

PVSYST 7

Stand Alone



INTRODUCTION

This document is the first chapter on the basic aspects of simulation for stand-alone systems.

More tutorials on different features of PVsyst are in preparation and will be added in the future. The complete reference manual for PVsyst is the online help that is accessible from the program through the “Help” entry in the menu, by pressing the F1 key or by clicking on the help icons  inside the windows and dialogs.

Contents

INTRODUCTION	2
Contents	3
Chapter 1: Basic Approach - My First Project	4
1.1 First contact with PVsyst	4
1.2 Define Orientation.....	8
1.2.1 Creating the first (basic) variant for this project	8
1.3 Definition of User's needs	10
1.3.1 Basic definition	10
1.3.2 Other profile	14
1.4 Define the System	18
1.5 Executing the first simulation.....	23
1.6 Conclusion	28

Chapter 1: Basic Approach - My First Project

1.1 First contact with PVsyst

Stand-alone systems are always organized around a battery storage. A PV array charges the battery or directly delivers its power to the user. Therefore, the daily profile of the user's needs (consumption) should be well defined (i.e., in hourly values).

On the hour, the simulation performs a balance between the PV production (depending on the irradiance) and the user's needs. The difference should be derived in the battery, either positively (charge) or negatively (discharge).

This energy balance is controlled by a controller. The role of the controller is to handle the energy flow, mainly for the protection of the battery:

- When the battery is full, the PV array should be disconnected.
- When the battery is empty, the user should be disconnected.

Moreover, the controller may manage the starting of an eventual back-up generator (Genset), when the battery is empty, and the solar gain is not sufficient.

In any case, the reconnection will be performed with a specific hysteresis, depending on the state of charge (SOC) of the battery.

Very little stand-alone systems (SHS: Solar Home Systems):

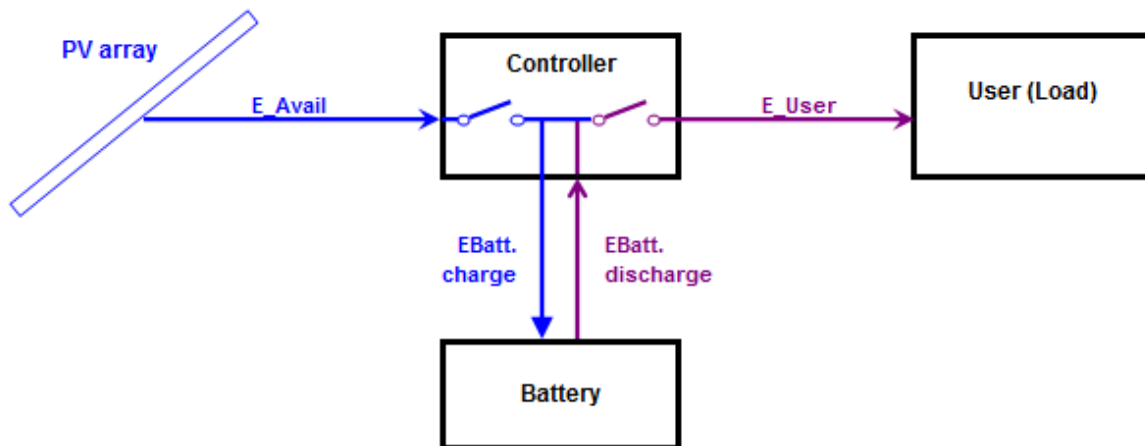


Figure 1: Very little stand-alone systems.

This concerns small systems (50 to 200 Wp) with a very limited consumption (some lights, radio-TV, computer, no fridge).

With these simple systems, the PV array (one or few modules) is usually connected directly to the battery, without power conditioning. This implies that the PV modules should be "12V" or "24V" modules, i.e., with 36 or 72 cells.

This type of installation is managed by simple controllers, acting either by disconnecting the battery, or short-circuiting the PV modules when the battery is full. These controllers have always the ability to control the load when the battery is empty.

Medium power systems (small household, communications):

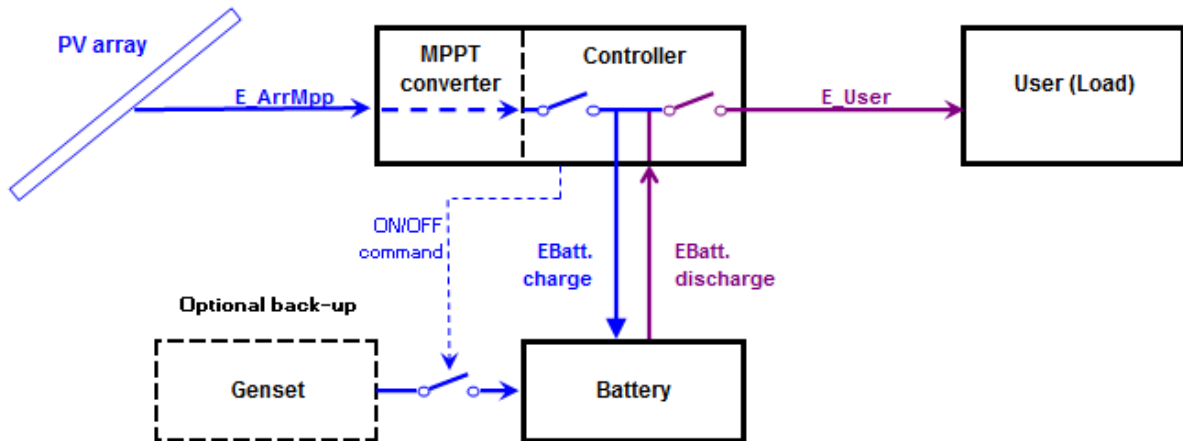


Figure 2: Medium power systems.

These systems are usually ranged between 200 Wp and 2 kWp.

The controller includes a power conditioning unit that can perform the maximum Power Tracking on the PV array. Therefore, the PV array voltage is no longer related to the Battery pack voltage. Most of the time, the controller is also able to ensure the load control, with a limited current capability (usually of the order of the charging current).

These installations may power lighting, fridges, washing machines, dishwashers, small electro-tools, etc. These may also be used in some small remote communication stations.

The energy may be used as DC energy or fed as AC energy through an inverter ("Battery inverter").

Currently, PVsyst does not implement the inverter. The Load is specified as energy, whichever way it will be used.

Such systems may - rarely - be supported by a back-up generator in case of lack of energy. If automatic, the Genset start/stop command should be managed by the controller.

High power systems (Household, communication relays, isolated little industry, etc)

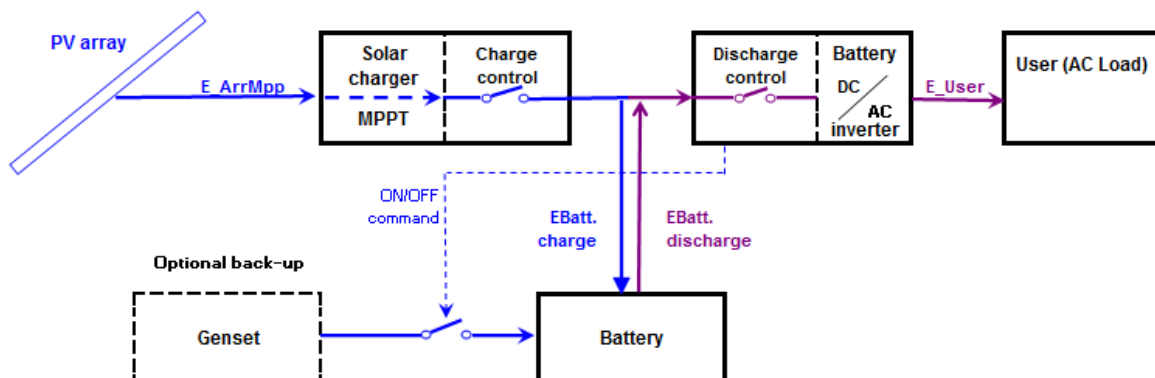


Figure 3: High power systems.

These may be stand-alone systems of 2 kWp to several dozens of kWp.

Such installations use one (or several) "Solar chargers", equipped with MPPT converters, and DC/AC battery inverters.

The controller is not a single device anymore: the charging control is ensured by the Solar charger (sometimes several in parallel) and the discharge control by the inverter. The inverter should also manage the back-up generator if any.

In PVsyst, we consider the Solar Charger as the "Controller for Stand Alone" component. For historical reasons (and simplification), this PVsyst component has also to control the discharge and the back-up generator. But as the parameters for these functions are not defined within the "Solar charger" physical devices (data sheets), the internal parameters for these controls (maximum current, thresholds, etc) will remain in the dialog of this component, but their values will be defined within the system. Their initial values will be adapted from the system configuration and will be modifiable according to the real Inverter used, or other control device.

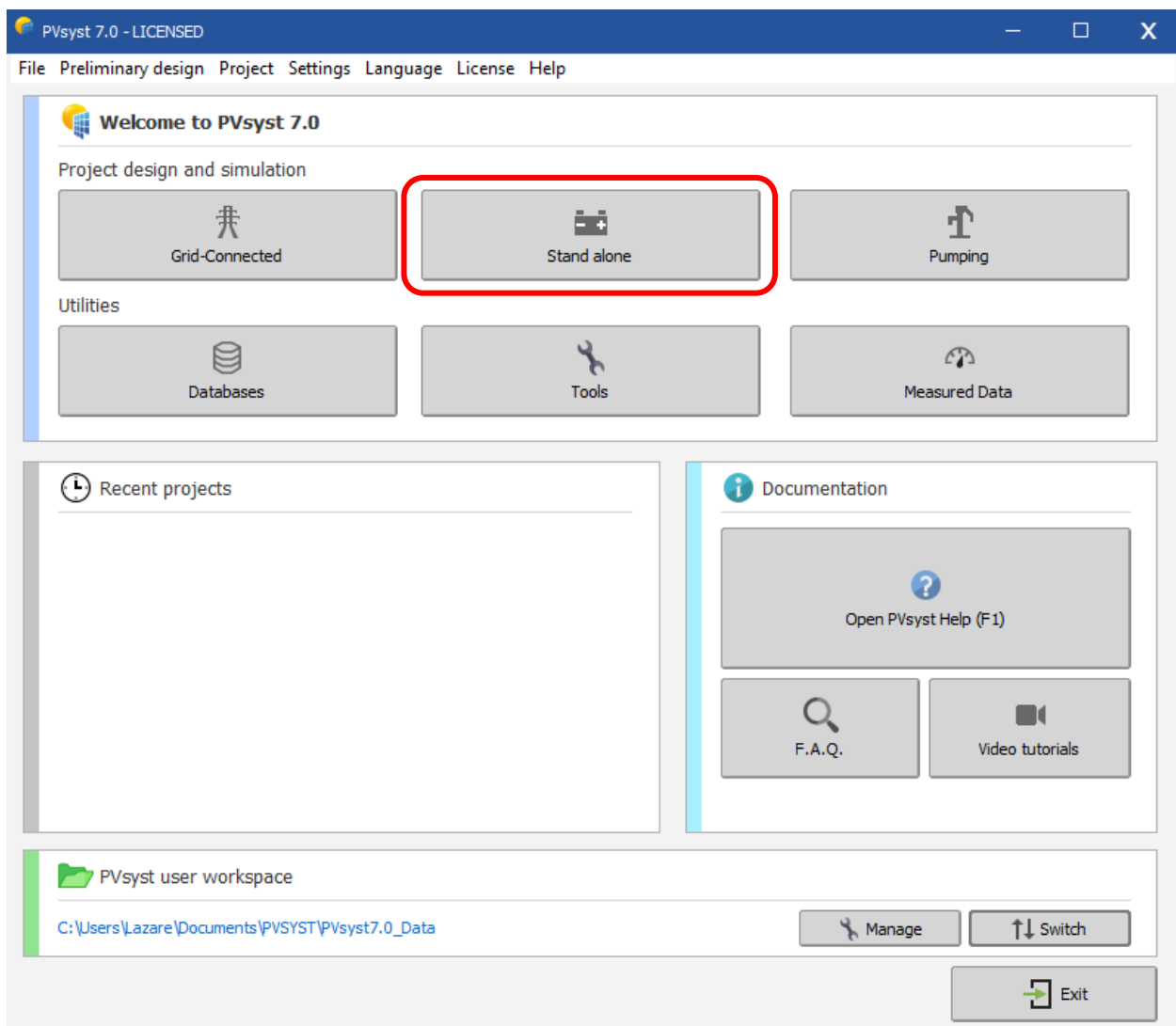


Figure 4: Starting a stand-alone project.

Stand-Alone system procedure – A step-by-step guide to define stand-alone system in PVsyst.

Step 1:

Similarly to any PVsyst system, you have to specify the orientation of the PV array.

Step 2:

You will be asked to define the user's needs.

By default, for small systems, this is proposed as a list of domestic appliances and their consumption (may be seasonal or monthly).

For industrial or bigger systems, you have many possibilities to define a load profile (including by a list of hourly values).

Step 3:

The Pre-sizing tool (on top) gives advice about the required Battery bank and PV array power.

The calculation is based on your meteorological files and above definitions. You should define:

- the required autonomy (usually around 4 days),
- the acceptable probability that the needs are not covered by the system (PLOL: "Probability of Loss of Load),
- the nominal voltage of the battery bank.

The program will then perform a system sizing, in a similar way as in the "Pre-sizing" section.

You also have a button for a more refined sizing studies for different meteorological distributions, or according to the PLOL parameter.

Step 4:

Define the battery pack by choosing a battery model ("Storage" page).

The program will propose the number of batteries in series and in parallel according to the suggestions obtained in the previous pre-sizing tool.

You should also define the operating temperature conditions for the batteries, according to your system implementation.

Step 5:

Define the array configuration and control strategy ("PV array" page) by:

- Acknowledging the pre-sizing propositions (planned power or available area),
- Choosing a PV module model in the database,
- Choosing the control strategy (direct coupling, MPPT or DCDC converter).

You are advised to start by choosing the "Universal controller" to get rid of the specific control conditions.

The program determines the number of modules in series and in parallel according to the battery voltage or MPPT conditions and required PV power.

1.2 Define Orientation

1.2.1 Creating the first (basic) variant for this project

After defining the site and the meteorological input of the project, you can proceed to create the first Variant. You will notice that in the beginning there are 2 buttons marked in red: “Orientation” and “User’s needs”.

The red color signifies that this variant of the project is not yet ready for simulation: additional input is required. Basic parameters that need to be defined for any of the variants, and not yet specified are the orientation of solar panels, User’s needs, type and number of PV modules, type and number of batteries that will be used.

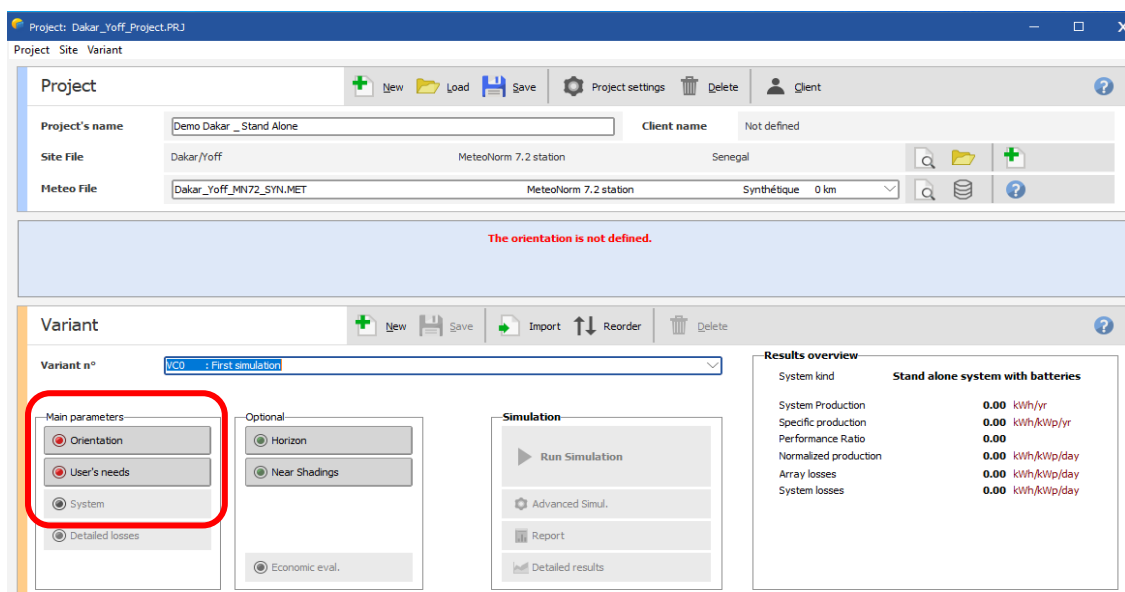


Figure 5: Basic parameters to be defined.

Firstly, you need to click on the “Orientation” Button:

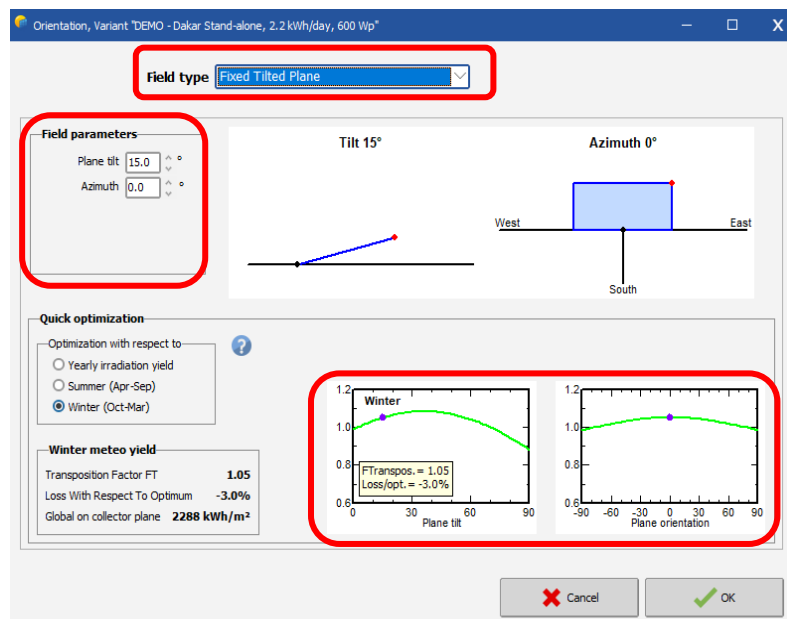


Figure 6 : Orientation dialog.

This tool aims at showing the best suited orientation for a PV system or what you lose when not optimally oriented.

The Transposition Factor is the ratio of the incident irradiation on the plane to the horizontal irradiation, i.e., what you gain (or lose) when tilting the collector plane.

Now, please observe that the optimization of the orientation depends on the planned use of the PV energy. For Stand-Alone systems, the relevant solar yield for sizing the system may be, for example, the winter months for a house or industrial system, or some specific months for leisure appliances.

Therefore, this tool gives the possibility to choose the optimization period by year, winter, summer, or chosen months.

Moreover, the optimization may depend on specific far-shading conditions (mountains): you can define a horizon line, and this will usually result in an azimuth displacement.

Quick optimizing tool in the "Orientation" part:

When choosing the (fixed) plane orientation, an information panel indicates the corresponding Transposition Factor, the difference (loss) with respect to the optimum orientation, and the available irradiation on this tilted plane.

A graph of the Transposition Factor in terms of the plane tilt and azimuth will indicate your actual choice with a violet circle on the curves, showing at once where you are positioned in terms of the optimum.

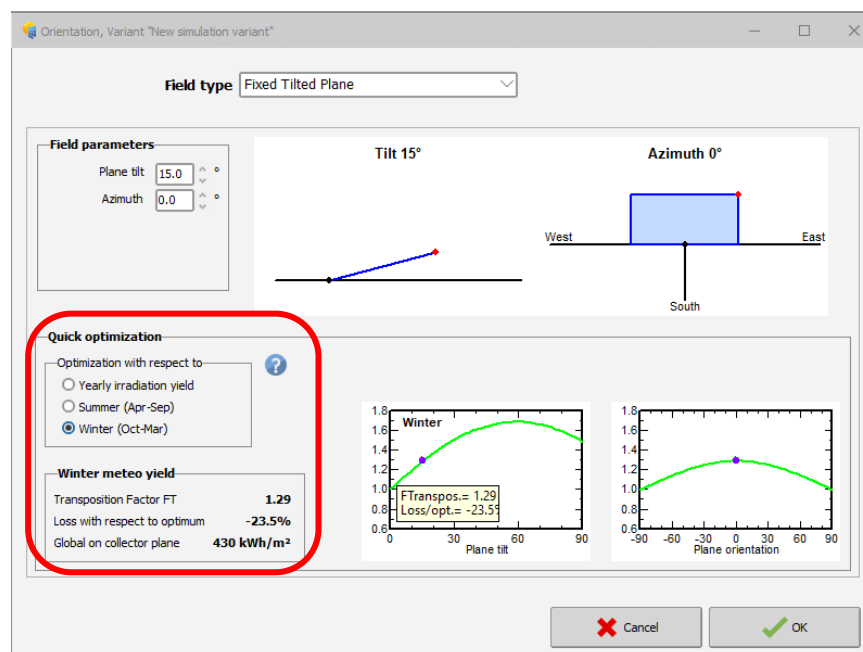


Figure 7: Orientation quick optimization tool.

1.3 Definition of User's needs

Now, we need to define the User's needs.

Several options are available:

- Use of a consumption profile available in the database.
- Import a consumption profile in CSV format.
- Use the user's needs definition interface.

1.3.1 Basic definition

We will use the user requirements definition interface to give you keys to customize the definition of your energy needs.

To complete your energy needs, you must in any case click on the "User's needs" button.

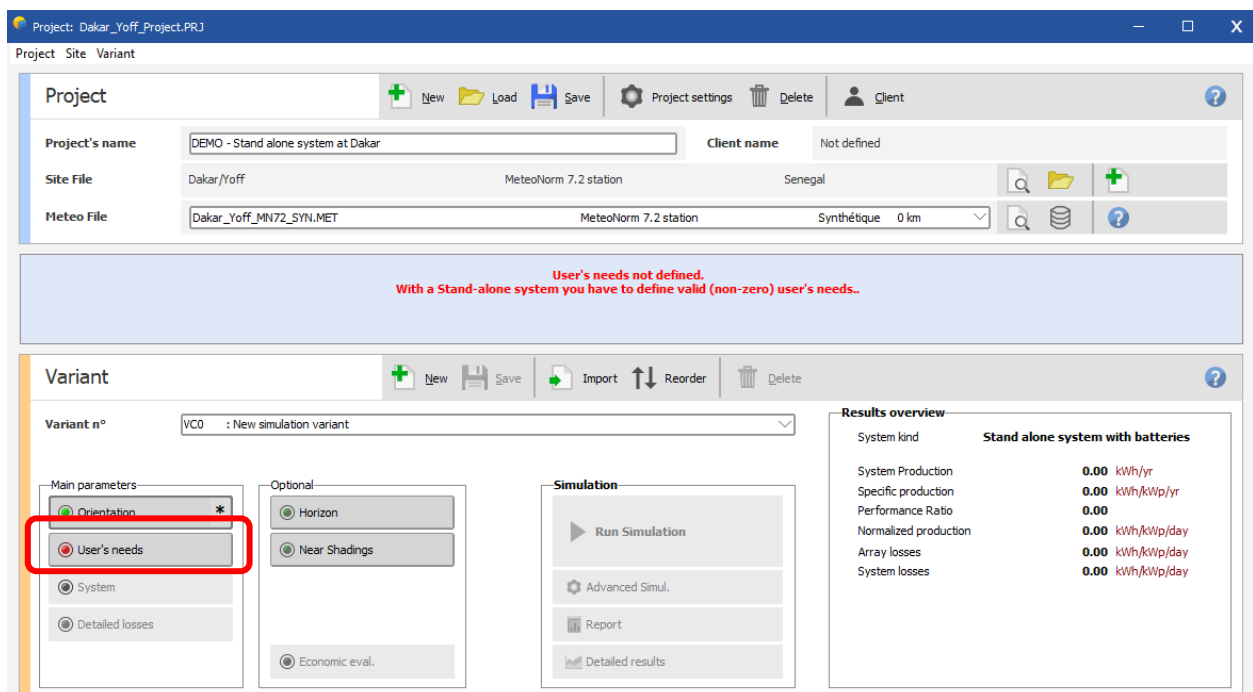


Figure 8: Defining the user's needs.

Once the "User's needs" menu is open, start by defining the frequency of your needs.

You can choose the distribution of your consumption between: Years, Seasons or Months.

Also, you can choose the number of days in week of your consumption.

Daily use of energy, variant "New simulation variant"

Definition of daily household consumptions for the year.

Consumption | Hourly distribution

Daily consumptions

Number	Appliance	Power	Daily use	Hourly distrib.	Daily energy
0	Lamps (LED or fluo)	0 W/lamp	0.0 h/day		0 Wh
0	TV / PC / Mobile	0 W/app	0.0 h/day		0 Wh
0	Domestic appliances	0 W/app	0.0 h/day		0 Wh
0	Fridge / Deep-freeze	0.00 kWh/day	24.0		0 Wh
0	Dish- and Cloth-washer	0.0 W aver.	2.0 h/day		0 Wh
0	Other uses	0 W/app	0.0 h/day		0 Wh
0	Other uses	0 W/app	0.0 h/day		0 Wh
Stand-by consumers		1 W tot	24 h/day		0 Wh
Total daily energy					0 Wh/day
Monthly energy					0.0 kWh/mth

Appliances info

Consumption definition by:

☒ Years ☐ Seasons ☐ Months

Week-end or Weekly use

☐ Use only during

7 days in a week

No appliance defined.

Model

Load Save Other profile Cancel OK

Figure 9: Consumption tab in the user's needs dialog.

The next step is to complete the table of daily consumption.

To do so, you will need to define the:

- number of appliances corresponding to the designation,
- unit power in Watts,
- the daily operating time.

You can modify / customize the name of each device in the "Appliance" section.

Please note that we are not talking about unit power, but the energy consumed (in kWh / day).

Once the definition of your energy requirements is complete, you have a balance sheet of the total daily and monthly energy consumed by your devices.

You can see that we have added 24 Watts on 24 hours a day for the Stand-By consumers. In fact, when your devices are off, very often a standby or other lamps remains on. It is therefore necessary to define this consumption in order to achieve a dimensioning closest to reality.

Daily use of energy, variant "New simulation variant"

Definition of daily household consumptions for the year.

Consumption | Hourly distribution

Daily consumptions

Number	Appliance	Power	Daily use	Hourly distrib.	Daily energy
4	Lamps (LED or fluo)	12 W/lamp	5.0 h/day	Specify hours	240 Wh
1	TV / PC / Mobile	240 W/app	4.0 h/day	Specify hours	960 Wh
3	Domestic appliances	28 W/app	2.0 h/day	Specify hours	168 Wh
1	Fridge / Deep-freeze	1.10 kWh/day	24.0 h/day	OK	1100 Wh
0	Dish- and Cloth-washer	0.0 W aver.	2.0 h/day		0 Wh
0	Other uses	0 W/app	0.0 h/day		0 Wh
0	Other uses	0 W/app	0.0 h/day		0 Wh
Stand-by consumers		24 W tot	24 h/day		576 Wh
Total daily energy					3044 Wh/day
Monthly energy					91.3 kWh/mth

Appliances info

Consumption definition by: ☒ Years ☐ Seasons ☐ Months

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

Appliance no 1: Please define the hourly distribution ! (second page)

Model: Load Save Other profile Cancel OK

Figure 10: Definition of daily household consumptions for the year.

Several error messages in red indicate that you are still yet to finish defining your “User’s needs”.

In fact, now that you have defined the devices and their power, you must enter the operating time slots for these devices.

It is important that these time slots are correctly completed because it is with these elements that the sizing of the photovoltaic field and the battery pack will be calculated by the “pre-sizing” tool.

When you click on the “hourly distribution” tab, the respective watch dials for your devices will be empty.

Only the dial for the refrigeration systems will be completed beforehand (obviously modifiable according to your project).

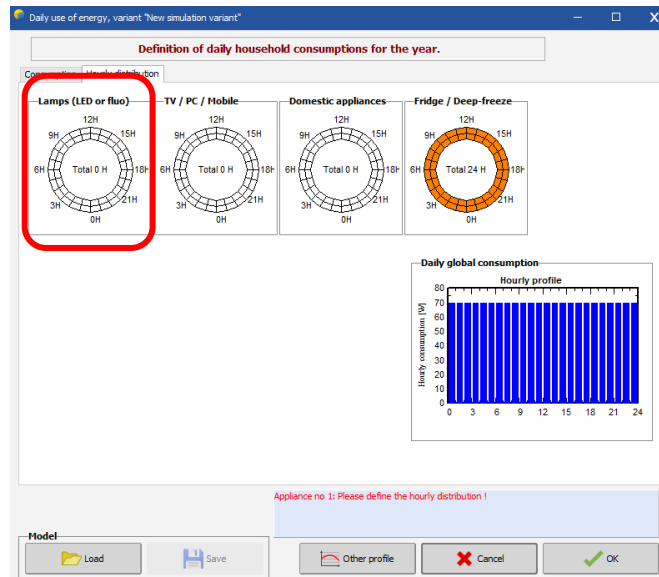


Figure 11: Defining the hourly distribution of each appliance.

Each dial is made up of 48 sections. Each section represents 30 min of the day. Left-click to define a schedule or a time range, and right-click to delete a schedule or a time range.

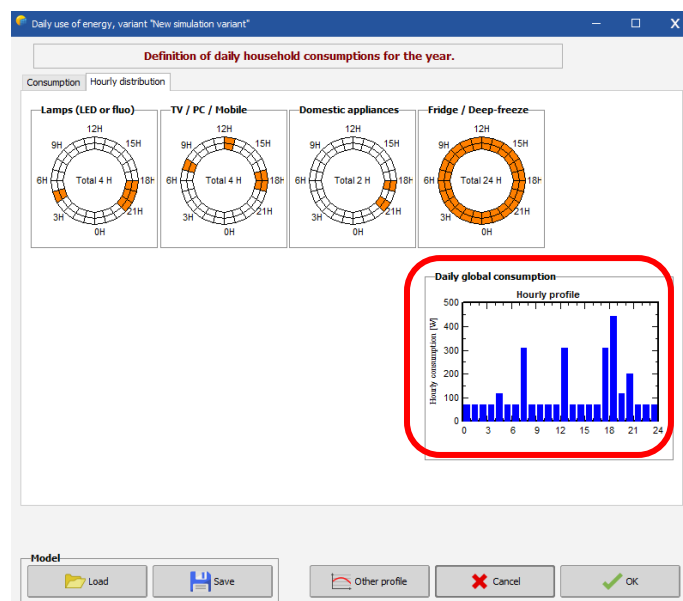


Figure 12: Daily consumption graph.

When you add a time slot, a graph corresponding to your daily consumption profile is automatically constructed.

Also, if the value of the operating hour positioned in the dials does not correspond to the daily use defined in the "Consumption" tab, the value defined in the dials in the "Hourly distribution" tab will be used for calculations.

Once the hourly distribution has been completed, you can return to the "Consumption" tab to check if a change in value has been made and if no error message appears.

Daily use of energy, variant "New simulation variant"

Definition of daily household consumptions for the year.

Consumption | Hourly distribution

Daily consumptions

Number	Appliance	Power	Daily use	Hourly distrib.	Daily energy
4	Lamps (LED or fluo)	12 W/lamp	4.0 h/day	OK	192 Wh
1	TV / PC / Mobile	240 W/app	4.0 h/day	OK	960 Wh
3	Domestic appliances	28 W/app	2.0 h/day	OK	168 Wh
1	Fridge / Deep-freeze	1.10 kWh/day	24.0	OK	1100 Wh
0	Dish- and Cloth-washer	0.0 W aver.	2.0 h/day		0 Wh
0	Other uses	0 W/app	0.0 h/day		0 Wh
0	Other uses	0 W/app	0.0 h/day		0 Wh
Stand-by consumers		24 W tot	24 h/day		576 Wh
Total daily energy					2996 Wh/day
Monthly energy					89.9 kWh/mth

Appliances info

Consumption definition by

☒ Years ☐ Seasons ☐ Months

Week-end or Weekly use

☐ Use only during

days in a week

Model

Load Save Other profile Cancel OK

Figure 13: Finalization of consumption definition.

When there is no longer a red message or an error message, you can validate this information by clicking OK. All these input parameters will be displayed in the final PDF report.

1.3.2 Other profile

Another way to define the consumption of the receivers is by importing a database in the CSV format. This can be done by clicking on the "Other profile" button, that gives you access to the table shown in **Erreur ! Source du renvoi introuvable.**

Here, you can define your consumption by:

- Loading a model,
- Fixing constant consumption,
- Defining the monthly values,
- Defining the daily profiles,
- Defining household consumers,
- Loading values from a CSV hourly / daily file.

Daily use of energy, variant "My first simulation"

Definition of daily household consumptions for the year.

Consumption | Hourly distribution

Daily consumptions

Number	Appliance	Power	Daily use	Hourly distrib.	Daily energy
4	Lamps (LED or fluo)	12 W/lamp	4.0 h/day	OK	192 Wh
1	TV / PC / Mobile	240 W/app	4.0 h/day	OK	960 Wh
3	Domestic appliances	28 W/app	2.0 h/day	OK	168 Wh
1	Fridge / Deep-freeze	1.10 kWh/day	24.0 h/day	OK	1099 Wh
0	Dish- and Cloth-washer	0.0 W aver.	0.0 h/day		0 Wh
0	Other uses	0 W/app	0.0 h/day		0 Wh
0	Other uses	0 W/app	0.0 h/day		0 Wh
Stand-by consumers		24 W tot	24 h/day		576 Wh
Total daily energy					2995 Wh/day
Monthly energy					89.9 kWh/mth

Appliances info

Consumption definition by: ☒ Years ☐ Seasons ☐ Months

Week-end or Weekly use: ☐ Use only during ☐ 7 days in a week

Model: Load Save **Other profile** Cancel OK

Figure 154: Defining consumption of receivers through "other profile".

User's needs definition/Variant: "My first simulation", Variant "My first simulation"

Comment: New User's needs

General features | Graph

Kind of load profile:

- ☐ Unlimited load (grid)
- ☐ Fixed constant consumption
- ☐ Monthly values
- ☐ Daily profiles
- ☐ Probability profiles
- ☒ Household consumers
- ☐ Load values from a CSV hourly/daily file

Household profiles:

- ☐ Constant over the year
- ☒ Seasonal modulation
- ☐ Weekly modulation

User's needs: Yearly energy defined

Average power: 457 W
Yearly energy: 4004 kWh/yr

Info system: Defined PV array

Nominal PV Power: 660 Wp
Estimated system yield: 1010 kWh/yr
PnomPV / PLoad average: 5.73 Pnom ratio

Domestic energy use values correctly defined, You can see them by pressing "Define household".

Model: Load Save Define household Print Cancel OK

Figure 145: Loading profiles.

Load values from a CSV hourly / daily file:

The most flexible way to define a custom load profile is to input it as an ASCII (CSV) hourly file.

Hourly Parameters file

The input source file should be prepared in a spreadsheet program (like MS-EXCEL), in the CSV-format (Comma Separated Values, separator may be semicolons or commas).

You can find a template named «PARAMS_Hourly_Template.CSV»:

- Either in the program's location, usually C:\ program files (x86) \ PVsyst7.x \ DataRO \ PVsyst7.0_Data \ Templates \
- Or in your workspace C: \ users \ YourSession \ PVsyst7.0_Data \ Templates \

In the latter case you should update/reload this file using «Files > Workspace > reload templates» in the main menu.

When modified, you will put your data file in your workspace \"user\" \ PVsyst7.0_Data \ user Hourly Params \.

PVsyst standard format for hourly parameters

The required format to import hourly parameters in PVsyst is the following:

- Text file (CSV format with commas or semicolons) written in ANSI (not UTF8).
- All lines beginning by # are comments, ignored.
- The blank lines are ignored.
- The first line without # holds the column title. It should begin by “date” and “P Load” for an hourly load power (other keywords for other parameters will be defined in the future).
- Second line: units of the data in this column, will be read and interpreted by the program.
- In sub-hourly data, specifying [kW] will be interpreted as powers (values will be averaged within the hour step), and [kWh] will be energies (values will be added within the hour).
- First column of data and hour EXCEL format (both European DD/MM/YY hh:mm or US MM/DD/YY hh:mm formats are recognized).
- Other columns: values according to the column title and units.
- The file should contain all hours of a generic year (from 01/01 at 0h00 to 31/12 at 23:00). The year is ignored.
- These dates/hours are not related to the real dates of your input meteorological file: they are for each hour of a generic year.
- Time label = beginning of the year.

Use of the file

After carefully preparing this file, the “Hourly Parameter” dialog will ask to choose it in your workspace \ UserHourlyParams\, or anywhere else.

The file content will appear, so that you can check it.

The program will also check its validity and give some integrated values so you can analyze it with plots.

The dialog will ask if you want to:

- Read the file at the time of the simulation (may be useful for batch mode),
- Read the file immediately and store it internally in your calculation version as input parameters for the simulation

Sub-hourly data

It is also possible to read sub-hourly data (for example Load profiles in 15-minutes steps).

Once the type of profile and the load are defined, you can click on "graph" to view the profile of your load.

On the abscissa axis, you will find the hours of operation per day by default.

On the ordinate axis, you will find the power of the load (previously defined).

You can change some display settings for the graph above:

- Values,
- Units,
- Number of Day.

Once all the data entered is set up and verified, you can validate it and continue your project by clicking on the "OK" button.

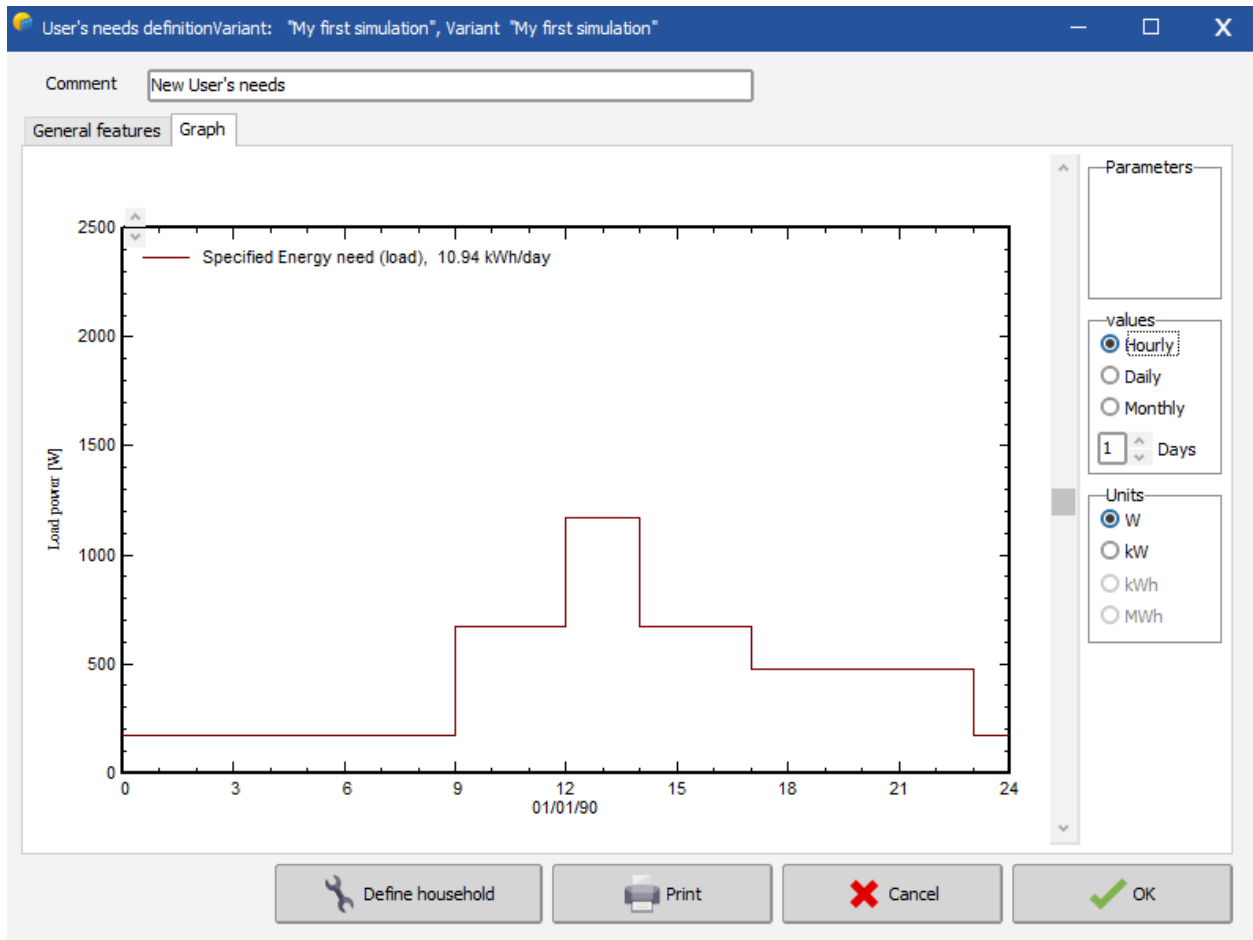


Figure 16: Graph of load power data in terms of hours.

1.4 Define the System

Once you defined the system orientation and your user's needs, the "System" tab will turn red which means that you can click on it to define your electrical system.

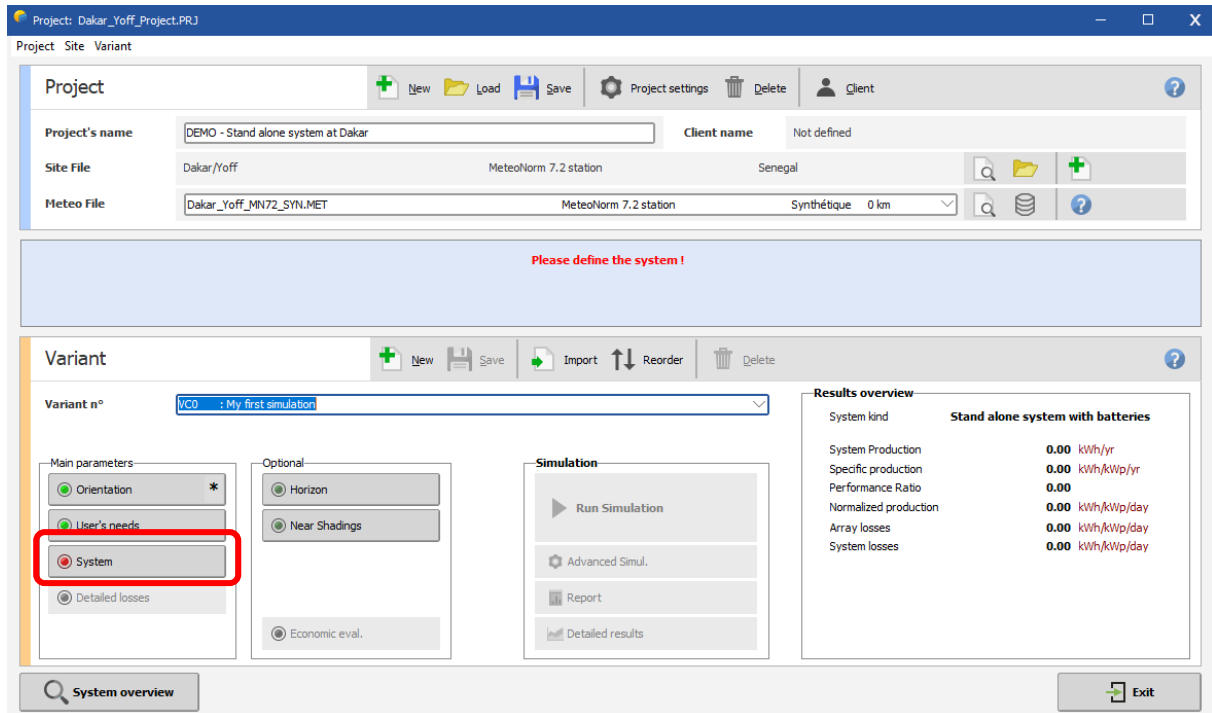


Figure 17: System definition.

In the "System" dialog, you must define the:

- characteristics of the battery pack,
- characteristics of the photovoltaic field,
- characteristics of the charge / discharge regulator.

You can add optional generator system via the "Back-up" tab.

The first tab in the "Systems" dialog contains several important information, such as:

- Pre-Sizing,
- Battery Set,
- Operating battery temperature.

Stand-alone system definition, Variant "My first simulation", Variant "My first simulation"

Av. daily needs
3.0 kWh/day/day

Enter accepted PLOL
5.0 %

Enter requested autonomy
4.0 day(s)

Detailed pre-sizing

Battery (user) voltage
24 V

Suggested capacity
587 Ah

Suggested PV power
695 Wp (nom.)

Storage PV Array Back-Up Simplified sketch

Procedure

The Pre-sizing suggestions are based on the Monthly meteo and the user's needs definition

- Pre-sizing: Define the desired Pre-sizing conditions (PLOL, Autonomy, Battery voltage)
- Storage: Define the battery pack (default checkboxes will approach the pre-sizing)
- PV Array design: Design the PV array (PV module) and the control mode. You are advised to begin with a universal controller.
- Back-Up: Define an eventual Genset

Specify the Battery set

Sort batteries by ☒ voltage ☐ capacity ☐ manufacturer

Generic 12 V 160 Ah Pb Sealed Gel Solar 12V / 160 Ah Since 2000

Lead-acid

2	☒ batteries in series	Number of batteries	8	Battery pack voltage	24 V
4	☒ batteries in parallel	Number of elements	48	Global capacity	640 Ah
100.0 %	Initial State of Wear (nb. of cycles)			Stored energy (80% DOD)	12.3 kWh
100.0 %	Initial State of Wear (static)			Total weight	594 kg
				Nb. cycles at 80% DOD	1300
				Total stored energy during the battery life	17066 kWh

Operating battery temperature

Temper. mode

The battery temperature is important for the ageing of the battery. An increase of 10 °C divides the "static" battery life by a factor of two.

Please choose the PV module. !

Figure 18: Defining the system's storage.

The Pre-Sizing tool calculates two pieces of information, the:

- Suggested capacity (battery),
- Suggested PV Power.

PLOL in percentage (%):

This value is the probability that the user's needs cannot be supplied (i.e., the time fraction when the battery is disconnected due to the "Low charge" regulator security).

It may be understood as the complement of the "Solar fraction" (although it is described in terms of time rather than energy). During the sizing process, the LOL requirement allows to determine the PV array size needed, for a given battery capacity.

The LOL is calculated using a simplified and fast yearly simulation: the program splits the monthly meteorological values into a realistic random sequence of 365 days (according to Collares-Pereira model), each day being divided into 3 periods: morning - day (with solar gains) - and evening. Then, it performs a day-by-day balance and reports the daily system state, in order to accumulate a realistic "LOL" yearly value.

This process is repeated with different PV-array sizes, in order to find the exact PV size matching the required "LOL".

Requested Autonomy in days:

In the Pre-sizing process, the proposed battery pack capacity is determined according to the required autonomy of the system, given in days.

The autonomy is defined as the time for which the load can be met with the battery alone, without any solar inputs, starting of course from a "fully charged" battery state. With non-constant loads (seasonal or monthly definition, weekly use), this is accounted as the worst-case scenario over the year.

The calculation takes the minimum SOC disconnecting threshold and the battery "energy efficiency" into account. It also has to apply a capacity correction, as this mode of use usually occurs at a rather slow discharge rate (therefore corresponding about to the C100 capacity definition, i.e., with discharge in about 100 hours); when the nominal capacity of the batteries in the PVsyst database is defined as the C10 value. The C100/C10 ratio is usually in the order of 120% to 130%.

These 3 sizing parameters are adjustable in the "Hidden parameter".

NB: When defining a very large autonomy, the global system optimization process will choose the "minimum" PV size which just meets the required "LOL".

This may lead to a very low average State of Charge value over large periods of the year, which is quite damaging for the battery.

Battery (user) voltage:

In a stand-alone PV system with direct coupling to the user (without inverter), the battery voltage determines the distribution voltage. Nowadays, many DC appliances can be found in 24V as well as in 12V. this choice should be made according to the system and/or appliance's power, as well as the extension of the planned distribution grid to minimize the ohmic wiring losses.

This choice should be made at the early planning stage of an installation, since the existing appliance voltage usually cannot be changed, and voltage translators will be expensive and not 100% efficient.

The rated distribution values could be chosen according to the following criteria (inverter supposed directly connected on the battery pack):

- 12V - small systems for lighting and TV:
 - Appliance max power: < 300 W.
 - Corresponding current: 25 A.
 - Inverter: about < 1 kW.

- 24V - medium size, household with fridge and little appliances, or wiring extension to more than 10 m:
 - Appliance max power: < 1000 W.
 - Corresponding current: 42 A.
 - Inverter: about < 5 kW.

- 48V - special industrial or agricultural use:
 - Appliance max power: < 3 kW.
 - Corresponding current: 62 A.
 - Inverter: about < 15 kW.

Higher powers require either high DC voltages (special appliances) or AC feeding through inverter.
NB: In a battery pack, when a cell is weaker than the other ones, it will drain out faster.

As all the cells are connected in series, i.e., with the same current, it may encounter deep discharges, or even reverse polarization (the forced current may reverse the polarity, like for the Hot spot in a PV array).

This will still further damage this bad cell. In the same way, during charging, as the capacity is lowered, the overcharging conditions will produce gassing before the other cells, leading to loss of electrolyte.

Therefore, in high voltage battery packs, in absence of a careful maintenance or compensating strategies, the risk of failure is strongly increased.

Pre-sizing Help tool:

With this tool, you can define a maximum surface or power that you want to install.

When a value is defined in one of the two boxes, the software will make a wiring suggestion via the PV Array Design tool.

Stand-alone system definition, Variant "My first simulation", Variant "My first simulation"

Av. daily needs Enter accepted PLOL 5.0 % ? Battery (user) voltage 24 V ?
3.0 kWh/day/day Enter requested autonomy 4.0 day(s) ? Suggested capacity 587 Ah
Suggested PV power 695 Wp (nom.)

Detailed pre-sizing

Storage PV Array Back-Up Simplified sketch

Sub-array name and Orientation
Name PV Array
Orient. Fixed Tilted Plane Tilt 15° Azimuth 0°

Presizing Help
☐ No sizing Enter planned power 0.7 kWp
... or available area 0 m²
Resize

Select the PV module
All modules Sort modules Power Technology
Generic 110 Wp 29V Si-poly Poly 110 Wp 72 cells Since 2015 Typical Open
Sizing voltages : Vmpp (60°C) 29.2 V
Voc (-10°C) 48.7 V

Select the control mode and the controller
☐ Universal controller Generic Direct coupling of PV array to battery
Operating mode Max. Charging - Discharging current
☒ Direct coupling Series 24 V 30 A 18 A Universal direct controller Open
☐ MPPT converter
☐ DC-DC converter Number of controllers 1 2

PV Array design
Number of modules and strings
Mod. in series 1 should be: 1 mod. nominal
Nb. strings 6 between 6 and 8
Nb. modules 6 Area 5 m²

Operating conditions:
Vmpp (60°C) 29 V
Vmpp (20°C) 35 V
Voc (-10°C) 49 V
Plane irradiance 1000 W/m²
Imp (STC) 19.1 A
Isc (STC) 20.7 A
Isc (at STC) 20.4 A
Max. operating power at 1000 W/m² and 50°C 0.7 kW
Array nom. Power (STC) 660 Wp

Figure 19: Presizing help tool.

Universal controller:

During the early stage of the study for a stand-alone system, the main issues are the global system sizing, i.e., the determination of the Battery pack, the PV array power, in terms of the user's needs and the meteorological conditions. After the quick pre-sizing evaluation, the results (PLOT, unused energy) must be assessed with a detailed hourly simulation.

The exact regulator strategy does not matter. To get rid of the control constraints, PVsyst introduces a general purpose "generic" universal controller, for the 3 different strategies: Direct coupling, MPPT converter or DCDC converter.

During the sizing process (specification of the battery pack and PV array), these special devices will adapt their parameters to the system, in order to always stay compatible with a normal behavior without control losses during the hourly simulation.

The main parameters to be adapted are:

- The control thresholds: their default values are specified in the "Hidden parameters" in terms of SOC. But you can change them for threshold's dependency studies and eventually define them in terms of Battery voltage.
- Temperature corrections for the battery voltage thresholds.
- With Power conditioning units, the input Voltages and Power according to the modules of the array, as well as the efficiency curve. The efficiency values (Euro and Max efficiencies) may be explicitly modified.
- The maximum Charging, Load and Back-up currents.
- Management of the back-up control if a Genset is specified.

All these parameters are stored in your calculation variant, therefore also keeping your modifications.

If you want to keep a specific configuration for further use, you can always save this Universal converter with the present parameters. In this case, please give it a significant name to the Manufacturer and Model parameters. You are advised to save it under a name like "Manufacturer_Model.RLT in your own database.

1.5 Executing the first simulation

On the Project's dashboard, all buttons are now green (occasionally orange) or off.

The "Run simulation" button is activated and we can click on it.

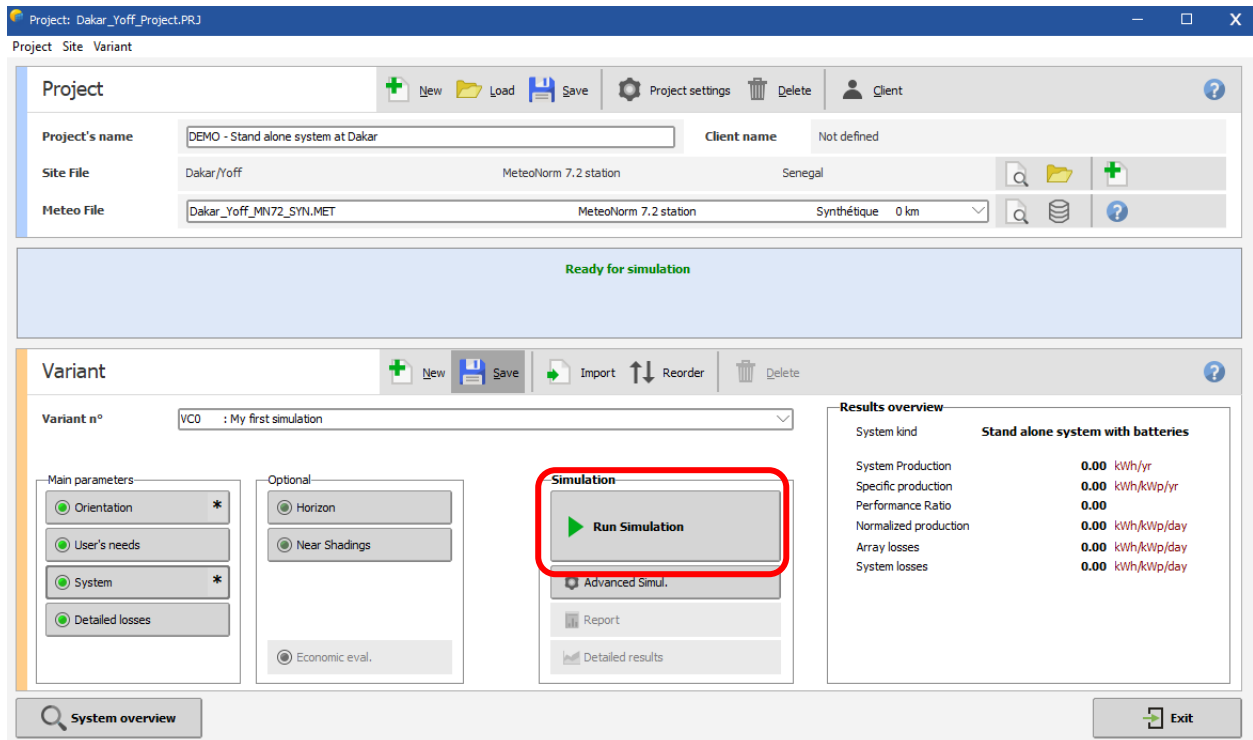


Figure 20: Run simulation.

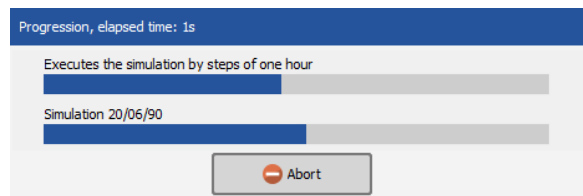


Figure 21: Progress bar.

A progress bar will appear, indicating how much of the simulation is still to be performed. Upon completion, you will be directed to the "Results" dialog.

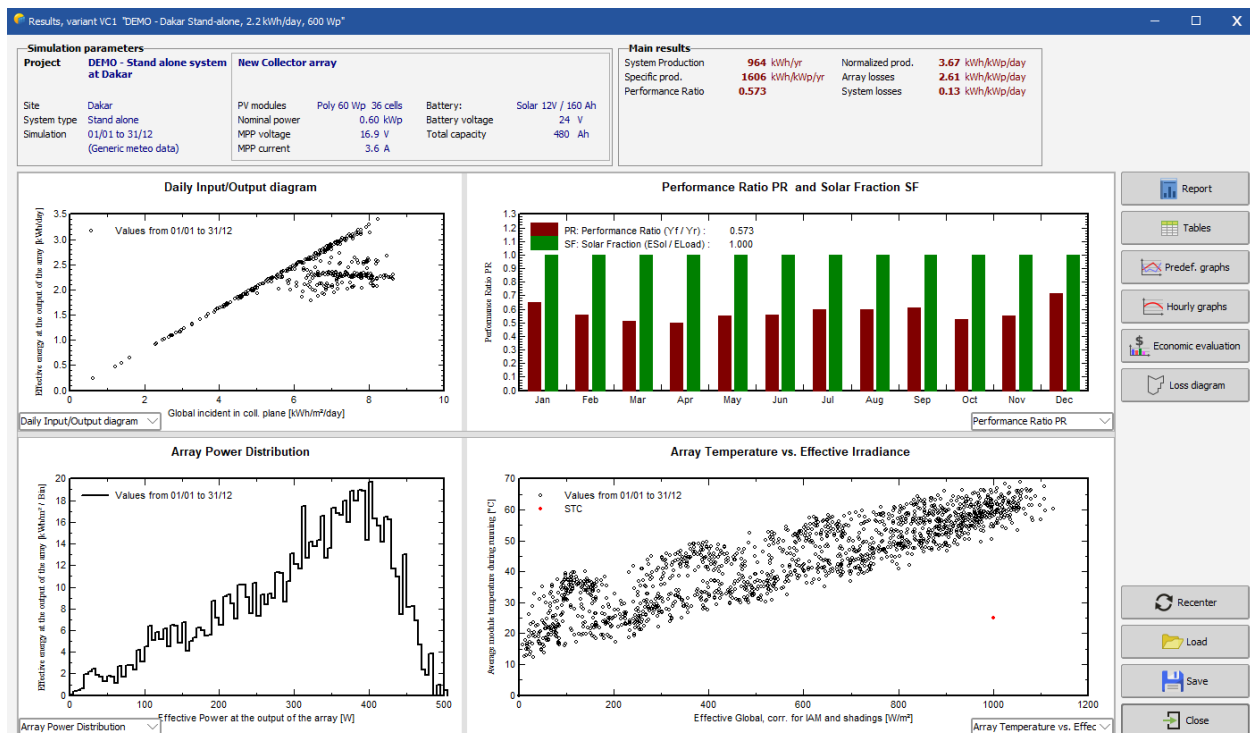


Figure 22: Results dialog.

On the top of the dialog is a summary of the simulation parameters that you should give a quick check to make sure that you made no obvious mistake in the input parameters. On its' right is a frame with six values that summarize at one glance the main results of the simulation. They only give a very rough picture of the results and are there to quickly spot obvious mistakes or to get a first impression of a change or a comparison between variants of the project.

The main information of the simulation results is gathered in the report. The other buttons give access to complementary tables and graphs for a deeper analysis of the simulation results. For now, we will ignore them. When you click on , you will get the complete report, which for this first simple variant consists of 7 pages (for simulations with more detail you can get up to 11 pages of report). In this report you will find:

Cover page: Various aspects of the simulation project and variant name including the PVsyst version number and information about the system kind, size and location

Second page: A high level summary of the project system and results of the simulation variant. A fully defined geographical site and meteo properties. Table of contents of the report is also provided.

Third page: General underlying parameter of the simulation: the system kind, plane orientation, general information about shadings (horizon and near shadings), components used and array configuration, loss parameters.

Fourth page: A detailed information on the user's need where the consumption of each households are presented in tables according to the season, and graph on the hourly distribution is illustrated on the bottom of the page.

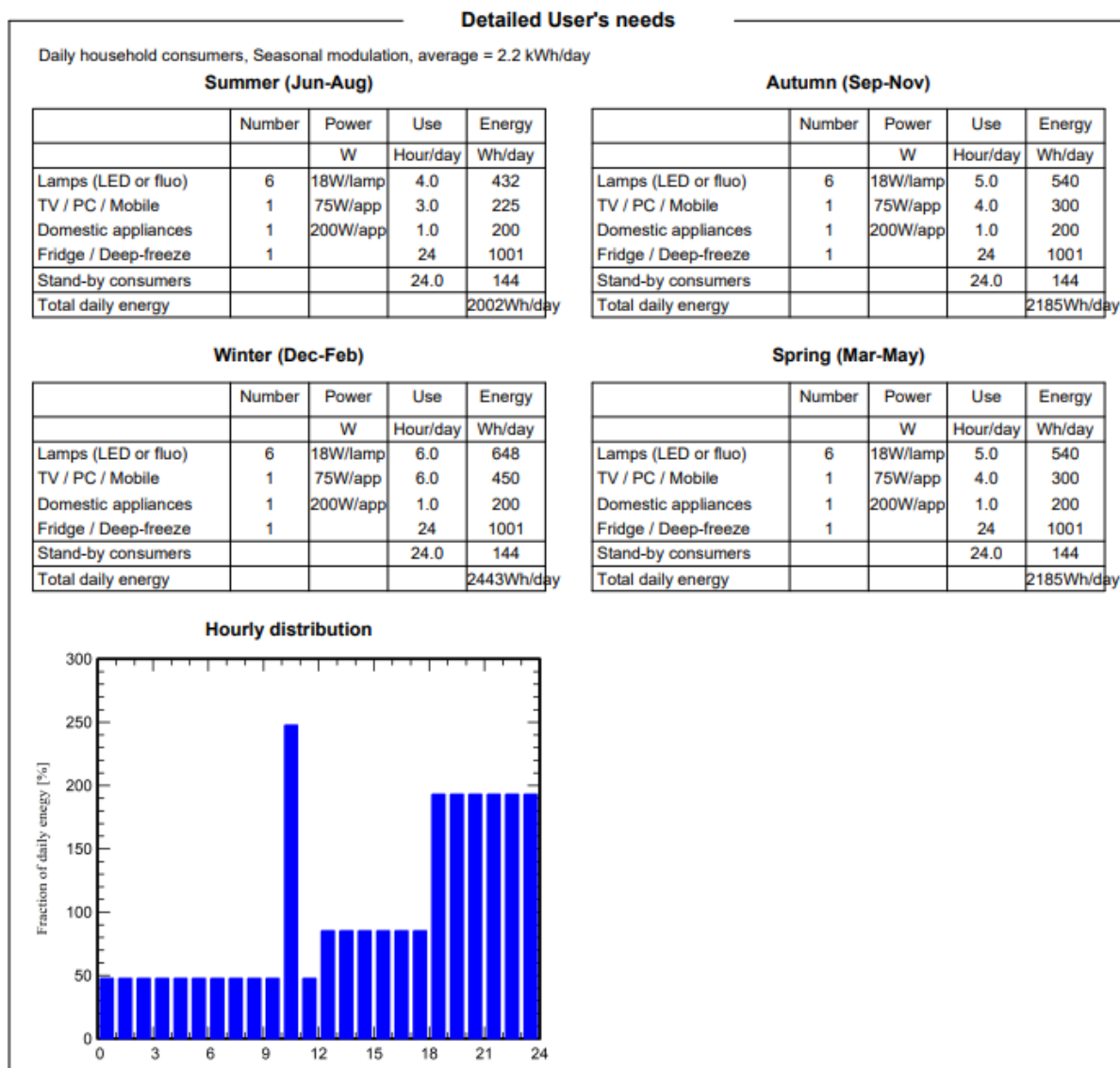


Figure 23: Detailed user's needs and hourly distribution.

Fifth page: This page displays the main results of the simulation, starting by defining three relevant quantities:

- System production,
- Loss of Load,
- Battery aging.

Main results			
System Production			
Available Energy	963.9 kWh/year	Specific production	1606 kWh/kWp/year
Used Energy	803.8 kWh/year	Performance Ratio PR	57.30 %
Excess (unused)	132.4 kWh/year	Solar Fraction SF	100.00 %
Loss of Load			
Time Fraction	0.0 %	Battery aging (State of Wear)	
Missing Energy	0.0 kWh/year	Cycles SOW	97.4 %
		Static SOW	90.0 %
		Battery lifetime	10.0 years

Figure 24: Main results of the simulation.

The monthly graphs are also presented below where the graph on the left represents the normalized production and the one on the right represents the performance ratio.

The bottom of this page consists of a table with the main variables, given as monthly values and the overall yearly value. The yearly value can be an average like the temperature, or a sum, like the irradiation or energies. The meaning of the different variables is the following:

- GlobHor: Global irradiation in the horizontal plane. This is our meteorological input value.
- GlobEff: Ambient (dry-bulb) average temperature. This is also our meteorological input value.
- E_Avail: Available Solar Energy.
- EUnused: Unused energy (battery full).
- E_Miss: Missing energy.
- E_User: Energy supplied to the user.
- E_Load: Energy need of the user (Load).
- SolFrac: Solar fraction (EUsed / ELoad).

Balances and main results

	GlobHor kWh/m ²	GlobEff kWh/m ²	E_Avail kWh	EUnused kWh	E_Miss kWh	E_User kWh	E_Load kWh	SolFrac ratio
January	165.9	183.8	78.91	0.00	0.000	75.73	75.73	1.000
February	181.6	192.7	83.92	9.19	0.000	68.40	68.40	1.000
March	211.1	209.7	92.05	20.95	0.000	67.73	67.73	1.000
April	223.9	208.1	91.34	23.02	0.000	65.54	65.54	1.000
May	218.7	192.3	84.25	16.02	0.000	67.73	67.73	1.000
June	196.4	169.5	74.29	9.65	0.000	60.05	60.05	1.000
July	184.7	162.0	71.00	7.08	0.000	62.06	62.06	1.000
August	180.3	164.3	71.87	8.06	0.000	62.06	62.06	1.000
September	175.4	168.9	73.80	6.99	0.000	65.54	65.54	1.000
October	198.0	204.4	89.48	17.91	0.000	67.73	67.73	1.000
November	170.4	186.7	81.68	13.21	0.000	65.54	65.54	1.000
December	150.1	166.6	71.26	0.30	0.000	75.73	75.73	1.000
Year	2256.5	2209.0	963.85	132.38	0.000	803.84	803.84	1.000

Figure 25: Monthly graphs in main results.

Sixth page: The PVsyst arrow loss diagram, showing an energetic balance and all losses along the system. This is a powerful indicator of the quality of your system, and will immediately indicate the sizing errors, if any. This is the PVsyst way of reporting the systems' behavior, with all detailed losses. This diagram is very useful for the analysis of the design choices and should be used when comparing systems or variants of the same project.

Note that there are different types of arrows on the diagram: The outward facing arrows represent losses of energy from the simulation. The size of the arrows is proportional to the loss amount of the system. The inward facing arrows represent energy gained of the system and the percentage are noted with a positive sign (+).

The report can be sent to a printer or copied to the clipboard.

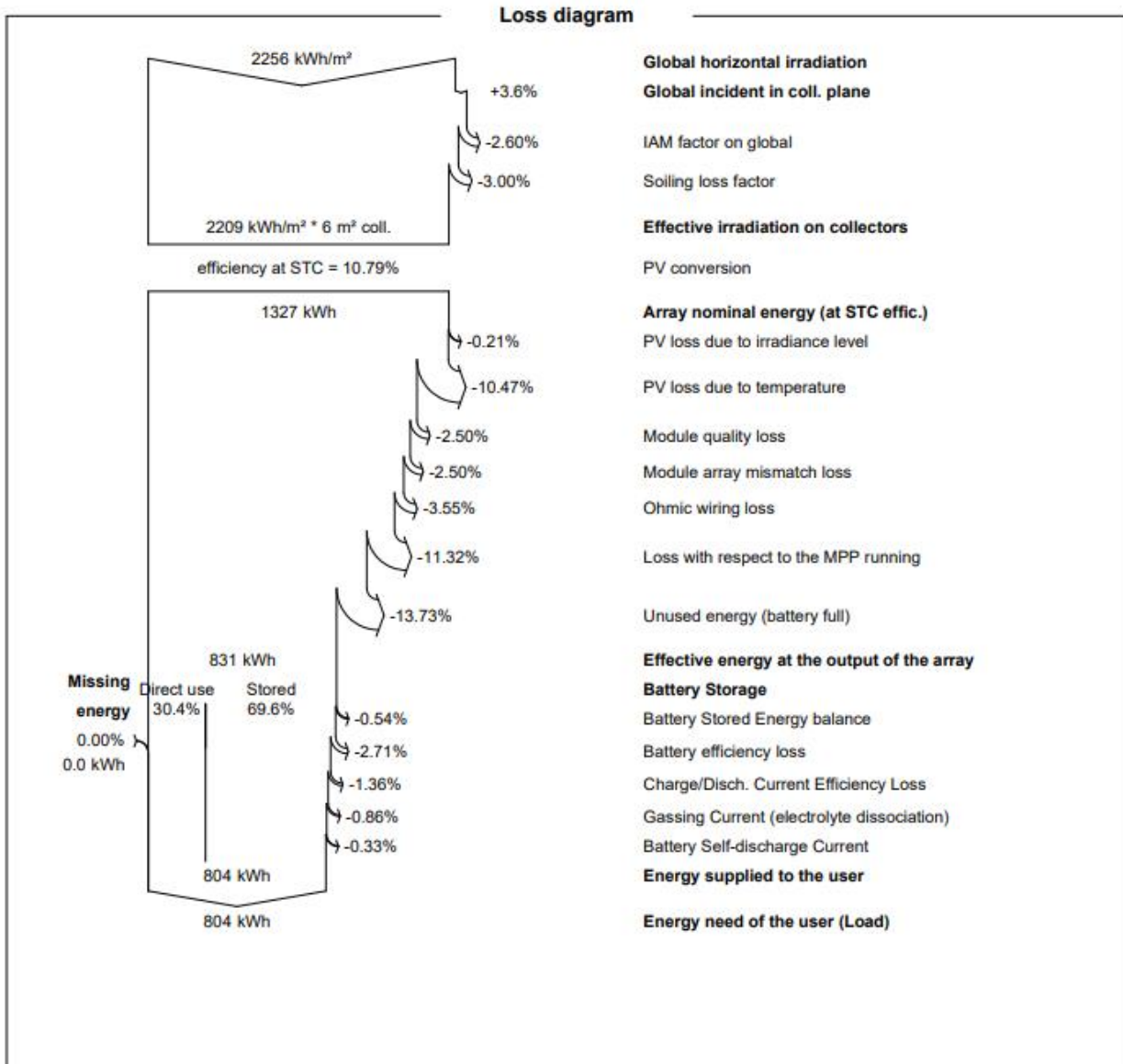


Figure 26: Arrow loss diagram.

Seventh page: Special graphs on the simulation. Daily input/output diagram and the distribution of power injected to the grid are shown.

1.6 Conclusion

In this document, we demonstrated the basic approach to run a first simulation project for stand-alone system project on PVsyst using an example, starting from the project specifications, defining its variants to executing and analyzing the results on the report.