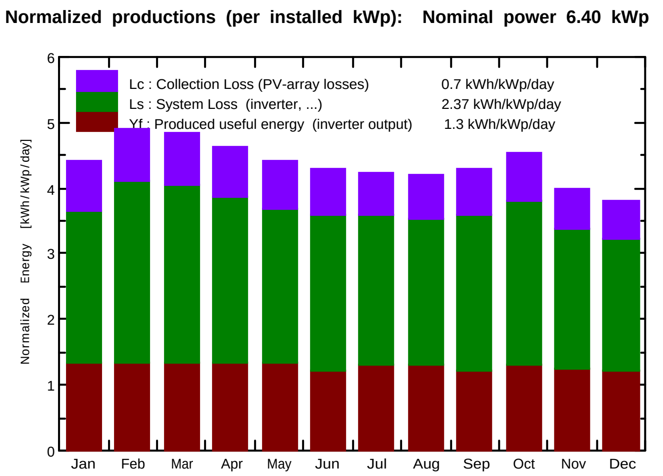
Grid-Connected System: Main results

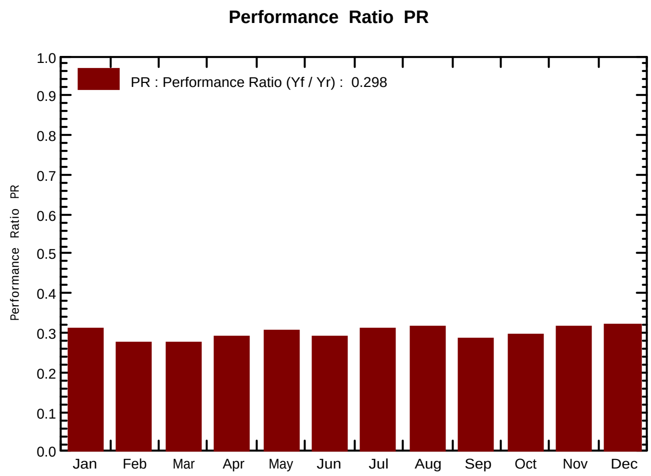
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	29.80 %	Solar Fraction SF	74.62 %
Battery ageing (State of Wear)	Cycles SOW	79.3%	Static SOW	80.0%
	Battery lifetime	4.8 years		





SELCO - working couple (6kw)

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.360	0.270	0.397	0.090
February	134.6	67.90	27.70	137.4	132.8	0.737	0.313	0.242	0.444	0.071
March	149.8	88.20	28.00	150.3	144.9	0.804	0.344	0.266	0.473	0.078
April	140.3	70.50	27.70	138.8	133.9	0.742	0.328	0.258	0.438	0.070
May	140.3	78.60	28.60	136.9	131.7	0.734	0.360	0.269	0.405	0.091
June	132.0	77.80	27.80	128.3	123.5	0.691	0.328	0.237	0.394	0.091
July	134.4	87.20	27.80	131.1	125.8	0.710	0.344	0.262	0.399	0.082
August	132.2	87.20	27.80	130.1	125.2	0.700	0.360	0.261	0.383	0.099
September	129.2	79.00	27.10	128.8	124.0	0.691	0.313	0.235	0.396	0.078
October	138.8	82.60	27.40	140.4	135.5	0.754	0.360	0.264	0.440	0.096
November	117.6	79.20	26.70	119.8	115.4	0.648	0.344	0.241	0.353	0.103
December	115.0	73.20	26.29	118.1	113.6	0.640	0.328	0.241	0.346	0.088
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	4.080	3.045	4.867	1.036

Legends:				
	GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
	DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
	T_Amb	T amb.	E_User	Energy supplied to the user
	GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
			EUnused	Unused energy (battery full, no grid injection)
			EFrGrid	Energy from the grid

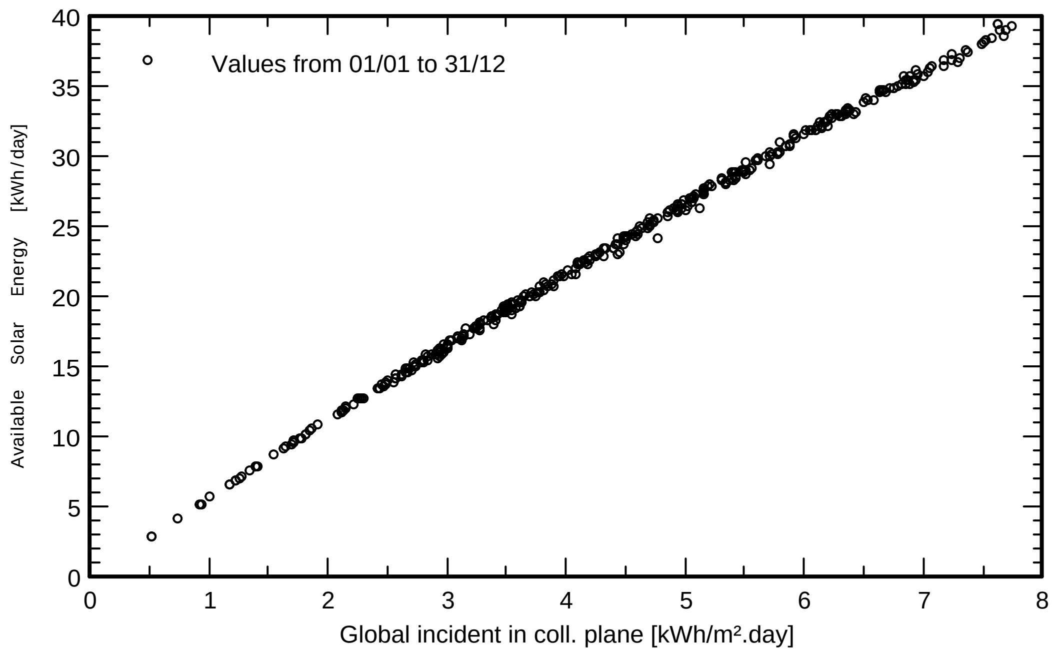
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

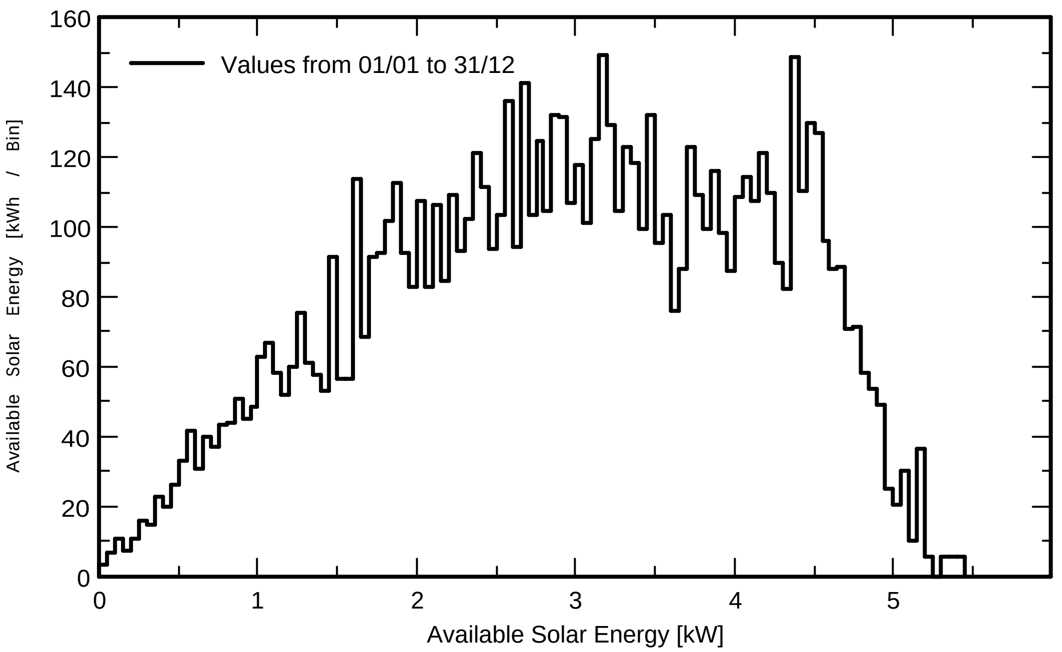
Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Daily Input/Output diagram



System Output Power Distribution



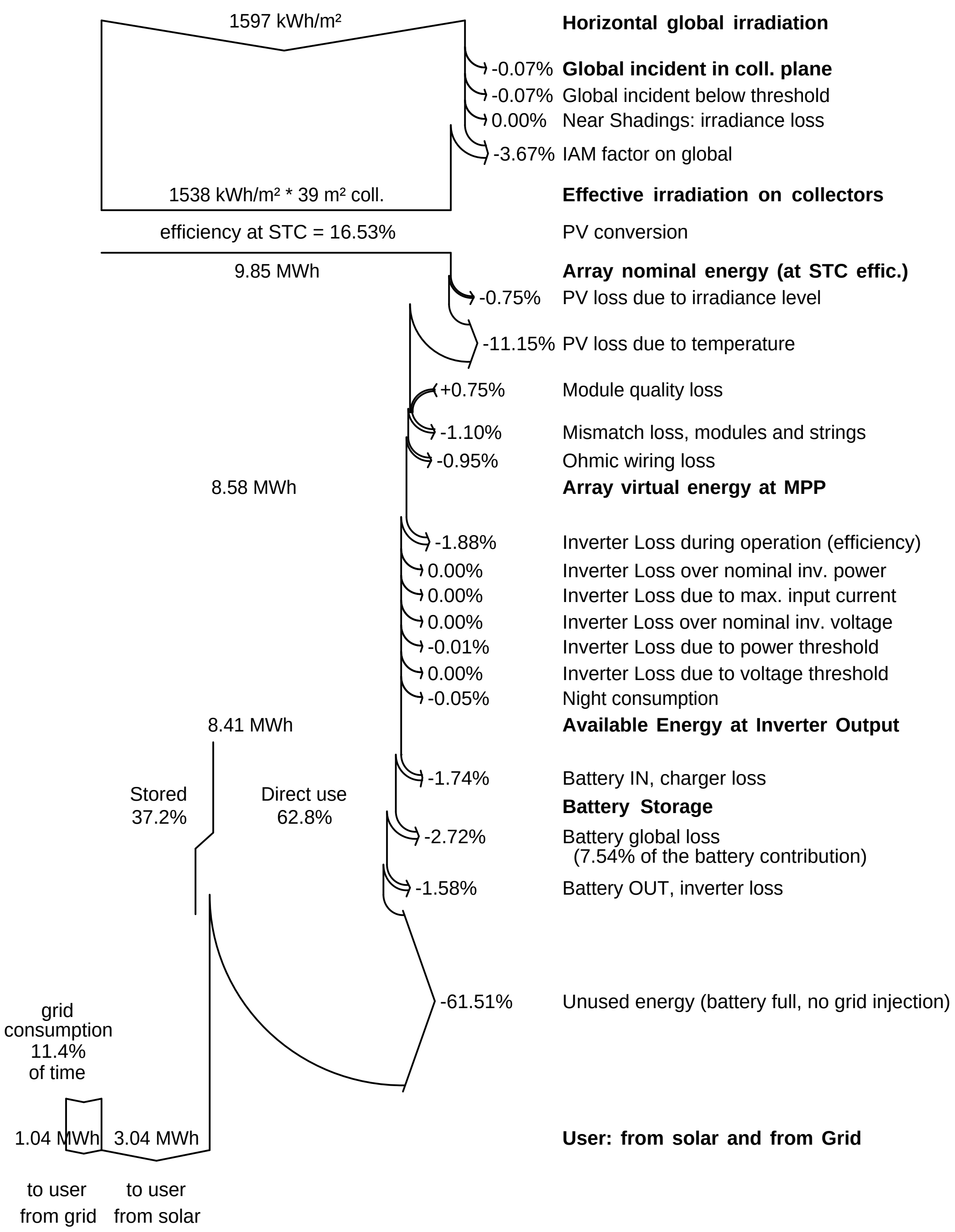
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4080 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

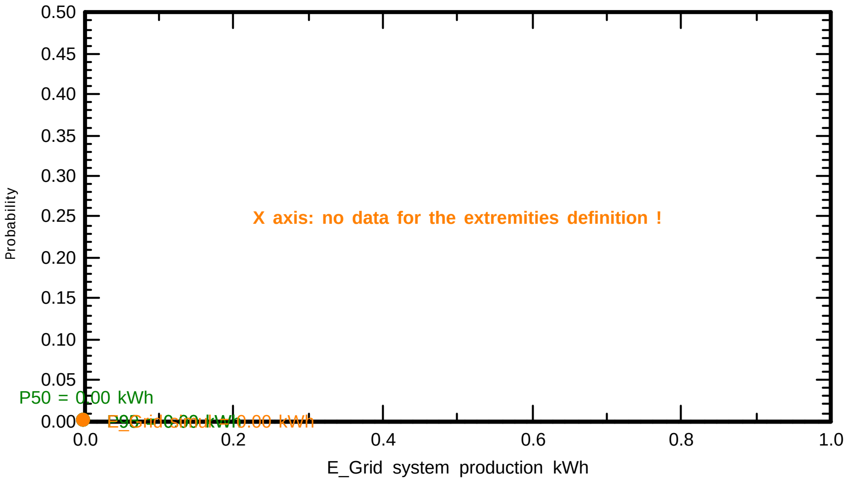
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : SELCO - working couple (6kw)

Simulation date 21/04/20 17h51

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	6.9 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	1.9 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

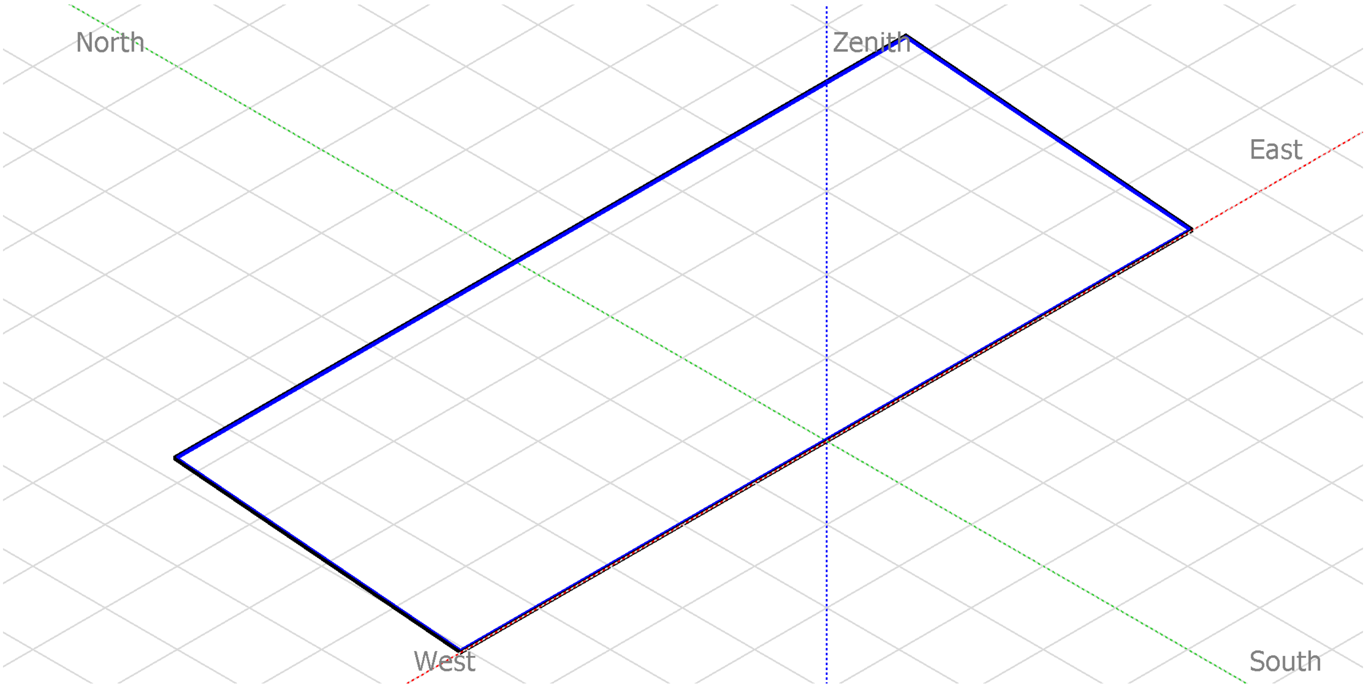
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

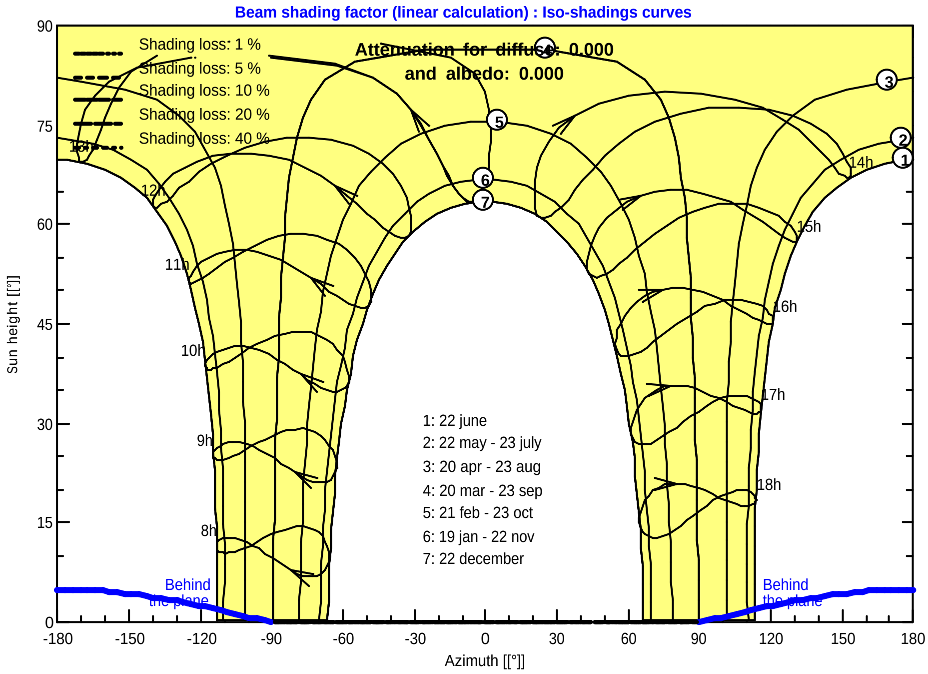
Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

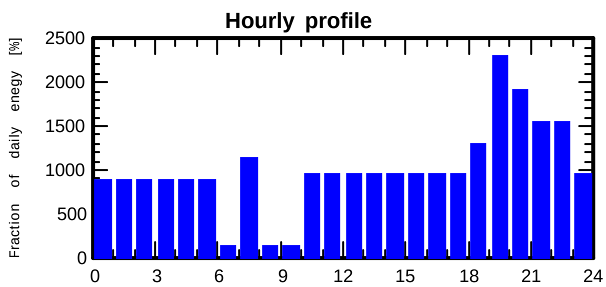
Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Daily household consumers, Constant over the year, average = 6.9 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	20	18 W/lamp	5 h/day	1800 Wh/day
TV / PC / Mobile	1	70 W/app	14 h/day	980 Wh/day
Iron	1	1200 W/app	1 h/day	600 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	2	750 W tot	10 h/day	15000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				23904 Wh/day



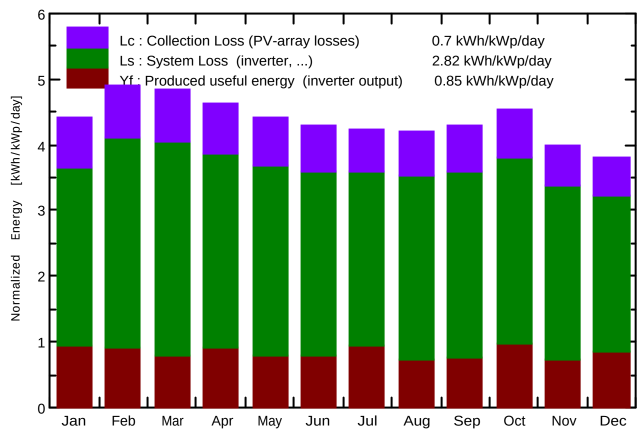
Grid-Connected System: Main results

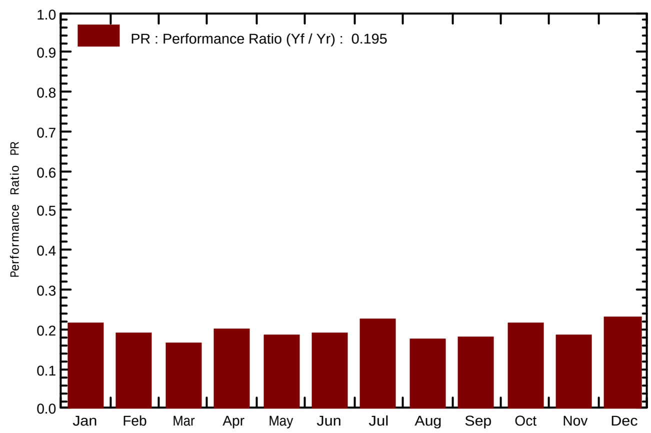
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	19.48 %	Solar Fraction SF	79.29 %
Battery ageing (State of Wear)	Cycles SOW	89.7%	Static SOW	80.0%
	Battery lifetime	5.0 years		





SELCO - working couple (6kw)
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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.239	0.188	0.481	0.051
February	134.6	67.90	27.70	137.4	132.8	0.737	0.191	0.165	0.529	0.027
March	149.8	88.20	28.00	150.3	144.9	0.804	0.191	0.158	0.600	0.034
April	140.3	70.50	27.70	138.8	133.9	0.742	0.215	0.176	0.530	0.039
May	140.3	78.60	28.60	136.9	131.7	0.734	0.215	0.162	0.513	0.053
June	132.0	77.80	27.80	128.3	123.5	0.691	0.191	0.155	0.490	0.037
July	134.4	87.20	27.80	131.1	125.8	0.710	0.239	0.188	0.485	0.051
August	132.2	87.20	27.80	130.1	125.2	0.700	0.191	0.147	0.499	0.045
September	129.2	79.00	27.10	128.8	124.0	0.691	0.191	0.147	0.500	0.045
October	138.8	82.60	27.40	140.4	135.5	0.754	0.239	0.193	0.513	0.046
November	117.6	79.20	26.70	119.8	115.4	0.648	0.191	0.141	0.462	0.050
December	115.0	73.20	26.29	118.1	113.6	0.640	0.215	0.172	0.431	0.043
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	2.510	1.990	6.033	0.520

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

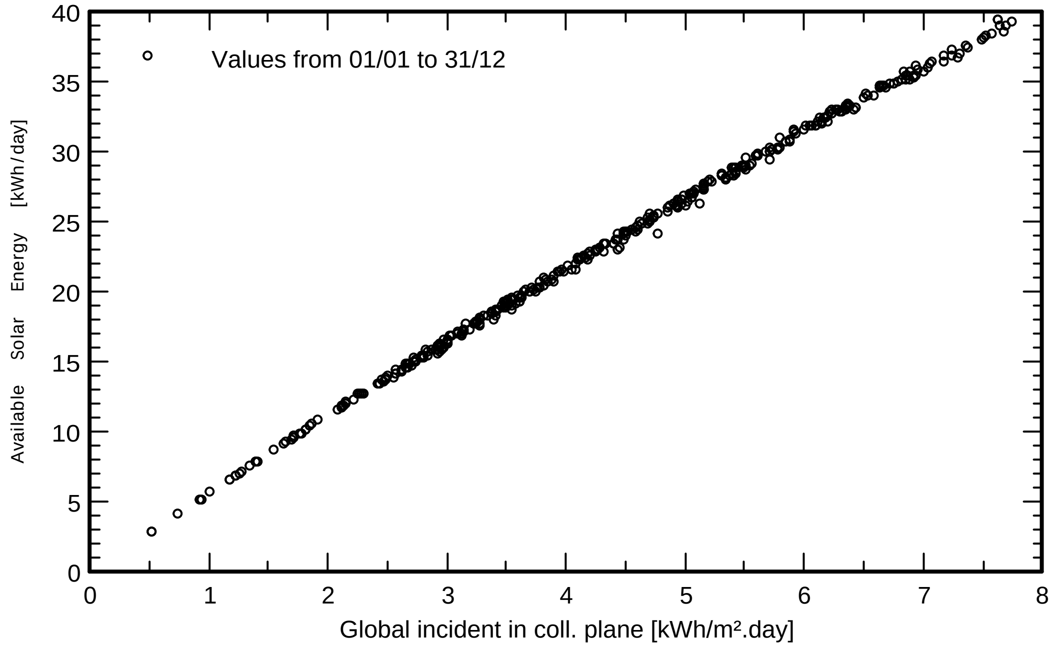
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

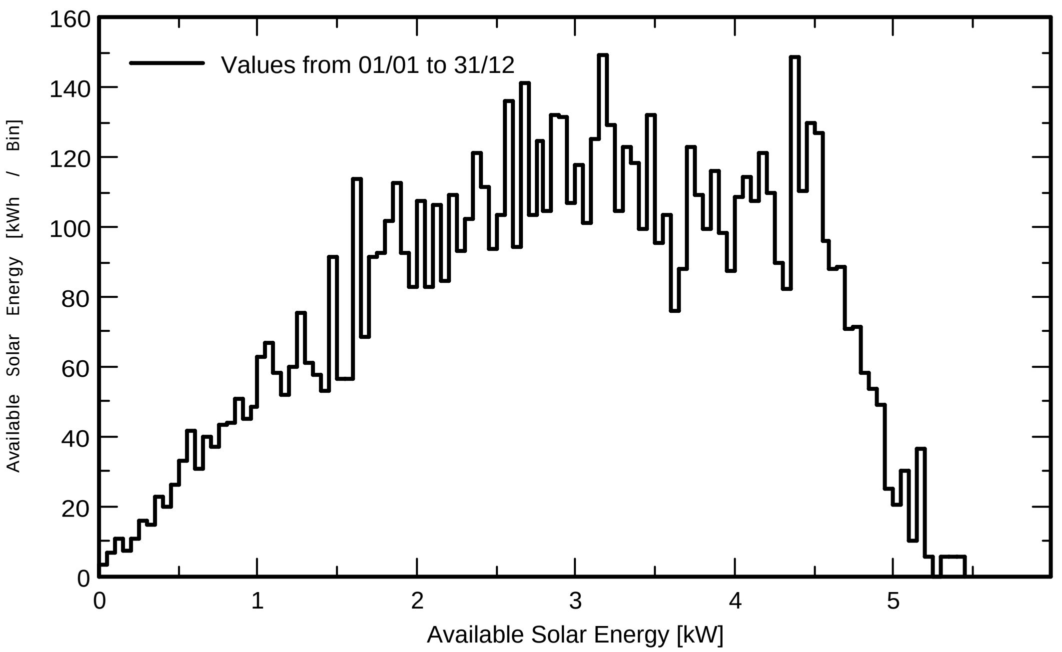
Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Daily Input/Output diagram



System Output Power Distribution



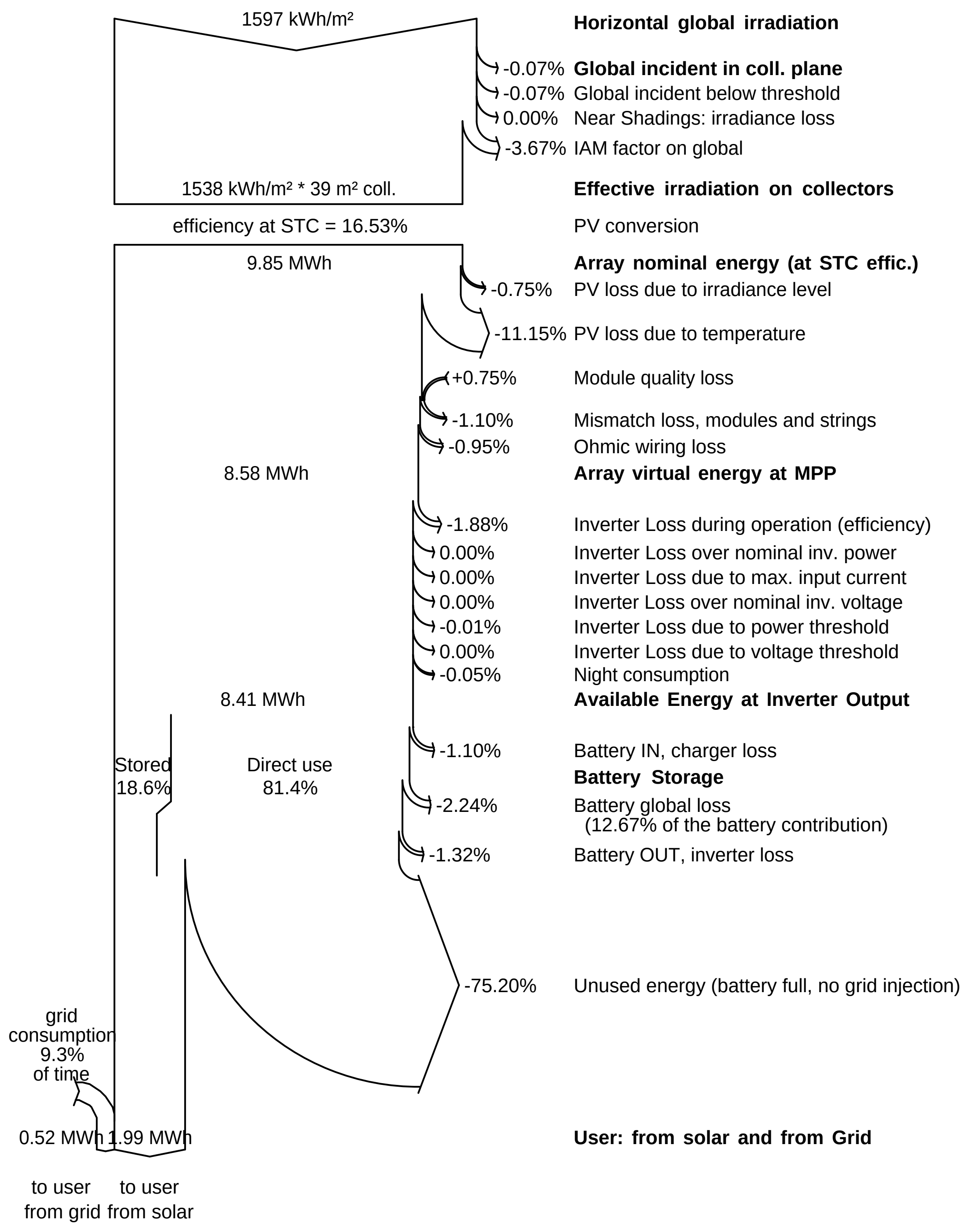
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - working couple (6kw)**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	2510 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

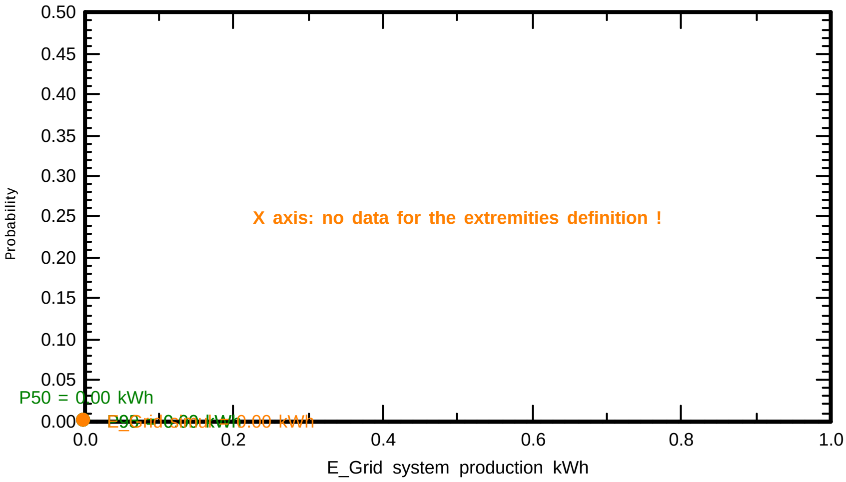
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - Small family - 6kw**

Simulation date 21/04/20 17h25

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	19.4 kWh/Day		

PV Array Characteristics

PV module	Si-mono Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	3.1 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

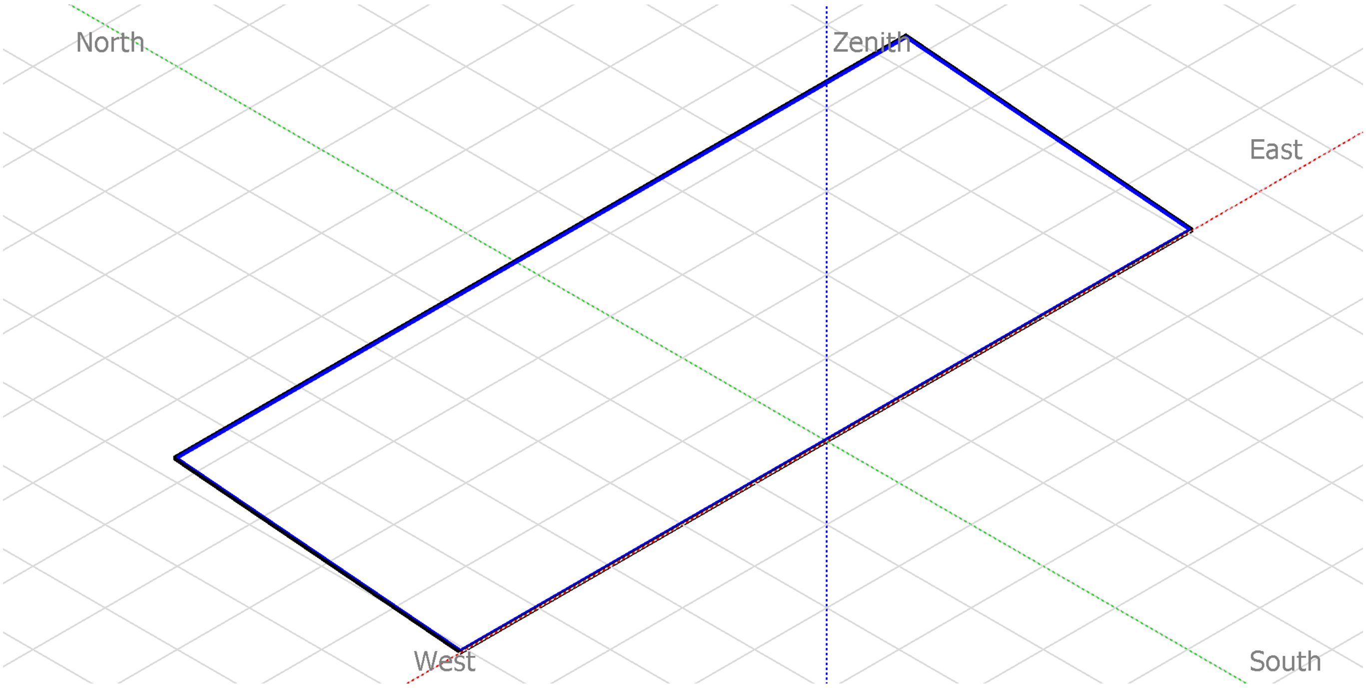
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

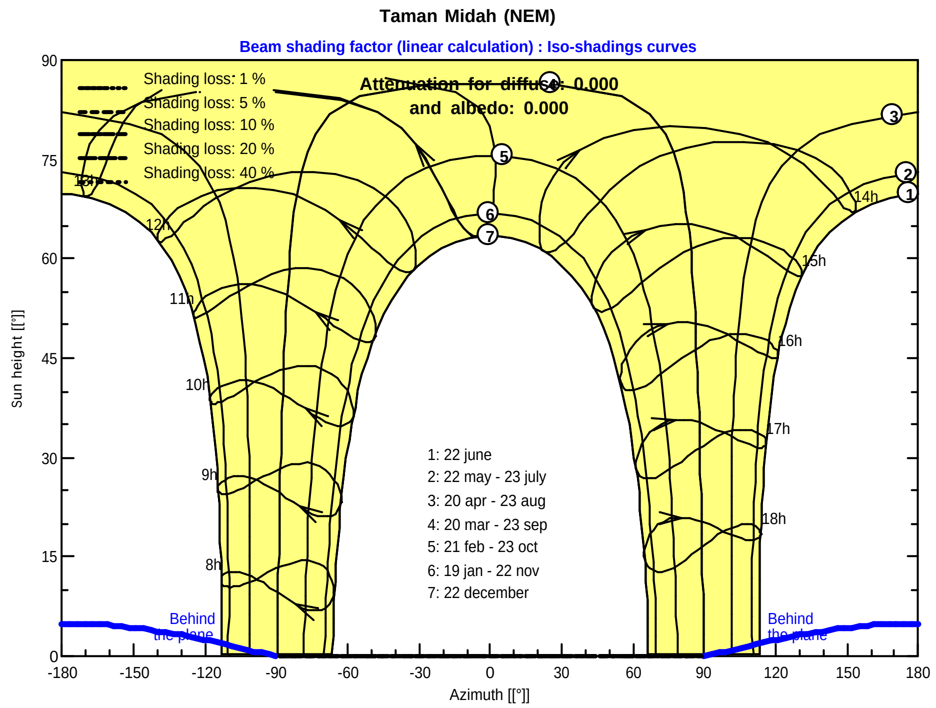
Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

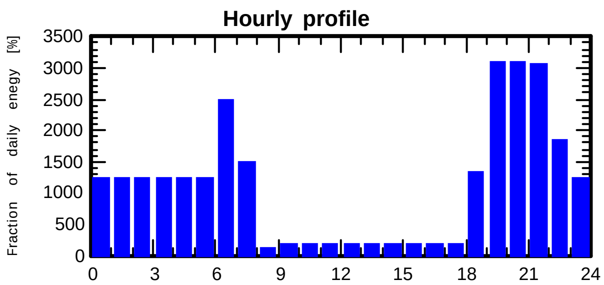
Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Daily household consumers, Constant over the year, average = 19.4 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	26	18 W/lamp	5 h/day	2340 Wh/day
TV / PC / Mobile	2	70 W/app	9 h/day	1260 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	2 h/day	3000 Wh/day
Aircond	3	750 W tot	7 h/day	15750 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				27074 Wh/day



Grid-Connected System: Main results

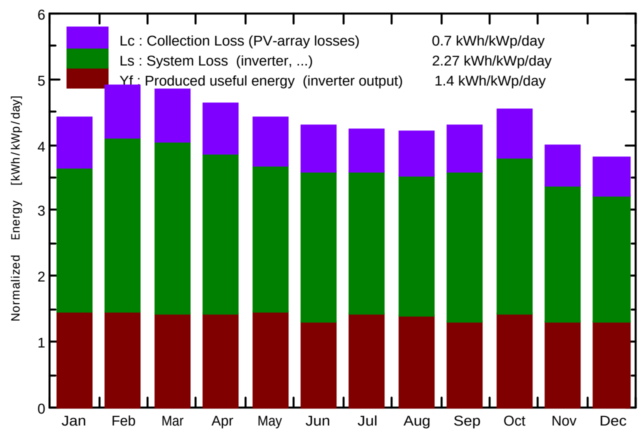
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - Small family - 6kw**

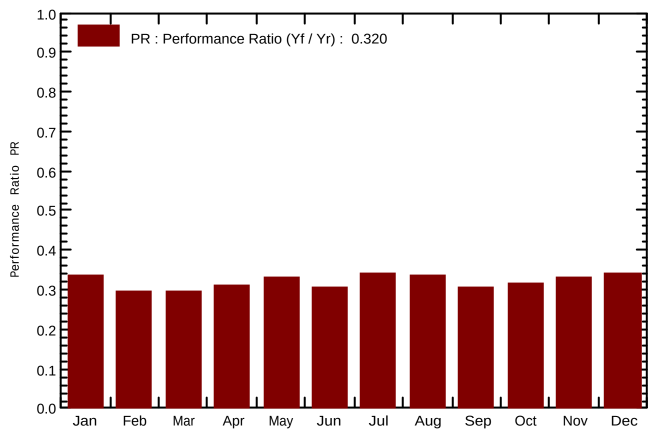
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	32.00 %	Solar Fraction SF	46.26 %
Battery ageing (State of Wear)	Cycles SOW	78.4%	Static SOW	80.0%
	Battery lifetime	4.6 years		

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



SELCO - Small family - 6kw

Balances and main results

	GlobHor	DiffHor	T_Amb	GlobInc	GlobEff	EArray	E_User	E_Solar	EUnused	EFrGrid
	kWh/m^2	kWh/m^2	°C	kWh/m^2	kWh/m^2	MWh	MWh	MWh	MWh	MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.623	0.292	0.373	0.330
February	134.6	67.90	27.70	137.4	132.8	0.737	0.541	0.262	0.420	0.280
March	149.8	88.20	28.00	150.3	144.9	0.804	0.596	0.284	0.449	0.312
April	140.3	70.50	27.70	138.8	133.9	0.742	0.569	0.278	0.415	0.291
May	140.3	78.60	28.60	136.9	131.7	0.734	0.623	0.289	0.382	0.333
June	132.0	77.80	27.80	128.3	123.5	0.691	0.569	0.252	0.373	0.316
July	134.4	87.20	27.80	131.1	125.8	0.710	0.596	0.284	0.375	0.311
August	132.2	87.20	27.80	130.1	125.2	0.700	0.623	0.279	0.361	0.343
September	129.2	79.00	27.10	128.8	124.0	0.691	0.541	0.250	0.371	0.291
October	138.8	82.60	27.40	140.4	135.5	0.754	0.623	0.285	0.419	0.338
November	117.6	79.20	26.70	119.8	115.4	0.648	0.596	0.253	0.339	0.342
December	115.0	73.20	26.29	118.1	113.6	0.640	0.569	0.259	0.324	0.310
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	7.066	3.269	4.601	3.798

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

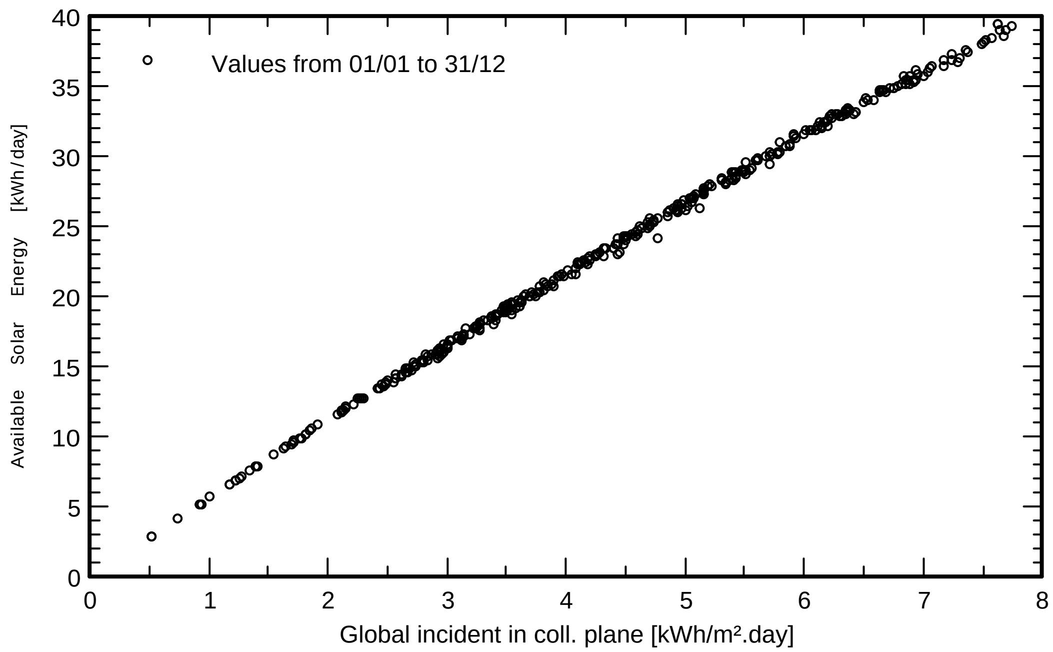
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

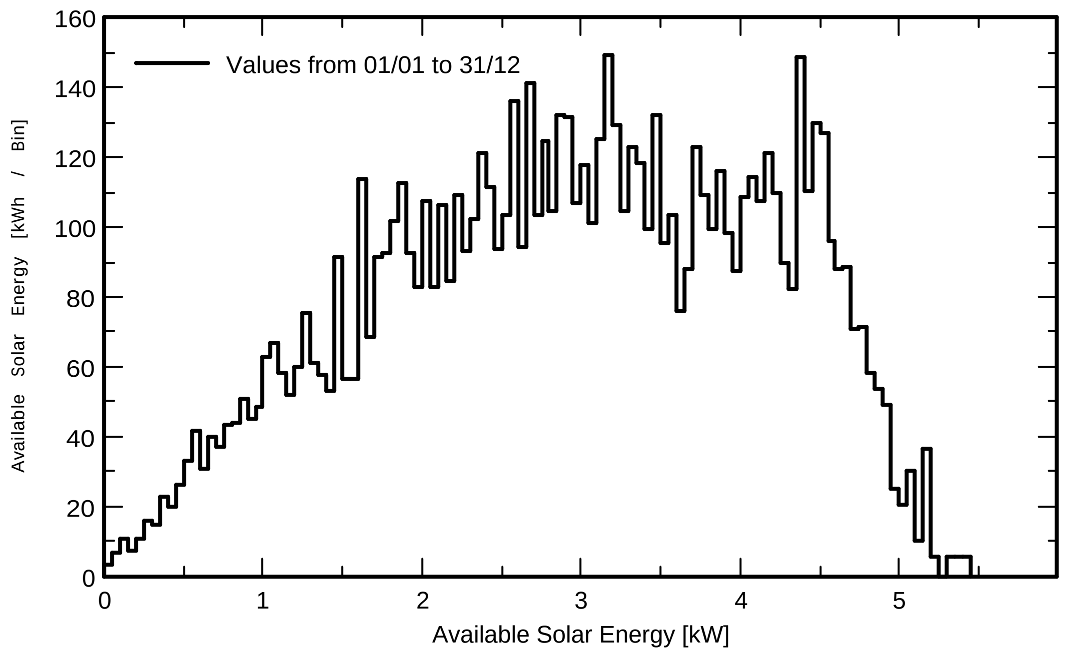
Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Daily Input/Output diagram



System Output Power Distribution



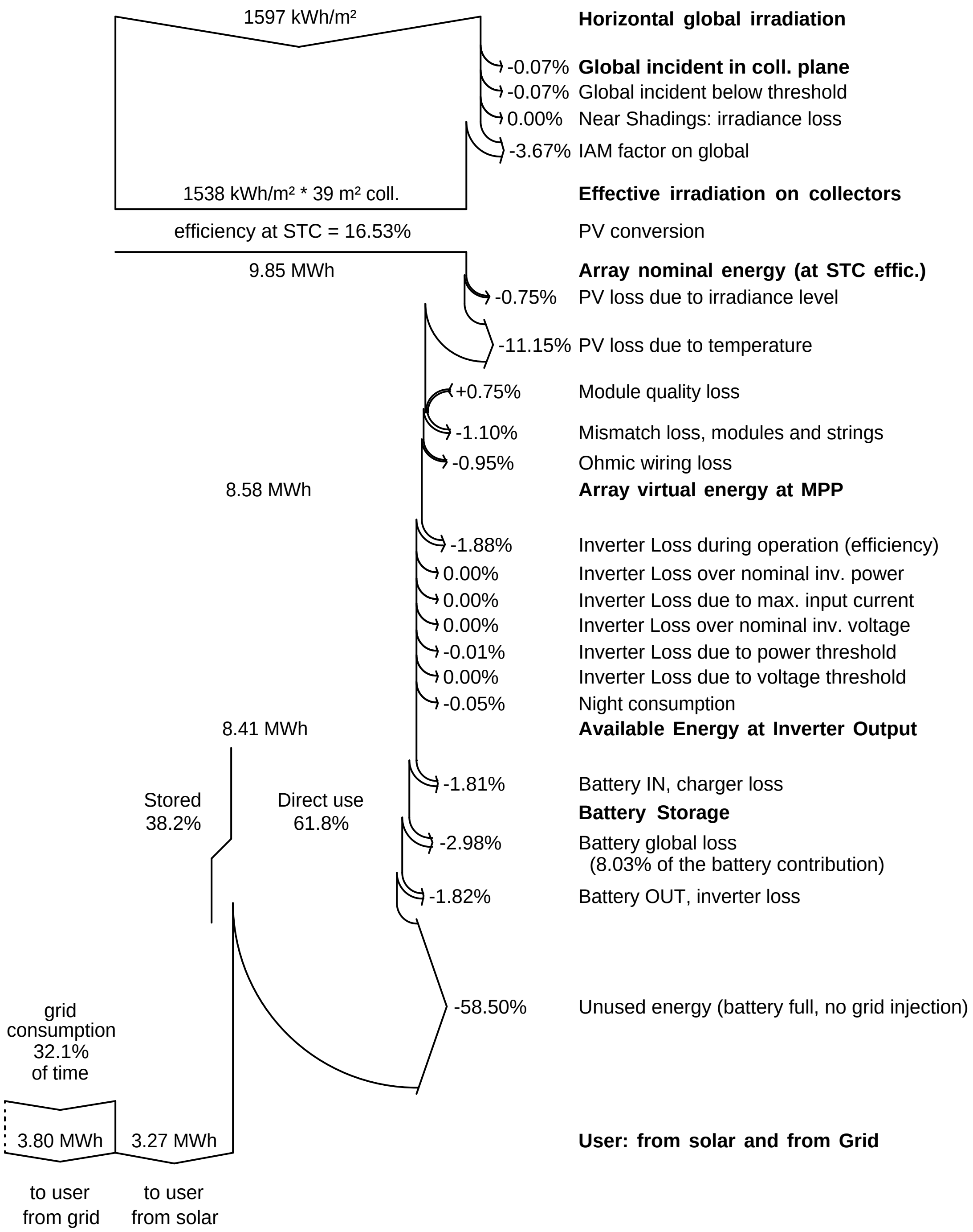
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

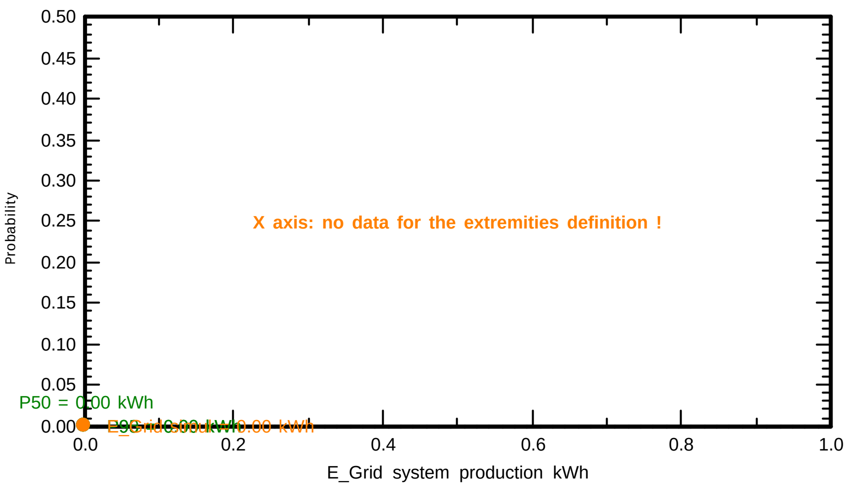
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - Small family - 6kw**

Simulation date 21/04/20 17h26

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	9.9 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	3.1 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

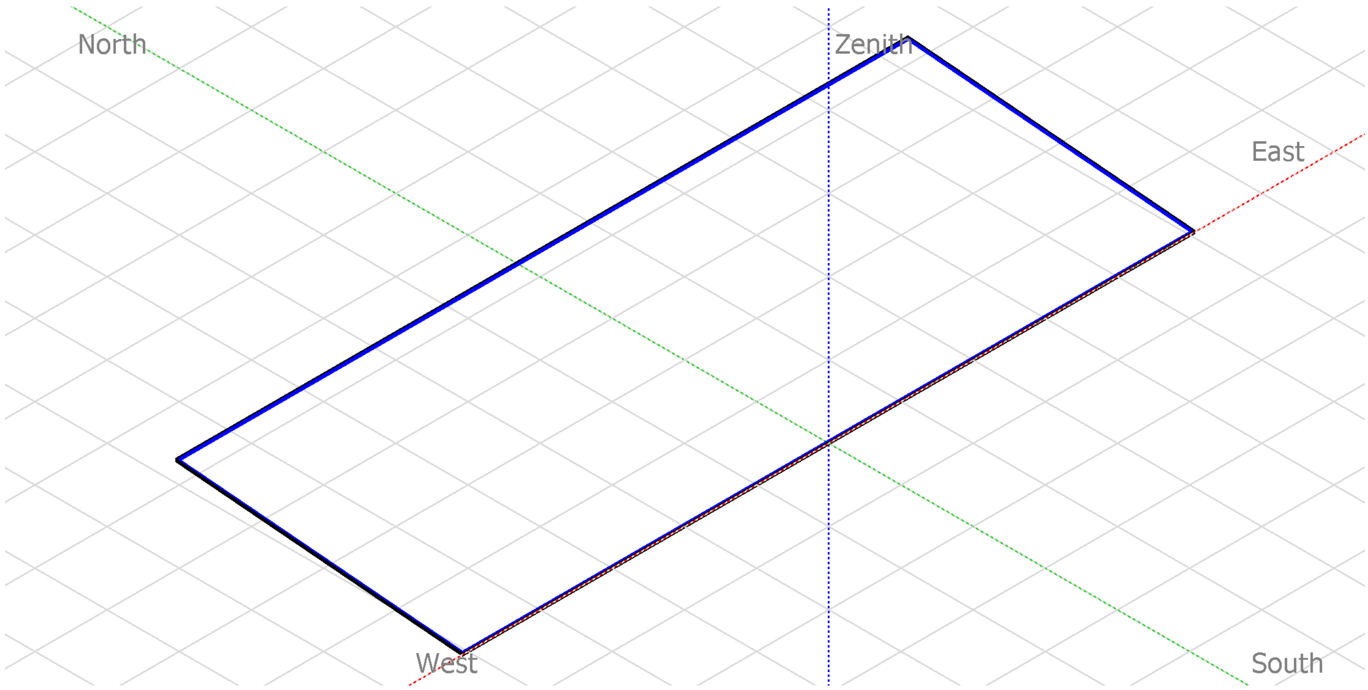
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

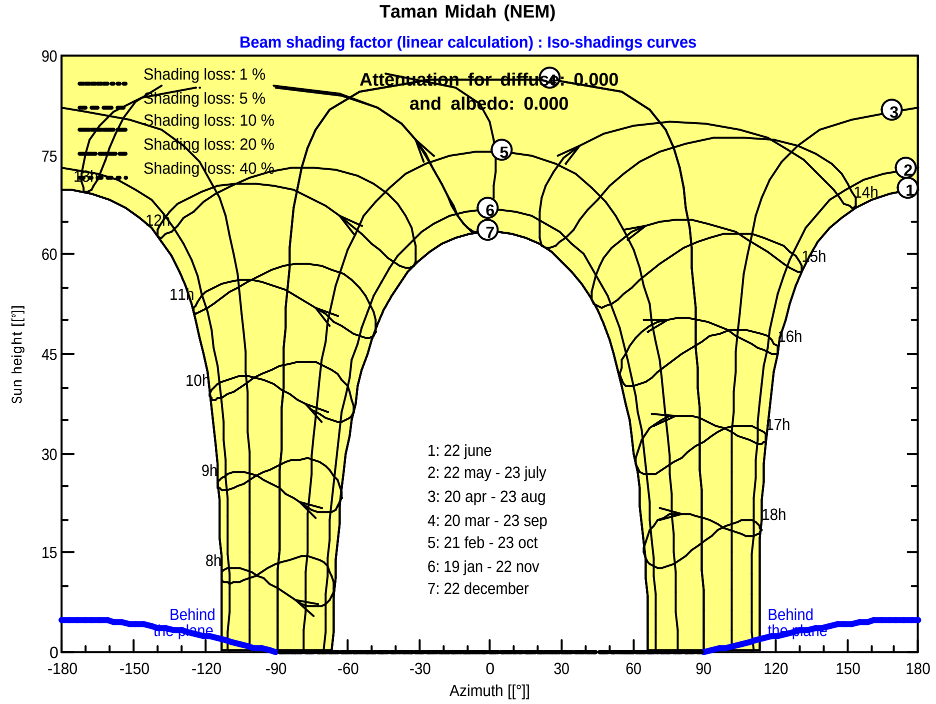
Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

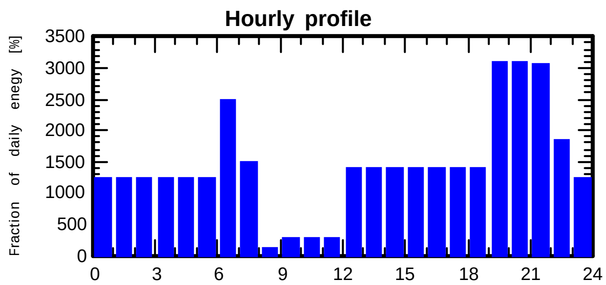
Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Daily household consumers, Constant over the year, average = 9.9 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	26	18 W/lamp	5 h/day	2340 Wh/day
TV / PC / Mobile	2	70 W/app	14 h/day	1960 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	2 h/day	3000 Wh/day
Aircond	3	750 W tot	10 h/day	22500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				34524 Wh/day



Grid-Connected System: Main results

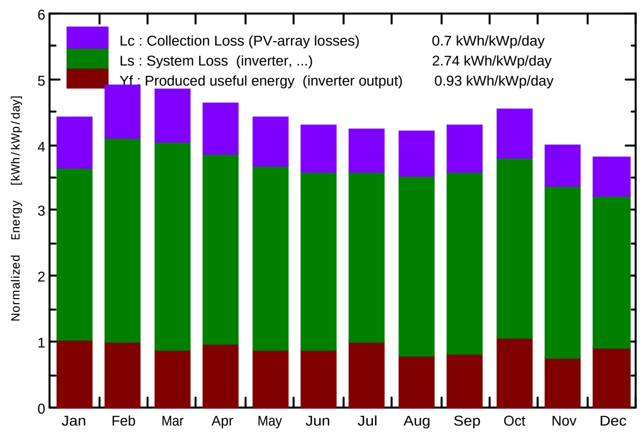
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - Small family - 6kw**

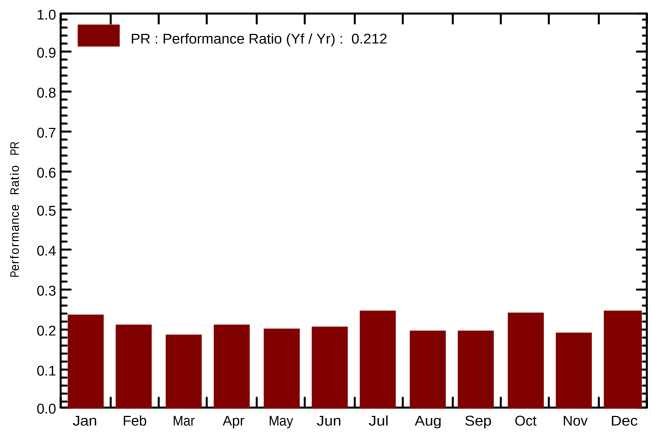
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	21.25 %	Solar Fraction SF	59.88 %
Battery ageing (State of Wear)	Cycles SOW	88.5%	Static SOW	80.0%
	Battery lifetime	5.0 years		

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



SELCO - Small family - 6kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.345	0.207	0.458	0.139
February	134.6	67.90	27.70	137.4	132.8	0.737	0.276	0.184	0.506	0.092
March	149.8	88.20	28.00	150.3	144.9	0.804	0.276	0.175	0.578	0.101
April	140.3	70.50	27.70	138.8	133.9	0.742	0.311	0.188	0.516	0.123
May	140.3	78.60	28.60	136.9	131.7	0.734	0.311	0.177	0.494	0.134
June	132.0	77.80	27.80	128.3	123.5	0.691	0.276	0.170	0.471	0.107
July	134.4	87.20	27.80	131.1	125.8	0.710	0.345	0.203	0.465	0.142
August	132.2	87.20	27.80	130.1	125.2	0.700	0.276	0.161	0.479	0.115
September	129.2	79.00	27.10	128.8	124.0	0.691	0.276	0.159	0.482	0.117
October	138.8	82.60	27.40	140.4	135.5	0.754	0.345	0.215	0.486	0.130
November	117.6	79.20	26.70	119.8	115.4	0.648	0.276	0.146	0.456	0.130
December	115.0	73.20	26.29	118.1	113.6	0.640	0.311	0.186	0.414	0.125
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	3.625	2.171	5.806	1.454

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

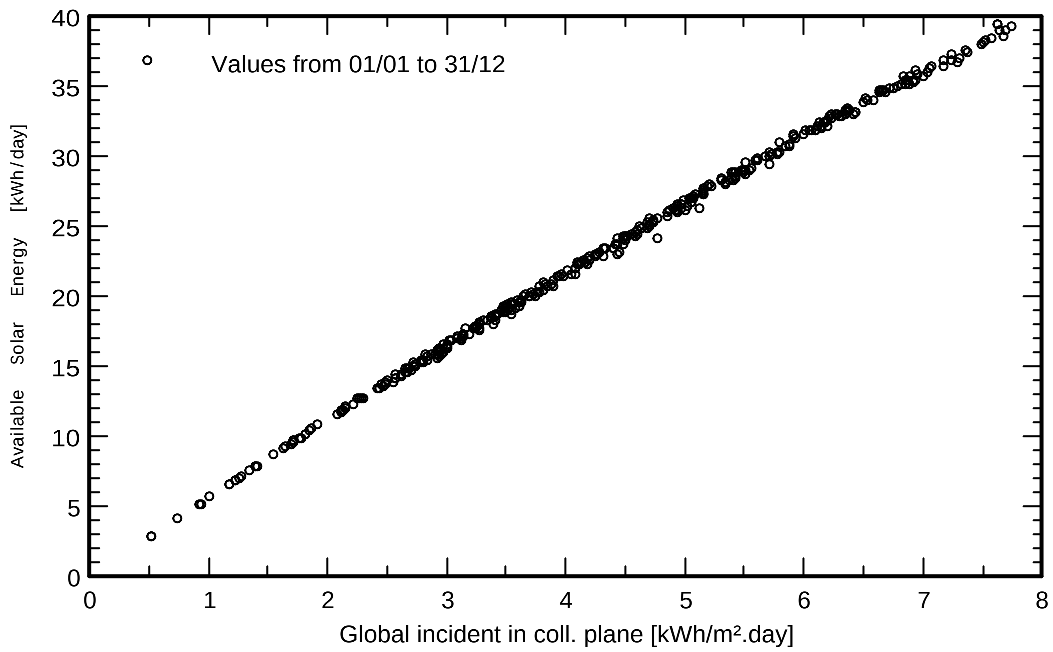
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

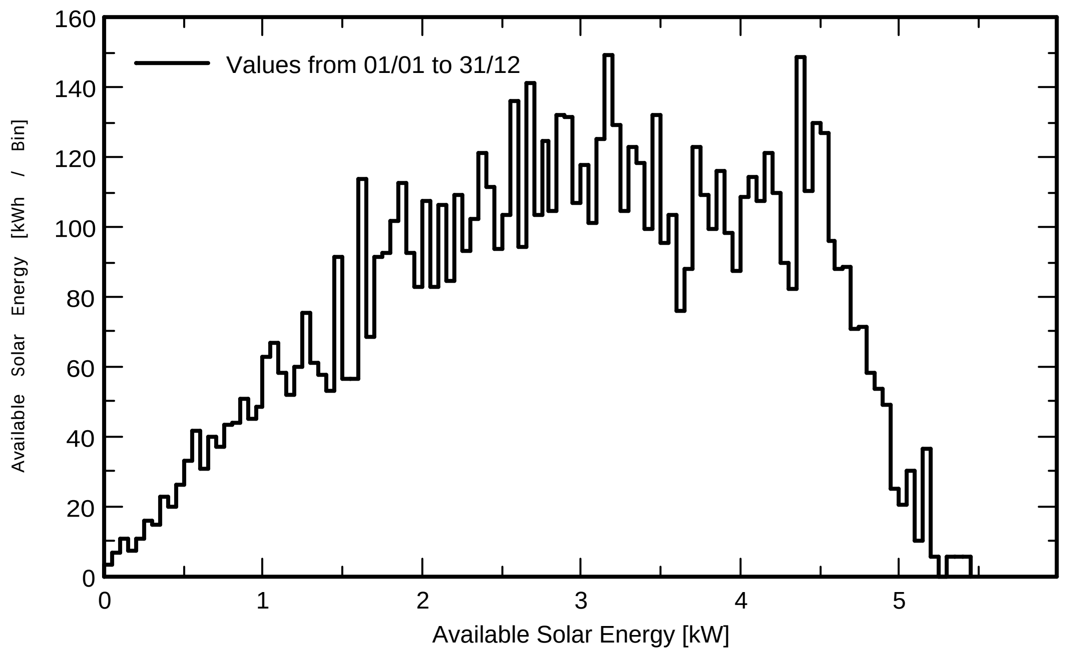
Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Daily Input/Output diagram



System Output Power Distribution



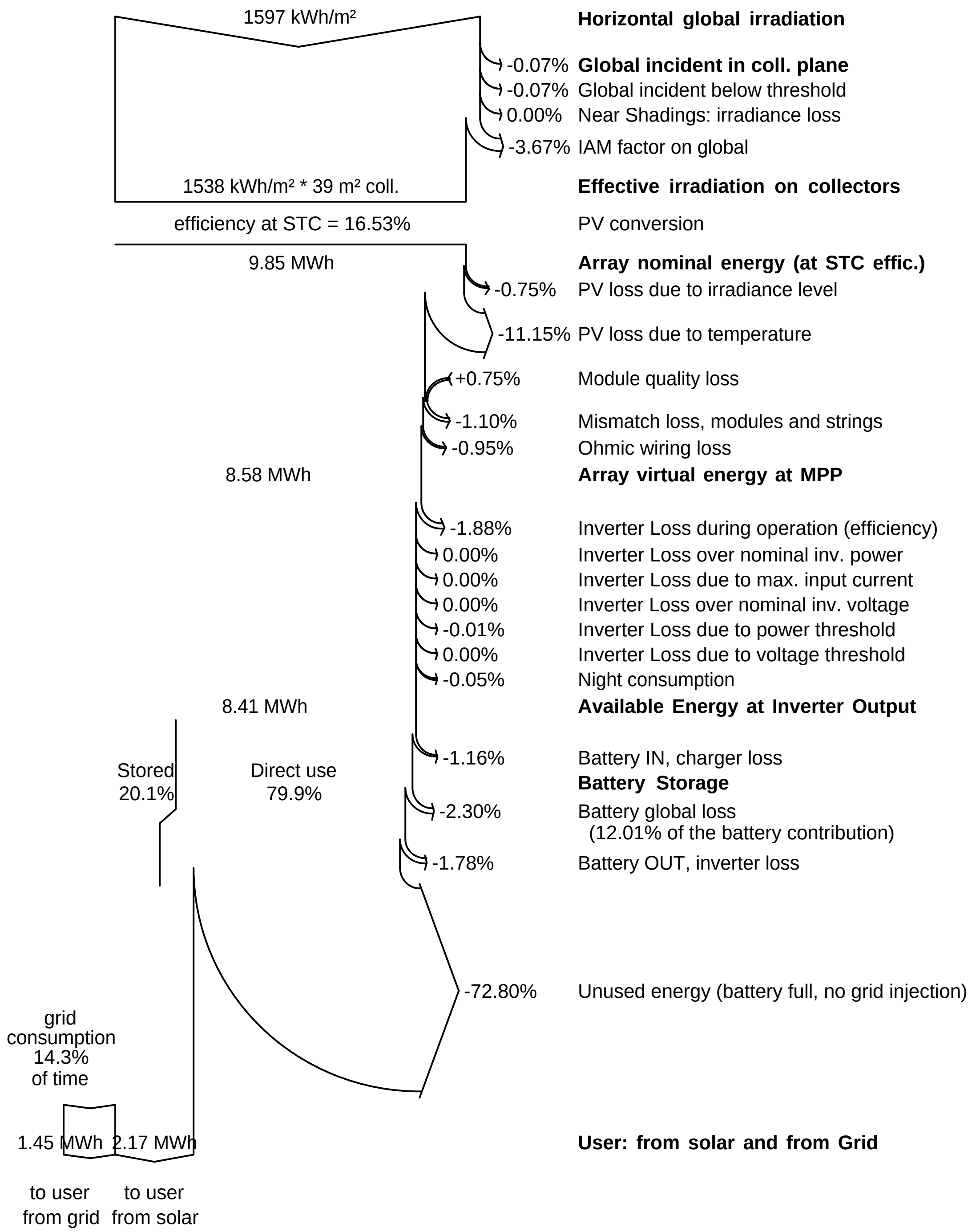
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - Small family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

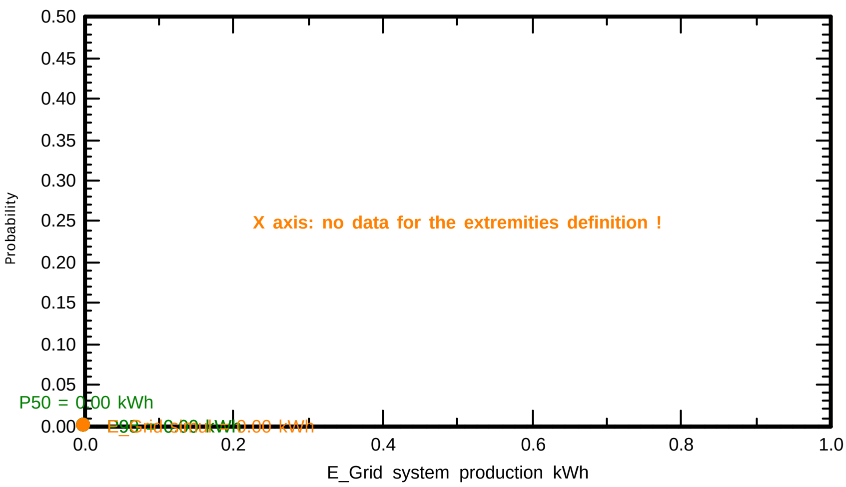
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - small family - 9kw**

Simulation date 21/04/20 17h27

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	19.4 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	3 in series x 4 in parallel		
	Voltage	36 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	14.1 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	7.5 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	3.1 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

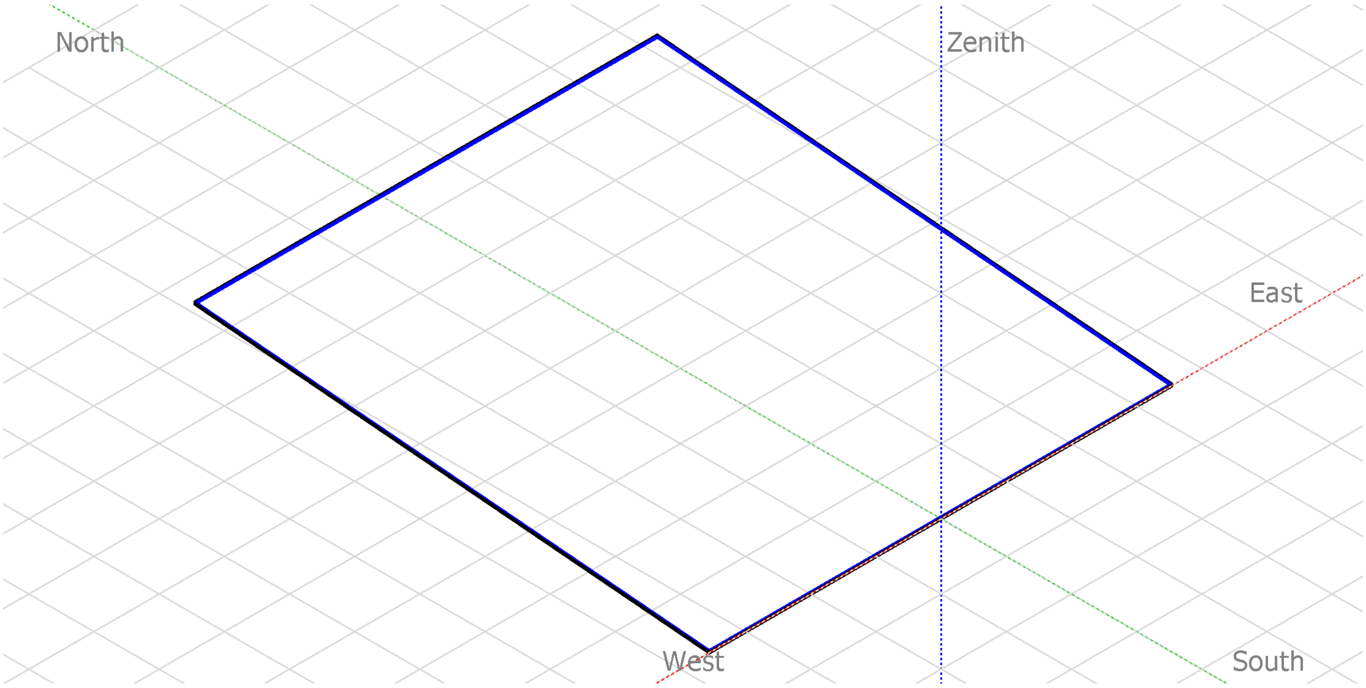
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

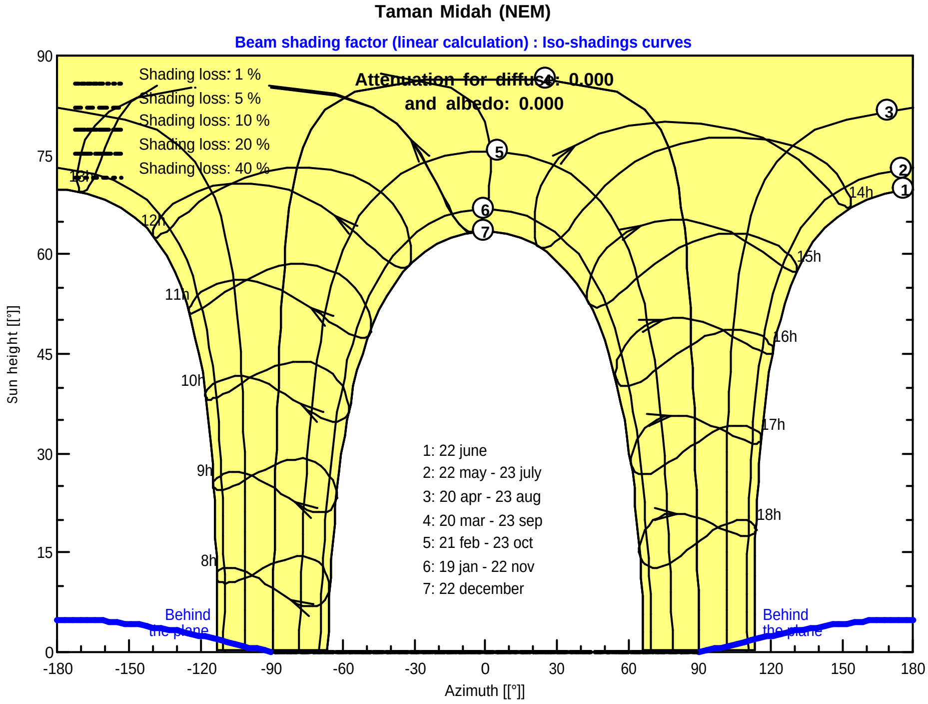
Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

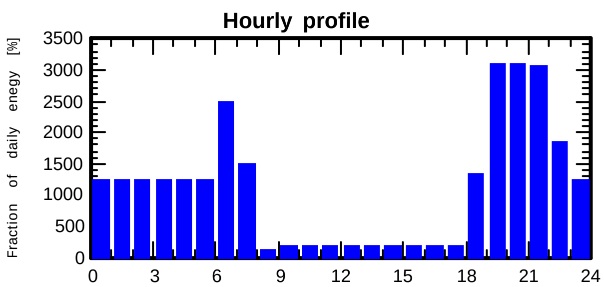
Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Daily household consumers, Constant over the year, average = 19.4 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	26	18 W/lamp	5 h/day	2340 Wh/day
TV / PC / Mobile	2	70 W/app	9 h/day	1260 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	2 h/day	3000 Wh/day
Aircond	3	750 W tot	7 h/day	15750 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				27074 Wh/day



Grid-Connected System: Main results

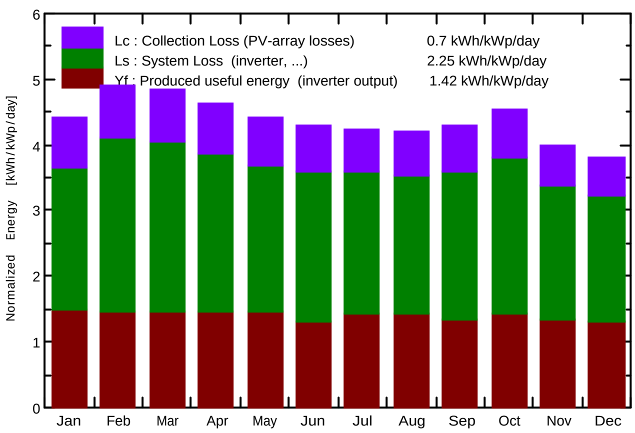
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - small family - 9kw**

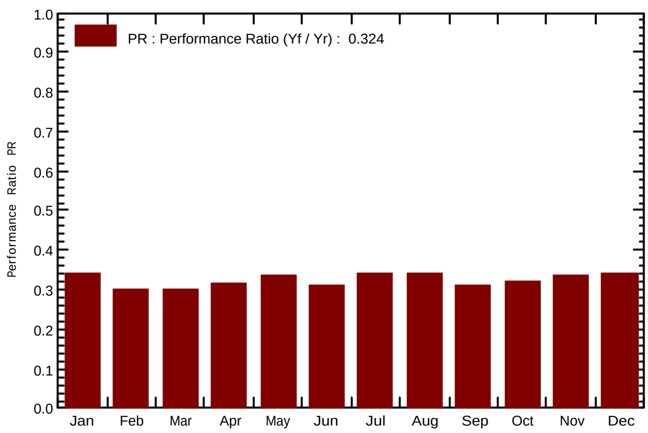
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	32.41 %	Solar Fraction SF	65.60 %
Battery ageing (State of Wear)	Cycles SOW	79.0%	Static SOW	80.0%
	Battery lifetime	4.8 years		

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



SELCO - small family - 9kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	1.016	0.623	0.416	0.512	0.207
February	134.6	67.90	27.70	137.4	132.8	1.031	0.541	0.370	0.583	0.171
March	149.8	88.20	28.00	150.3	144.9	1.125	0.596	0.404	0.619	0.191
April	140.3	70.50	27.70	138.8	133.9	1.039	0.569	0.395	0.575	0.174
May	140.3	78.60	28.60	136.9	131.7	1.027	0.623	0.410	0.529	0.213
June	132.0	77.80	27.80	128.3	123.5	0.967	0.569	0.357	0.515	0.211
July	134.4	87.20	27.80	131.1	125.8	0.994	0.596	0.402	0.519	0.194
August	132.2	87.20	27.80	130.1	125.2	0.980	0.623	0.397	0.497	0.226
September	129.2	79.00	27.10	128.8	124.0	0.968	0.541	0.358	0.513	0.183
October	138.8	82.60	27.40	140.4	135.5	1.056	0.623	0.404	0.581	0.219
November	117.6	79.20	26.70	119.8	115.4	0.907	0.596	0.361	0.466	0.234
December	115.0	73.20	26.29	118.1	113.6	0.896	0.569	0.362	0.453	0.207
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	7.066	4.636	6.361	2.431

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

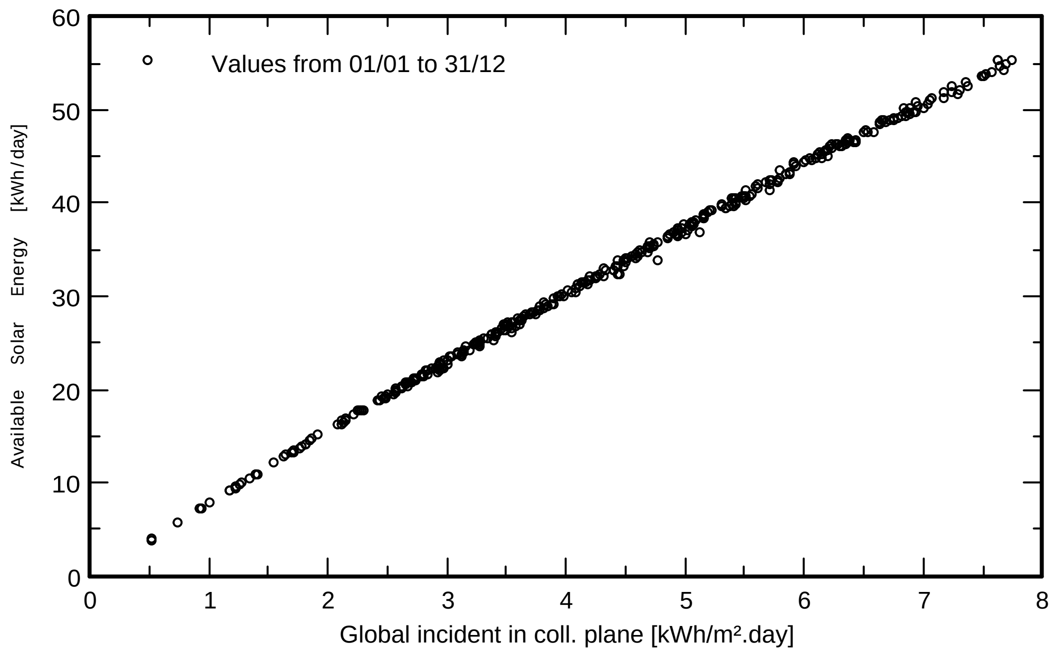
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

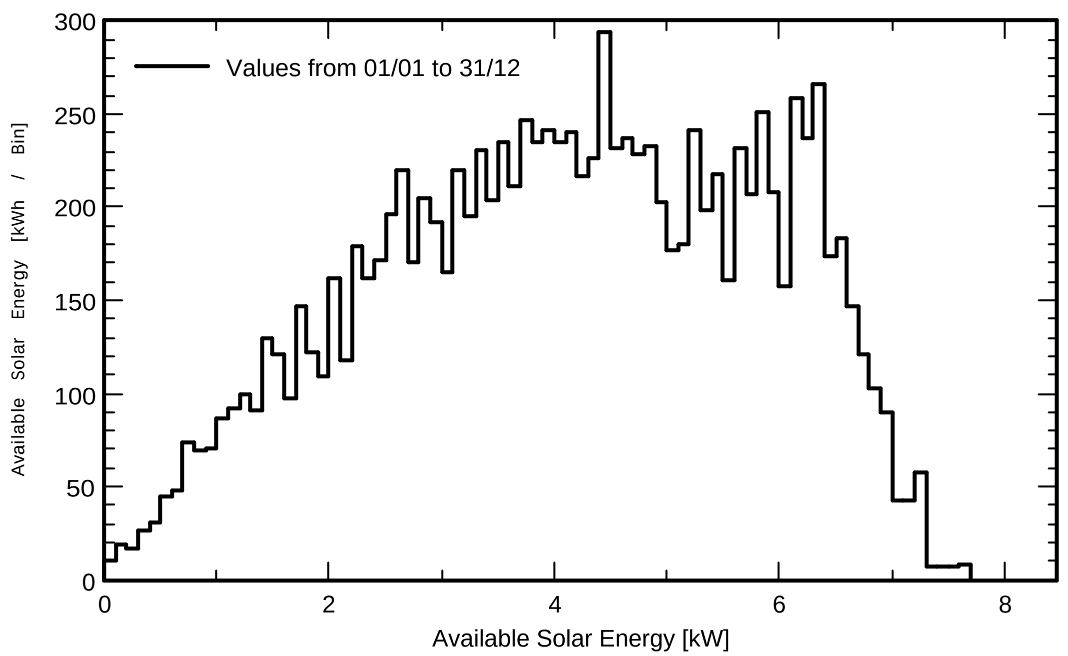
Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Daily Input/Output diagram



System Output Power Distribution



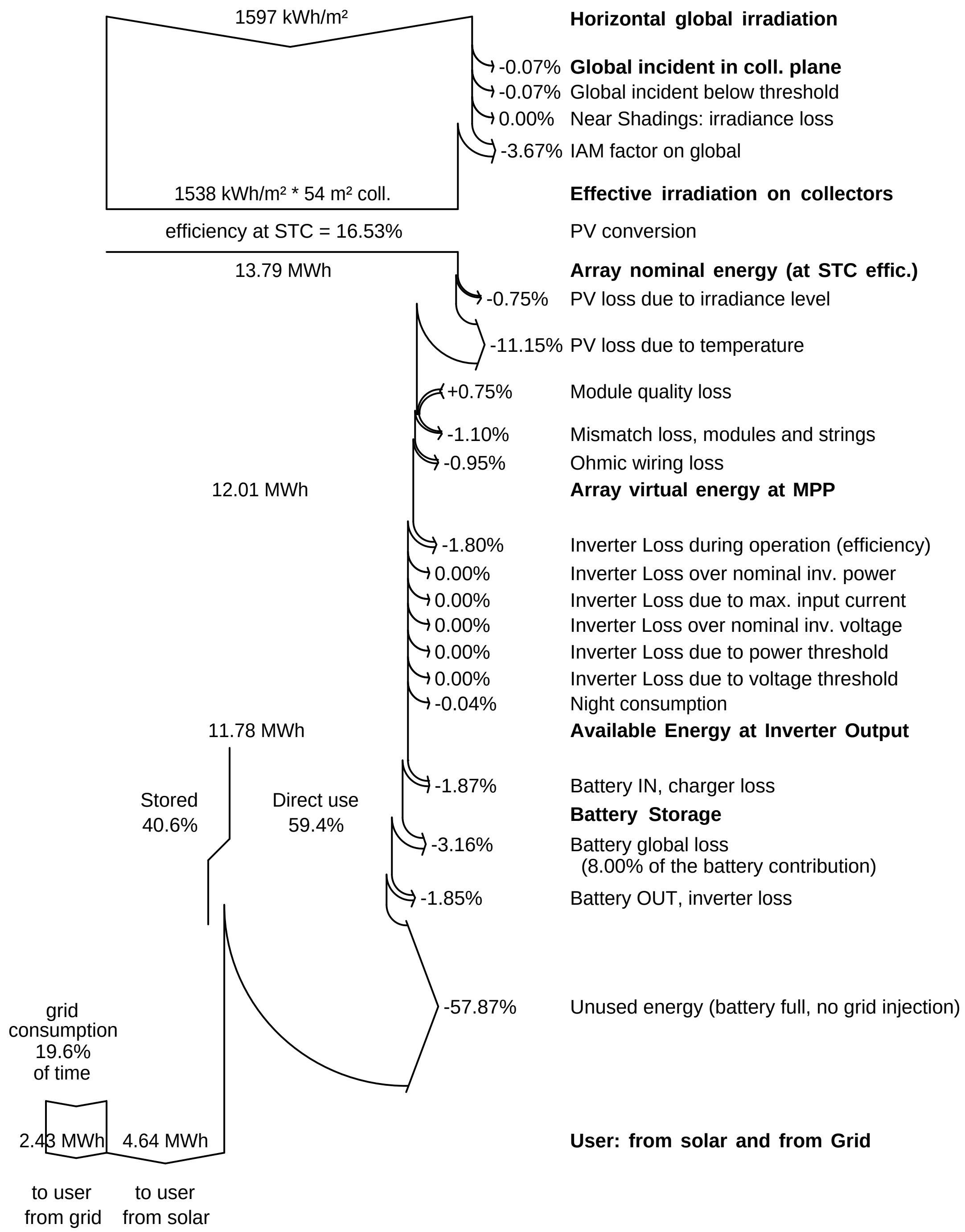
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	7066 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

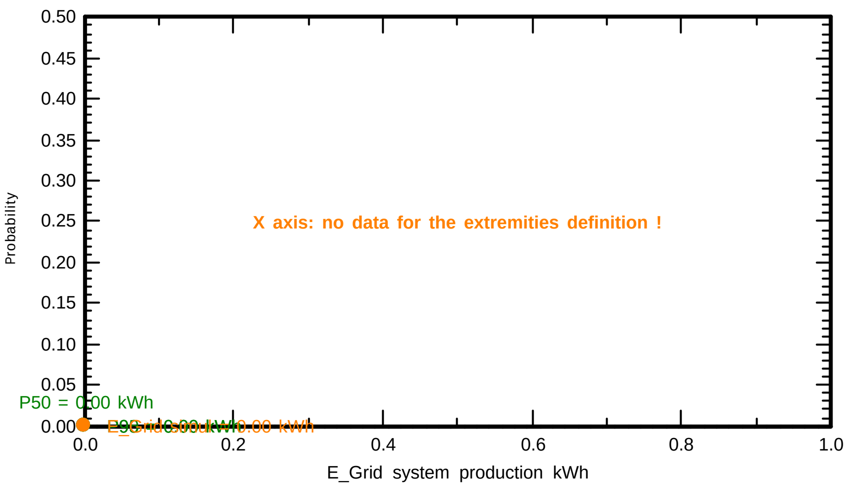
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - small family - 9kw**

Simulation date 21/04/20 17h28

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	9.9 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	3 in series x 4 in parallel		
	Voltage	36 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	14.1 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	7.5 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	3.1 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

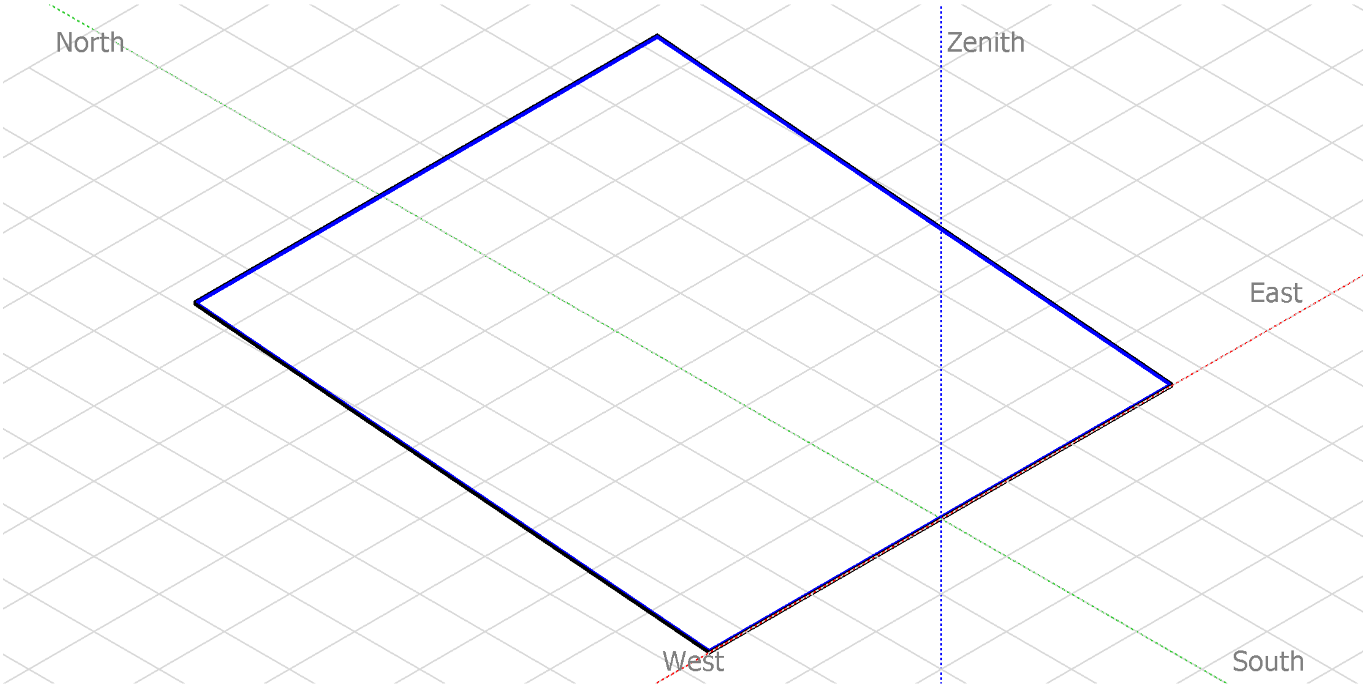
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

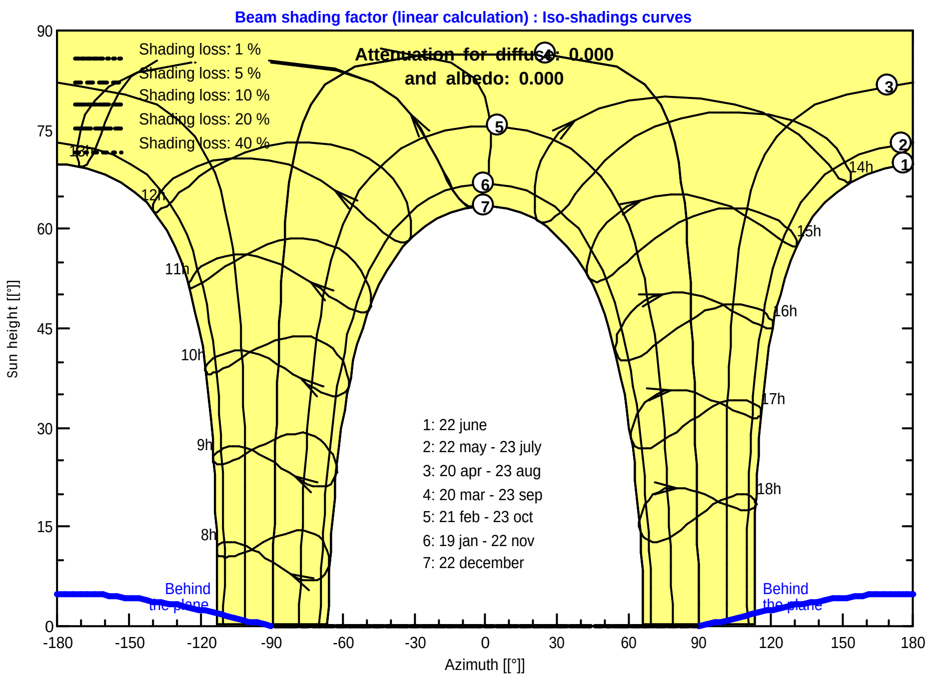
Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

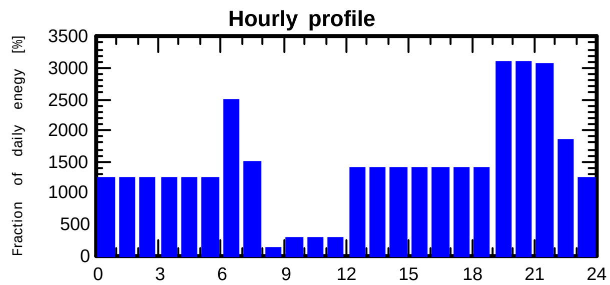
Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Daily household consumers, Constant over the year, average = 9.9 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	26	18 W/lamp	5 h/day	2340 Wh/day
TV / PC / Mobile	2	70 W/app	14 h/day	1960 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	1	2000 W tot	2 h/day	3000 Wh/day
Aircond	3	750 W tot	10 h/day	22500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				34524 Wh/day



Grid-Connected System: Main results

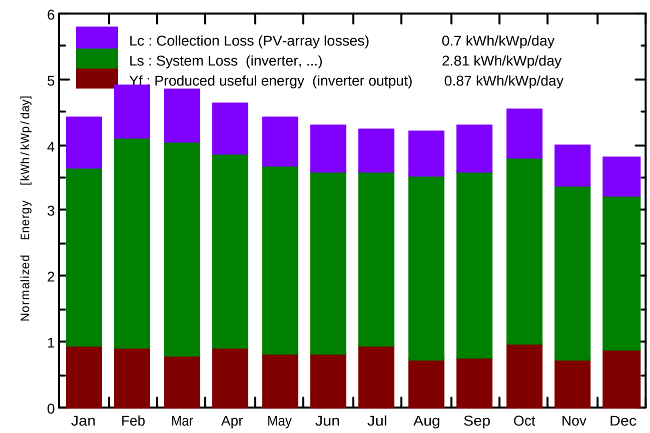
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - small family - 9kw**

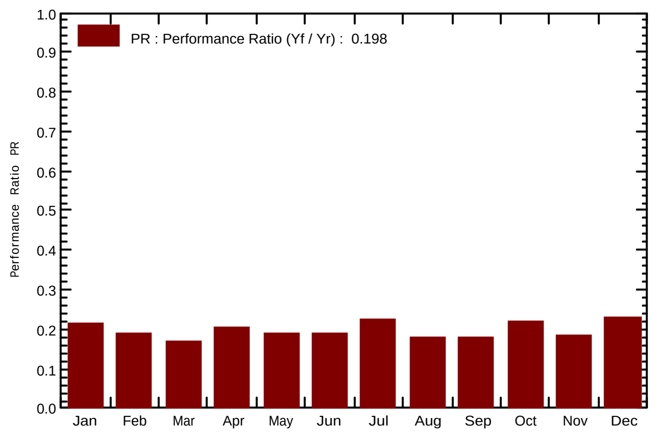
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	19.78 %	Solar Fraction SF	78.05 %
Battery ageing (State of Wear)	Cycles SOW	89.2%	Static SOW	80.0%
	Battery lifetime	5.0 years		

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



SELCO - small family - 9kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	1.016	0.345	0.265	0.665	0.080
February	134.6	67.90	27.70	137.4	132.8	1.031	0.276	0.234	0.734	0.043
March	149.8	88.20	28.00	150.3	144.9	1.125	0.276	0.225	0.833	0.051
April	140.3	70.50	27.70	138.8	133.9	1.039	0.311	0.252	0.736	0.059
May	140.3	78.60	28.60	136.9	131.7	1.027	0.311	0.231	0.710	0.080
June	132.0	77.80	27.80	128.3	123.5	0.967	0.276	0.220	0.679	0.056
July	134.4	87.20	27.80	131.1	125.8	0.994	0.345	0.266	0.672	0.079
August	132.2	87.20	27.80	130.1	125.2	0.980	0.276	0.209	0.688	0.067
September	129.2	79.00	27.10	128.8	124.0	0.968	0.276	0.208	0.693	0.068
October	138.8	82.60	27.40	140.4	135.5	1.056	0.345	0.275	0.708	0.070
November	117.6	79.20	26.70	119.8	115.4	0.907	0.276	0.199	0.643	0.077
December	115.0	73.20	26.29	118.1	113.6	0.896	0.311	0.246	0.597	0.065
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	3.625	2.829	8.360	0.796

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

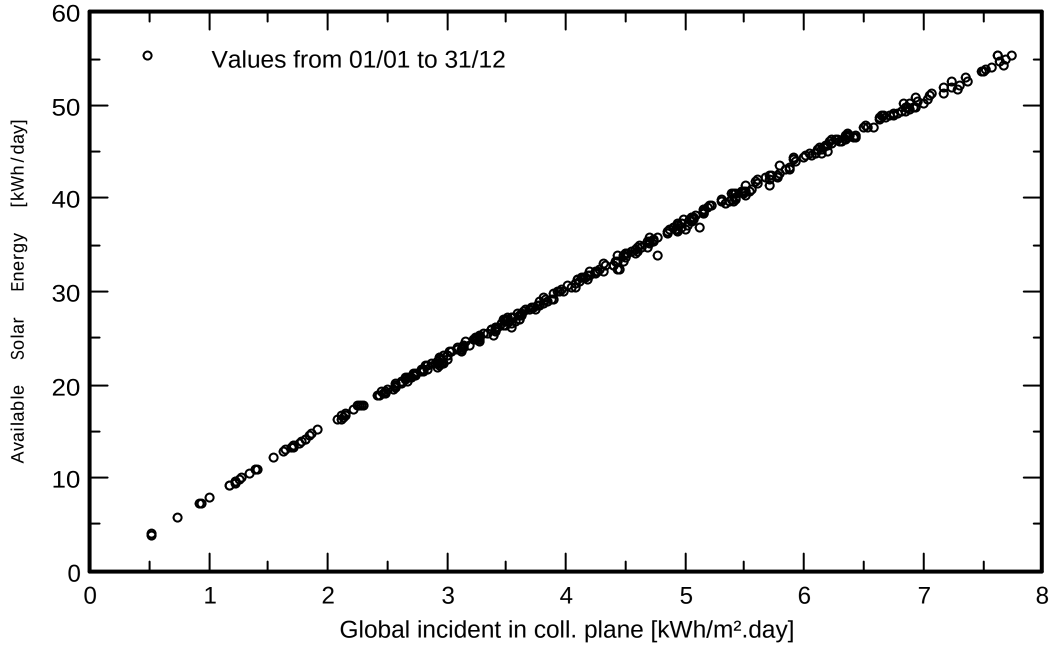
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

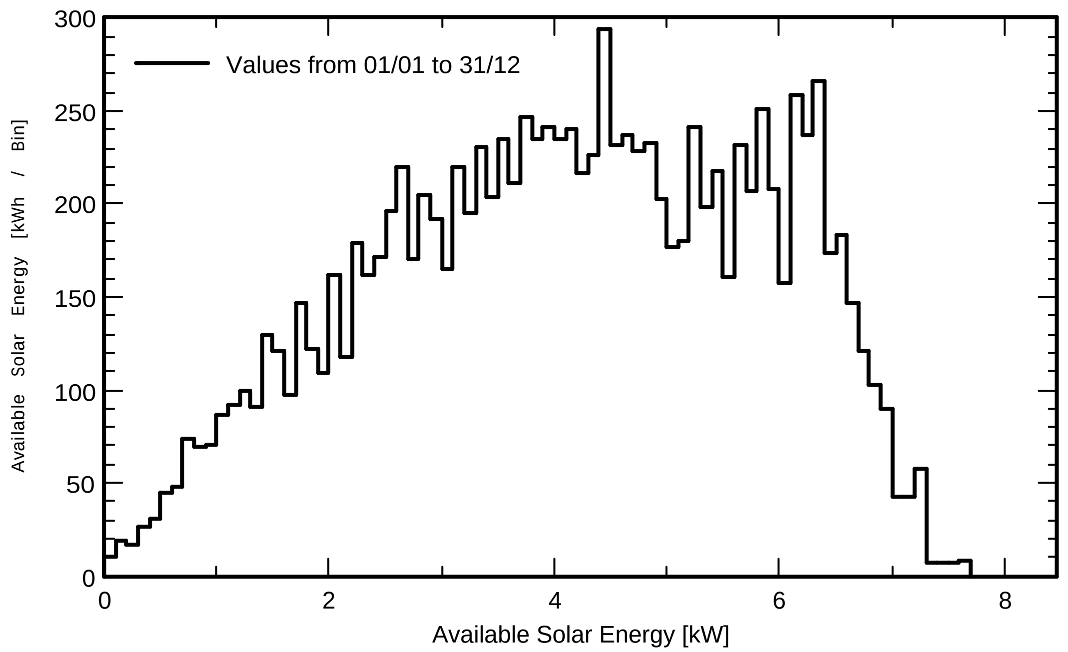
Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Daily Input/Output diagram



System Output Power Distribution



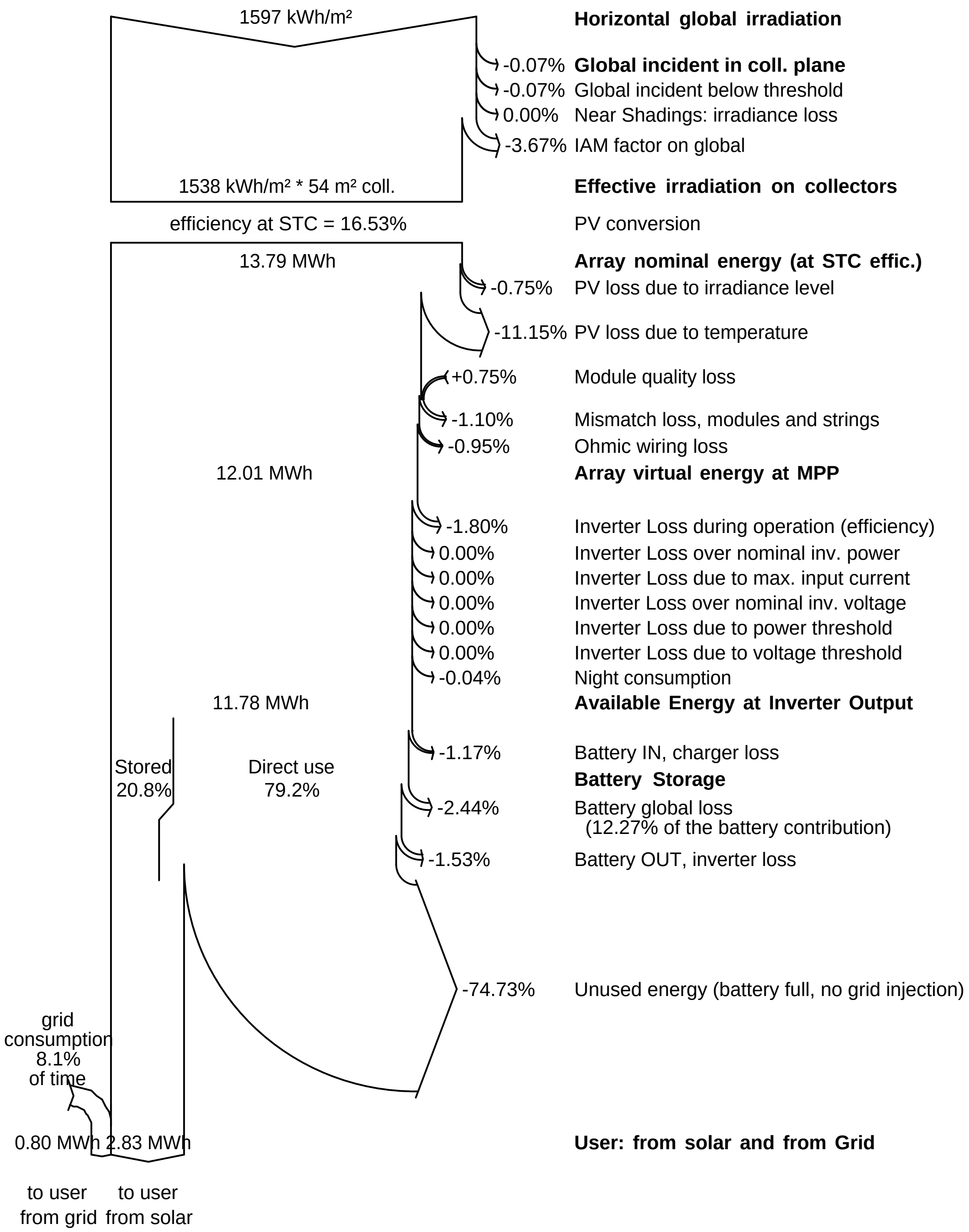
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - small family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	3625 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

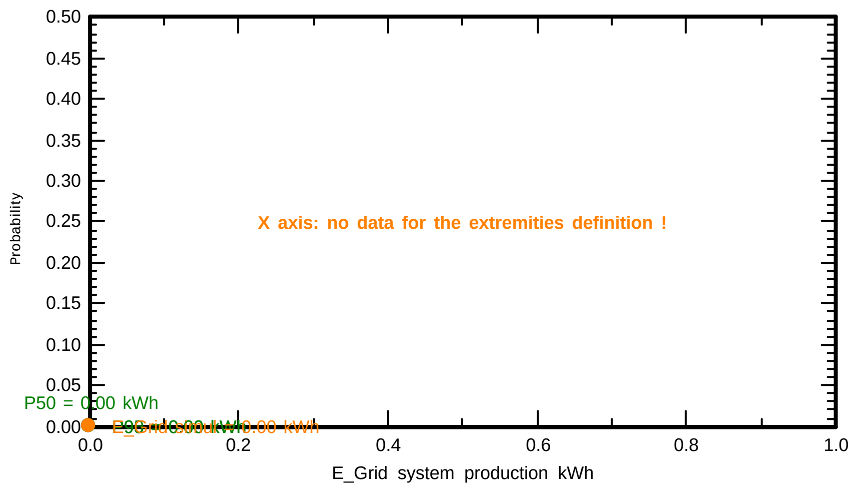
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - average family - 6kw**

Simulation date 21/04/20 16h13

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	25.1 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	5.2 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

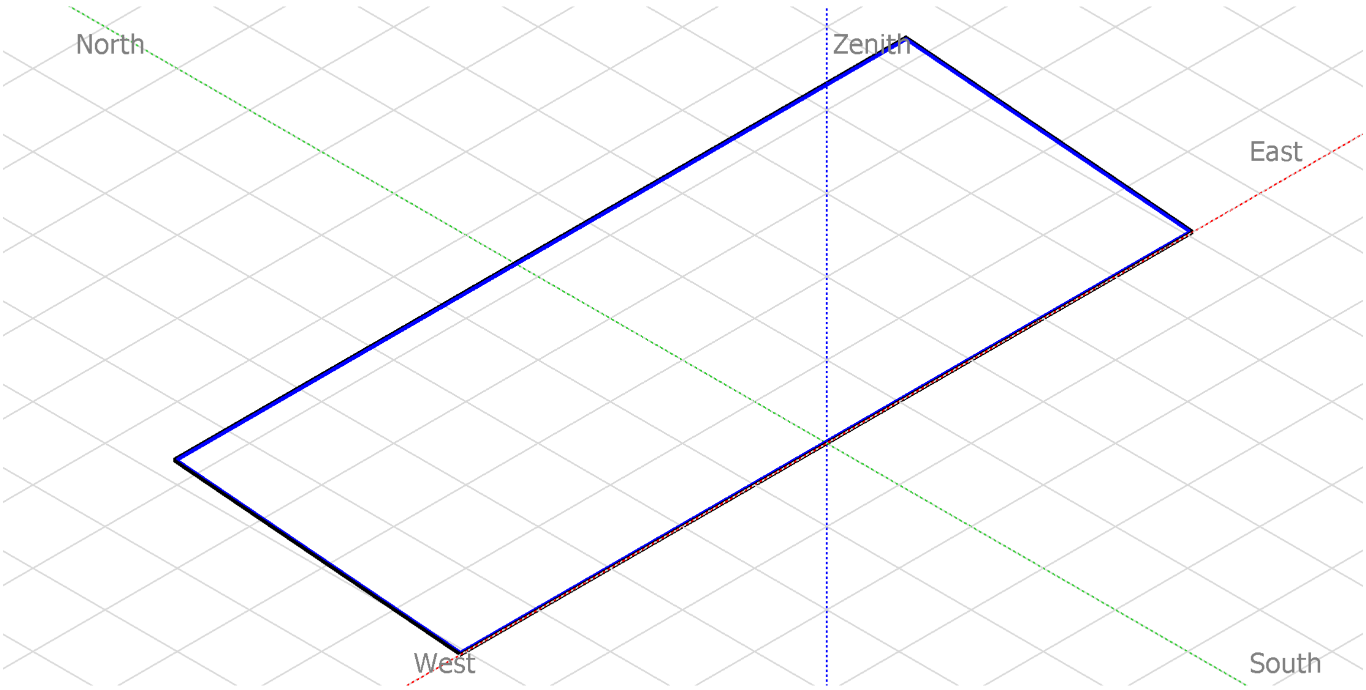
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

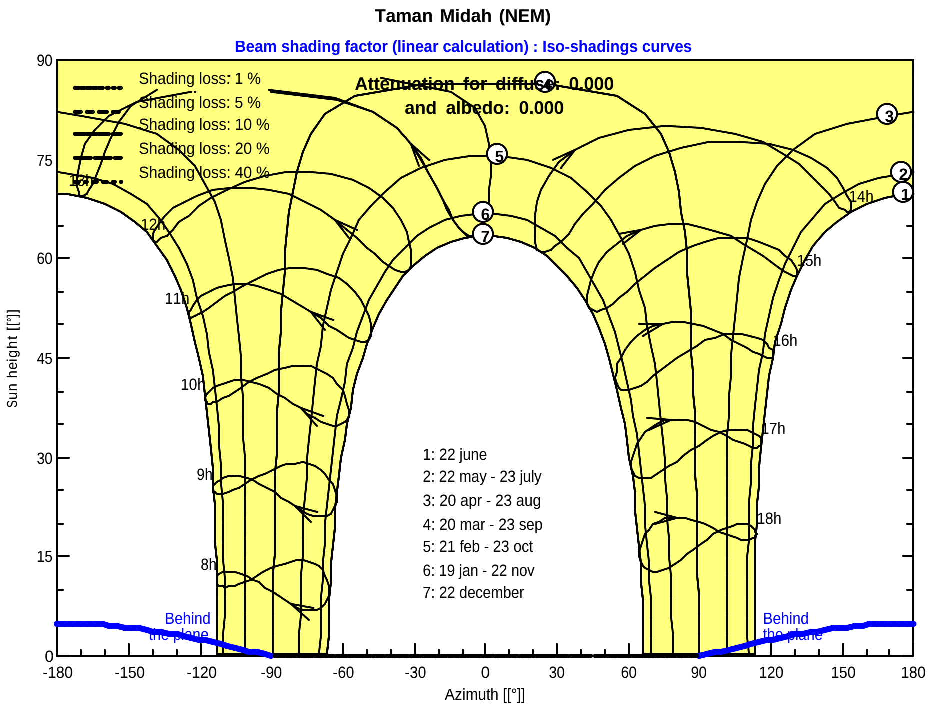
Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

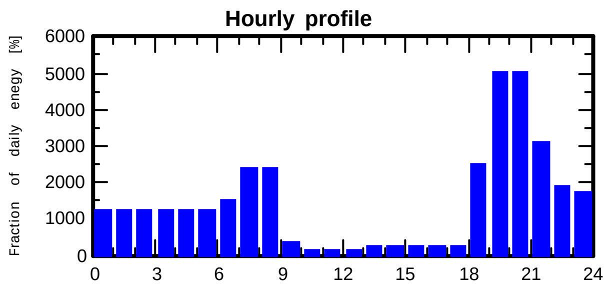
Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Daily household consumers, Constant over the year, average = 25.1 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	28	18 W/lamp	6 h/day	3024 Wh/day
TV / PC / Mobile	2	70 W/app	10 h/day	1400 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	3	750 W tot	8 h/day	18000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				35148 Wh/day



Grid-Connected System: Main results

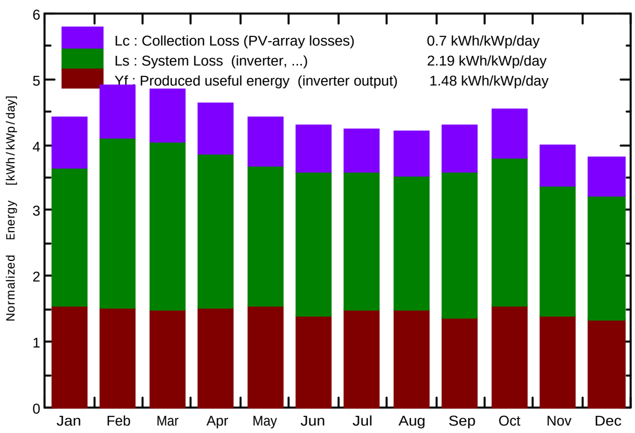
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 6kw**

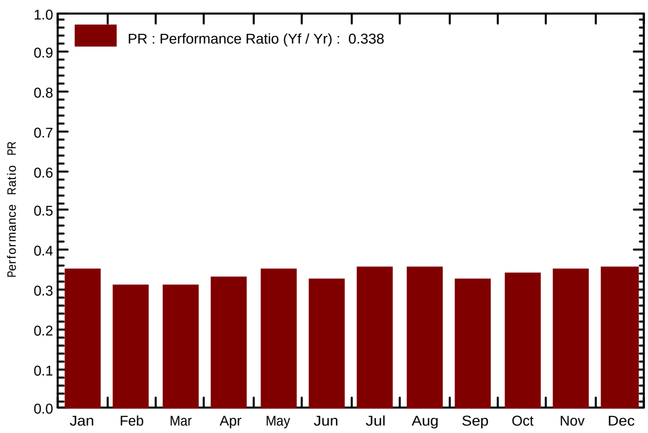
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	33.81 %	Solar Fraction SF	37.65 %
Battery ageing (State of Wear)	Cycles SOW	79.1%	Static SOW	80.0%
	Battery lifetime	4.8 years		

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



SELCO - average family - 6kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.808	0.307	0.356	0.502
February	134.6	67.90	27.70	137.4	132.8	0.737	0.703	0.274	0.405	0.429
March	149.8	88.20	28.00	150.3	144.9	0.804	0.773	0.299	0.432	0.475
April	140.3	70.50	27.70	138.8	133.9	0.742	0.738	0.295	0.394	0.443
May	140.3	78.60	28.60	136.9	131.7	0.734	0.808	0.307	0.362	0.501
June	132.0	77.80	27.80	128.3	123.5	0.691	0.738	0.268	0.355	0.470
July	134.4	87.20	27.80	131.1	125.8	0.710	0.773	0.297	0.361	0.477
August	132.2	87.20	27.80	130.1	125.2	0.700	0.808	0.295	0.343	0.514
September	129.2	79.00	27.10	128.8	124.0	0.691	0.703	0.267	0.355	0.436
October	138.8	82.60	27.40	140.4	135.5	0.754	0.808	0.307	0.393	0.501
November	117.6	79.20	26.70	119.8	115.4	0.648	0.773	0.270	0.320	0.504
December	115.0	73.20	26.29	118.1	113.6	0.640	0.738	0.269	0.310	0.469
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	9.174	3.454	4.384	5.720

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

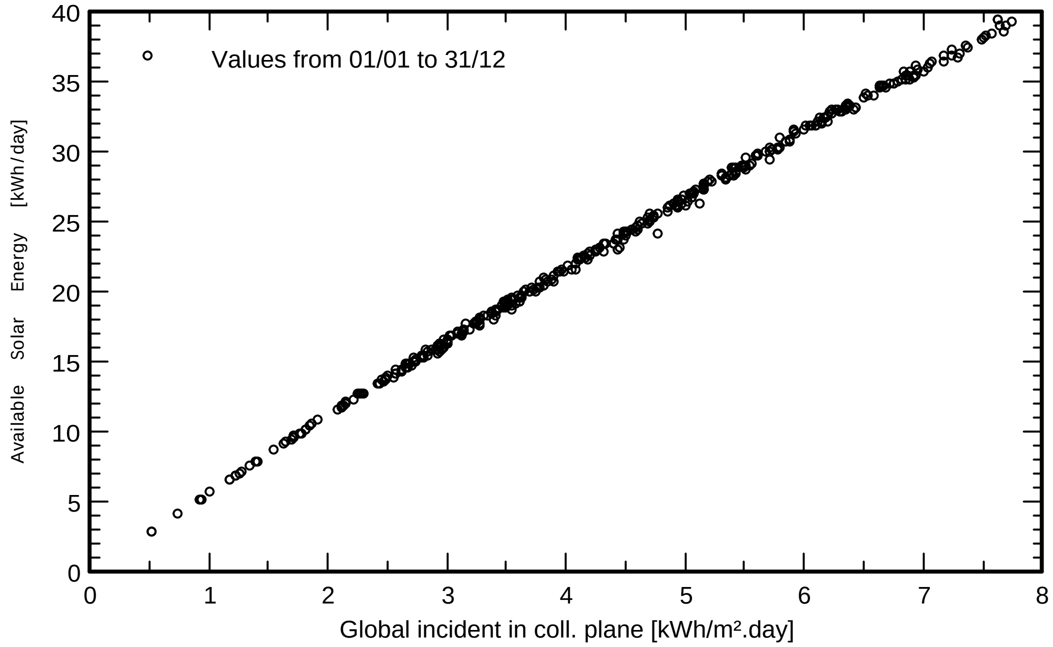
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

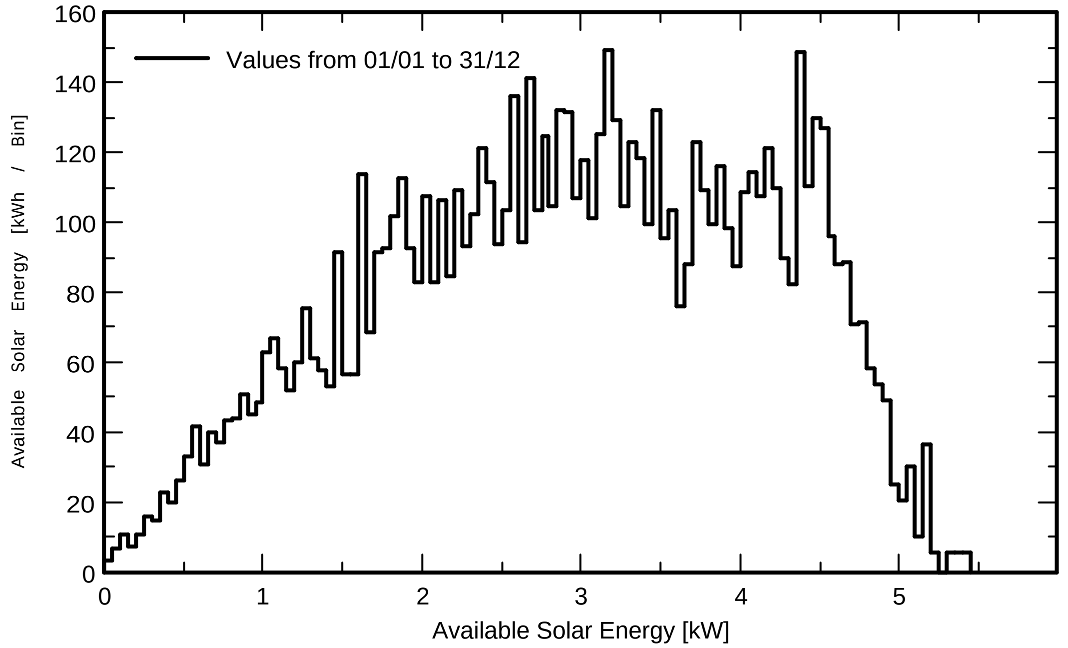
Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Daily Input/Output diagram



System Output Power Distribution



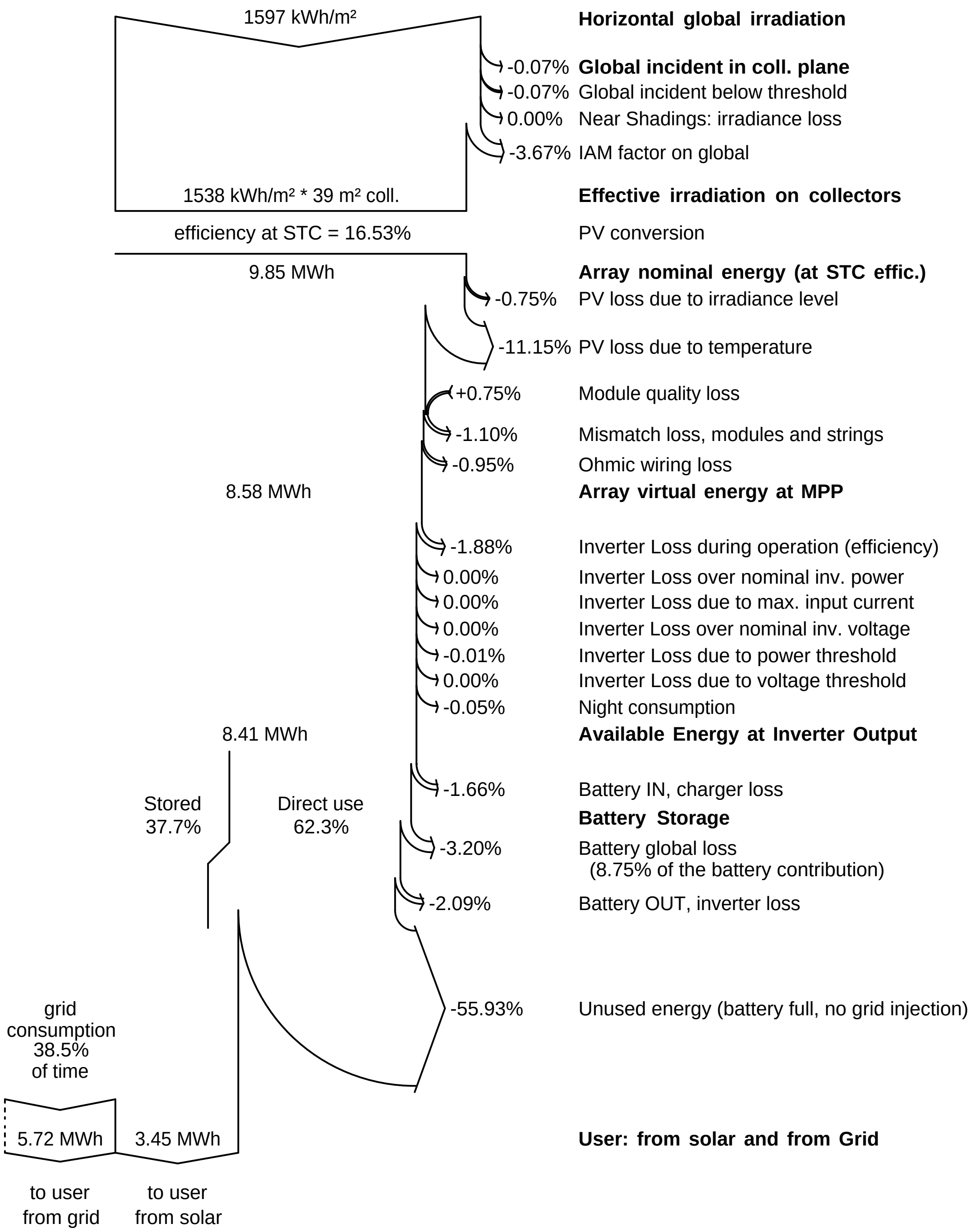
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

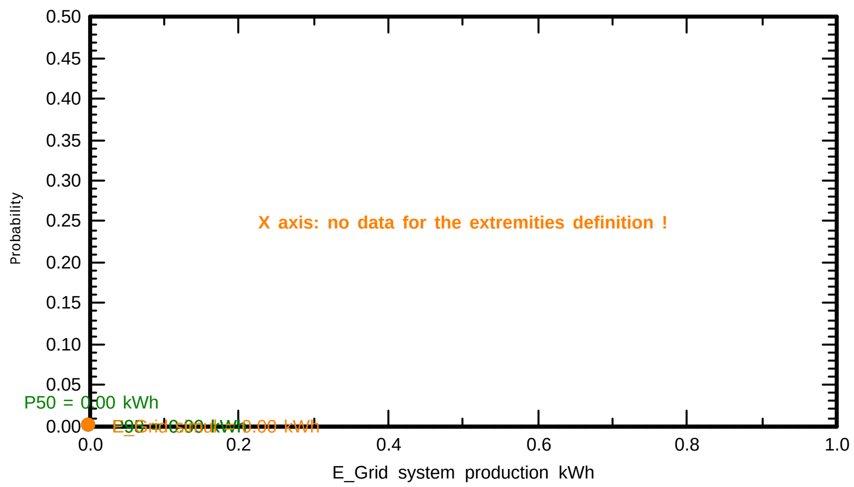
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - average family - 6kw**

Simulation date 21/04/20 16h14

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	11.1 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	5.2 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

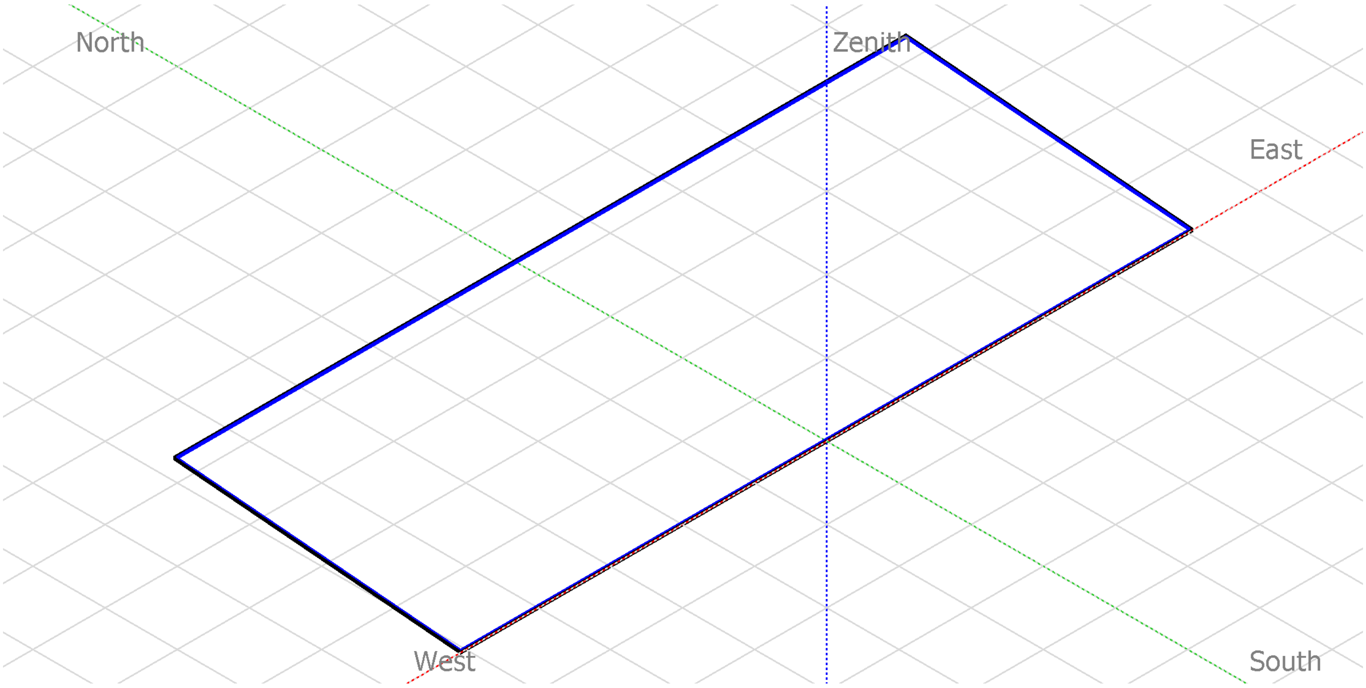
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

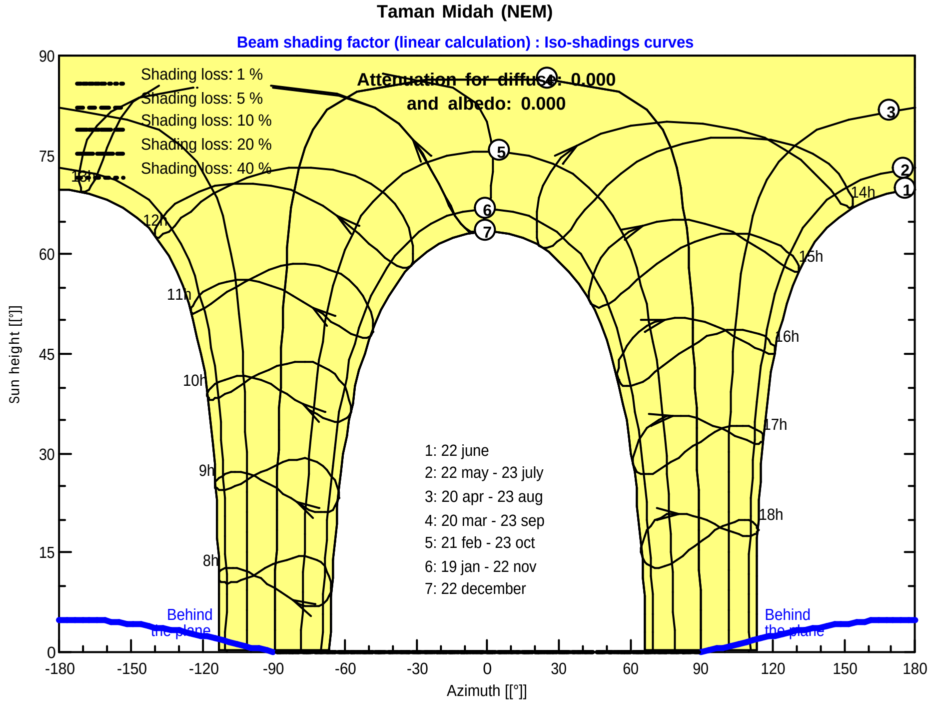
Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

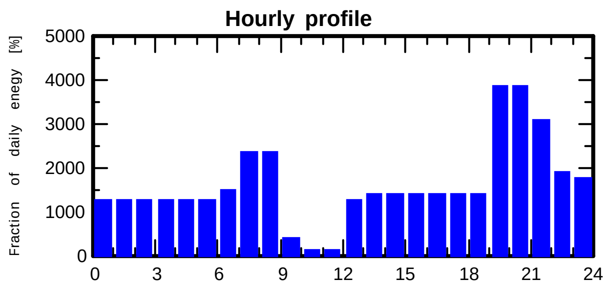
Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Daily household consumers, Constant over the year, average = 11.1 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	28	18 W/lamp	6 h/day	3024 Wh/day
TV / PC / Mobile	2	70 W/app	10 h/day	1400 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	3	750 W tot	10 h/day	21375 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				38523 Wh/day



Grid-Connected System: Main results

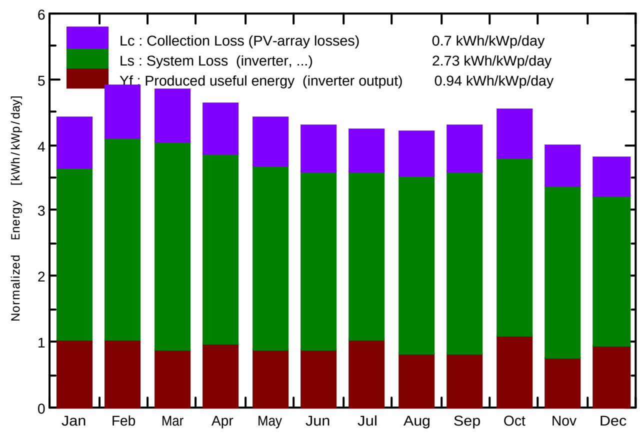
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 6kw**

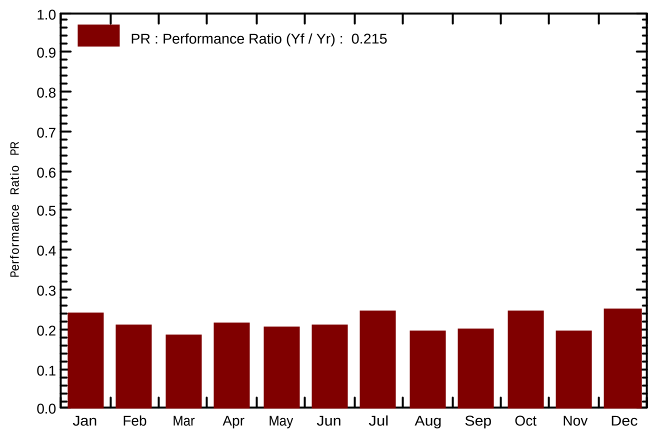
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	21.51 %	Solar Fraction SF	54.33 %
Battery ageing (State of Wear)	Cycles SOW	87.8%	Static SOW	80.0%
	Battery lifetime	5.0 years		

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



SELCO - average family - 6kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.385	0.209	0.451	0.176
February	134.6	67.90	27.70	137.4	132.8	0.737	0.308	0.186	0.500	0.123
March	149.8	88.20	28.00	150.3	144.9	0.804	0.308	0.177	0.571	0.131
April	140.3	70.50	27.70	138.8	133.9	0.742	0.347	0.189	0.510	0.157
May	140.3	78.60	28.60	136.9	131.7	0.734	0.347	0.179	0.488	0.168
June	132.0	77.80	27.80	128.3	123.5	0.691	0.308	0.172	0.464	0.137
July	134.4	87.20	27.80	131.1	125.8	0.710	0.385	0.205	0.458	0.180
August	132.2	87.20	27.80	130.1	125.2	0.700	0.308	0.163	0.471	0.145
September	129.2	79.00	27.10	128.8	124.0	0.691	0.308	0.162	0.475	0.146
October	138.8	82.60	27.40	140.4	135.5	0.754	0.385	0.221	0.475	0.164
November	117.6	79.20	26.70	119.8	115.4	0.648	0.308	0.147	0.449	0.161
December	115.0	73.20	26.29	118.1	113.6	0.640	0.347	0.187	0.406	0.159
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	4.045	2.197	5.719	1.847

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

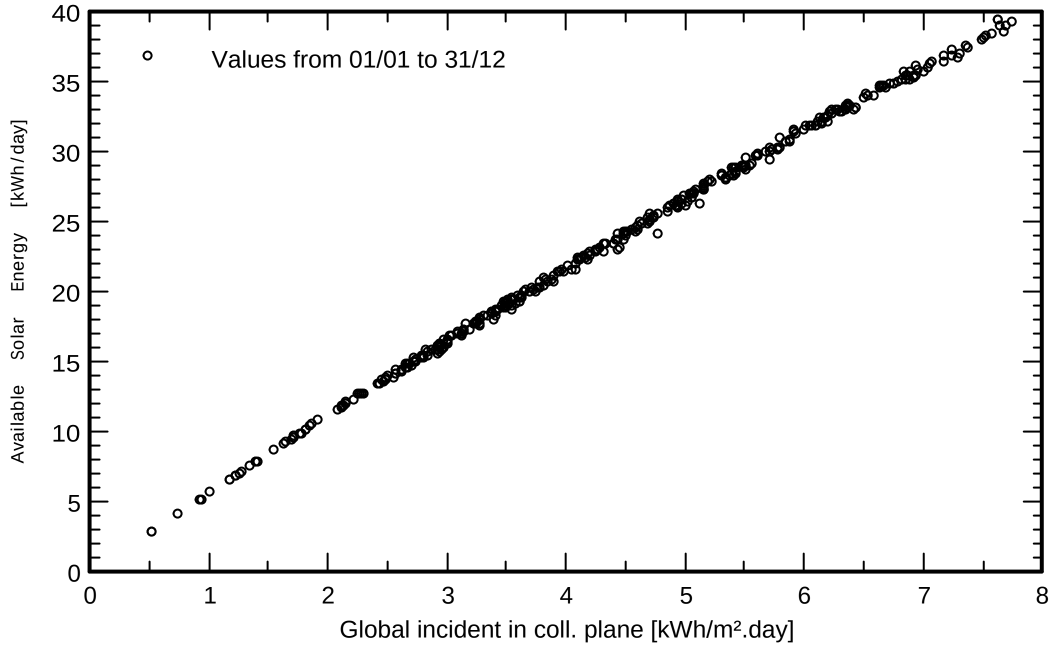
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

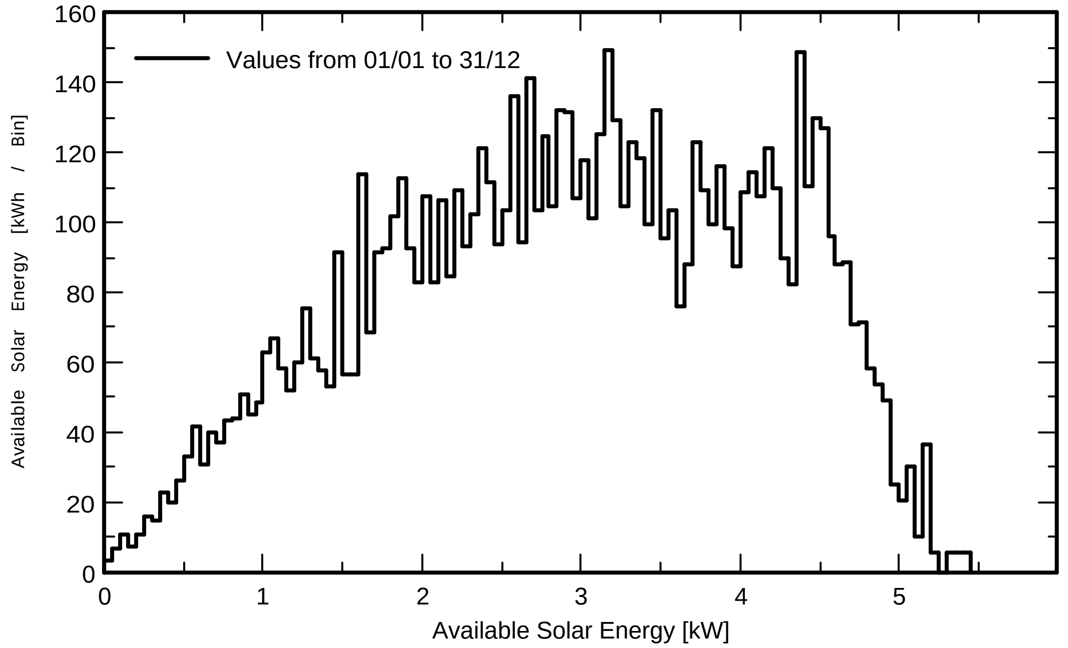
Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Daily Input/Output diagram



System Output Power Distribution



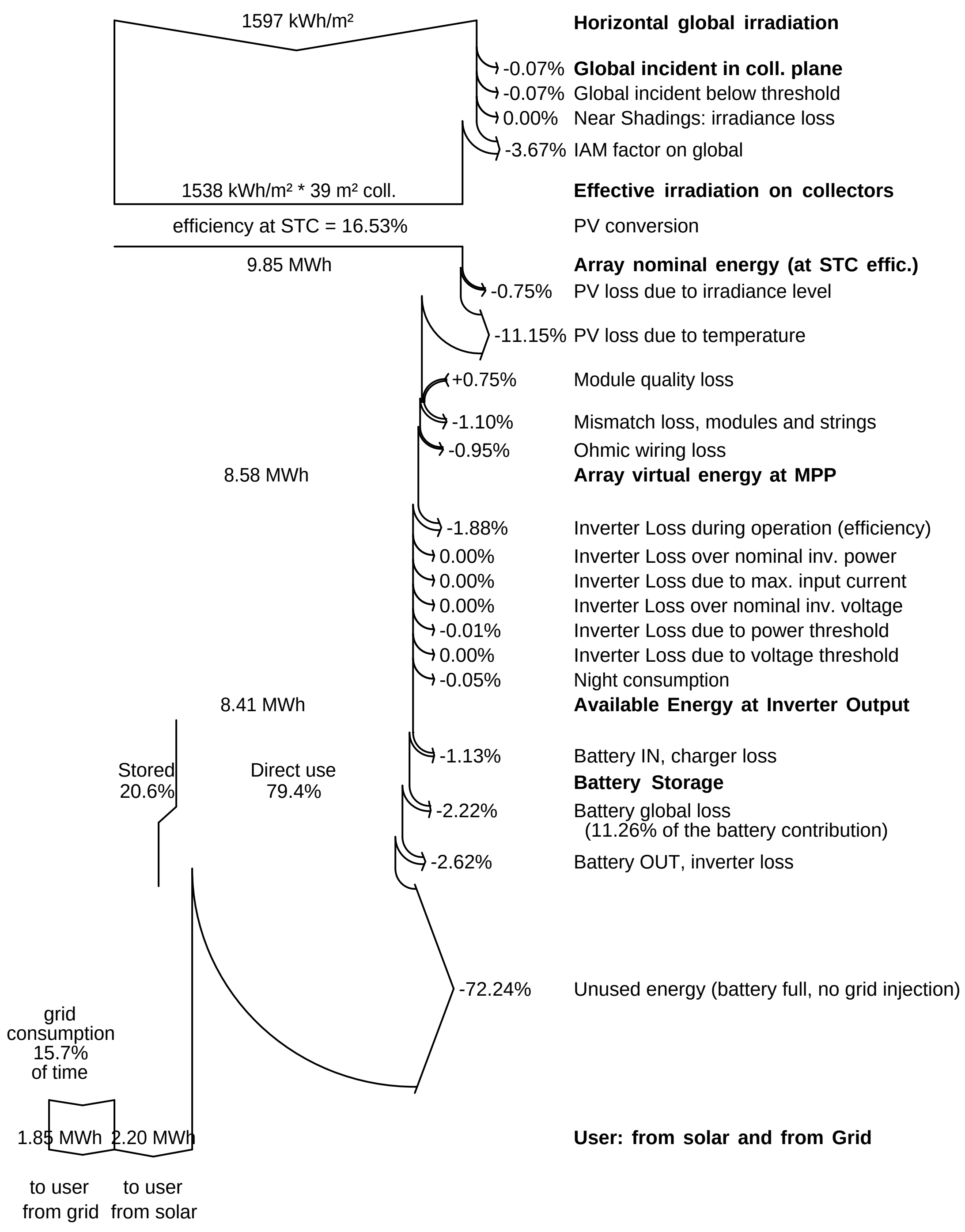
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

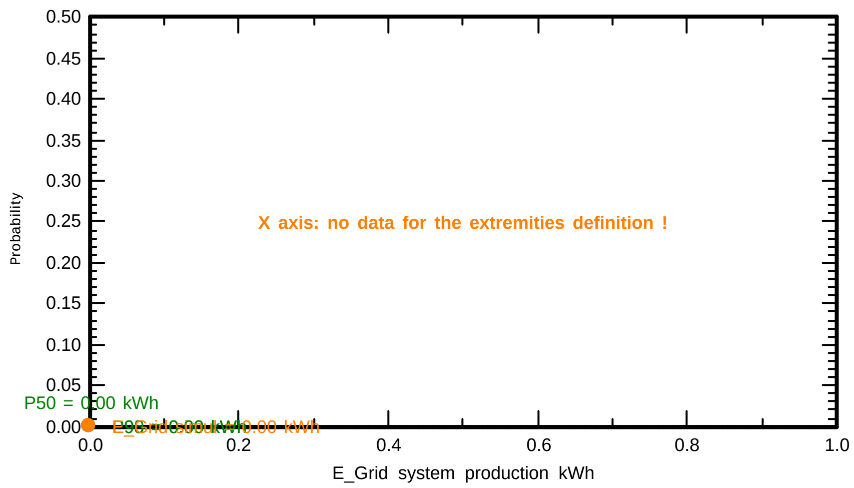
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : SELCO - average family - 9kw

Simulation date 21/04/20 16h17

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	25.1 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	3 in series x 4 in parallel		
	Voltage	36 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	14.1 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	7.5 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	5.2 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss			Loss Fraction	-0.8 %
Module Mismatch Losses			Loss Fraction	1.0 % at MPP
Strings Mismatch loss			Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM =	1 - bo (1/cos i - 1)	bo Param.	0.05

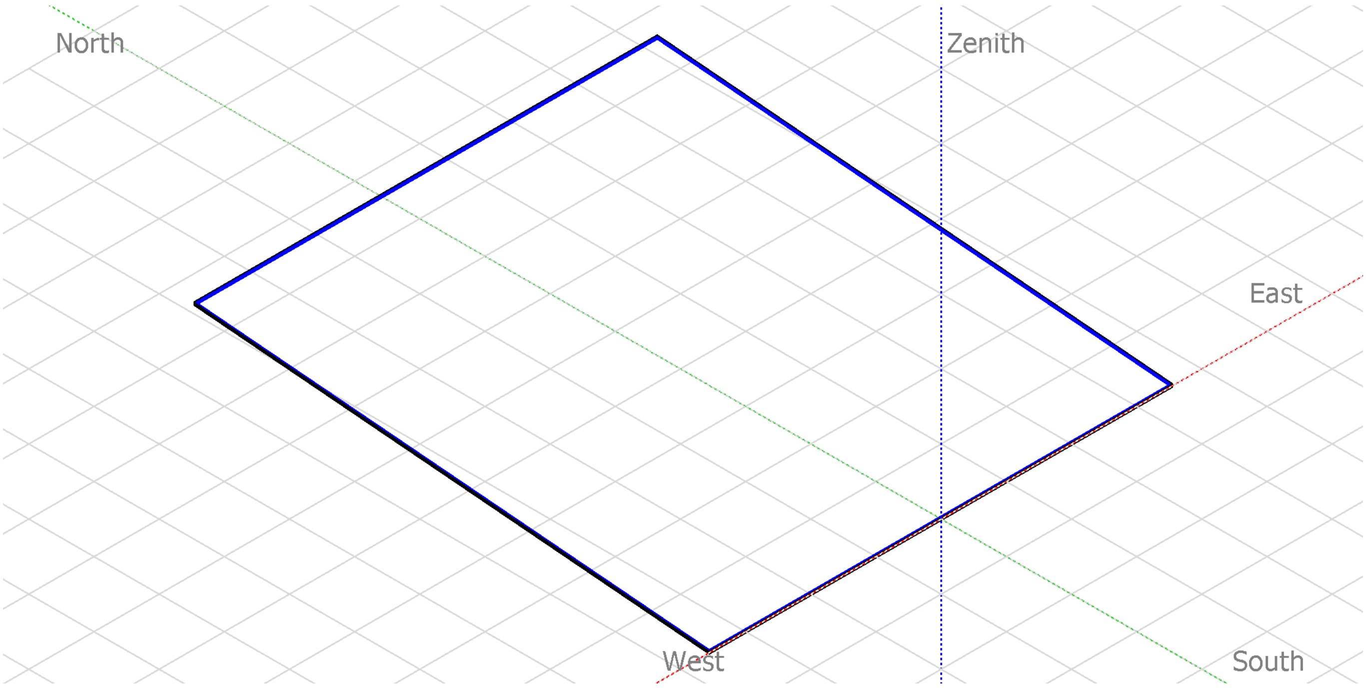
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

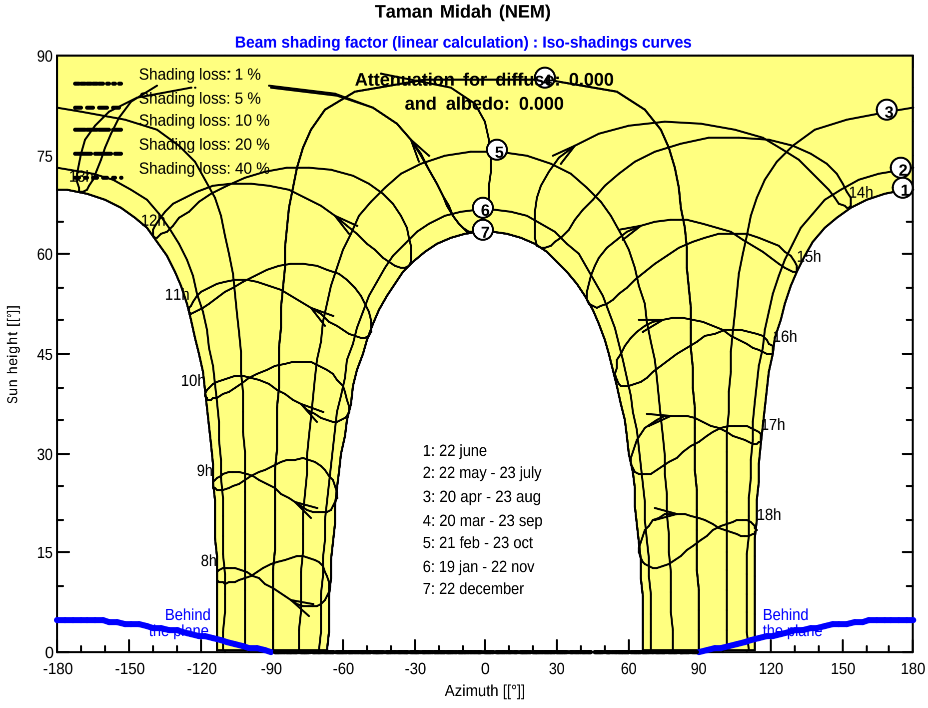
Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

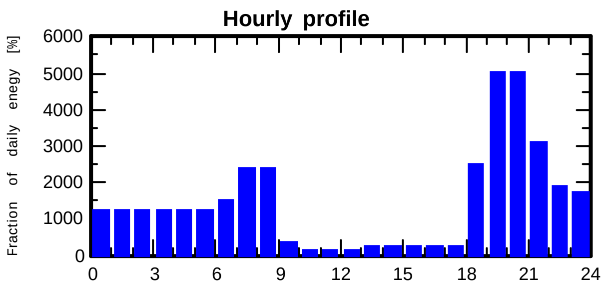
Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Daily household consumers, Constant over the year, average = 25.1 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	28	18 W/lamp	6 h/day	3024 Wh/day
TV / PC / Mobile	2	70 W/app	10 h/day	1400 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	3	750 W tot	8 h/day	18000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				35148 Wh/day



Grid-Connected System: Main results

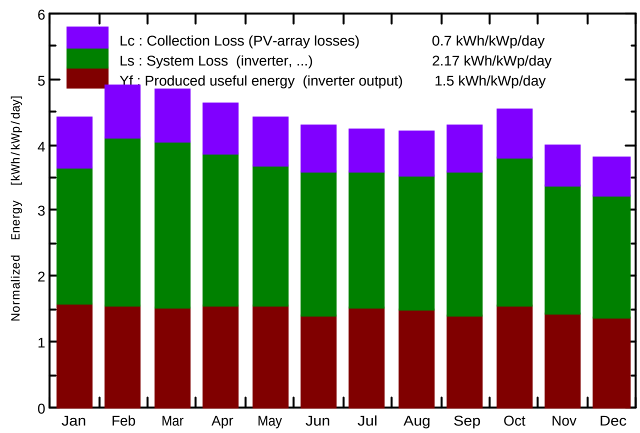
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 9kw**

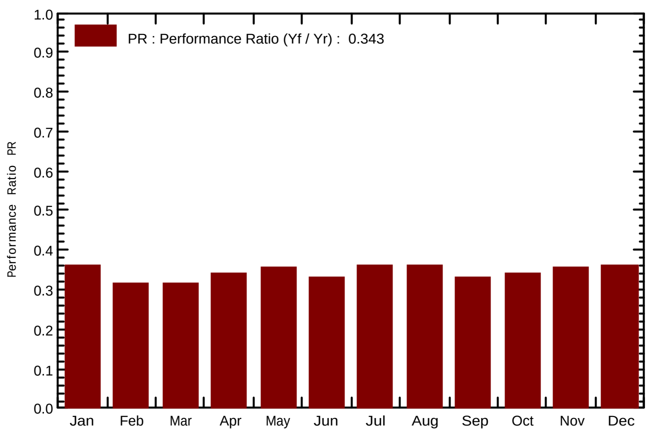
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	34.34 %	Solar Fraction SF	53.54 %
Battery ageing (State of Wear)	Cycles SOW	79.0%	Static SOW	80.0%
	Battery lifetime	4.8 years		

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



SELCO - average family - 9kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	1.016	0.808	0.438	0.489	0.371
February	134.6	67.90	27.70	137.4	132.8	1.031	0.703	0.389	0.561	0.314
March	149.8	88.20	28.00	150.3	144.9	1.125	0.773	0.426	0.593	0.347
April	140.3	70.50	27.70	138.8	133.9	1.039	0.738	0.421	0.544	0.317
May	140.3	78.60	28.60	136.9	131.7	1.027	0.808	0.436	0.501	0.373
June	132.0	77.80	27.80	128.3	123.5	0.967	0.738	0.380	0.490	0.359
July	134.4	87.20	27.80	131.1	125.8	0.994	0.773	0.425	0.496	0.349
August	132.2	87.20	27.80	130.1	125.2	0.980	0.808	0.420	0.472	0.388
September	129.2	79.00	27.10	128.8	124.0	0.968	0.703	0.379	0.490	0.324
October	138.8	82.60	27.40	140.4	135.5	1.056	0.808	0.431	0.549	0.377
November	117.6	79.20	26.70	119.8	115.4	0.907	0.773	0.384	0.440	0.389
December	115.0	73.20	26.29	118.1	113.6	0.896	0.738	0.382	0.429	0.356
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	9.174	4.912	6.054	4.262

Legends:				
	GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
	DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
	T_Amb	T amb.	E_User	Energy supplied to the user
	GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
			EUnused	Unused energy (battery full, no grid injection)
			EFrGrid	Energy from the grid

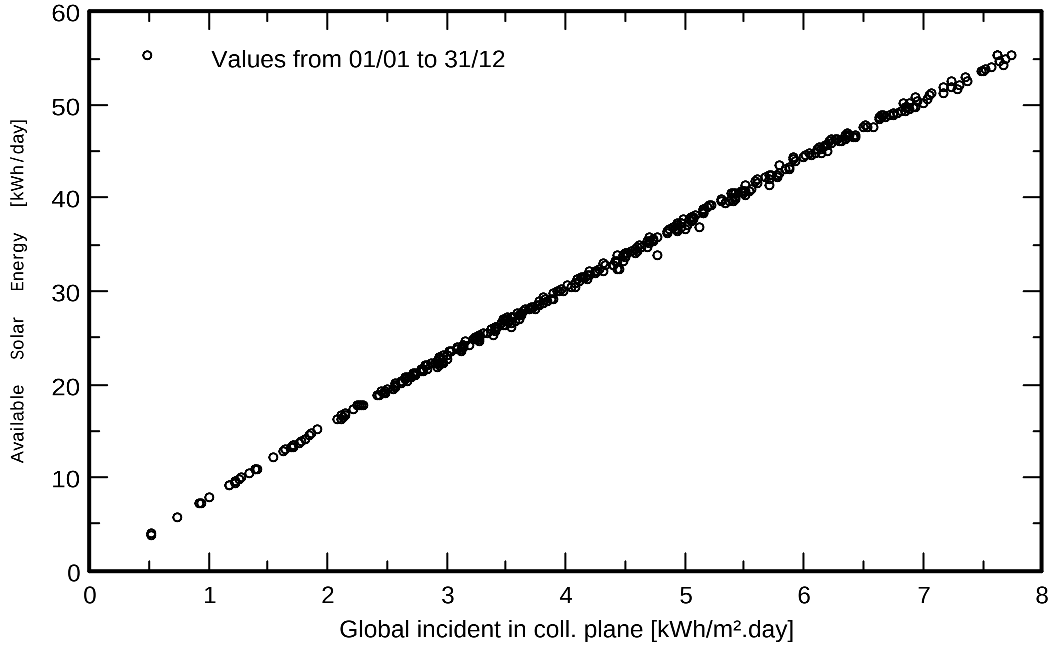
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

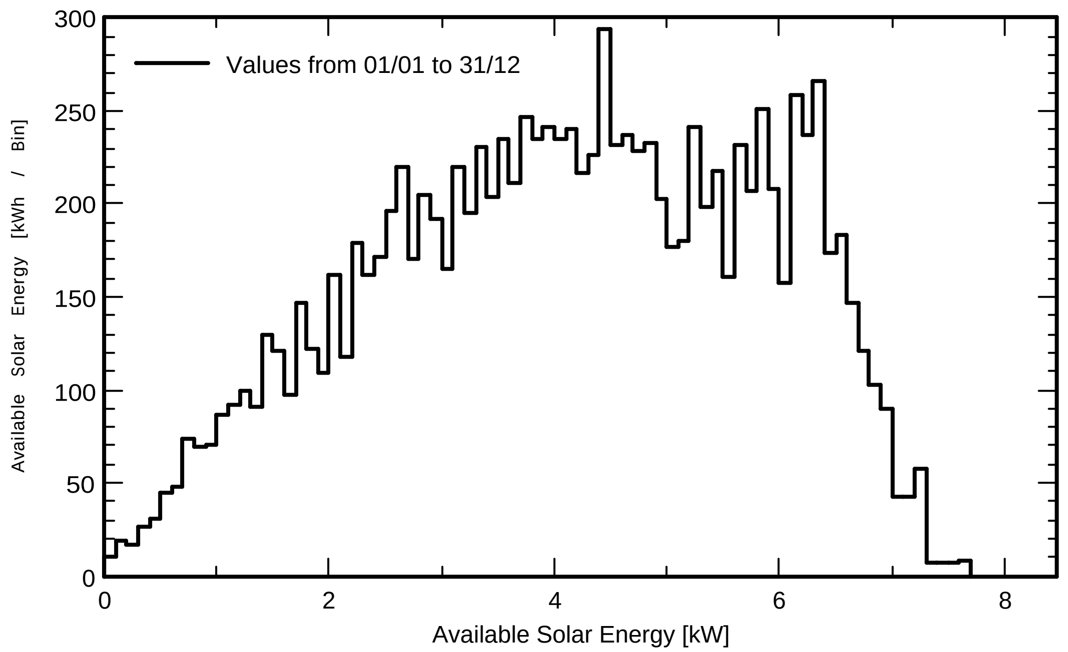
Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Daily Input/Output diagram



System Output Power Distribution



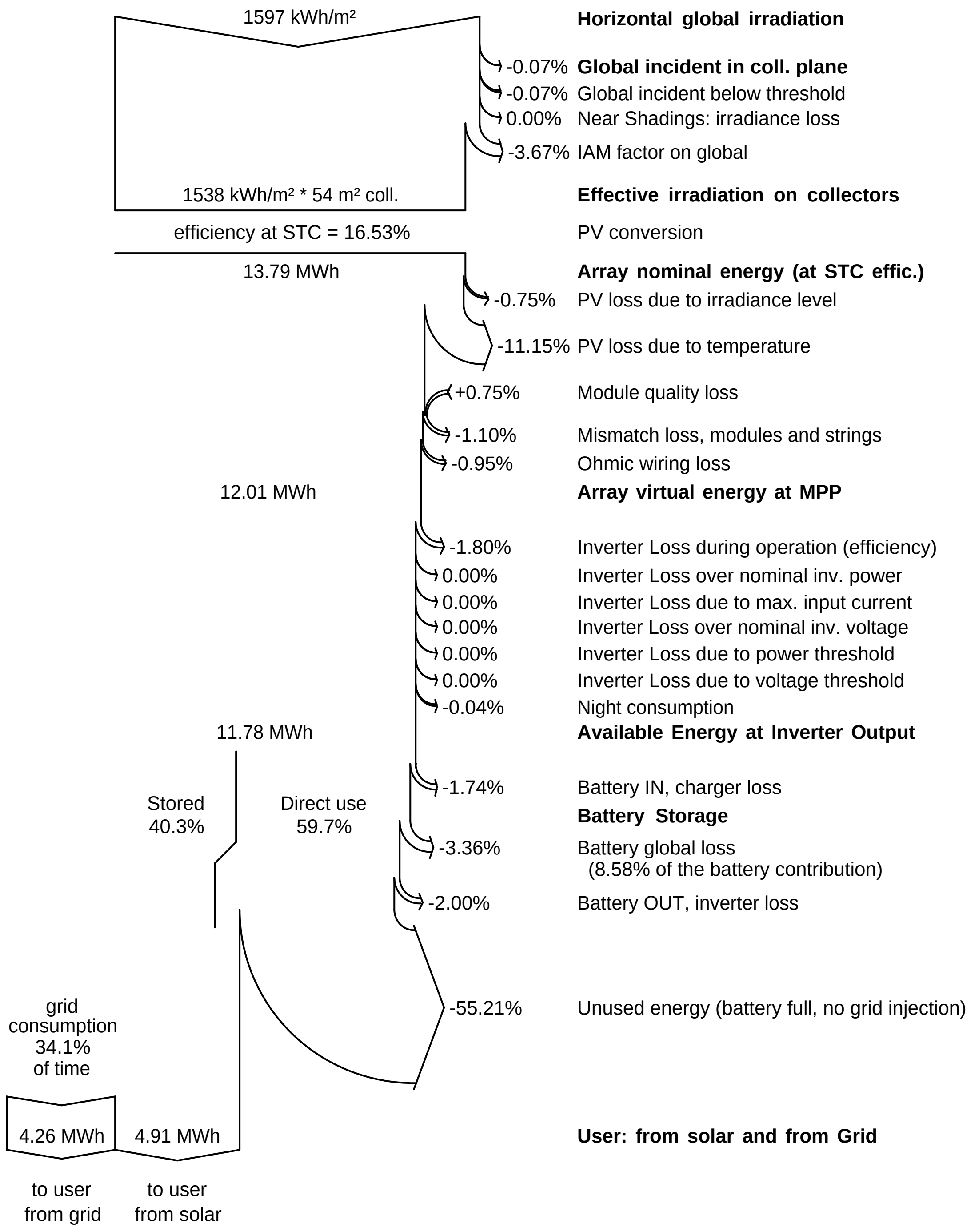
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	9174 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

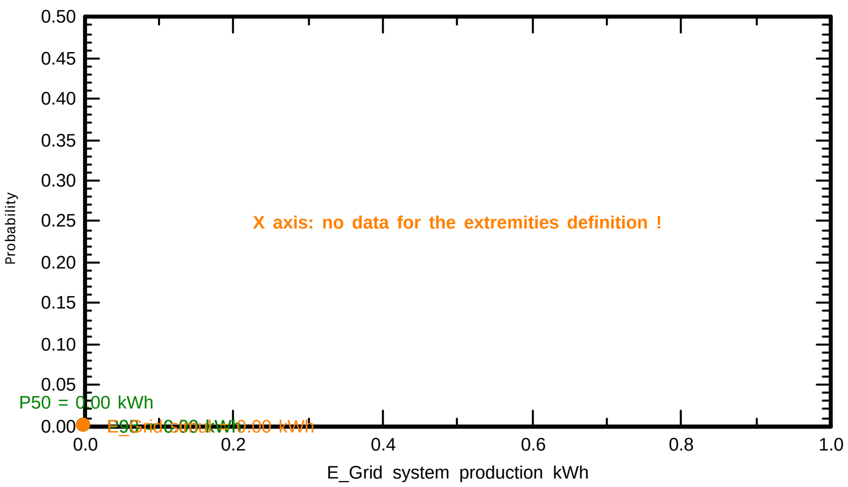
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site		**Kuala Lumpur/Subang**	Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : SELCO - average family - 9kw

Simulation date 21/04/20 16h19

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	11.1 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	3 in series x 4 in parallel		
	Voltage	36 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	14.1 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	7.5 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	5.2 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

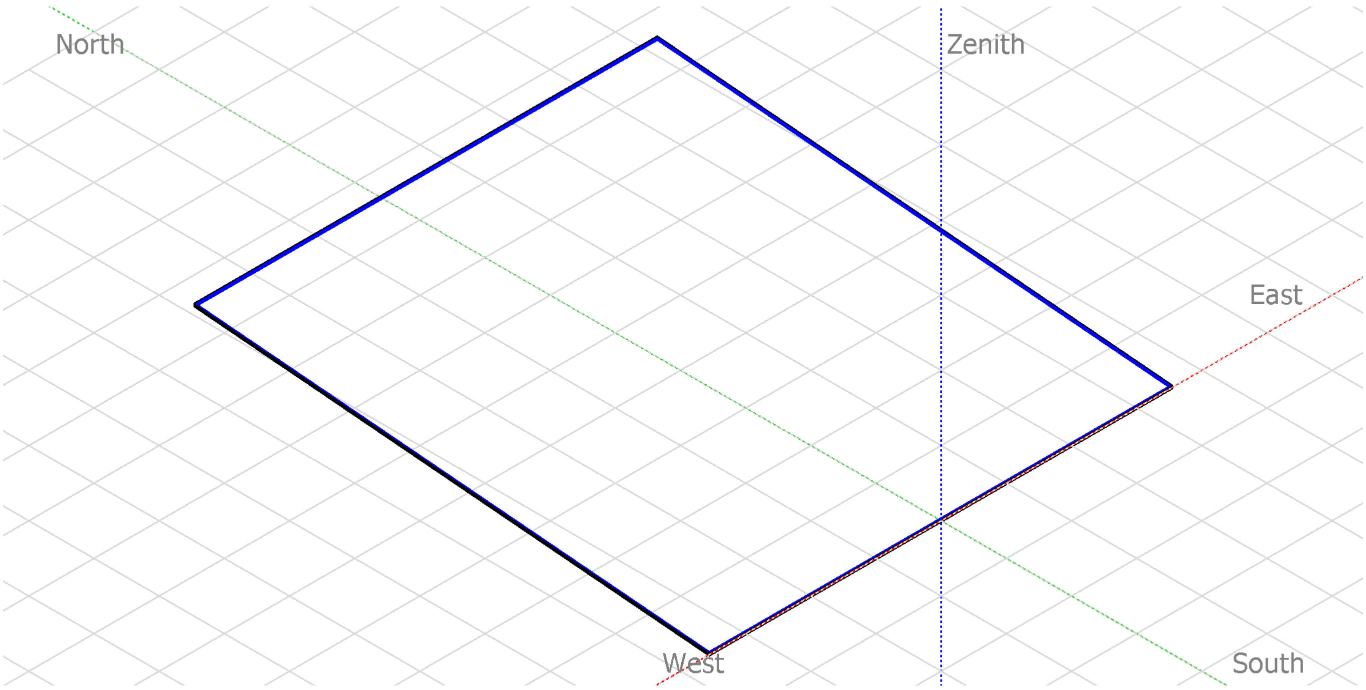
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

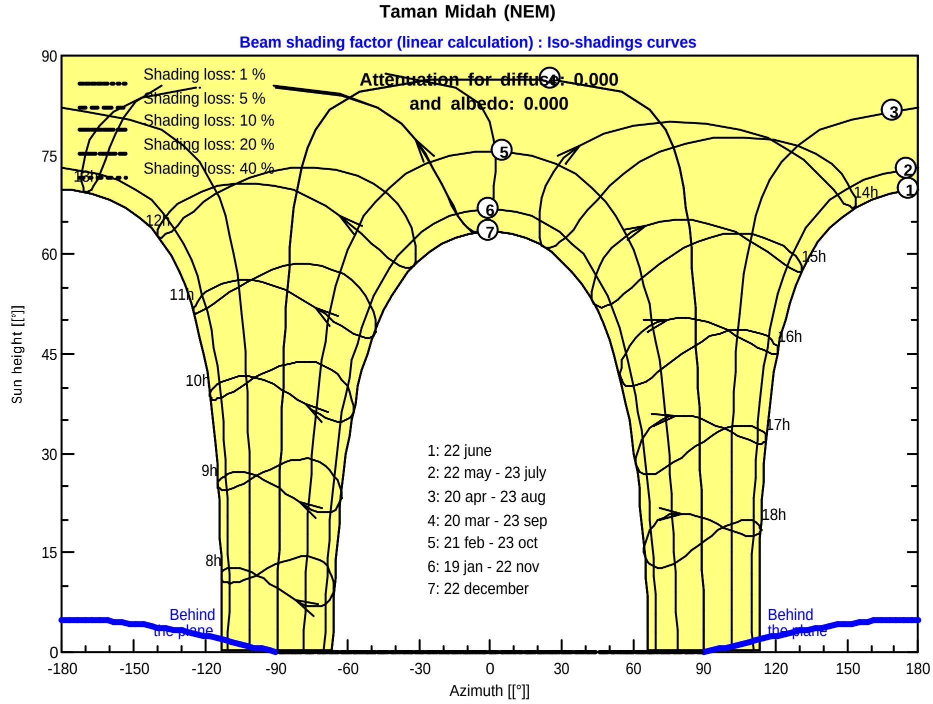
Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

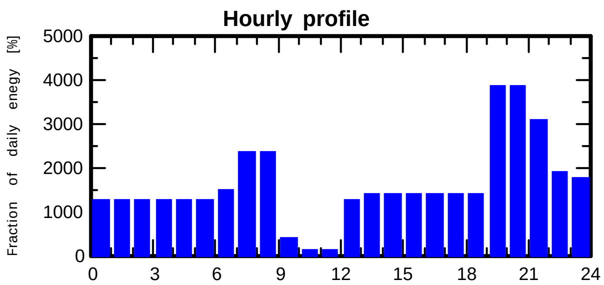
Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Daily household consumers, Constant over the year, average = 11.1 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	28	18 W/lamp	6 h/day	3024 Wh/day
TV / PC / Mobile	2	70 W/app	10 h/day	1400 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		1 Wh/day	500 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	3	750 W tot	10 h/day	21375 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				38523 Wh/day



Grid-Connected System: Main results

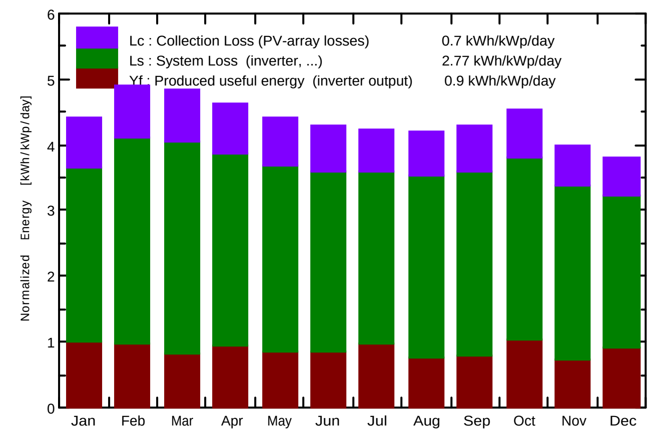
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 9kw**

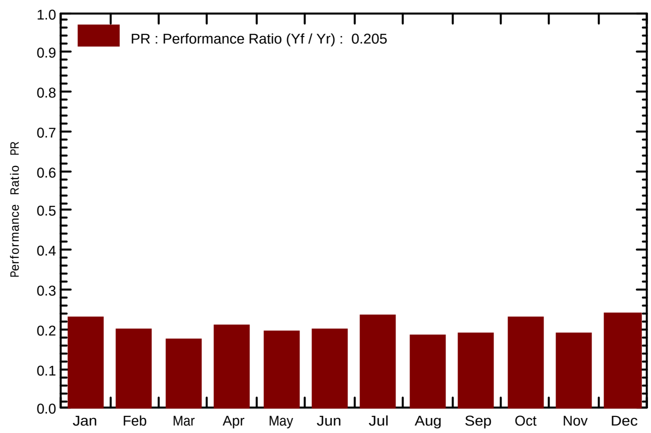
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	20.55 %	Solar Fraction SF	72.65 %
Battery ageing (State of Wear)	Cycles SOW	88.4%	Static SOW	80.0%
	Battery lifetime	5.0 years		

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



SELCO - average family - 9kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	1.016	0.385	0.278	0.646	0.107
February	134.6	67.90	27.70	137.4	132.8	1.031	0.308	0.245	0.717	0.063
March	149.8	88.20	28.00	150.3	144.9	1.125	0.308	0.235	0.816	0.074
April	140.3	70.50	27.70	138.8	133.9	1.039	0.347	0.258	0.724	0.088
May	140.3	78.60	28.60	136.9	131.7	1.027	0.347	0.238	0.698	0.109
June	132.0	77.80	27.80	128.3	123.5	0.967	0.308	0.230	0.663	0.078
July	134.4	87.20	27.80	131.1	125.8	0.994	0.385	0.276	0.657	0.109
August	132.2	87.20	27.80	130.1	125.2	0.980	0.308	0.217	0.671	0.091
September	129.2	79.00	27.10	128.8	124.0	0.968	0.308	0.217	0.678	0.091
October	138.8	82.60	27.40	140.4	135.5	1.056	0.385	0.288	0.691	0.098
November	117.6	79.20	26.70	119.8	115.4	0.907	0.308	0.202	0.636	0.106
December	115.0	73.20	26.29	118.1	113.6	0.896	0.347	0.254	0.581	0.092
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	4.045	2.938	8.178	1.106

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

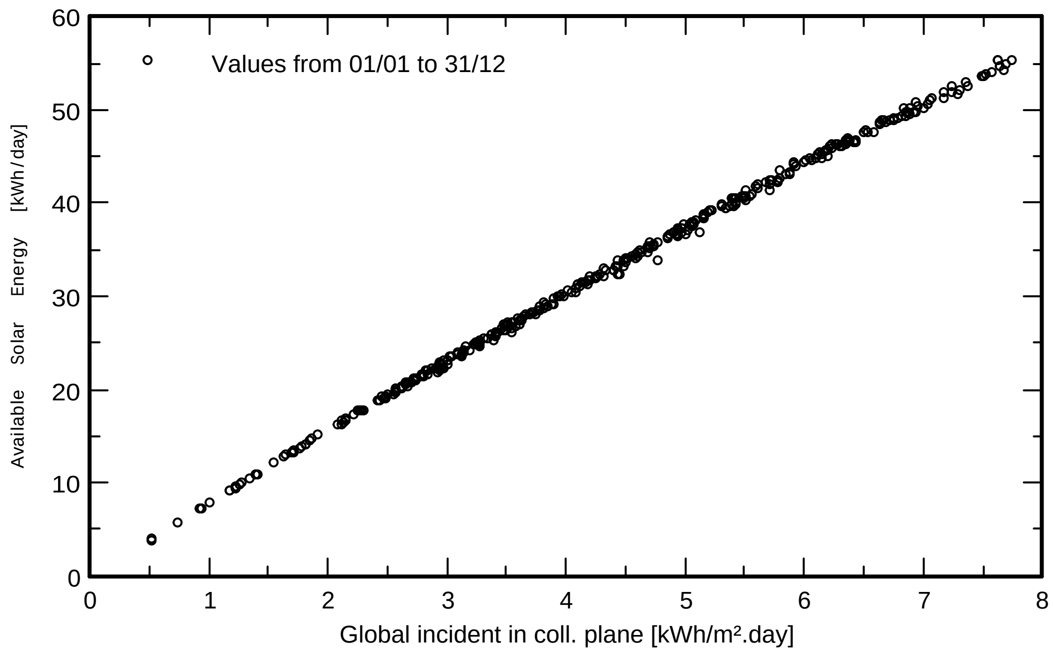
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

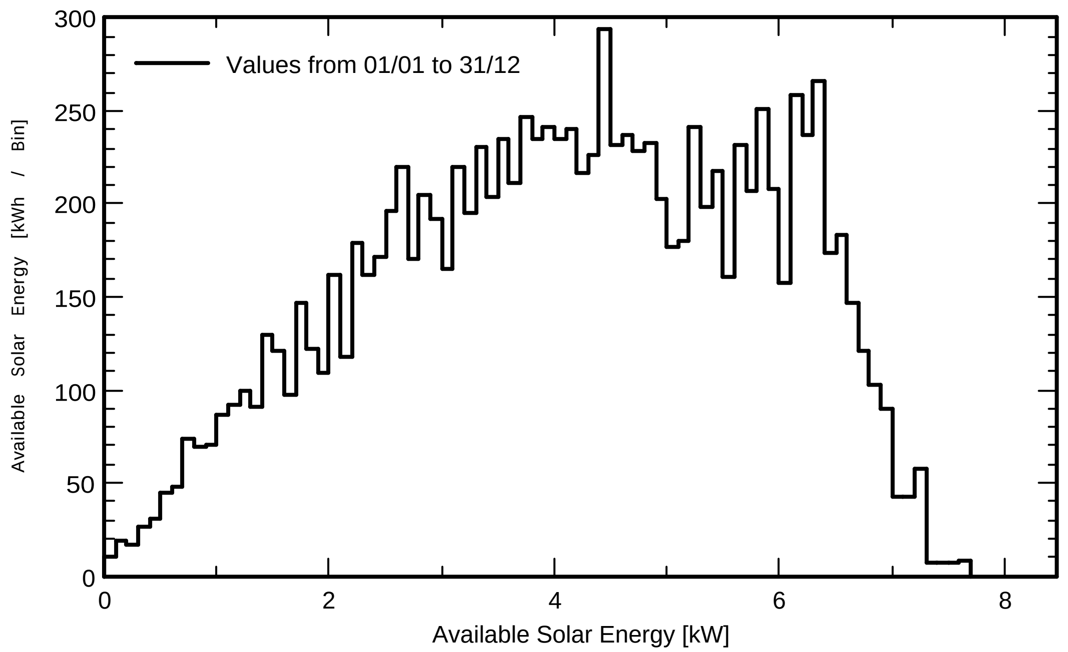
Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Daily Input/Output diagram



System Output Power Distribution



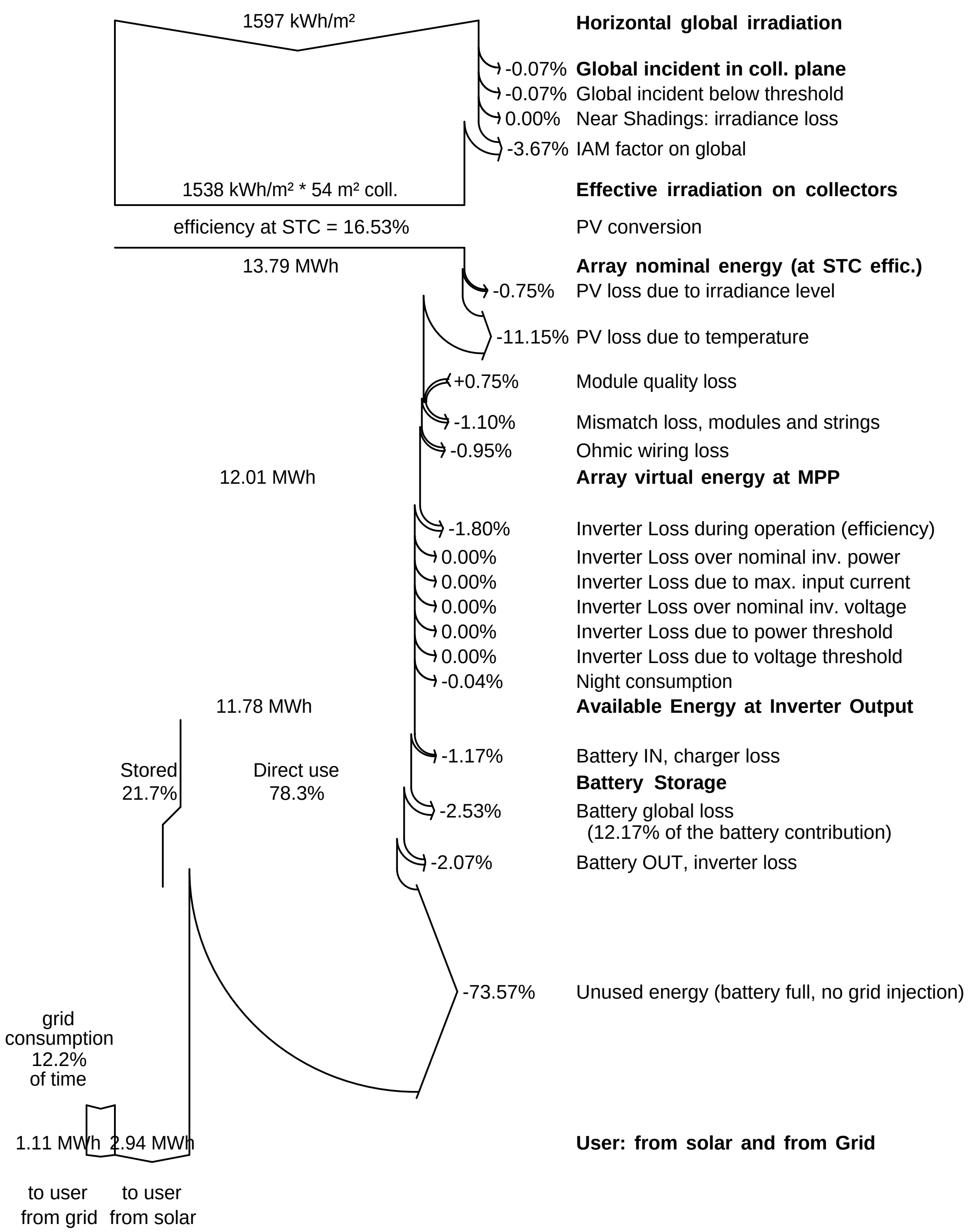
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - average family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4045 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

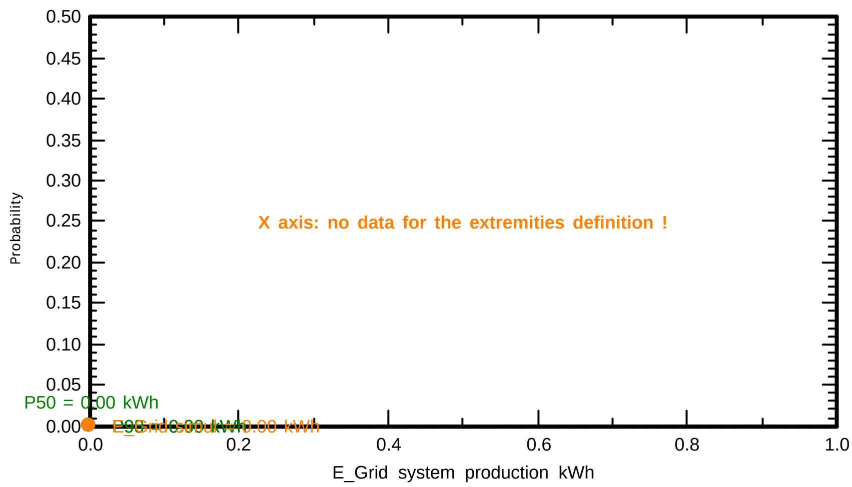
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - big family - 6kw**

Simulation date 21/04/20 15h44

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	32.6 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	5.6 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

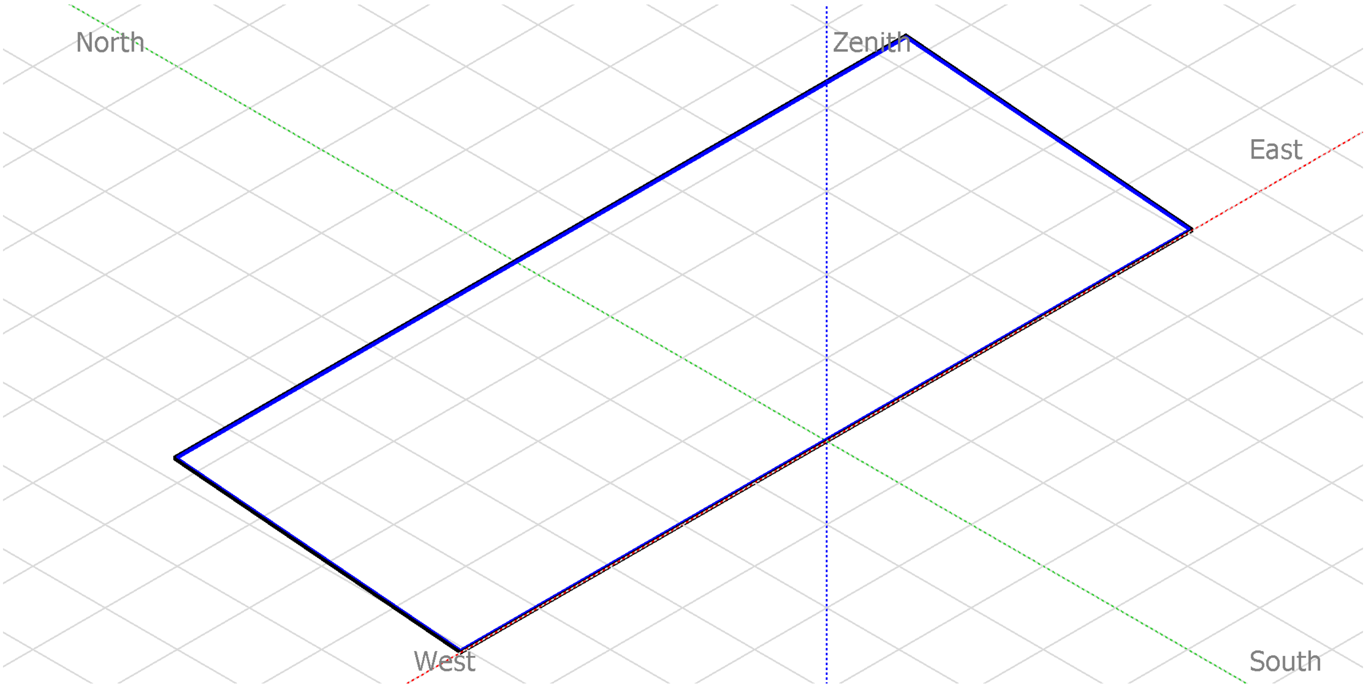
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

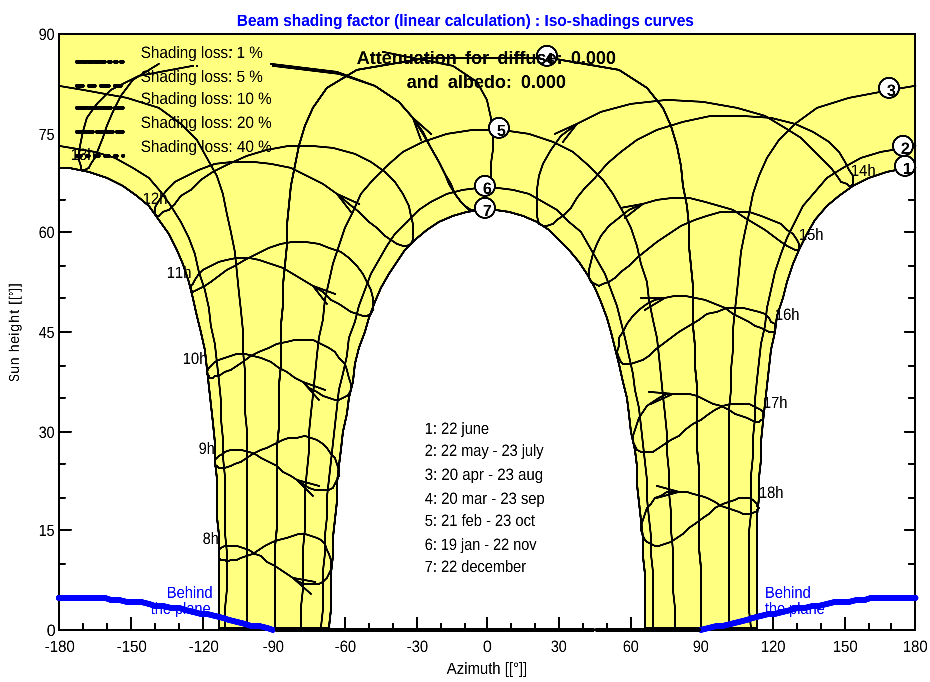
Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

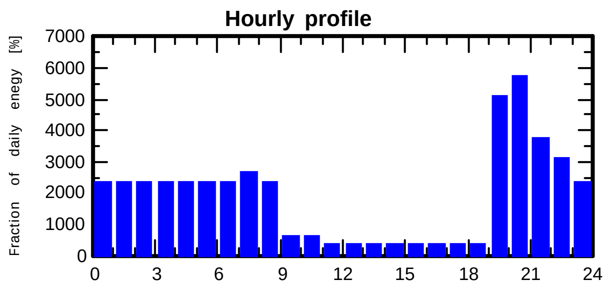
Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Daily household consumers, Constant over the year, average = 32.6 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	5 h/day	2700 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	750 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	6	750 W tot	6 h/day	27000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				45614 Wh/day



Grid-Connected System: Main results

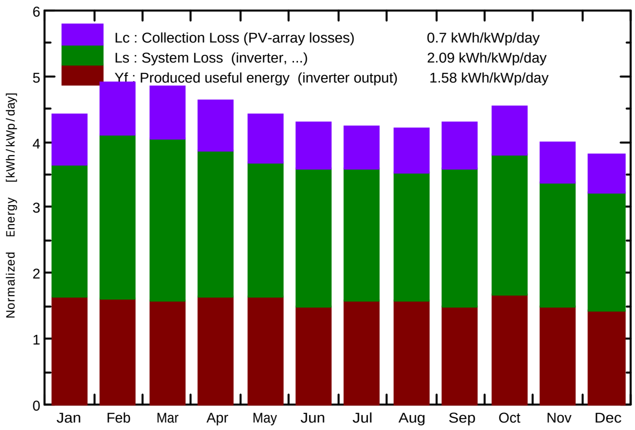
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 6kw**

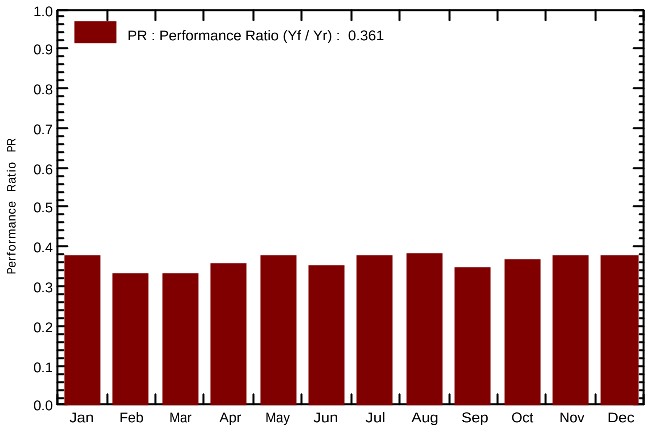
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	36.09 %	Solar Fraction SF	30.97 %
Battery ageing (State of Wear)	Cycles SOW	80.8%	Static SOW	80.0%
	Battery lifetime	5.0 years		

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



SELCO - big family - 6kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	1.049	0.326	0.332	0.723
February	134.6	67.90	27.70	137.4	132.8	0.737	0.912	0.290	0.386	0.622
March	149.8	88.20	28.00	150.3	144.9	0.804	1.004	0.317	0.411	0.686
April	140.3	70.50	27.70	138.8	133.9	0.742	0.958	0.315	0.371	0.643
May	140.3	78.60	28.60	136.9	131.7	0.734	1.049	0.329	0.336	0.720
June	132.0	77.80	27.80	128.3	123.5	0.691	0.958	0.288	0.332	0.670
July	134.4	87.20	27.80	131.1	125.8	0.710	1.004	0.315	0.340	0.689
August	132.2	87.20	27.80	130.1	125.2	0.700	1.049	0.316	0.316	0.733
September	129.2	79.00	27.10	128.8	124.0	0.691	0.912	0.285	0.334	0.627
October	138.8	82.60	27.40	140.4	135.5	0.754	1.049	0.331	0.365	0.718
November	117.6	79.20	26.70	119.8	115.4	0.648	1.004	0.290	0.297	0.714
December	115.0	73.20	26.29	118.1	113.6	0.640	0.958	0.284	0.295	0.674
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	11.905	3.687	4.115	8.219

Legends:				
GlobHor	Horizontal global irradiation		GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation		EArray	Effective energy at the output of the array
T_Amb	T amb.		E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane		E_Solar	Energy from the sun
			EUnused	Unused energy (battery full, no grid injection)
			EFrGrid	Energy from the grid

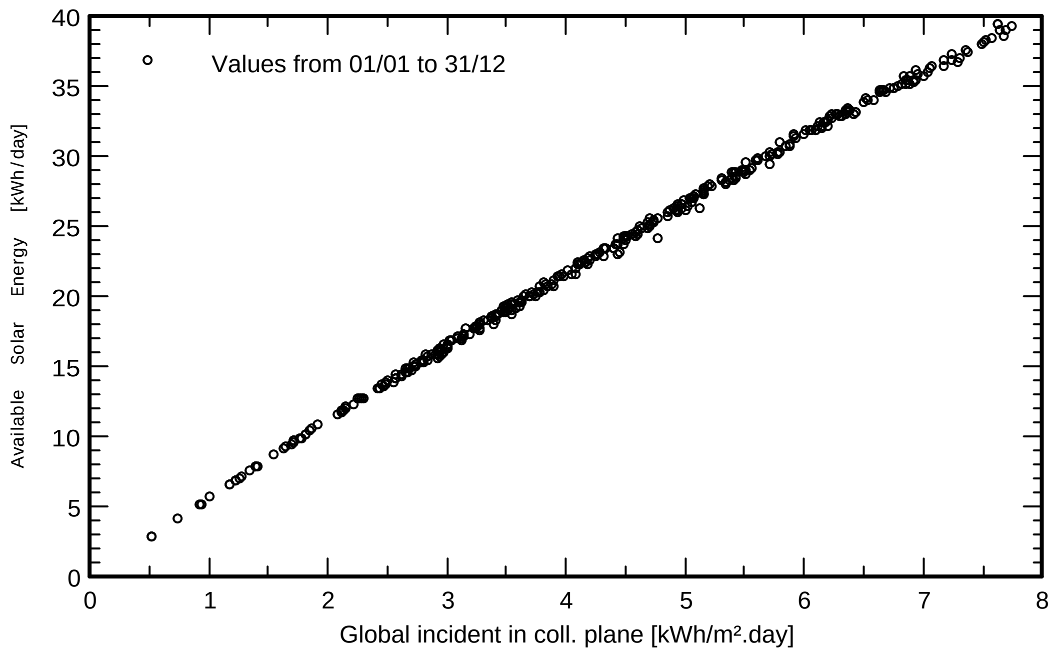
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

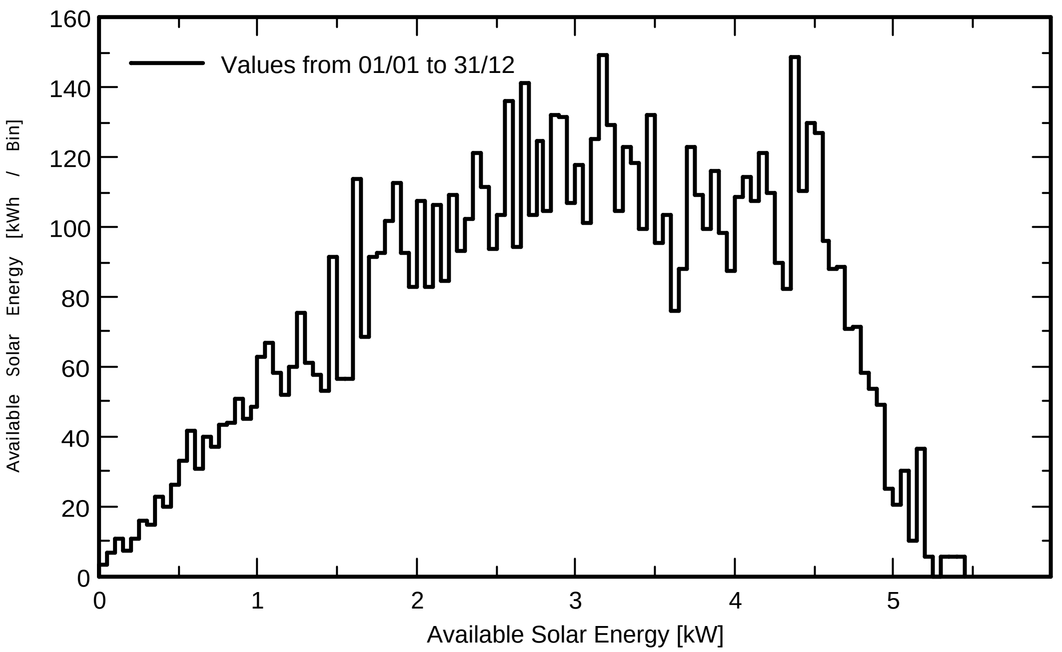
Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Daily Input/Output diagram



System Output Power Distribution



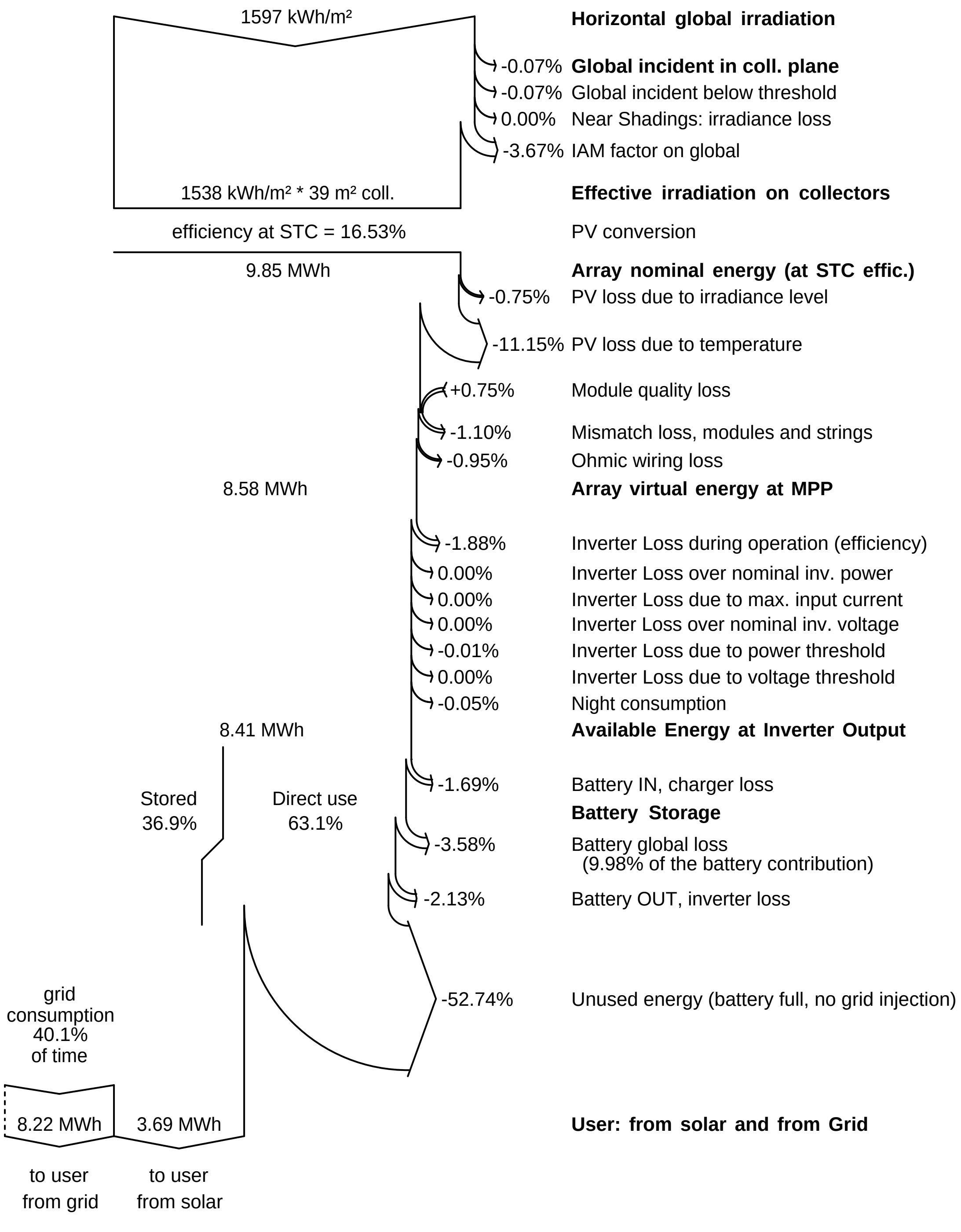
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

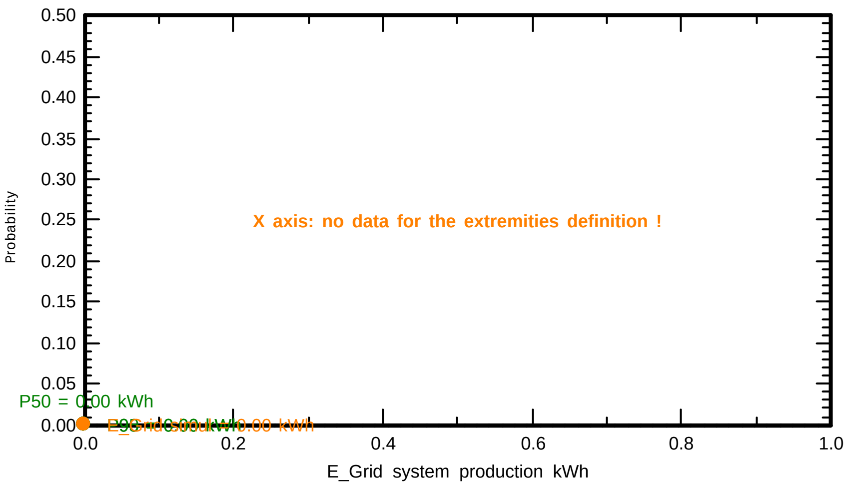
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - big family - 6kw**

Simulation date 21/04/20 15h45

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	15.7 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	5.6 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

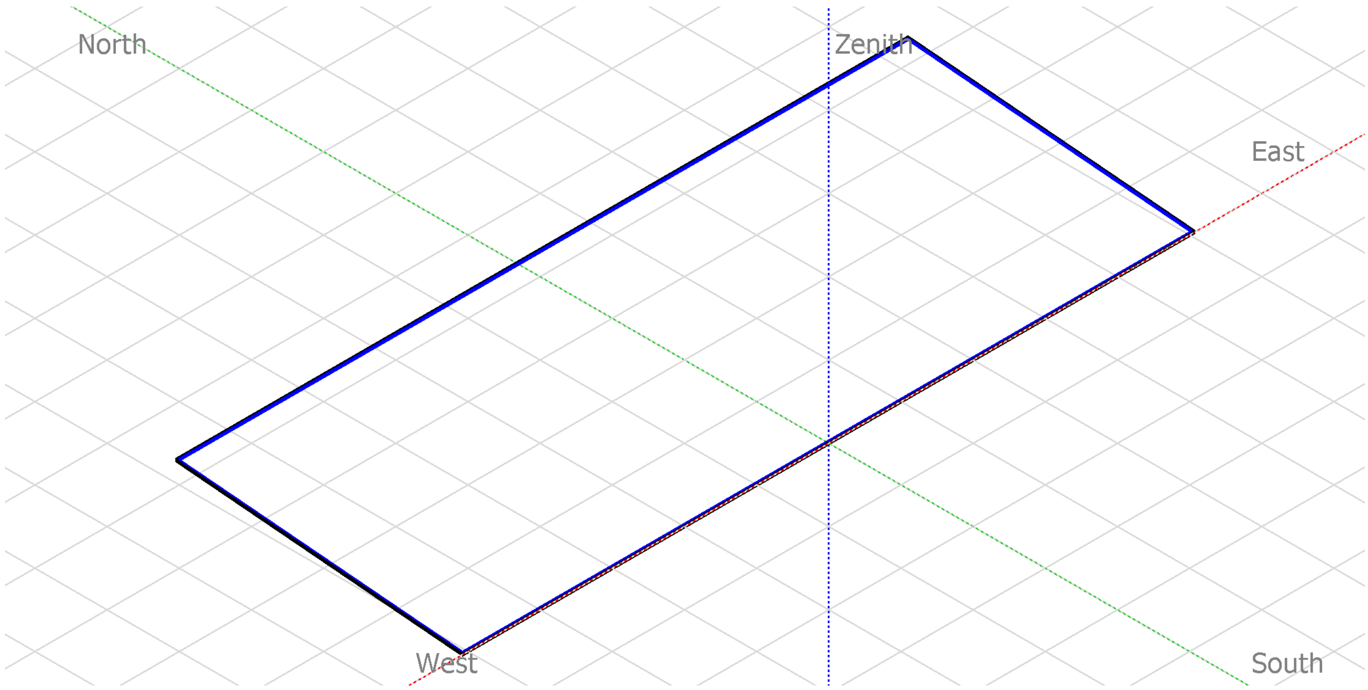
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

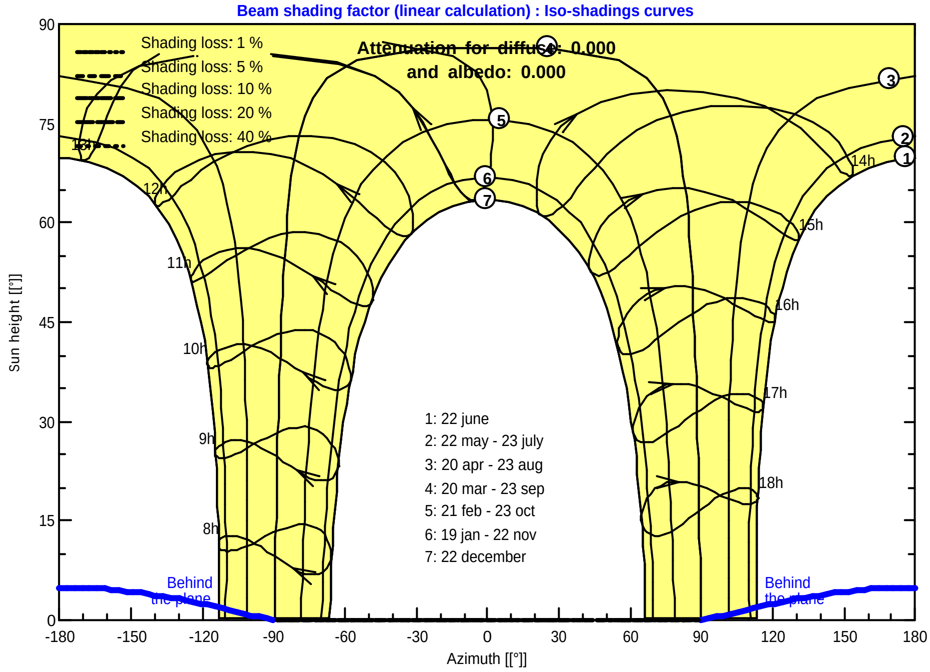
Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram

Taman Midah (NEM)

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



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

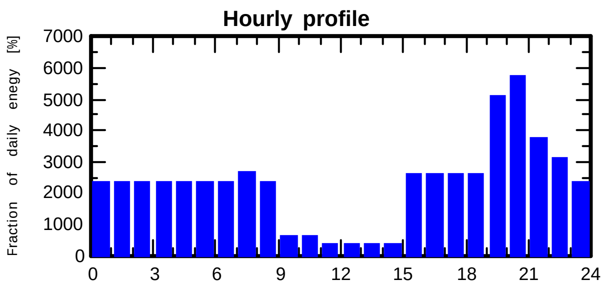
Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Daily household consumers, Constant over the year, average = 15.7 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	5 h/day	2700 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	750 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	6	750 W tot	8 h/day	36000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				54614 Wh/day



Grid-Connected System: Main results

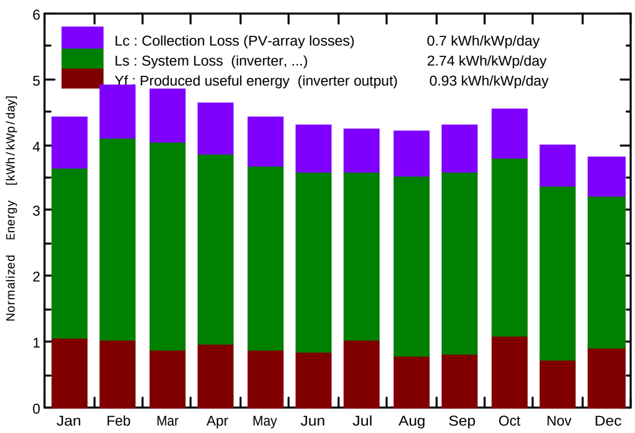
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 6kw**

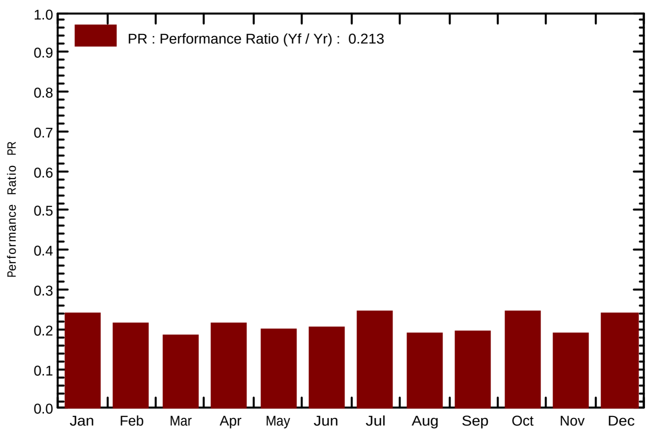
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	21.32 %	Solar Fraction SF	37.98 %
Battery ageing (State of Wear)	Cycles SOW	87.3%	Static SOW	80.0%
	Battery lifetime	5.0 years		

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



SELCO - big family - 6kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.546	0.211	0.450	0.335
February	134.6	67.90	27.70	137.4	132.8	0.737	0.437	0.187	0.498	0.250
March	149.8	88.20	28.00	150.3	144.9	0.804	0.437	0.177	0.570	0.260
April	140.3	70.50	27.70	138.8	133.9	0.742	0.492	0.191	0.507	0.301
May	140.3	78.60	28.60	136.9	131.7	0.734	0.492	0.176	0.492	0.316
June	132.0	77.80	27.80	128.3	123.5	0.691	0.437	0.167	0.468	0.270
July	134.4	87.20	27.80	131.1	125.8	0.710	0.546	0.205	0.458	0.342
August	132.2	87.20	27.80	130.1	125.2	0.700	0.437	0.157	0.477	0.280
September	129.2	79.00	27.10	128.8	124.0	0.691	0.437	0.162	0.477	0.275
October	138.8	82.60	27.40	140.4	135.5	0.754	0.546	0.221	0.474	0.325
November	117.6	79.20	26.70	119.8	115.4	0.648	0.437	0.143	0.452	0.294
December	115.0	73.20	26.29	118.1	113.6	0.640	0.492	0.182	0.412	0.310
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	5.734	2.178	5.738	3.556

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

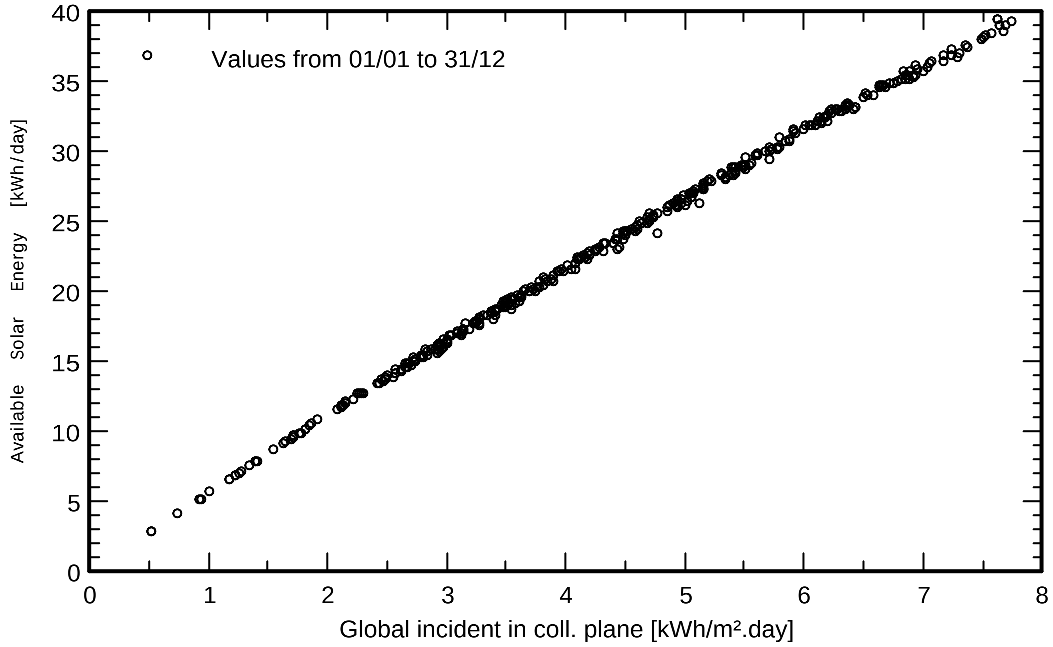
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

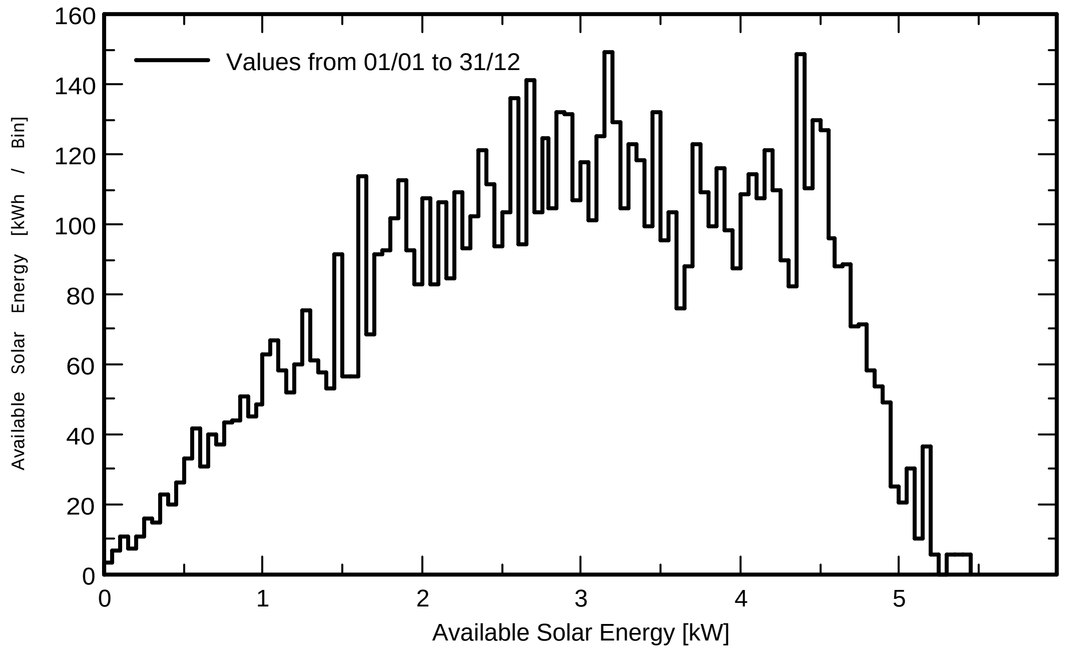
Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Daily Input/Output diagram



System Output Power Distribution



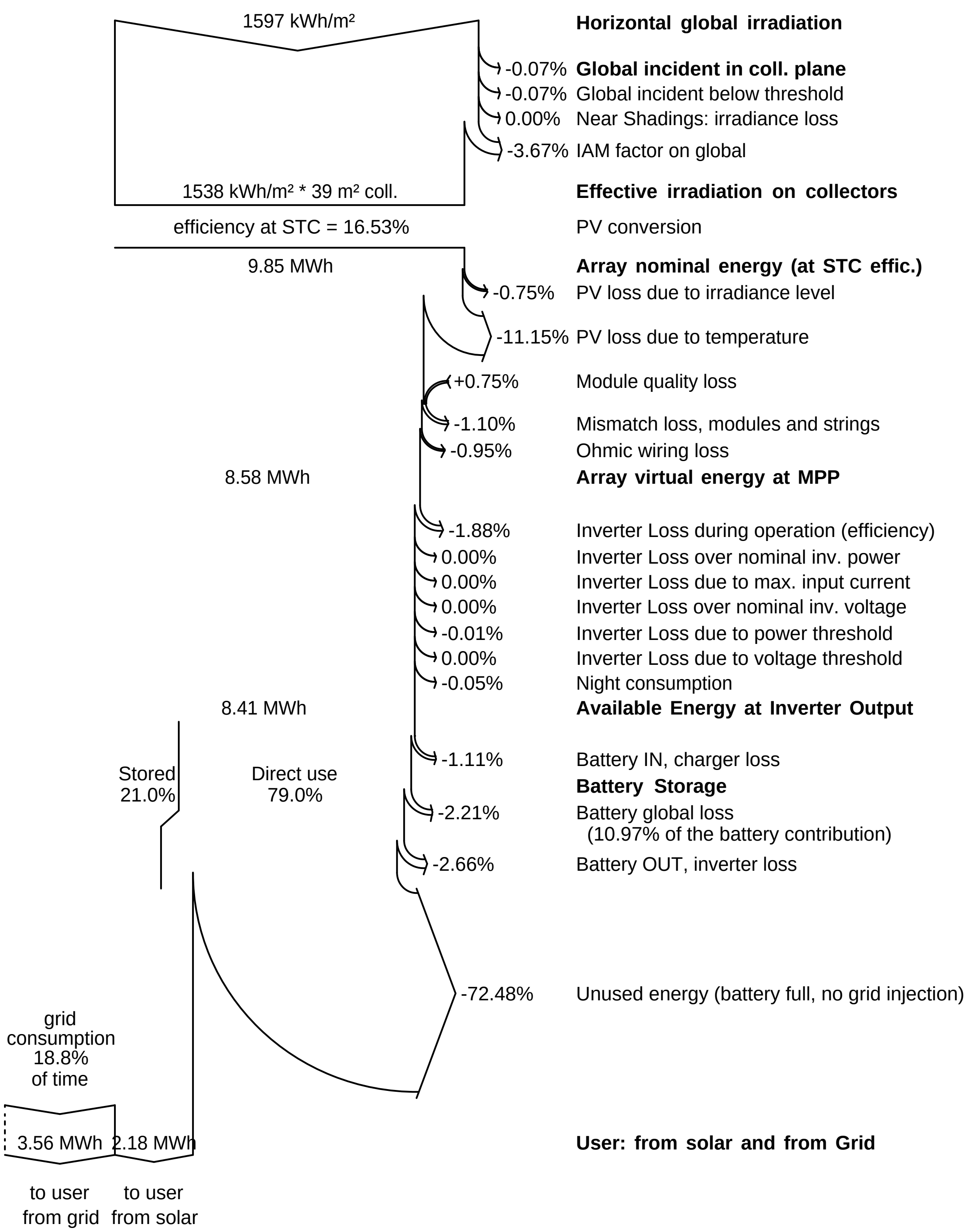
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 6kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

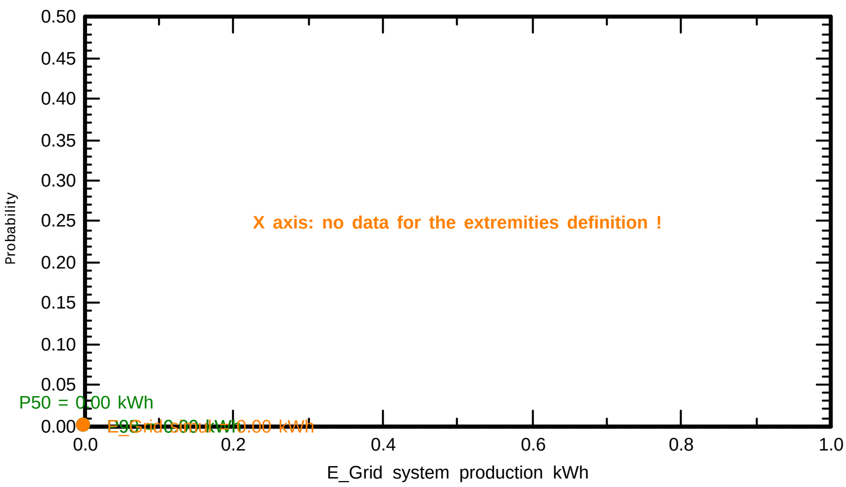
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **SELCO - big family - 9kw**

Simulation date 21/04/20 15h47

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	32.6 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	3 in series x 4 in parallel		
	Voltage	36 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	14.1 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	7.5 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	5.6 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

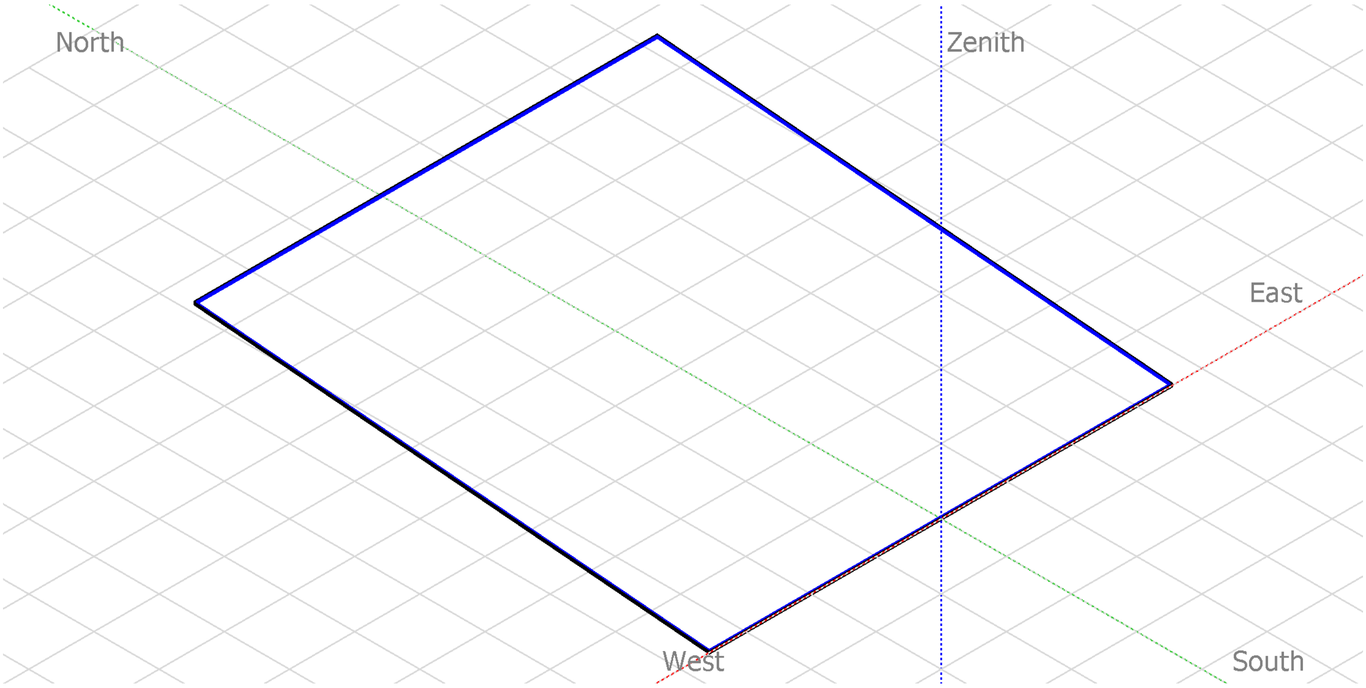
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

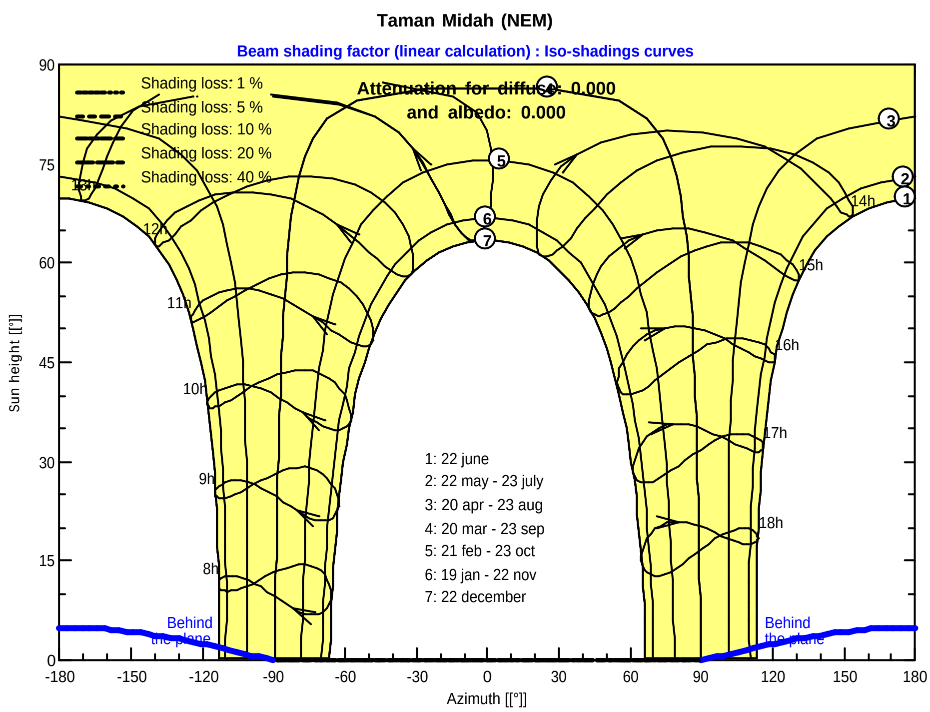
Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

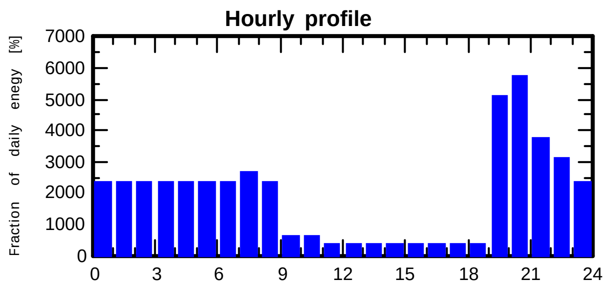
Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Daily household consumers, Constant over the year, average = 32.6 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	5 h/day	2700 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	750 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	6	750 W tot	6 h/day	27000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				45614 Wh/day



Grid-Connected System: Main results

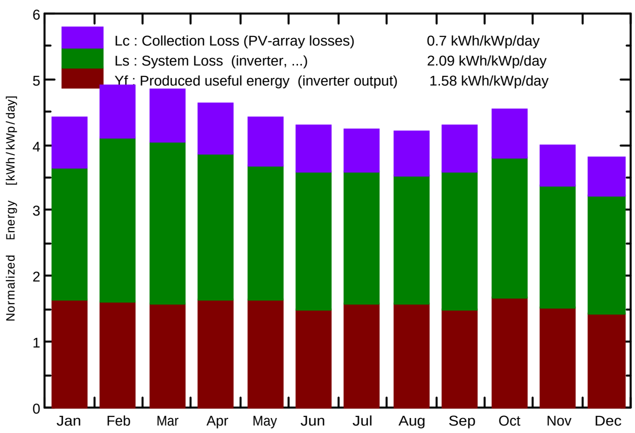
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 9kw**

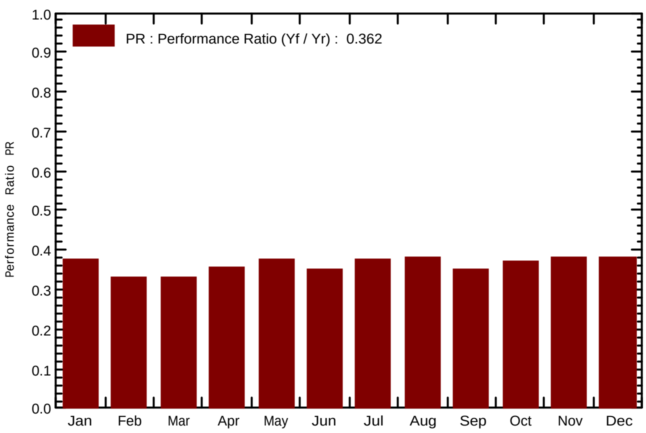
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	36.24 %	Solar Fraction SF	43.54 %
Battery ageing (State of Wear)	Cycles SOW	80.0%	Static SOW	80.0%
	Battery lifetime	5.0 years		

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



SELCO - big family - 9kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	1.016	1.049	0.458	0.465	0.591
February	134.6	67.90	27.70	137.4	132.8	1.031	0.912	0.408	0.543	0.505
March	149.8	88.20	28.00	150.3	144.9	1.125	1.004	0.445	0.575	0.559
April	140.3	70.50	27.70	138.8	133.9	1.039	0.958	0.444	0.521	0.514
May	140.3	78.60	28.60	136.9	131.7	1.027	1.049	0.461	0.472	0.588
June	132.0	77.80	27.80	128.3	123.5	0.967	0.958	0.404	0.464	0.554
July	134.4	87.20	27.80	131.1	125.8	0.994	1.004	0.442	0.477	0.561
August	132.2	87.20	27.80	130.1	125.2	0.980	1.049	0.443	0.446	0.606
September	129.2	79.00	27.10	128.8	124.0	0.968	0.912	0.402	0.465	0.510
October	138.8	82.60	27.40	140.4	135.5	1.056	1.049	0.466	0.512	0.583
November	117.6	79.20	26.70	119.8	115.4	0.907	1.004	0.409	0.415	0.595
December	115.0	73.20	26.29	118.1	113.6	0.896	0.958	0.401	0.411	0.557
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	11.905	5.184	5.765	6.722

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

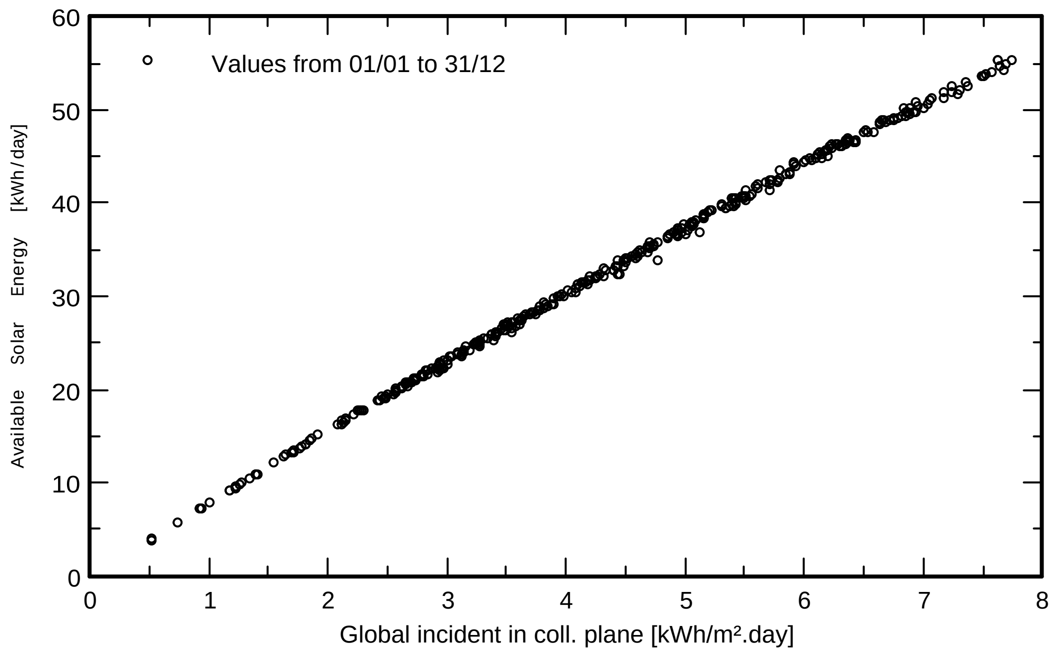
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

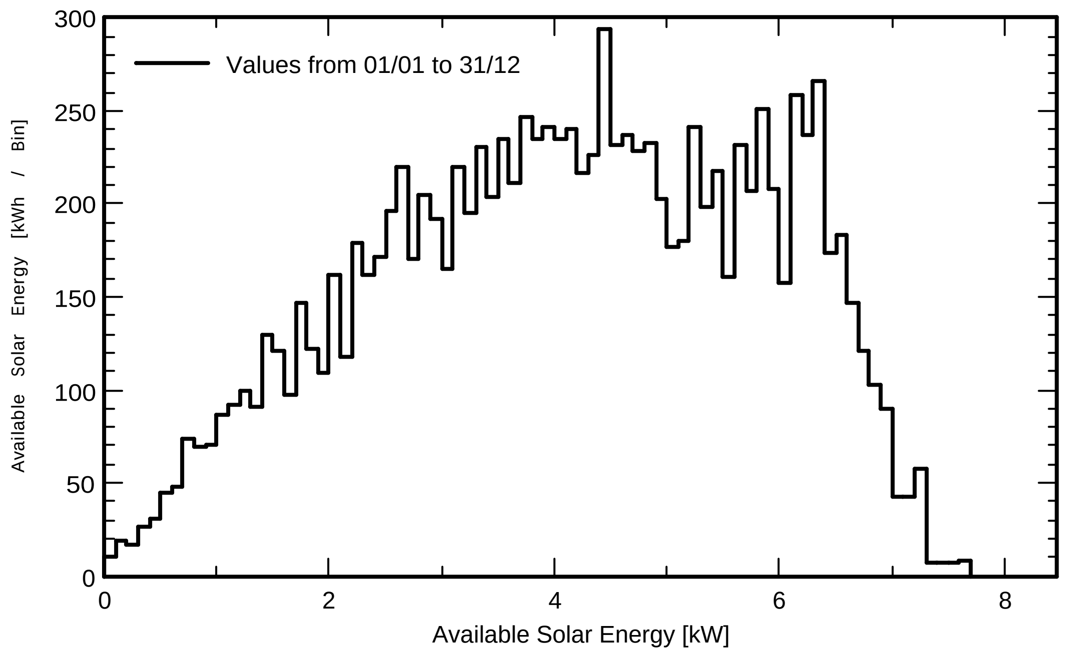
Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Daily Input/Output diagram



System Output Power Distribution



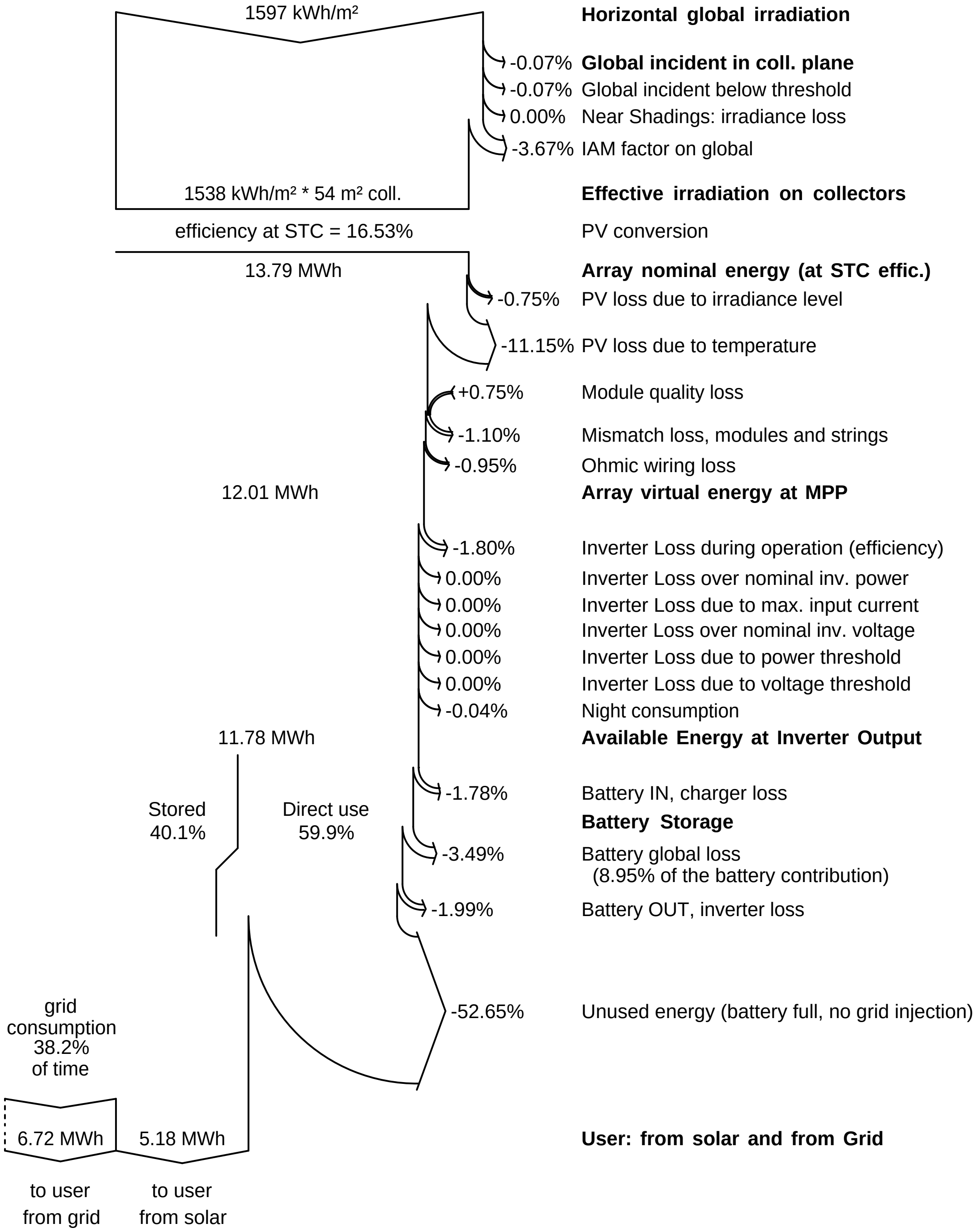
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.91 MWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

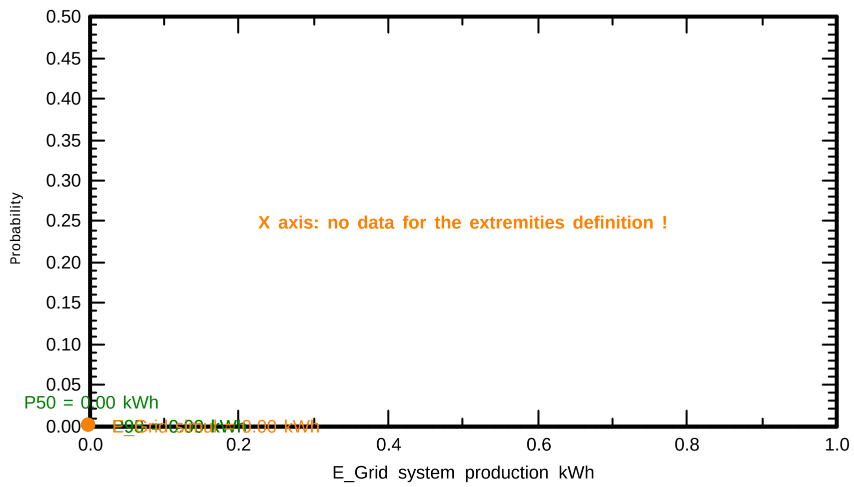
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : SELCO - big family - 9kw

Simulation date 21/04/20 15h48

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	15.7 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	3 in series x 4 in parallel		
	Voltage	36 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	14.1 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	7.5 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	5.6 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

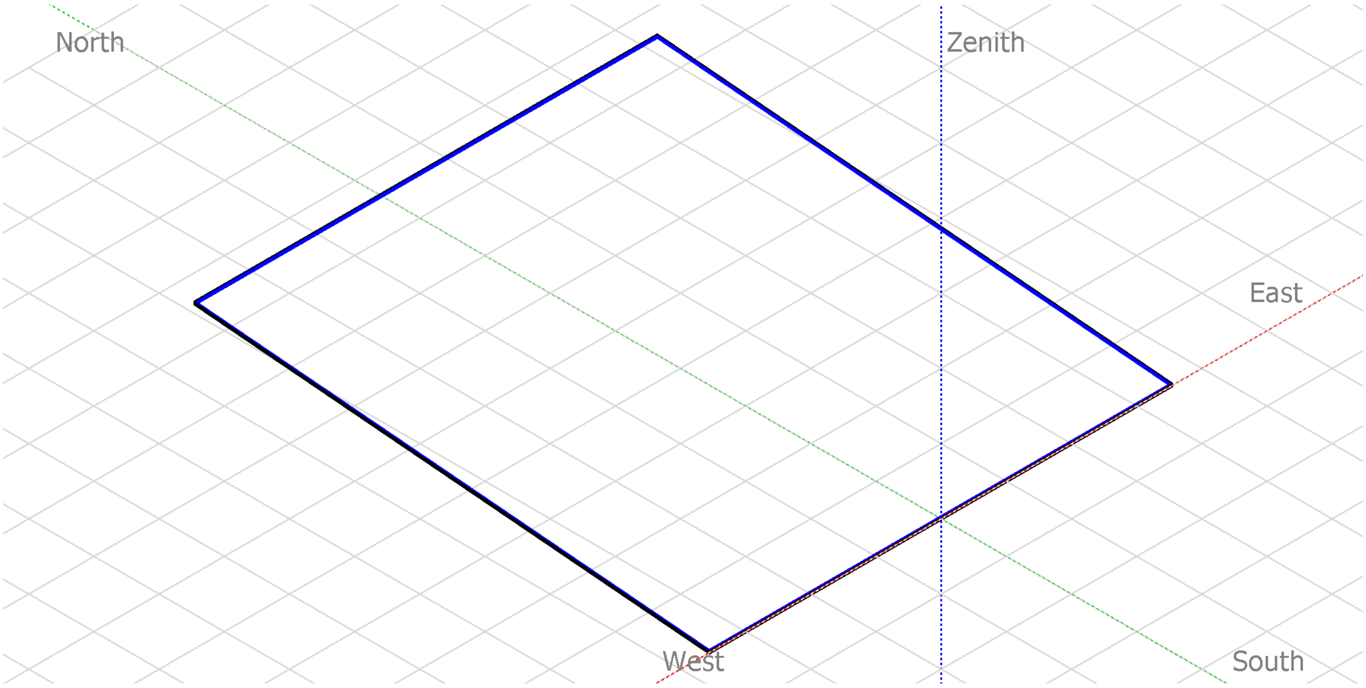
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

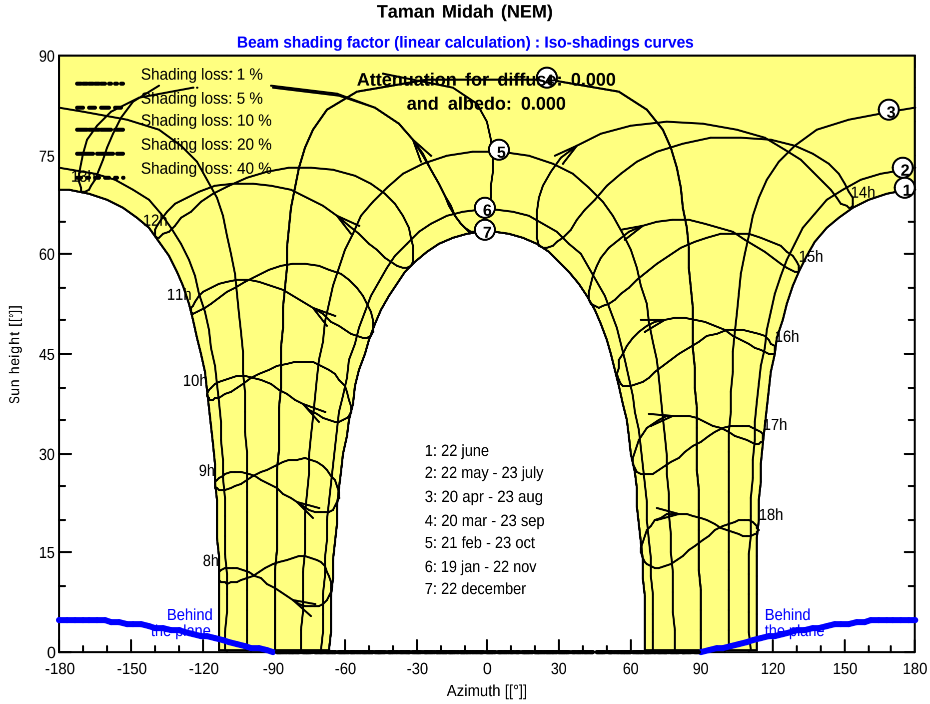
Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

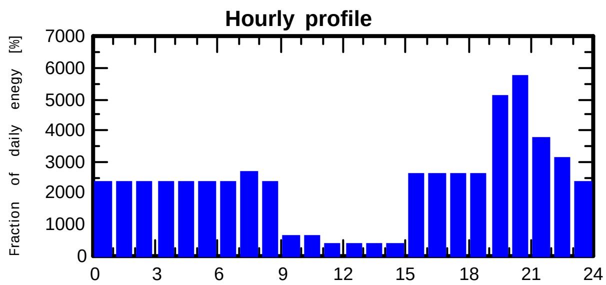
Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Daily household consumers, Constant over the year, average = 15.7 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	5 h/day	2700 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	750 Wh/day
Instant water heater	2	2000 W tot	2 h/day	8000 Wh/day
Aircond	6	750 W tot	8 h/day	36000 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				54614 Wh/day



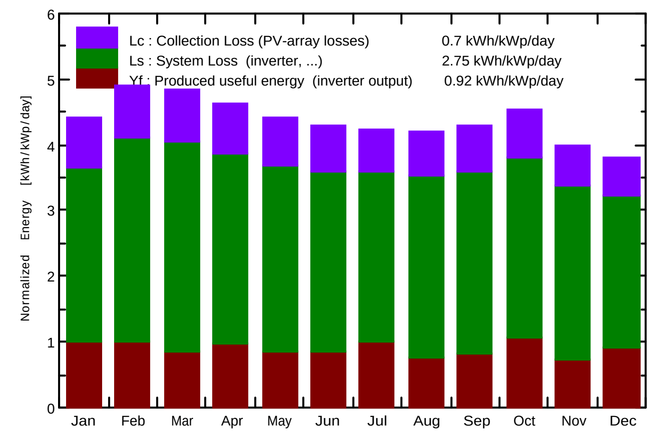
Grid-Connected System: Main results

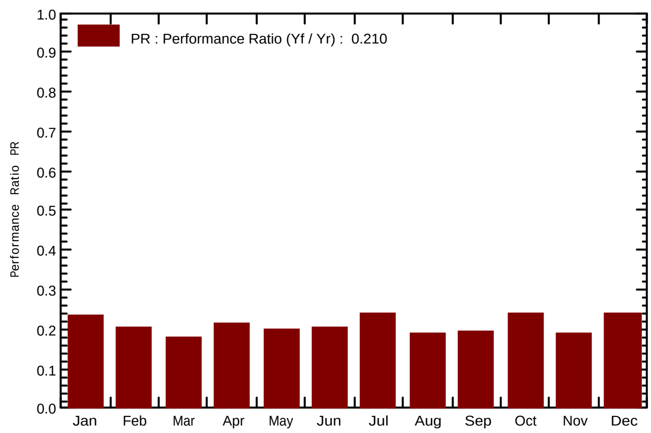
Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	21.02 %	Solar Fraction SF	52.43 %
Battery ageing (State of Wear)	Cycles SOW	87.8%	Static SOW	80.0%
	Battery lifetime	5.0 years		





SELCO - big family - 9kw

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	1.016	0.546	0.285	0.640	0.261
February	134.6	67.90	27.70	137.4	132.8	1.031	0.437	0.254	0.708	0.183
March	149.8	88.20	28.00	150.3	144.9	1.125	0.437	0.242	0.807	0.194
April	140.3	70.50	27.70	138.8	133.9	1.039	0.492	0.265	0.716	0.227
May	140.3	78.60	28.60	136.9	131.7	1.027	0.492	0.243	0.692	0.249
June	132.0	77.80	27.80	128.3	123.5	0.967	0.437	0.234	0.657	0.203
July	134.4	87.20	27.80	131.1	125.8	0.994	0.546	0.283	0.649	0.263
August	132.2	87.20	27.80	130.1	125.2	0.980	0.437	0.218	0.671	0.219
September	129.2	79.00	27.10	128.8	124.0	0.968	0.437	0.223	0.673	0.214
October	138.8	82.60	27.40	140.4	135.5	1.056	0.546	0.302	0.674	0.244
November	117.6	79.20	26.70	119.8	115.4	0.907	0.437	0.202	0.634	0.235
December	115.0	73.20	26.29	118.1	113.6	0.896	0.492	0.255	0.580	0.236
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	5.734	3.007	8.102	2.728

Legends:
- GlobHor: Horizontal global irradiation
- DiffHor: Horizontal diffuse irradiation
- T_Amb: T amb.
- GlobInc: Global incident in coll. plane
- GlobEff: Effective Global, corr. for IAM and shadings
- EArray: Effective energy at the output of the array
- E_User: Energy supplied to the user
- E_Solar: Energy from the sun
- EUnused: Unused energy (battery full, no grid injection)
- EFrGrid: Energy from the grid

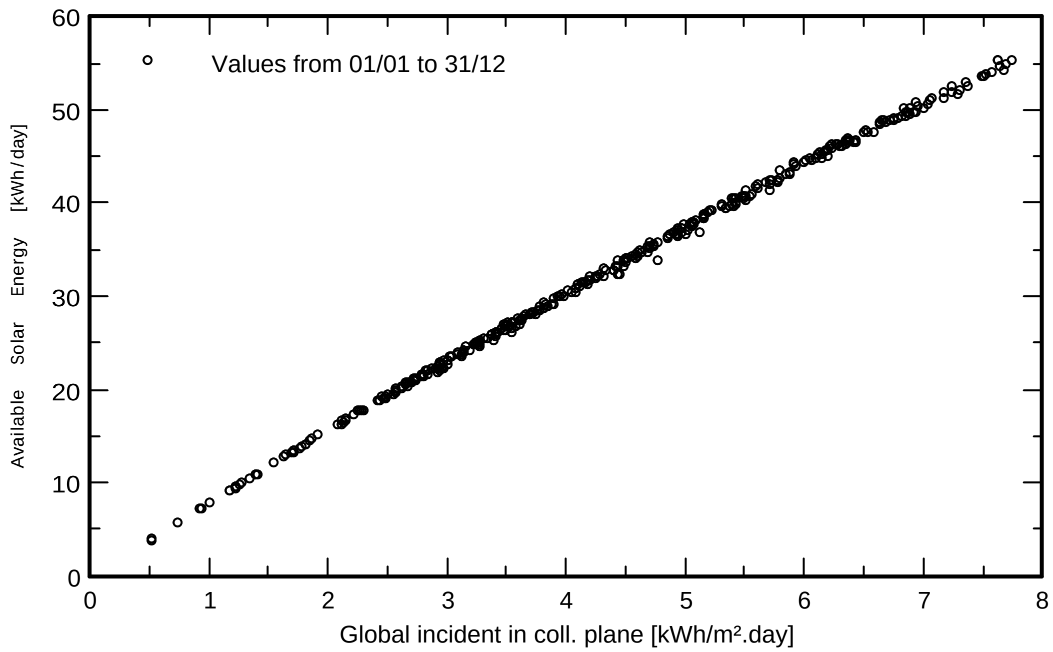
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

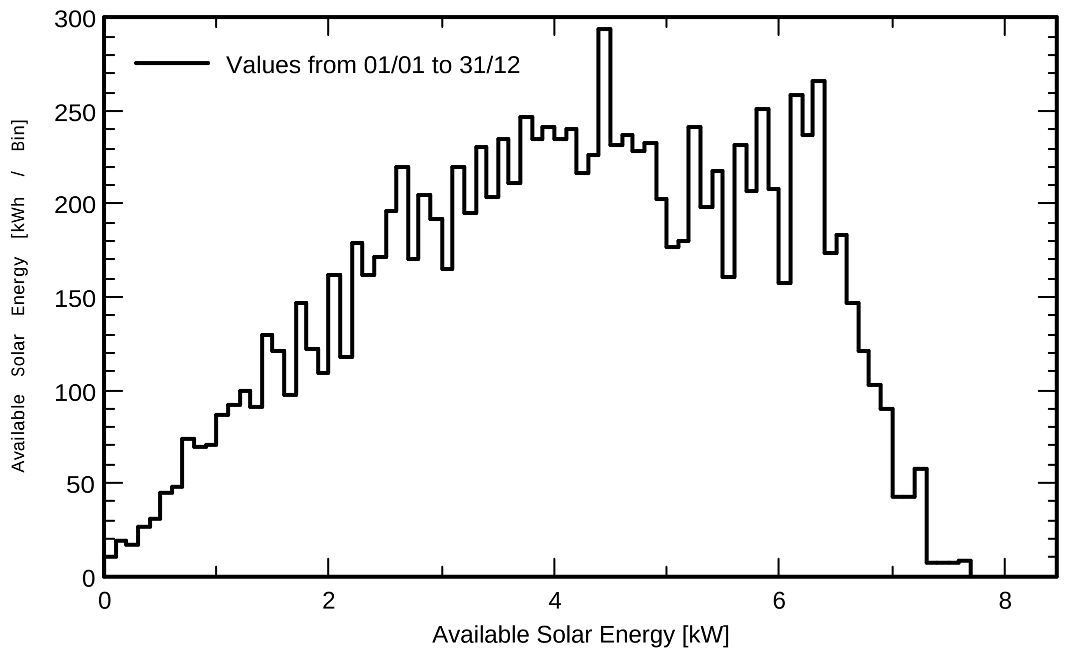
Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Daily Input/Output diagram



System Output Power Distribution



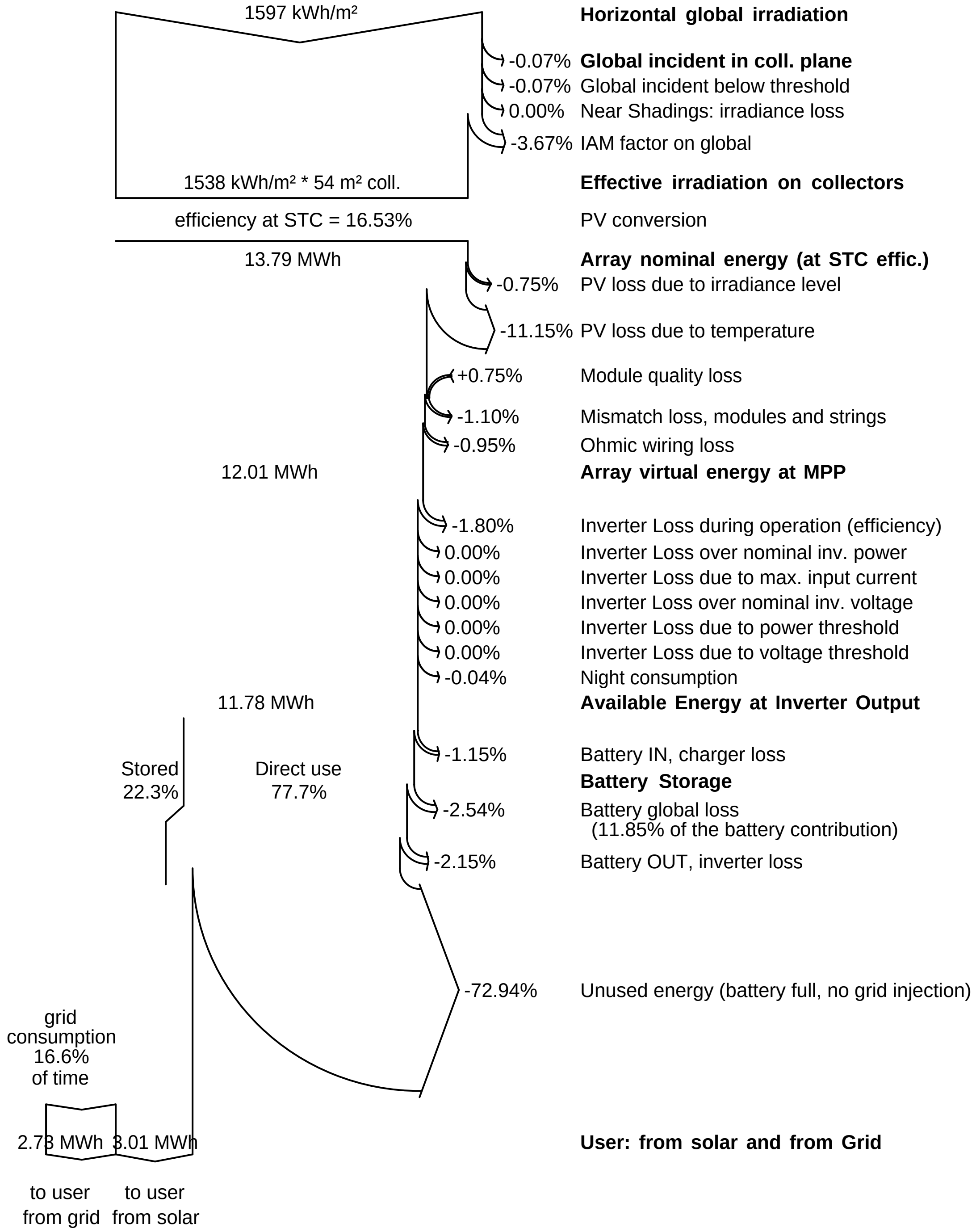
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **SELCO - big family - 9kw**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	5734 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

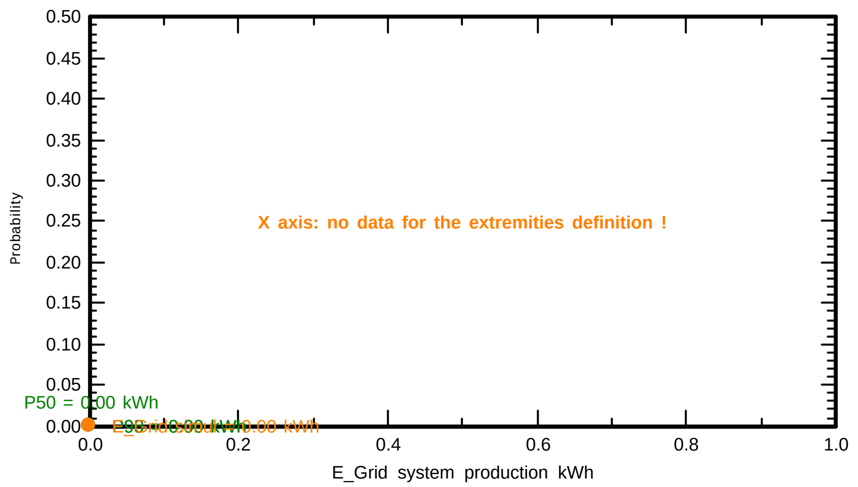
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : **Taman Midah (NEM)**

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : **Own house - SELCO 6kw inv**

Simulation date 21/04/20 14h40

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	30.4 kWh/Day		

PV Array Characteristics

PV module	Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database		Manufacturer	JA Solar		
Number of PV modules		In series	10 modules	In parallel	2 strings
Total number of PV modules		Nb. modules	20	Unit Nom. Power	320 Wp
Array global power		Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)		U mpp	336 V	I mpp	17 A
Total area		Module area	**38.8 m²**	Cell area	34.4 m²

Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	6.6 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

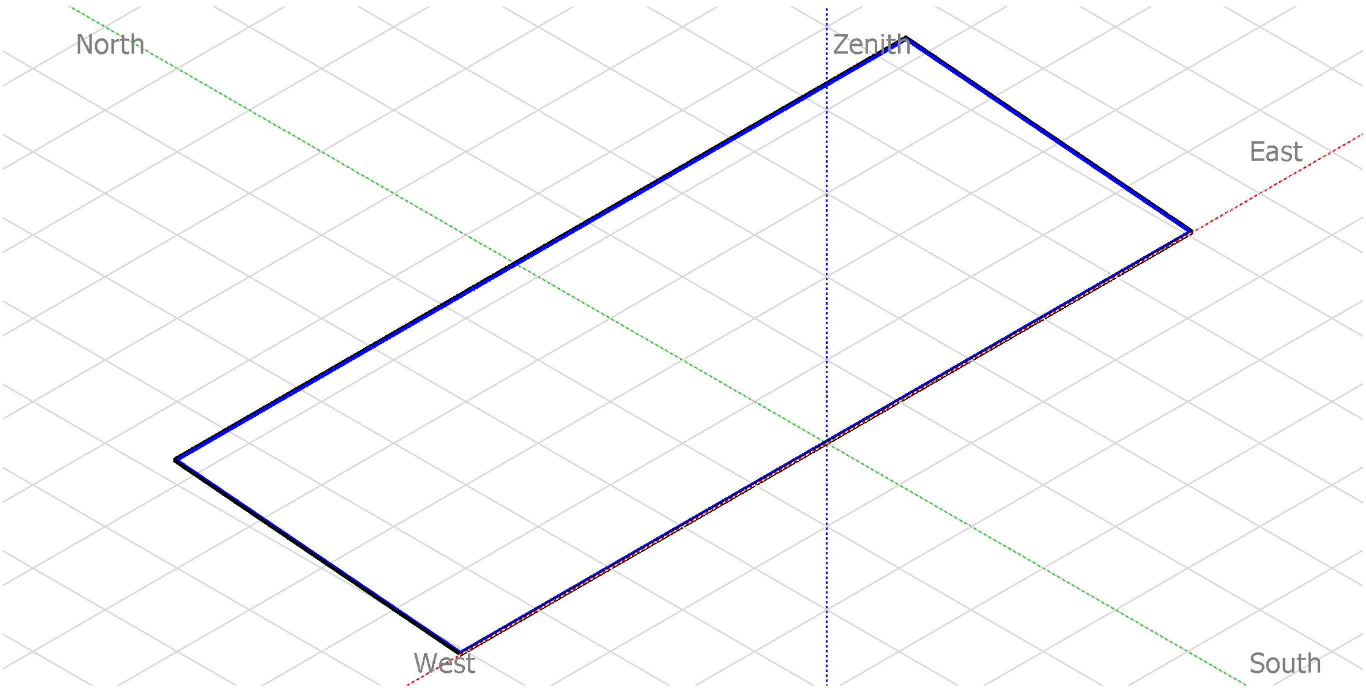
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

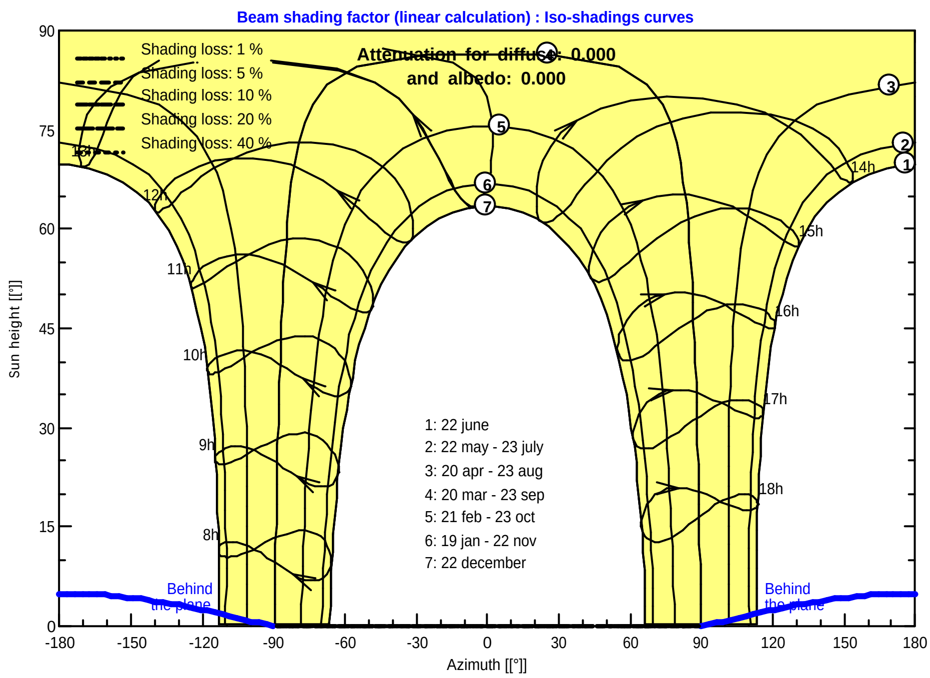
Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

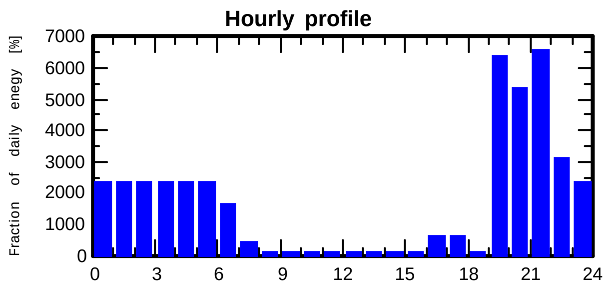
Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Daily household consumers, Constant over the year, average = 30.4 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	6 h/day	2970 Wh/day
TV / PC / Mobile	3	70 W/app	4 h/day	840 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	1000 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	6	750 W tot	7 h/day	31500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				42534 Wh/day



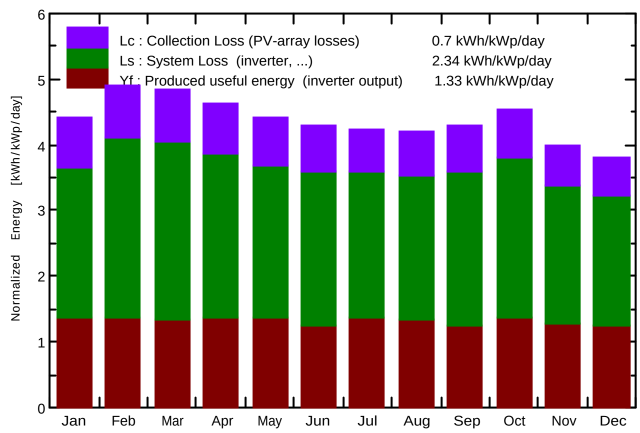
Grid-Connected System: Main results

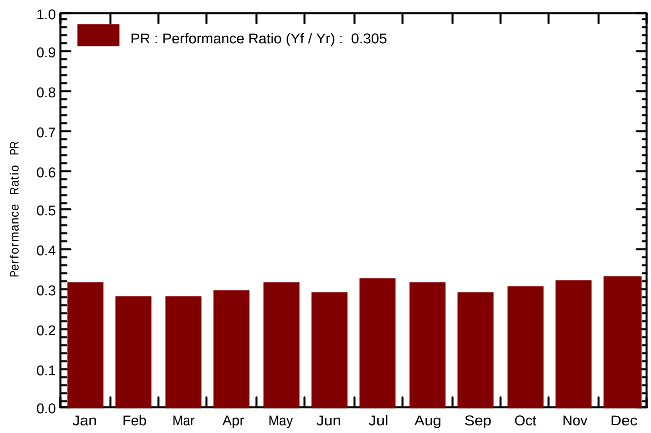
Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	30.52 %	Solar Fraction SF	28.09 %
Battery ageing (State of Wear)	Cycles SOW	81.2%	Static SOW	80.0%





Own house - SELCO 6kw inv
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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.978	0.276	0.380	0.703
February	134.6	67.90	27.70	137.4	132.8	0.737	0.851	0.248	0.424	0.603
March	149.8	88.20	28.00	150.3	144.9	0.804	0.936	0.268	0.457	0.667
April	140.3	70.50	27.70	138.8	133.9	0.742	0.893	0.264	0.418	0.629
May	140.3	78.60	28.60	136.9	131.7	0.734	0.978	0.276	0.387	0.702
June	132.0	77.80	27.80	128.3	123.5	0.691	0.893	0.240	0.376	0.653
July	134.4	87.20	27.80	131.1	125.8	0.710	0.936	0.271	0.379	0.664
August	132.2	87.20	27.80	130.1	125.2	0.700	0.978	0.264	0.367	0.714
September	129.2	79.00	27.10	128.8	124.0	0.691	0.851	0.239	0.378	0.612
October	138.8	82.60	27.40	140.4	135.5	0.754	0.978	0.276	0.417	0.702
November	117.6	79.20	26.70	119.8	115.4	0.648	0.936	0.245	0.336	0.690
December	115.0	73.20	26.29	118.1	113.6	0.640	0.893	0.248	0.324	0.645
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	11.101	3.118	4.642	7.983

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

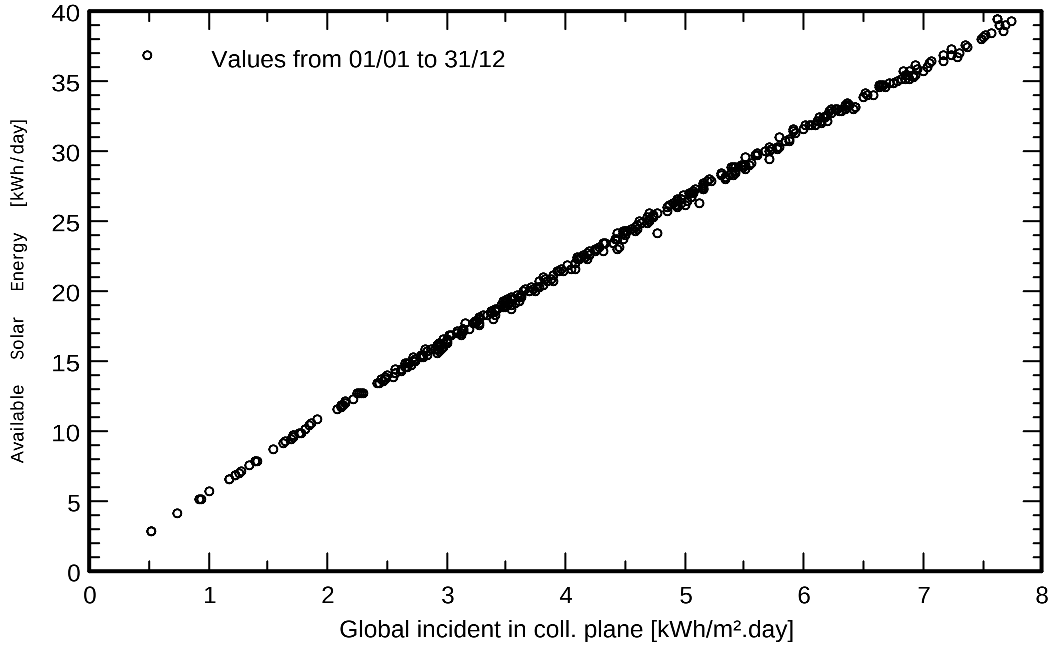
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

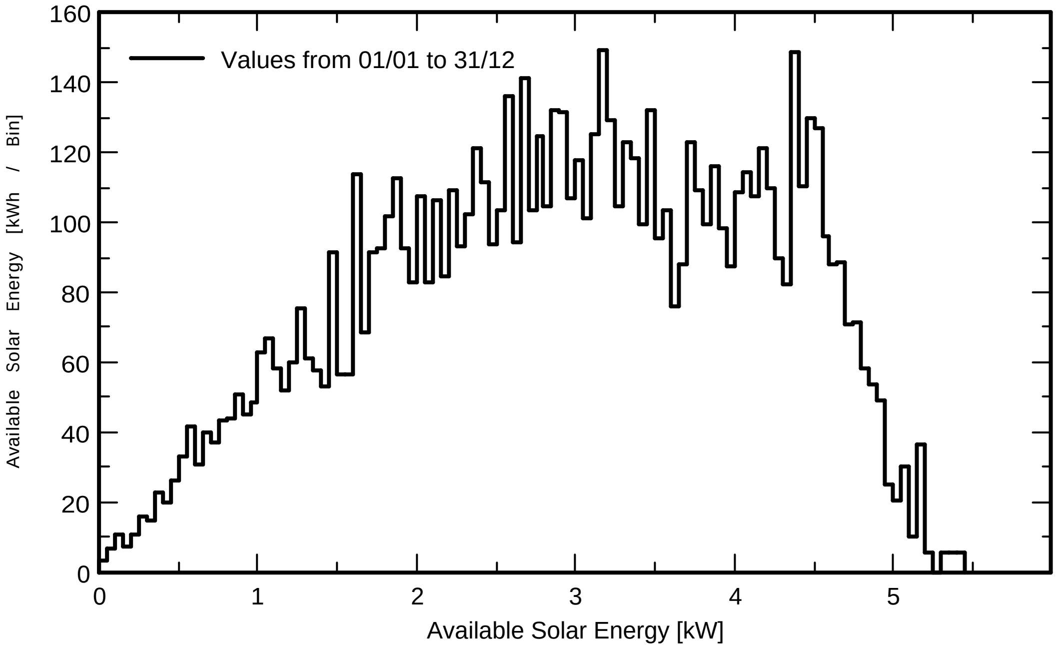
Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Daily Input/Output diagram



System Output Power Distribution



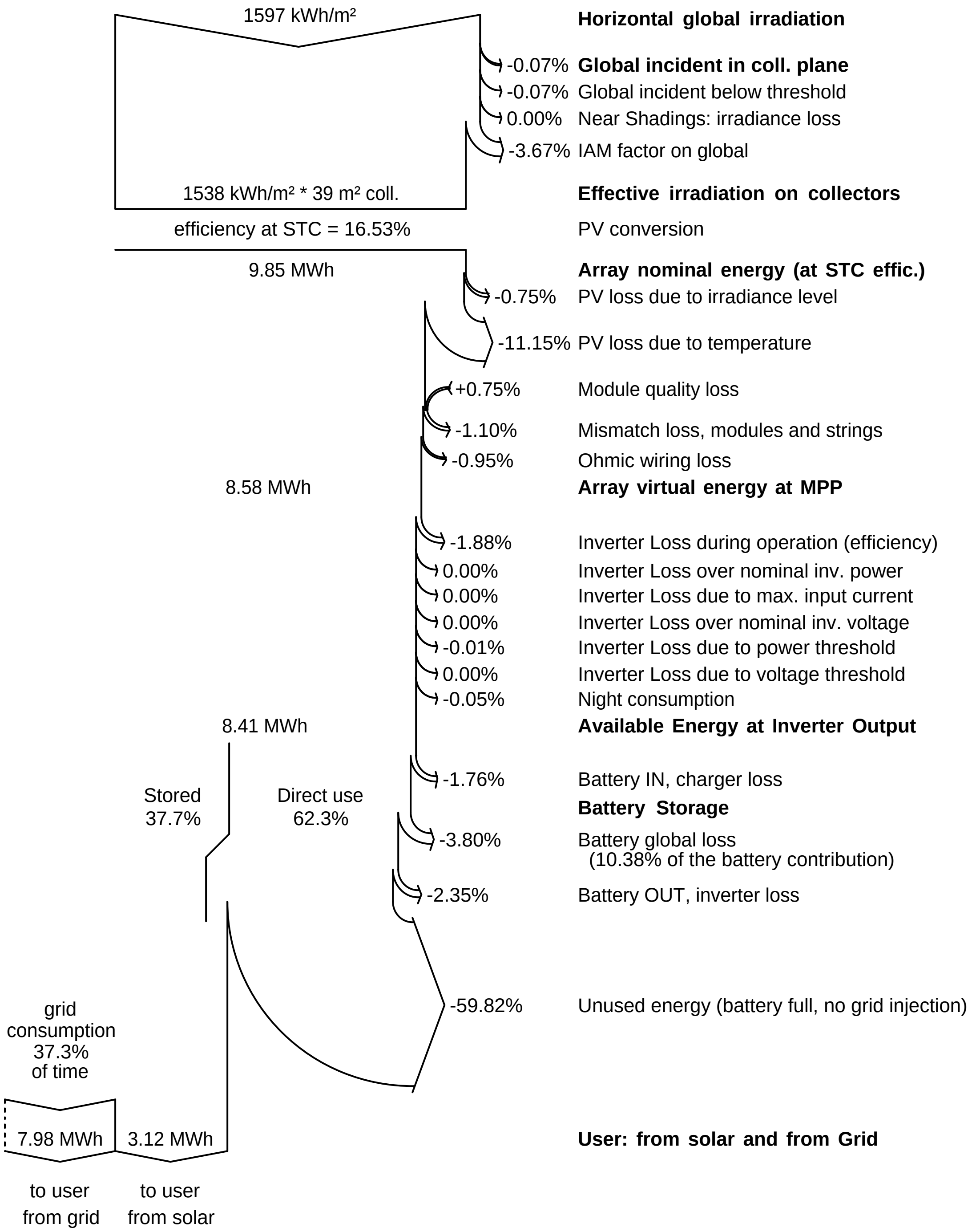
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

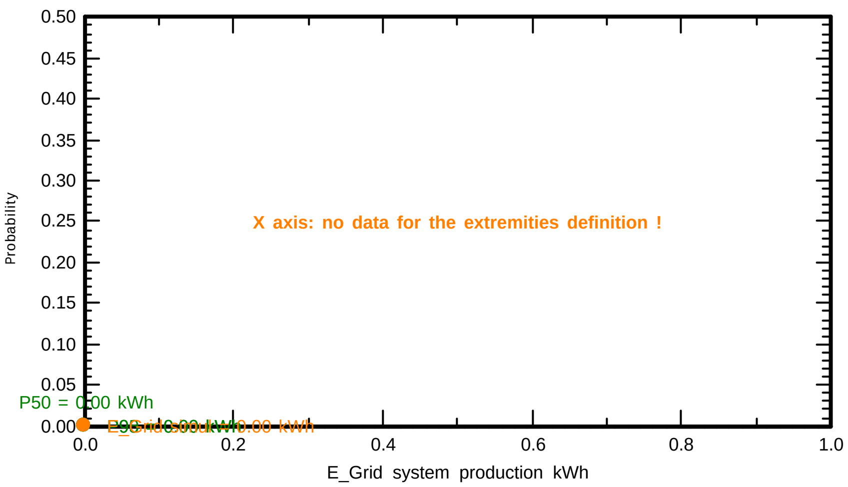
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: CO2 Balance

Project : **Taman Midah (NEM)**

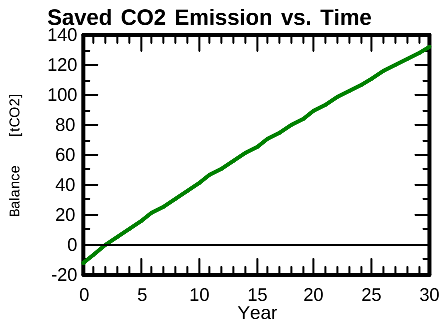
Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Produced Emissions	**Total:**	**11.84 tCO2**		
	Source:	Detailed calculation from table below		
Replaced Emissions	**Total:**	**166.5 tCO2**		
	System production:	8408.96 kWh/yr	Lifetime:	30 years
			Annual Degradation:	1.0 %
	Grid Lifecycle Emissions:	660 gCO2/kWh		
	Source:	IEA List	Country:	Malaysia
CO2 Emission Balance	**Total:**	**132.6 tCO2**		

System Lifecycle Emissions Details:

Item	Modules	Supports
LCE	1713 kgCO2/kWp	4.40 kgCO2/kg
Quantity	6.40 kWp	200 kg
Subtotal [kgCO2]	10961	880



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : Own house - SELCO 6kw inv

Simulation date 21/04/20 14h41

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	12.8 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	10 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	20	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**6.40 kWp**	At operating cond.	5.75 kWp (50°C)
Array operating characteristics (50°C)	U mpp	336 V	I mpp	17 A
Total area	Module area	**38.8 m²**	Cell area	34.4 m²
Inverter	Model	**SUN2000L-5KTL**		
Original PVsyst database	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	90-500 V	Unit Nom. Power	5.00 kWac
			Max. power (=>40°C)	5.50 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	5.0 kWac
			Pnom ratio	1.28
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	2 in series x 4 in parallel		
	Voltage	24 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	9.4 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	5.4 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	6.6 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	332 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

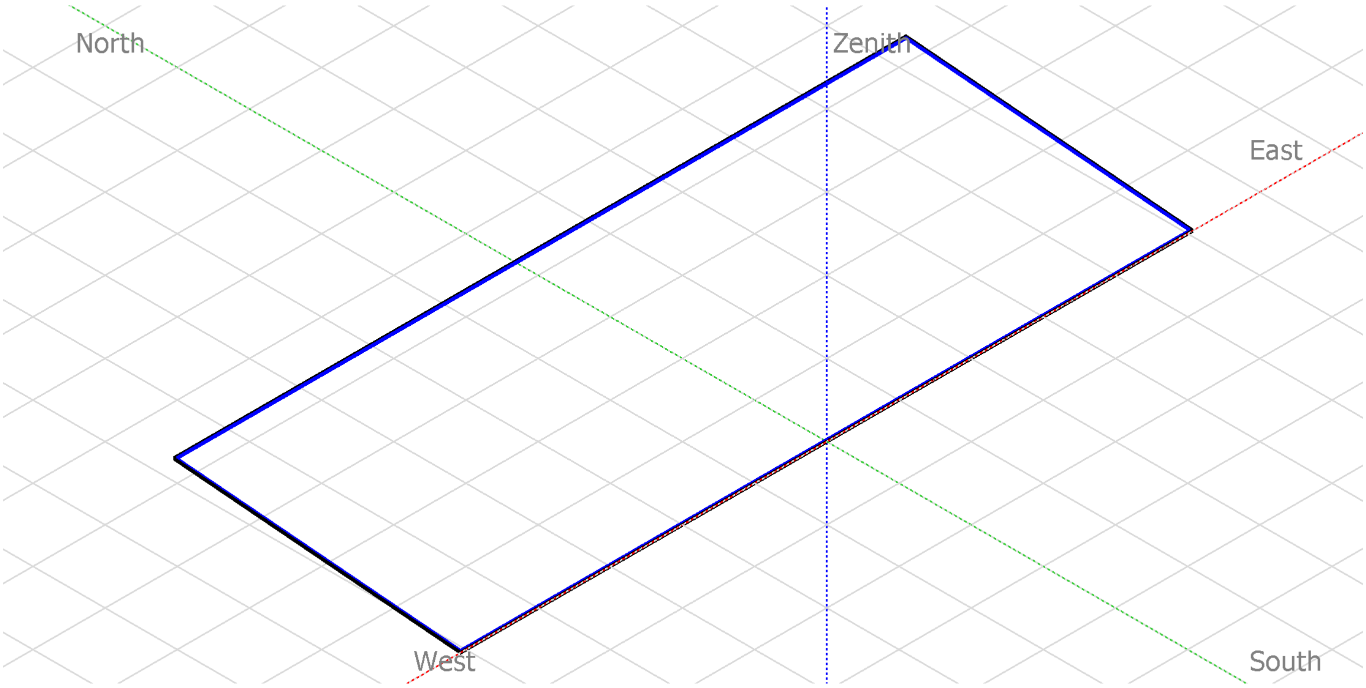
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

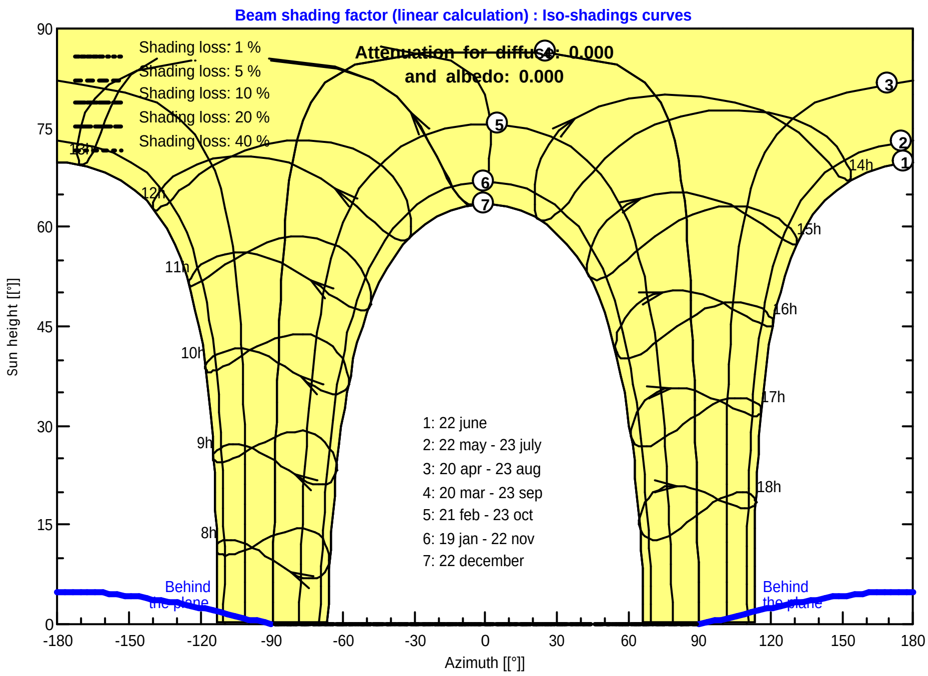
Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

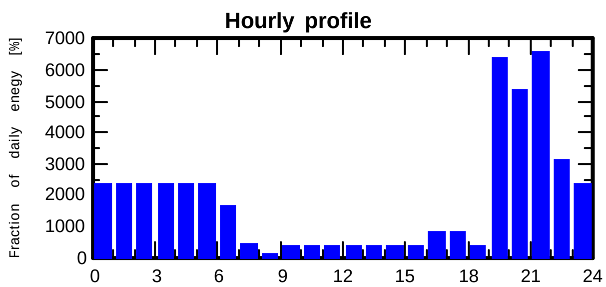
Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Daily household consumers, Constant over the year, average = 12.8 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	6 h/day	2970 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	1000 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	6	750 W tot	7 h/day	31500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				44634 Wh/day



Grid-Connected System: Main results

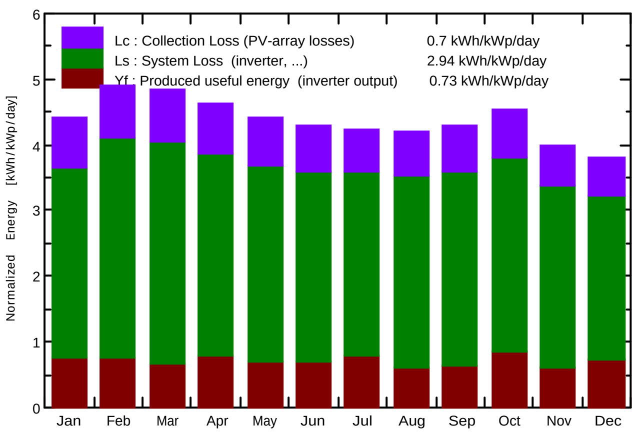
Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 6kw inv**

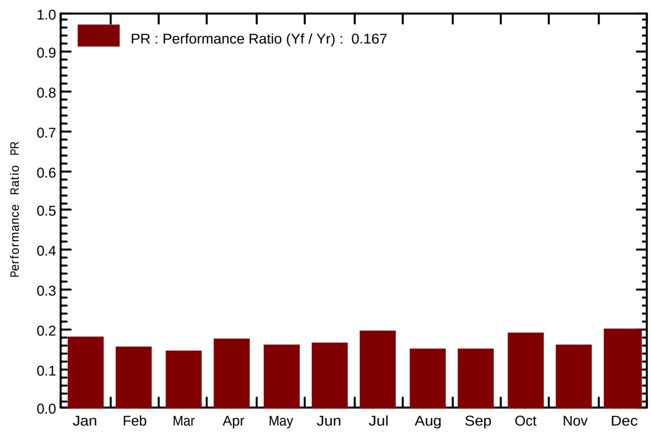
Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Main simulation results				
System Production	**Produced Energy**	**8.41 MWh/year**	Specific prod.	1314 kWh/kWp/year
	Performance Ratio PR	16.70 %	Solar Fraction SF	36.40 %
Battery ageing (State of Wear)	Cycles SOW	87.6%	Static SOW	80.0%

Normalized productions (per installed kWp): Nominal power 6.40 kWp



Performance Ratio PR



Own house - SELCO 6kw inv

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	0.726	0.446	0.156	0.499	0.290
February	134.6	67.90	27.70	137.4	132.8	0.737	0.357	0.138	0.541	0.219
March	149.8	88.20	28.00	150.3	144.9	0.804	0.357	0.136	0.605	0.221
April	140.3	70.50	27.70	138.8	133.9	0.742	0.402	0.153	0.538	0.249
May	140.3	78.60	28.60	136.9	131.7	0.734	0.402	0.139	0.519	0.262
June	132.0	77.80	27.80	128.3	123.5	0.691	0.357	0.134	0.495	0.223
July	134.4	87.20	27.80	131.1	125.8	0.710	0.446	0.161	0.495	0.285
August	132.2	87.20	27.80	130.1	125.2	0.700	0.357	0.124	0.506	0.233
September	129.2	79.00	27.10	128.8	124.0	0.691	0.357	0.124	0.509	0.233
October	138.8	82.60	27.40	140.4	135.5	0.754	0.446	0.170	0.518	0.277
November	117.6	79.20	26.70	119.8	115.4	0.648	0.357	0.122	0.466	0.235
December	115.0	73.20	26.29	118.1	113.6	0.640	0.402	0.149	0.438	0.253
Year	1597.2	953.59	27.58	1596.2	1537.5	8.575	4.687	1.706	6.129	2.981

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

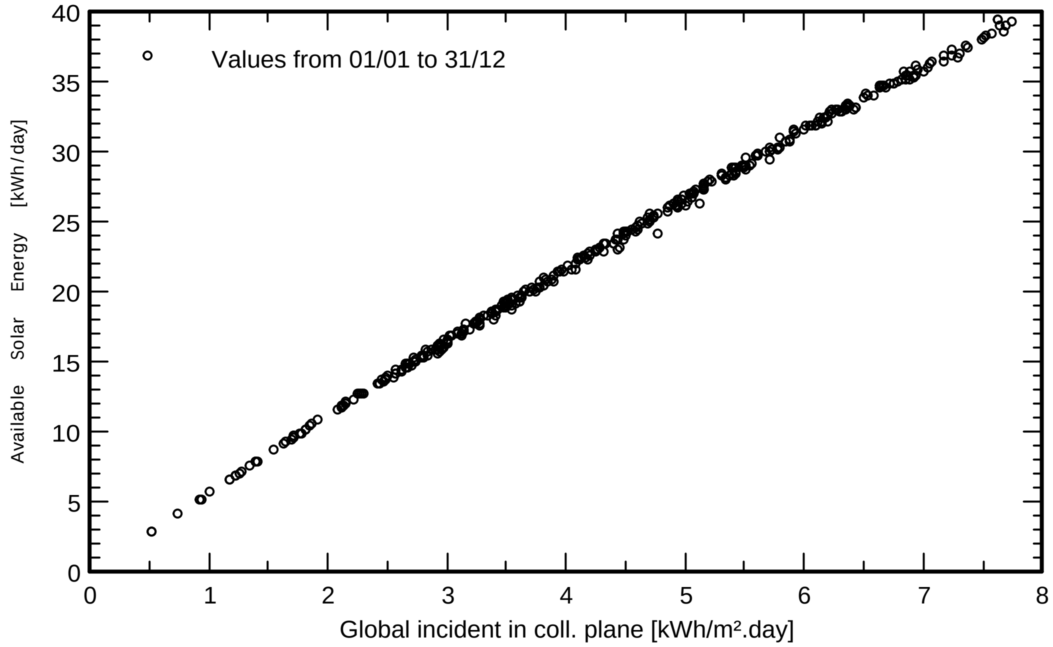
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

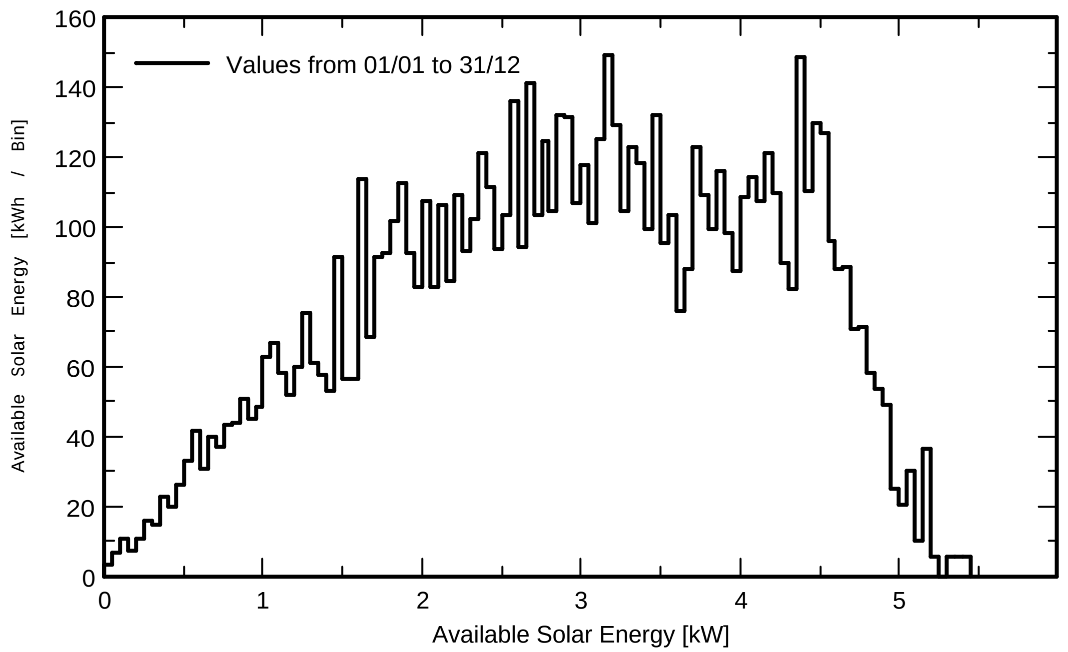
Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Daily Input/Output diagram



System Output Power Distribution



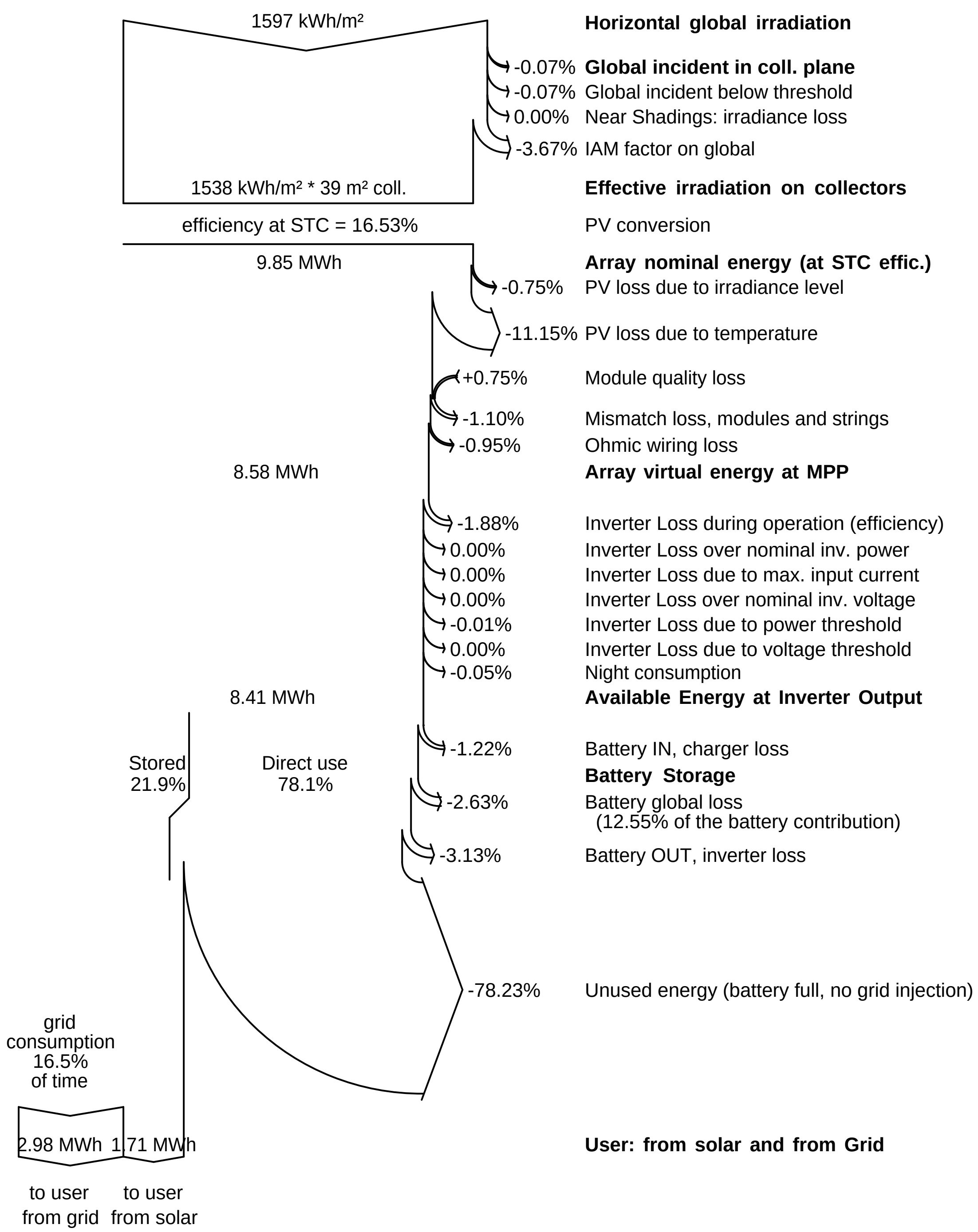
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

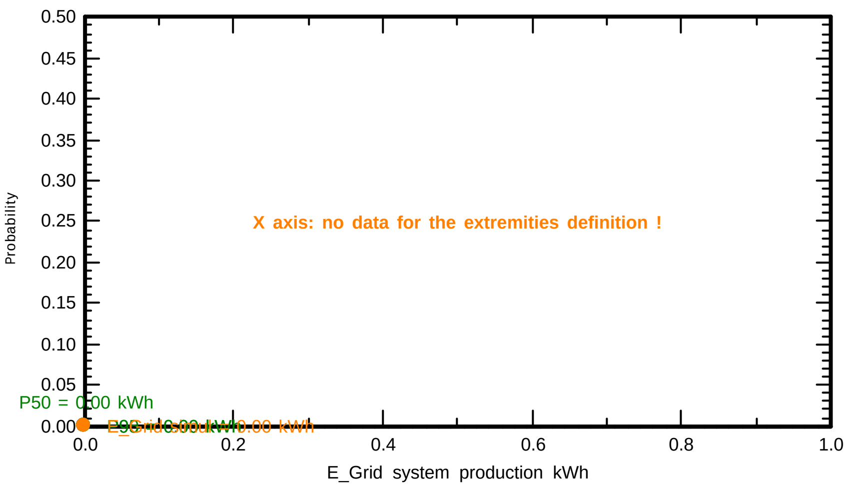
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: CO_2 Balance

Project : **Taman Midah (NEM)**

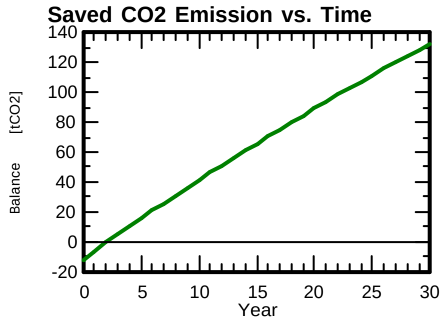
Simulation variant : **Own house - SELCO 6kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	20	Pnom total	**6.40 kWp**
Inverter	Model	SUN2000L-5KTL	Pnom	5.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Produced Emissions	**Total:**	**11.84 tCO2**		
	Source:	Detailed calculation from table below		
Replaced Emissions	**Total:**	**166.5 tCO2**		
	System production:	8408.96 kWh/yr	Lifetime:	30 years
			Annual Degradation:	1.0 %
	Grid Lifecycle Emissions:	660 gCO2/kWh		
	Source:	IEA List	Country:	Malaysia
CO2 Emission Balance	**Total:**	**132.6 tCO2**		

System Lifecycle Emissions Details:

Item	Modules	Supports
LCE	1713 kgCO2/kWp	4.40 kgCO2/kg
Quantity	6.40 kWp	200 kg
Subtotal [kgCO2]	10961	880



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : Own house - SELCO 9kw inv

Simulation date 21/04/20 15h11

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	30.4 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	3 in series x 4 in parallel		
	Voltage	36 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	14.1 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	7.5 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	6.6 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

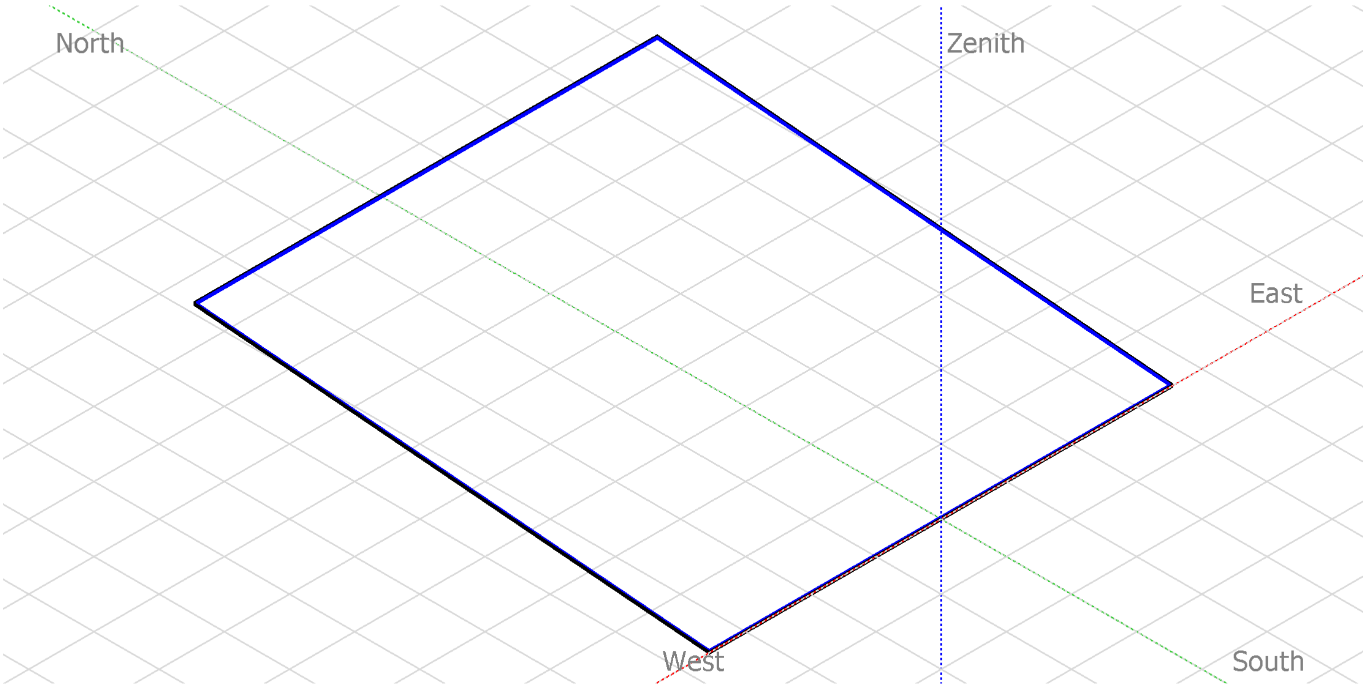
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

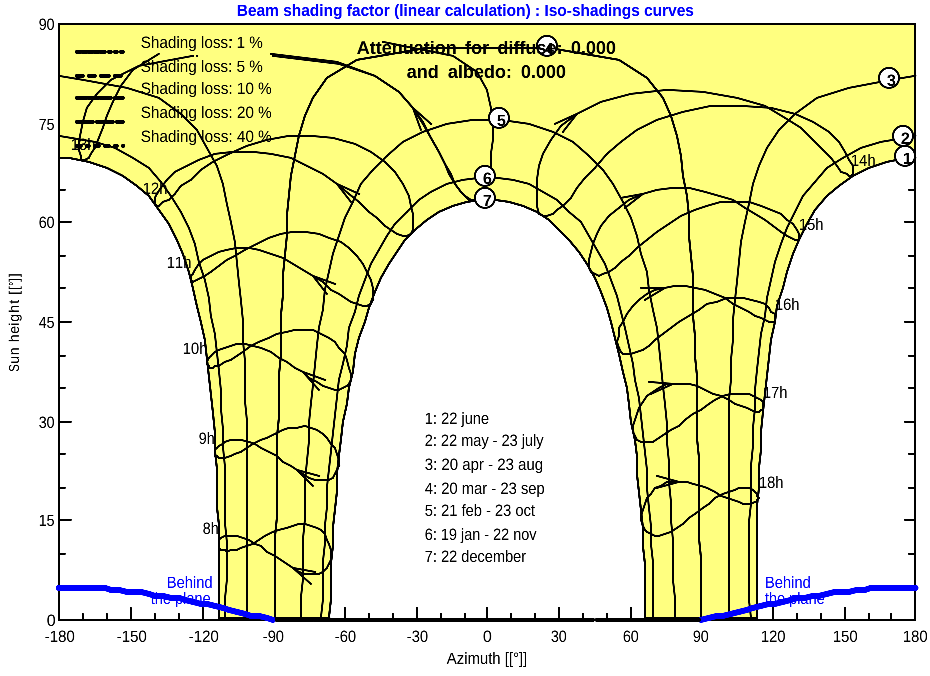
Simulation variant : **Own house - SELCO 9kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

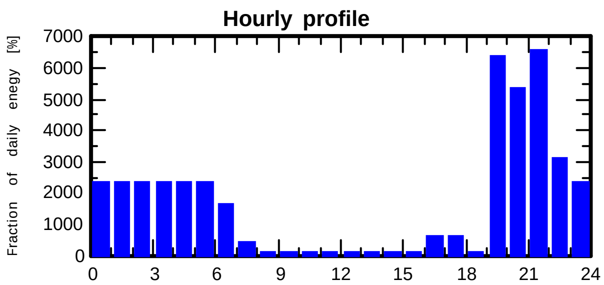
Simulation variant : **Own house - SELCO 9kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Daily household consumers, Constant over the year, average = 30.4 kWh/day

Annual values

Use 5 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	6 h/day	2970 Wh/day
TV / PC / Mobile	3	70 W/app	4 h/day	840 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	1000 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	6	750 W tot	7 h/day	31500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				42534 Wh/day



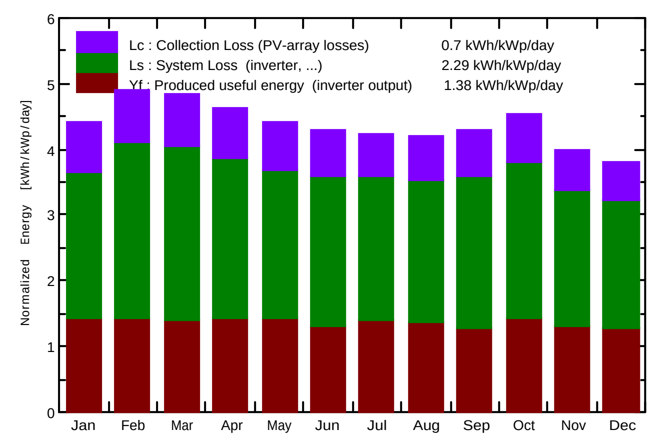
Grid-Connected System: Main results

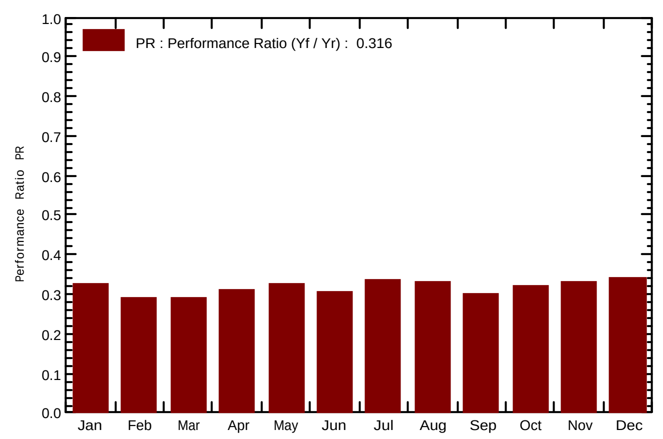
Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 9kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	31.64 %	Solar Fraction SF	40.76 %
Battery ageing (State of Wear)	Cycles SOW	80.1%	Static SOW	80.0%
	Battery lifetime	5.0 years		





Own house - SELCO 9kw inv
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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	1.016	0.978	0.400	0.522	0.578
February	134.6	67.90	27.70	137.4	132.8	1.031	0.851	0.358	0.589	0.492
March	149.8	88.20	28.00	150.3	144.9	1.125	0.936	0.388	0.630	0.548
April	140.3	70.50	27.70	138.8	133.9	1.039	0.893	0.384	0.580	0.509
May	140.3	78.60	28.60	136.9	131.7	1.027	0.978	0.400	0.532	0.578
June	132.0	77.80	27.80	128.3	123.5	0.967	0.893	0.350	0.517	0.543
July	134.4	87.20	27.80	131.1	125.8	0.994	0.936	0.392	0.524	0.544
August	132.2	87.20	27.80	130.1	125.2	0.980	0.978	0.385	0.504	0.594
September	129.2	79.00	27.10	128.8	124.0	0.968	0.851	0.347	0.520	0.504
October	138.8	82.60	27.40	140.4	135.5	1.056	0.978	0.402	0.575	0.576
November	117.6	79.20	26.70	119.8	115.4	0.907	0.936	0.357	0.462	0.579
December	115.0	73.20	26.29	118.1	113.6	0.896	0.893	0.361	0.445	0.532
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	11.101	4.525	6.400	6.576

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

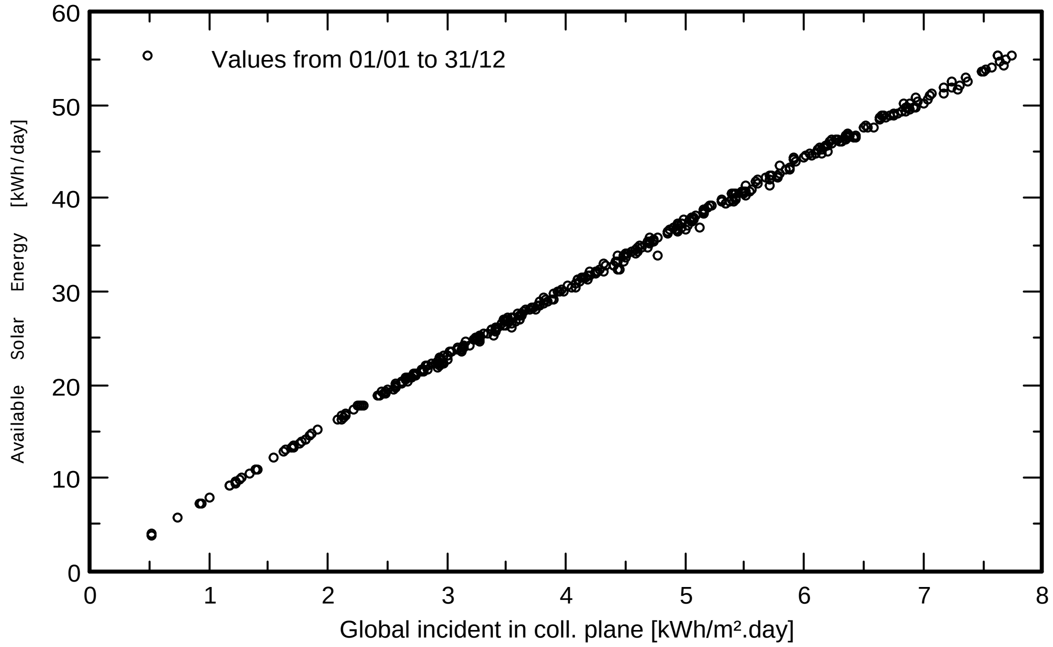
Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

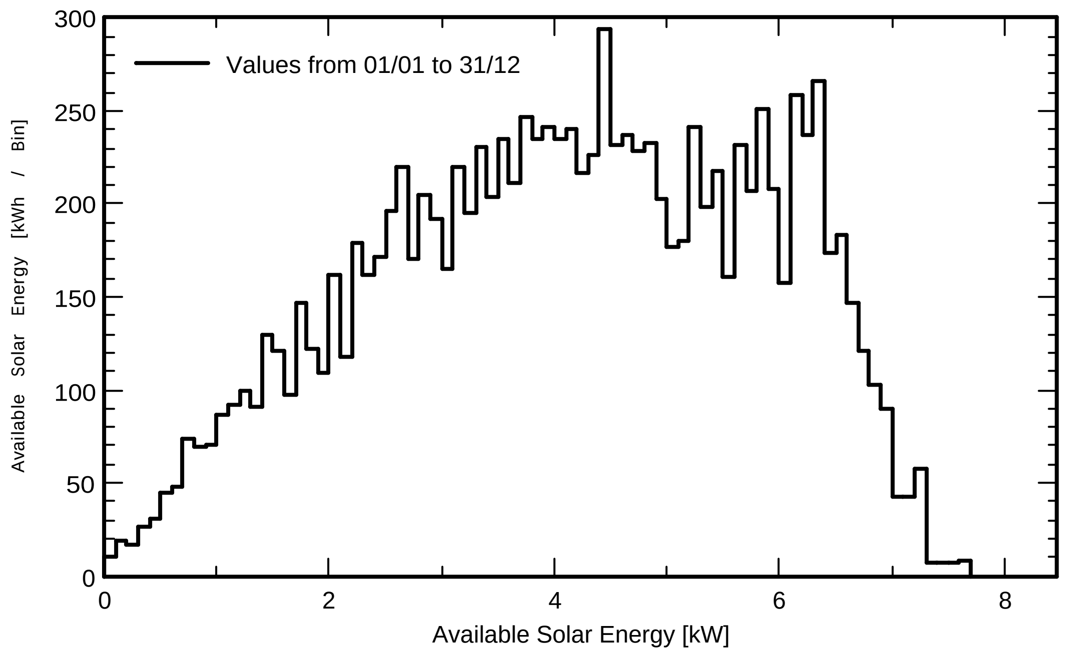
Simulation variant : **Own house - SELCO 9kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Daily Input/Output diagram



System Output Power Distribution



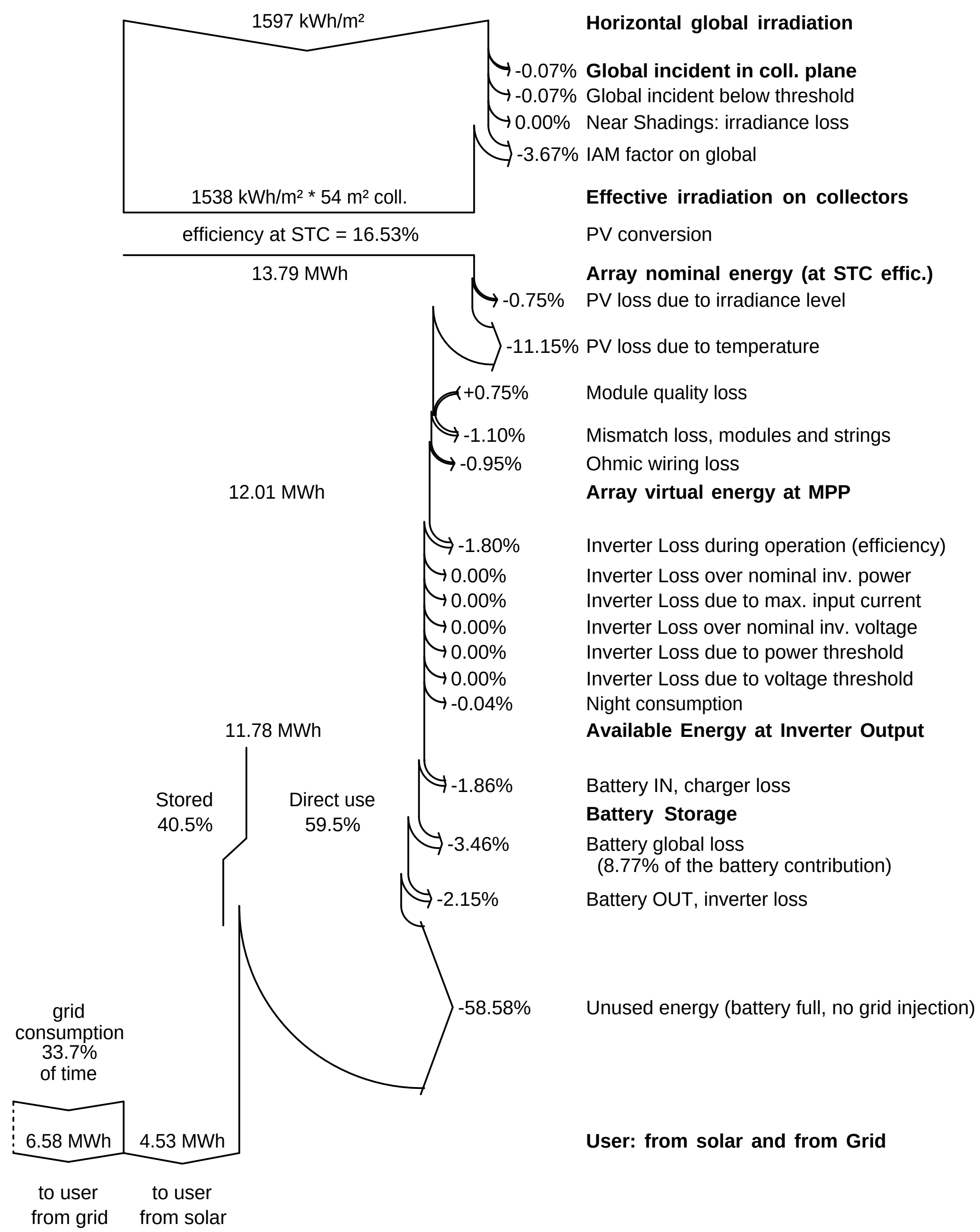
Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 9kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 9kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	11.10 MWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

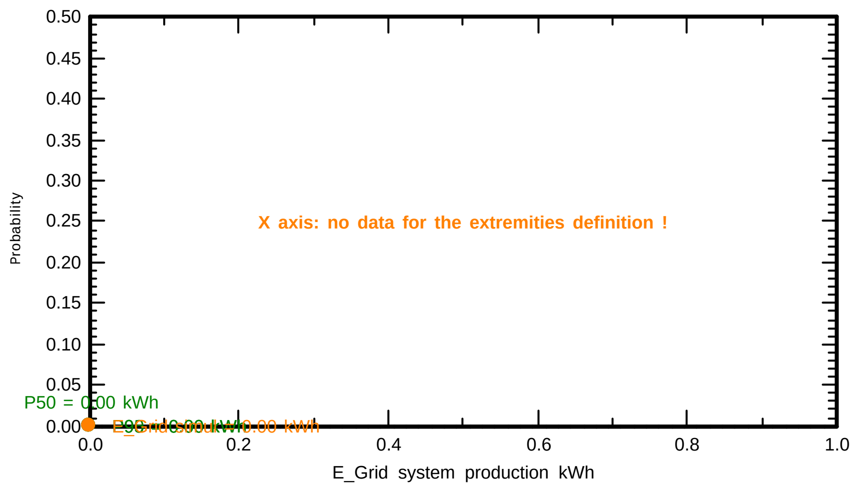
Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution



Grid-Connected System: Simulation parameters

Project : Taman Midah (NEM)

Geographical Site	**Kuala Lumpur/Subang**		Country	**Malaysia**
Situation	Latitude	3.12° N	Longitude	101.55° E
Time defined as	Legal Time	Time zone UT+8	Altitude	17 m
	Albedo	0.20		
Meteo data:	**Kuala Lumpur/Subang**	MeteoNorm 7.2 station - Synthetic		

Simulation variant : Own house - SELCO 9kw inv

Simulation date 21/04/20 15h12

Simulation parameters	System type	**Sheds on ground**		
Collector Plane Orientation	Tilt	5°	Azimuth	0°
Models used	Transposition	Perez	Diffuse	Perez, Meteonorm
Horizon	Free Horizon			
Near Shadings	Linear shadings			
Storage	Kind	Self-consumption, No grid reinjection		
	Charging strategy	When excess solar power is available		
	Discharging strategy	As soon as power is needed		
User's needs :	Daily household consumers	Constant over the year		
	average	12.8 kWh/Day		

PV Array Characteristics

PV module Si-mono	Model	**JAM6-72-320/SI**		
Original PVsyst database	Manufacturer	JA Solar		
Number of PV modules	In series	14 modules	In parallel	2 strings
Total number of PV modules	Nb. modules	28	Unit Nom. Power	320 Wp
Array global power	Nominal (STC)	**8.96 kWp**	At operating cond.	8.05 kWp (50°C)
Array operating characteristics (50°C)	U mpp	470 V	I mpp	17 A
Total area	Module area	**54.3 m²**	Cell area	48.2 m²
Inverter	Model	**SUN2000L-8KTL**		
Custom parameters definition	Manufacturer	Huawei Technologies		
Characteristics	Operating Voltage	200-850 V	Unit Nom. Power	8.00 kWac
			Max. power (=>40°C)	8.80 kWac
Inverter pack	Nb. of inverters	2 * MPPT 50 %	Total Power	8.0 kWac
			Pnom ratio	1.12
Battery	Model	**PVX-2120L**		
	Manufacturer	Concorde		
Battery Pack Characteristics	Nb. of units	3 in series x 4 in parallel		
	Voltage	36 V	Nominal Capacity	784 Ah (C10)
	Discharging min. SOC	50.0 %	Stored energy	14.1 kWh
	Temperature	Fixed (20°C)		
Battery input charger	Model	Generic		
	Max. charging power	7.5 kWdc	Max./ Euro efficiency	97.0/95.0 %
Battery to Grid inverter	Model	Generic		
	Max. discharging power	6.6 kWac	Max./ Euro efficiency	97.0/95.0 %

PV Array loss factors

Thermal Loss factor	Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss	Global array res.	465 mOhm	Loss Fraction	1.5 % at STC

Grid-Connected System: Simulation parameters

Module Quality Loss		Loss Fraction	-0.8 %
Module Mismatch Losses		Loss Fraction	1.0 % at MPP
Strings Mismatch loss		Loss Fraction	0.10 %
Incidence effect, ASHRAE parametrization	IAM = 1 - bo (1/cos i - 1)	bo Param.	0.05

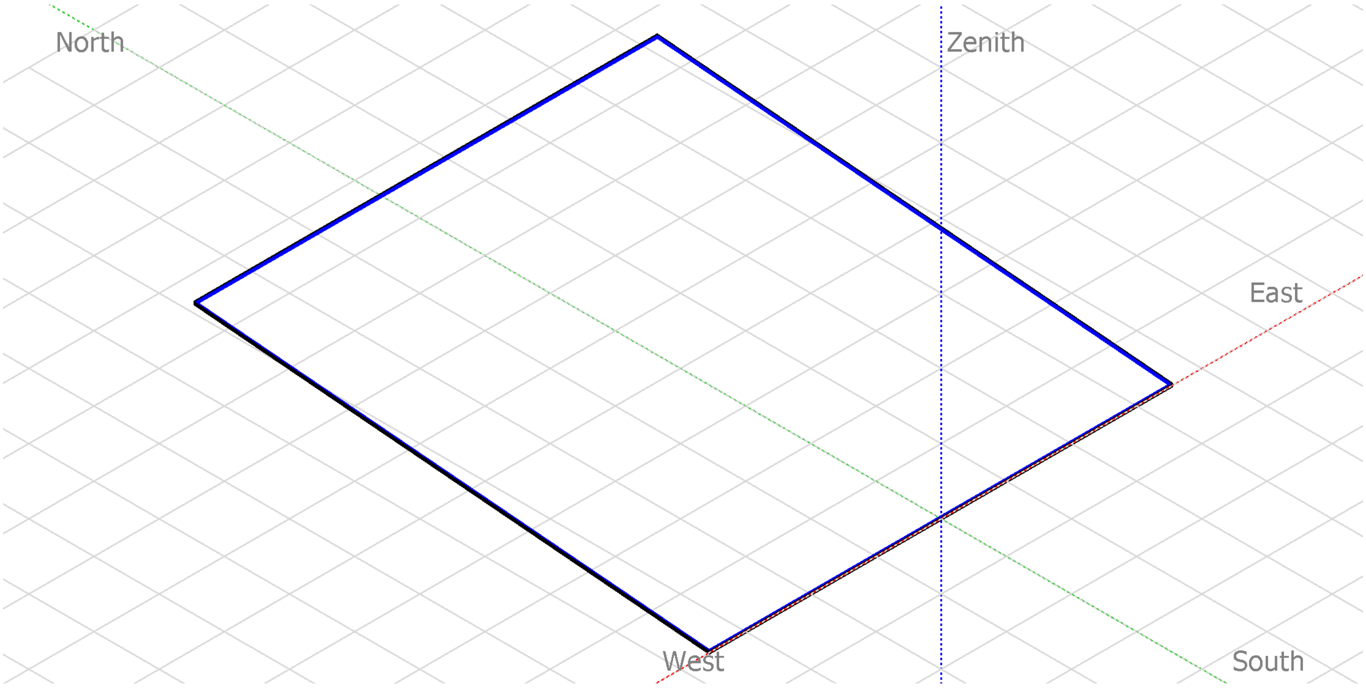
Grid-Connected System: Near shading definition

Project : **Taman Midah (NEM)**

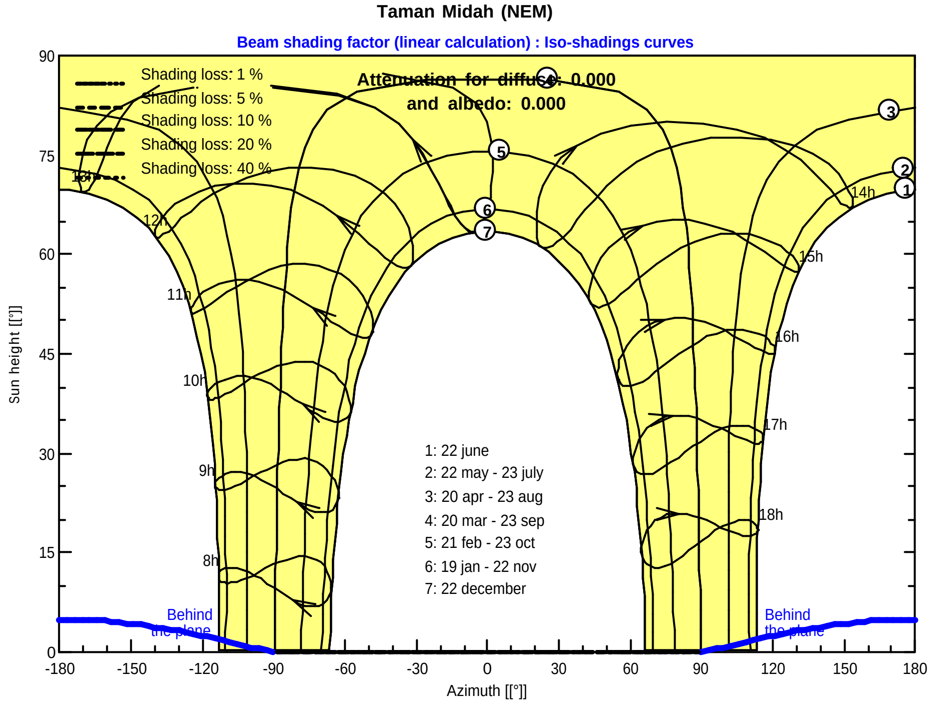
Simulation variant : **Own house - SELCO 9kw inv**

Main system parameters	System type	**Sheds on ground**		
Near Shadings	Linear shadings			
PV Field Orientation	tilt	5°	azimuth	0°
PV modules	Model	JAM6-72-320/SI	Pnom	320 Wp
PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Perspective of the PV-field and surrounding shading scene



Iso-shadings diagram



Grid-Connected System: Detailed User's needs

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 9kw inv**

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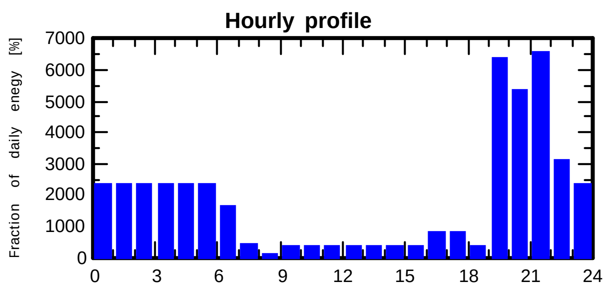
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Daily household consumers, Constant over the year, average = 12.8 kWh/day

Annual values

Use 2 days a week	Number	Power	Use	Energy
Lamps (LED or fluo)	30	18 W/lamp	6 h/day	2970 Wh/day
TV / PC / Mobile	3	70 W/app	14 h/day	2940 Wh/day
Iron	1	1200 W/app	1 h/day	1200 Wh/day
Fridge / Deep-freeze	1		24 Wh/day	3000 Wh/day
Dish- & Cloth-washers	1		2 Wh/day	1000 Wh/day
Instant water heater	1	2000 W tot	1 h/day	2000 Wh/day
Aircond	6	750 W tot	7 h/day	31500 Wh/day
Stand-by consumers			24 h/day	24 Wh/day
Total daily energy				44634 Wh/day



Grid-Connected System: Main results

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 9kw inv**

Main system parameters	System type	**Sheds on ground**		
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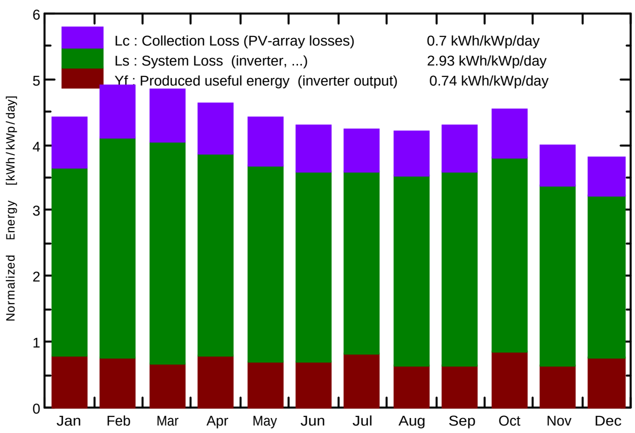
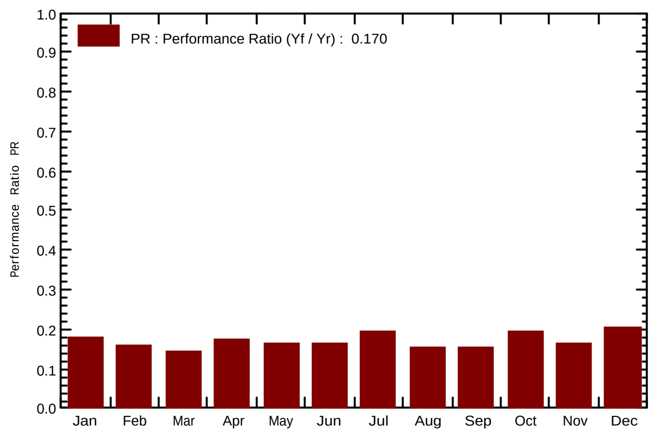
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Main simulation results				
System Production	**Produced Energy**	**11.78 MWh/year**	Specific prod.	1315 kWh/kWp/year
	Performance Ratio PR	16.99 %	Solar Fraction SF	51.85 %
Battery ageing (State of Wear)	Cycles SOW	87.8%	Static SOW	80.0%
	Battery lifetime	5.0 years		

Normalized productions (per installed kWp): Nominal power 8.96 kWp



Performance Ratio PR



Own house - SELCO 9kw inv

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	EUnused MWh	EFrGrid MWh
January	133.0	82.20	28.10	136.3	131.2	1.016	0.446	0.220	0.701	0.226
February	134.6	67.90	27.70	137.4	132.8	1.031	0.357	0.194	0.765	0.163
March	149.8	88.20	28.00	150.3	144.9	1.125	0.357	0.192	0.851	0.165
April	140.3	70.50	27.70	138.8	133.9	1.039	0.402	0.217	0.757	0.184
May	140.3	78.60	28.60	136.9	131.7	1.027	0.402	0.201	0.729	0.201
June	132.0	77.80	27.80	128.3	123.5	0.967	0.357	0.191	0.695	0.166
July	134.4	87.20	27.80	131.1	125.8	0.994	0.446	0.229	0.696	0.217
August	132.2	87.20	27.80	130.1	125.2	0.980	0.357	0.177	0.707	0.180
September	129.2	79.00	27.10	128.8	124.0	0.968	0.357	0.176	0.717	0.181
October	138.8	82.60	27.40	140.4	135.5	1.056	0.446	0.242	0.728	0.205
November	117.6	79.20	26.70	119.8	115.4	0.907	0.357	0.175	0.654	0.182
December	115.0	73.20	26.29	118.1	113.6	0.896	0.402	0.214	0.613	0.187
Year	1597.2	953.59	27.58	1596.2	1537.5	12.005	4.687	2.430	8.614	2.257

Legends:

GlobHor	Horizontal global irradiation	GlobEff	Effective Global, corr. for IAM and shadings
DiffHor	Horizontal diffuse irradiation	EArray	Effective energy at the output of the array
T_Amb	T amb.	E_User	Energy supplied to the user
GlobInc	Global incident in coll. plane	E_Solar	Energy from the sun
		EUnused	Unused energy (battery full, no grid injection)
		EFrGrid	Energy from the grid

Grid-Connected System: Special graphs

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 9kw inv**

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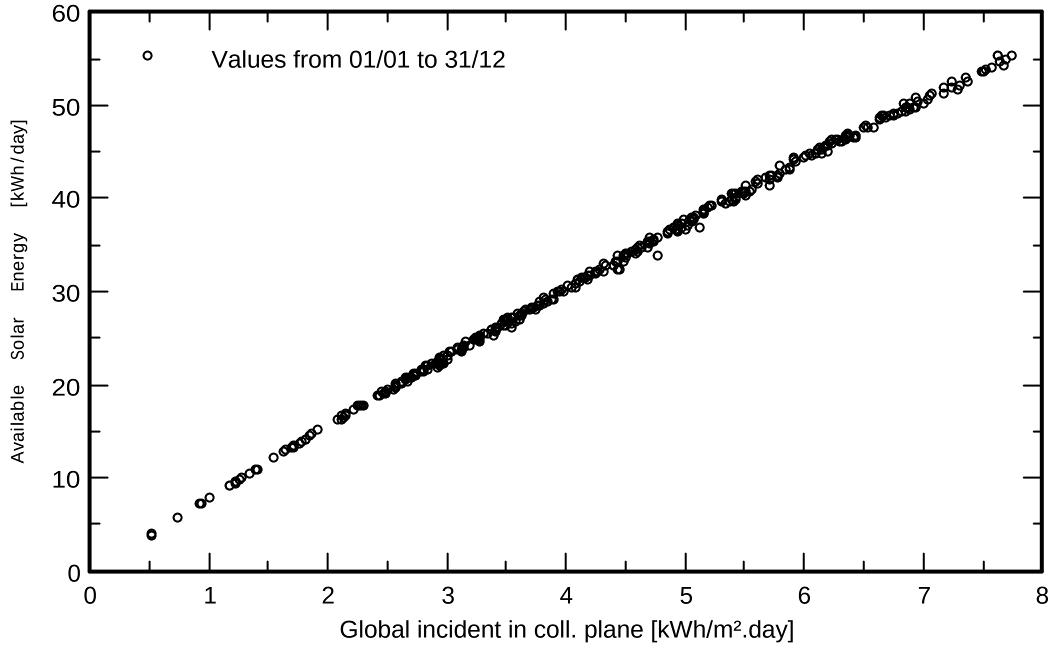
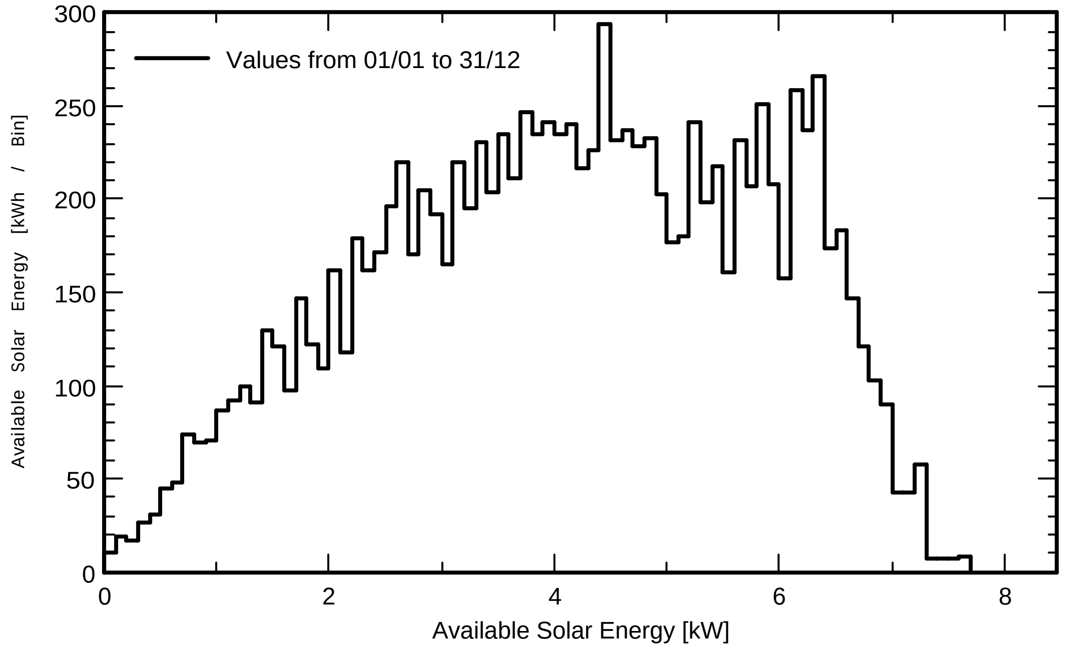
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Daily Input/Output diagram



System Output Power Distribution



Grid-Connected System: Loss diagram

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 9kw inv**

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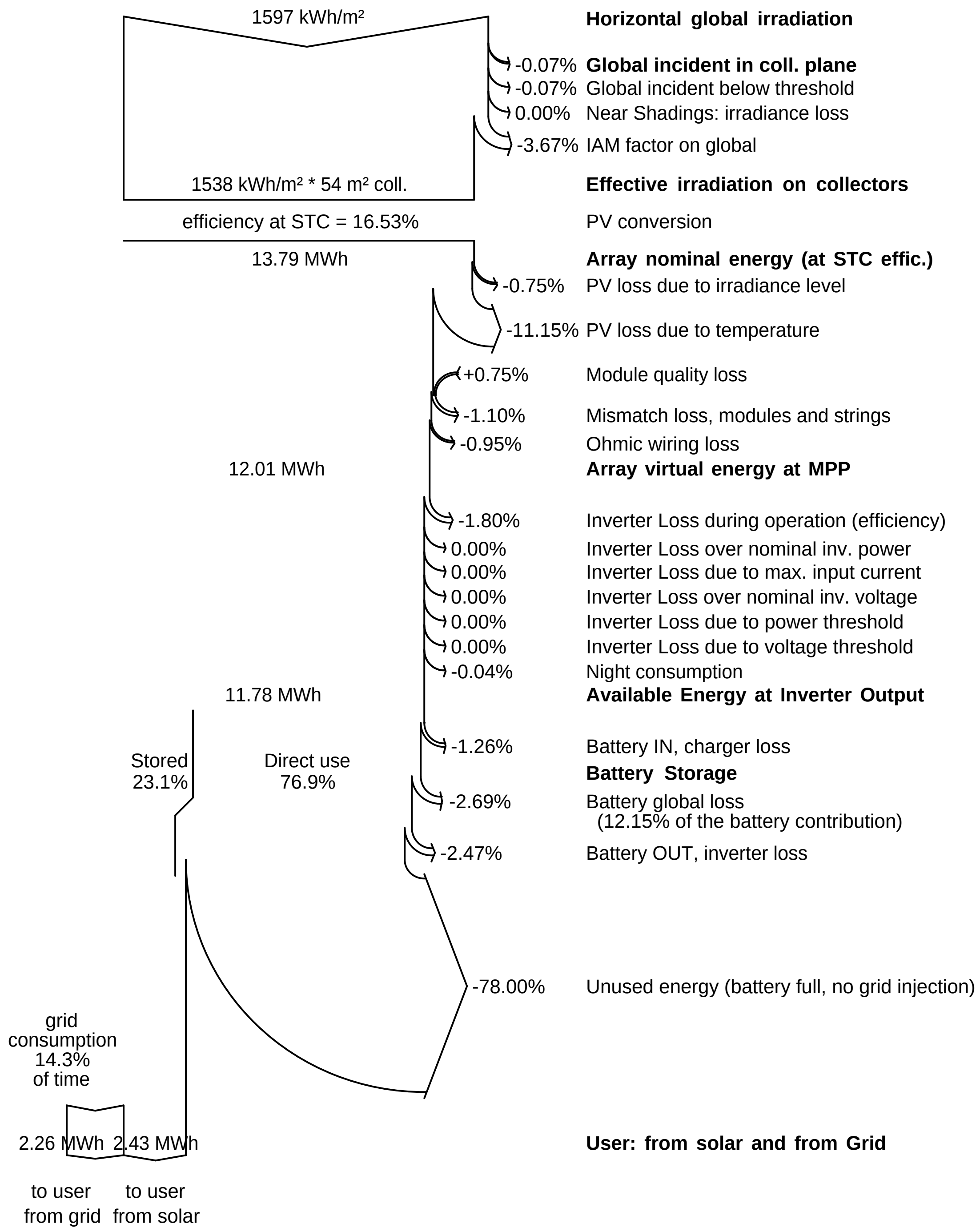
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Loss diagram over the whole year



Grid-Connected System: P50 - P90 evaluation

Project : **Taman Midah (NEM)**

Simulation variant : **Own house - SELCO 9kw inv**

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PV Array	Nb. of modules	28	Pnom total	**8.96 kWp**
Inverter	Model	SUN2000L-8KTL	Pnom	8.00 kW ac
User's needs	Daily household consumers	Constant over the year	Global	4687 kWh/year

Evaluation of the Production probability forecast

The probability distribution of the system production forecast for different years is mainly dependent on the meteo data used for the simulation, and depends on the following choices:

Meteo data source		MeteoNorm 7.2 station		
Meteo data	Kind	Not defined	Year	1995
Specified Deviation	Year deviation from aver.	3 %		
Year-to-year variability	Variance	0.5 %		

The probability distribution variance is also depending on some system parameters uncertainties

Specified Deviation	PV module modelling/parameters	1.0 %	
	Inverter efficiency uncertainty	0.5 %	
	Soiling and mismatch uncertainties	1.0 %	
	Degradation uncertainty	1.0 %	
Global variability (meteo + system)	Variance	1.9 %	(quadratic sum)

Annual production probability	**Variability**	**0.00 MWh**
	P50	**0.00 MWh**
	P90	**0.00 MWh**
	P95	**0.00 MWh**

Probability distribution