

TUTORIAL PVSYST SA

PVsyst 7

Stand Alone



www.pvsyst.com

INTRODUCTION

This document contains two different tutorials describing basic aspects of a simulation:

- Creation of a Stand-Alone project
- Study of the report

More tutorials are in preparation and will be added in the future. They will explain in more detail the different features of PVsyst. The complete reference manual of PVsyst is the online help, which is accessible from the program through the "Help" entry in the top menus, by pressing the F1 key or by clicking on the ?? help icons within windows and dialogs.

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Part 1: Basic Approach - My First Project

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.
- The user's needs (consumption) should be well defined, with its daily profile (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).

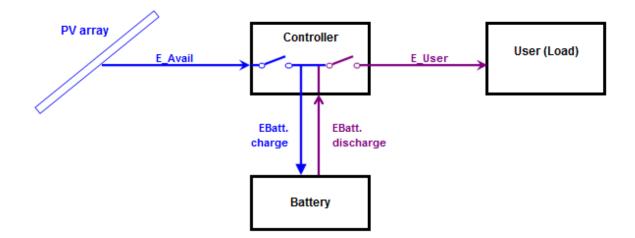
This energy balance is controlled by a controller. The role of the controller is to handle the energy flow, mainly for the protection of the battery:

- 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 reconnexion will be performed with a specified hysteresis, depending on the state of charge (SOC) of the battery.

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



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

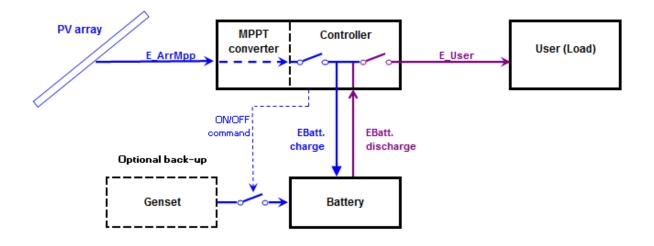
With these simple systems, the PV array (one or few modules) is usually connected directly to the battery, without power conditioning. This implies that the PV modules should be "12V" or "24V" modules, i.e. with 36 or 72 cells.

This type of installation is managed with 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 of controlling the load when the battery is empty.



Medium power systems (small household, communications):



These systems usually range between 200 Wp and 2 kWp.

The controller includes a power conditioning unit, able to 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).

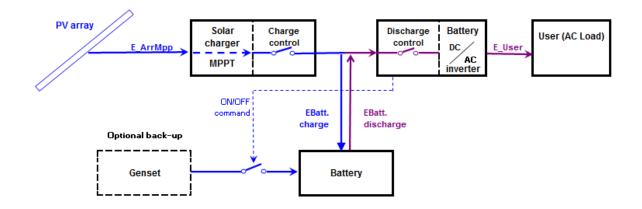
These installations may power lighting, fridges, washing machines, dishwashers, small electro-tools, etc. These may also be used in some small remote communication stations.

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

At present, PVsyst doesn't 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.)



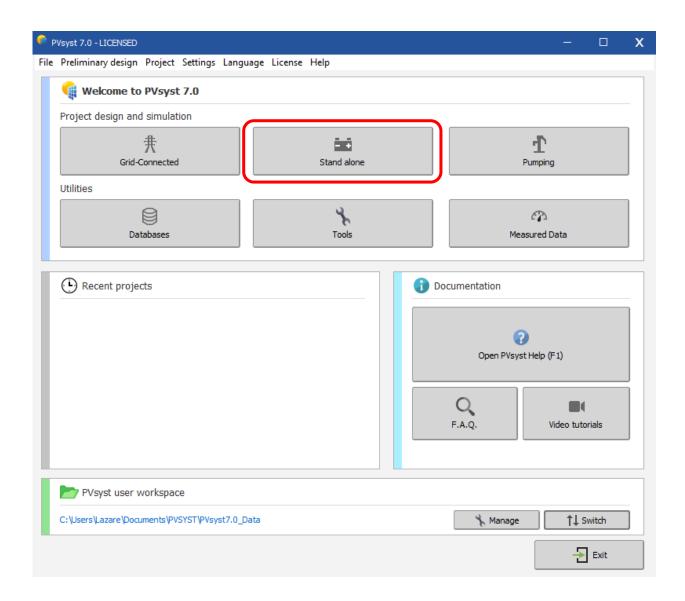


These may be stand-alone systems of 2 kWp to several dozens of kWp.

Such installations are using 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.





Stand-Alone system procedure:

This gives a step-by-step procedure when defining a stand-alone system in PVsyst.

First step:

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

Second step:

You are 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 of defining a load profile (including by a list of hourly values).

Third step:

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 for "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 study, for different meteorological distributions, or according to the PLOL parameter.

Fourth step:

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.

Fifth step:

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

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

In a first step, you are advised to choose 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.



2- Define Orientation

Creating the first (basic) variant for this project

After having defined 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 means 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.

ject: Dakar_Yoff_Proj t Site Variant	ect.PKJ	-	
Project		🛨 New 🎦 Load 💾 Save 🔯 Project settings 前 Delete 👗 Client	
roject's name	Demo Dakar _ Stand Alone	Client name Not defined	
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1eteo File	Dakar_Yoff_MN72_SYN.MET	MeteoNorm 7.2 station Synthétique 0 km 🕥 📿 😂 ဈ	
		The orientation is not defined.	
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Firstly, you need to click on "Orientation Button":

Orientation, Variant "DEMO - Dakar Stand-alone,	2.2 kWh/day, 600 Wp"			—		x
Field type Fixed Ti	ted Plane]				
Field parameters	Tilt 15°		Azimuth 0°			
Azimuth 0.0		West	South	1	East	
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Optimization with respect to Vearly irradiation yield						
Summer (Apr-Sep) Winter (Oct-Mar)	1.2 Winter 1.0		1.2			١
Winter meteo yield Transposition Factor FT 1.05 Loss With Respect To Optimum -3.0% Global on collector plane 2288 kWh/m²	0.8 FTranspos. = 1.05 Loss/opt. = -3.0%		- 0.8 - - - - -90 -60 -30	<u>1</u>	- - - 60 90	D
Global on collector plane 2288 kWn/m ²	Plane tit		Cancel	rientation	ок	<u>ר</u>

This is a tool aiming 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 for 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 of choosing the optimization period: 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.

Clicking "Show optimization" button, you can see a graph of the Transposition Factor as a function of the plane tilt and azimuth. These graphs also indicate your actual choice by a violet dot on the curves, showing at once where you are positioned with respect to the optimum.



3- Basic 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 needs definition interface

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" tab.

t Site Variant	ject.PRJ	-	
Project		🛨 New 📂 Load 💾 Save 🔯 Project settings ញ Delete 🚨 Client	
Project's name	DEMO - Stand alone system at Daka	ar Client name Not defined	
ite File	Dakar/Yoff	MeteoNorm 7.2 station Senegal 💽 📂 💼	
eteo File	Dakar_Yoff_MN72_SYN.MET	MeteoNorm 7.2 station Synthétique 0 km 🗸 👌 💡	
'ariant		E New E Save Import A Reorder	
/ariant /ariant n°	VC0 : New simulation variant	Import Import	eries
ariant nº	VC0 : New simulation variant Optional Wear Shadings	Simulation Results overview System kind Stand alone system with batt System kind Stand alone system with batt System Production 0.00 kWh/kW Performance Ratio 0.00 kWh/kW Normalized production 0.00 kWh/kW Array losses 0.00 kWh/kW	eries p/yr p/day p/day
Ariant n° Aain parameters Orientation User's needs	Optional Optional Optional	Simulation Results System kind Stand alone system with batt Num System Production 0.00 kWh/yr Specific production 0.00 kWh/yr Normalized production 0.00 kWh/yr Normalized production 0.00 kWh/yr	eries p/yr p/day p/day
ariant n° Main parameters	Optional Optional Optional	Simulation System Kind Stand alone system with batt s Simulation 0.00 kWh/kWl Run Simulation 0.00 kWh/kWl Yearding production 0.00 kWh/kWl Array losses 0.00 kWh/kWl System Size 0.00 kWh/kWl	eries p/yr p/day p/day



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
- Months

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

Daily use of energy, variant "New simu	ulation variant"			- 0	
Definitio	n of daily househ	old consumptions for the ye	ar.		
onsumption 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		
Appliances info		Total daily energy	0 Wh/day		
Appliances info		Monthly energy	0.0 kWh/mth		
Consumption definition by Years Seasons Months	Week-end or Week				
Yodel	P	vo appliance defined.			

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

To do this, you will need to define:

- 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.

🕝 D	aily use of	energy, variant "New simul	ation variar	nt"				—		х
Γ		Definition	n of daily	househ	old consumpt	tions for the ye	ar.]		
Co	nsumption	Hourly distribution]		
		sumptions								
		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	ОК	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			
U1					Total da	ily energy	3044 Wh/day			
	A	ppliances info			Mont	nly energy	91.3 kWh/mth			
	Consum 9 Years 9 Seaso 9 Month	ns	Use only	d or Weel / during ays in a wee						
—M	odel				Appliance no 1: P (second page)	ease define the hou	rly distribution !			
		> Load	Save			Other profile	X Cancel	 ✓ 	ок	

Several error messages in red indicate that you have not finished 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).

루 Daily use	of energy, variant "N	lew simulation variant*			-		х
Con	De	finition of daily househo	old consumptions for th	e year.			
-Lamp	s (LED or fluo)	-TV / PC / Mobile	Domestic appliances	Fridge / Deep-freeze			
9H 6H 3H	Total 0 H OH	9H 6H Total 0 H 3H 0H	9H 6H Total 0 H 3H 0H	9H 15H 6H Total 24 H 18H 3H 21H 0H			
				Daily global consumption			
				80 Hourly pro	ofile		
				Al (6) (6) (6) (6) (6) (6) (6) (6)	2 15 18	21 24	L
		۵	ppliance no 1: Please define th	e hourly distribution !			
Model	boad	Save	Other profile	X Cancel	-	ок	

Each dial is made up of 48 sections. Each section represents 30 min of the day. To define a schedule or a time range you can do so using the left mouse button.

	De	finition of daily househo	d consumptions for the	e year.		
onsumption	Hourly distribution	n				
9H	LED or fluo) 12H 15H Total 4 H	TV / PC / Mobile 12H 9H 6H Total 4 H	Domestic appliances	Fridge / Deep-freeze 12H 9H 15H 6H Total 24 H 18H		
зн	OH 21H	3H OH	3H OH Z1H	3H 0H 0H Daily global consumption	ofile	
				500 (A) 400 - (A) 100 - 100 - 400 - 400 - 400 -		
				0 3 6 9 1	2 15 18	21

To delete a schedule or a time range you can do this by using the right click of your mouse.

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.

	Definition	of daily	househ	old cons	umpt	ions for the yea	ar.			
onsumption	Hourly distribution									
Daily con	sumptions									
Number	Appliance	Power		Daily use	e	Hourly distrib.	Daily er	nergy		
4 ^	Lamps (LED or fluo)	12	W/lamp	4.0	h/day	ок	192	Wh		
1 ^	TV / PC / Mobile	240	W/app	4.0	h/day	ок	960	Wh		
3	Domestic appliances	28	W/app	2.0	h/day	ок	168	Wh		
1 ^	Fridge / Deep-freeze	1.10	kWh/day	24.0		ок	1100	Wh		
0	Dish- and Cloth-washer	0.0	W aver.	2.0	h/day		0	Wh		
0	Other uses		W/app	0.0	h/day		0	Wh		
0	Other uses		W/app	0.0	h/day		0	Wh		
	Stand-by consumers	24	W tot	24 h/da	у		576	Wh		
0				То	tal da	ily energy	2996	Wh/day		
A)	opliances info					ly energy		kWh/mth		
Consum Years Seaso Month	ns	Week-end		-						

When there is no longer a red message or an error message, you can validate this information by clicking OK.

All of these input parameters will be displayed in the final PDF report.



4- Define the System

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

roject	1	ew 📂 Load 💾 Save 🛛 🕸 Project settings 🍈 Delete 🔹 Glient	
oject's name	DEMO - Stand alone system at Dakar	Client name Not defined	
te File	Dakar/Yoff	MeteoNorm 7.2 station Senegal 🔍 📂 🕇)
teo File	Dakar_Yoff_MN72_SYN.MET	MeteoNorm 7.2 station Synthétique 0 km 🖂 📃 🧯	
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	VC0 : My first simulation	jew 💾 Save 🖌 Import 📬 Reorder 👘 Delete 	th batteries
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riant n° ain parameters Orientation	VC0 : My first simulation	Simulation System Kind Stand alone system will System Kind Stand alone system will System Forduction 0.00 k Specific production 0.00 k Performance Ratio 0.00 k Normalized production 0.00 k	Wh/yr
riant n° ain parameters Orientation	VCO : My first simulation	Simulation Simulation Simulation Run Simulation Run Simulation 0.00 k Array losses 0.00 k	Wh/yr Wh/kWp/yr Wh/kWp/day
riant n°	VCO : My first simulation	Simulation System Kind Stand alone system will Run Simulation System Voduction 0.00 k Run Simulation Run Simulation Normalized production 0.00 k Array losses 0.00 k System System System System System System	Wh/yr Wh/kWp/yr Wh/kWp/day Wh/kWp/day

In the "system" tab, you must define:

- 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



In this first window several important information:

- Pre-Sizing
- Battery Set
- Operating battery temperature

Av. daily needs Enter accepted 3.0 kWh/day/day Enter requester Deta	d autonomy 4.0 0 day(s)	st simulation" Battery (user) voltage Suggested capacity Suggested PV power	24 ≎ V 587 Ah 695 Wp (nom.)	
1 Pre-sizing Define 2 Storage Define 3 PV Array design Design	e-sizing suggestions are based on the Mor the desired Pre-sizing conditions (PLOL, A the battery pack (default checkboxes will the PV array (PV module) and the control an eventual Genset	utonomy, Battery volta approach the pre-sizin	age) g)	ontroller.
Sort batteries by voltage Generic Lead-acid C batteries in series	12 V 160 Ah Pb Sealed Gel	B	h Since 2000 attery pack voltage ilobal capacity tored energy (80% DOD)	24 V 640 Ah 12.3 kWh
4 & batteries in paral 100.0 & M Initial State of 100.0 & Initial State of Operating battery temperat	Number of elements f Wear (nb. of cycles) f Wear (static)	48	gy during the battery life	594 kg 1300 17066 kWh
Temper. mode External ambient The battery temperature is import battery. An increase of 10 °C divid by a factor of two.	ant for the ageing of the		Please choose the P	V module. !

The Pre-Sizing tool calculates two pieces of information:

- Suggested capacity (battery)
- Suggested PV Power

<u>PLOL in % :</u>

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 for determining 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 day(s :

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 during which the load can be met with the battery alone, without any solar inputs, starting of course from a "full 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 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 be empty earlier.

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 damage further 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 simulati	ion", Variant "My	/ first simulation"		
Av. daily needs Enter accepted PLOL 5.0 3.0 kWh/day/day Enter requested autonomy 4.0 Image: Comparison of the second	% ? day(s) ?	Battery (user) volt Suggested capacity Suggested PV powe	/ 587 Ah	
Storage PV Array Back-Up Simplified sketch				
Sub-array name and Orientation Name PV Array Orient. Fixed Tilted Plane Azir	Tilt 15° nuth 0°	Presizing Help O No sizing Resize	Enter planned power O 0.7 or available area O 0	/ kWp m ²
Select the PV module				
All modules Sort modules O Pow	er O Ted	nnology		
Generic 🗸 110 Wp 29V Si-poly	Poly 110 Wp	72 cells Since 20	15 Typical 🗸	Q Open
	s: Vmpp (60°C) Voc (-10°C)	29.2 V 48.7 V		
Select the control mode and the controller	Direct couplin	g of PV array to batte	rv	
🕜 🗆 Universal controller 🛛 Generic 🔍) · ·		,	
Operating mode Series 24 V	^o Max. Charging 30 A	 Discharging current 18 A Universa 	al direct controller	🗁 Open
Direct coupling MPPT converter		IOA Oniversa		
O DC-DC converter				
PV Array design Number of modules and strings Mod. in series 1 2 1 mod. nominal Nb. strings 6 2 between 6 and 8	Operating cor Vmpp (60°C) Vmpp (20°C) Voc (-10°C)	nditions: 29 V 35 V 49 V		
Nb. modules 6 Area 5 m ²	Plane irradian Impp (STC) Isc (STC) Isc (at STC)	ce 1000 W/m² 19.1 A 20.7 A 20.4 A	Max. operating power at 1000 W/m ² and 50°C) Array nom. Power (STC)	0.7 kW 660 Wp

Universal controller:

During the early stage of a stand-alone system study, the main issues are the global system sizing, i.e. the determination of the Battery pack, the PV array power, as function of the user's needs and the meteorological conditions. After the quick pre-sizing evaluation, the results (PLOL, 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

5- Executing the first simulation

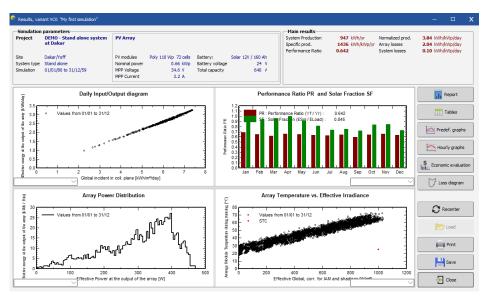
On the Project's dashboard, all buttons are now green (occasionally orange) or Off.

roject: Dakar_Yoff_Proj	t.PRJ – 🗆	
ct Site Variant		
Project	🚹 New 📂 Load 💾 Save 🔯 Project settings 🛅 Delete L Qient	6
Project's name	DEMO - Stand alone system at Dakar Client name Not defined	
Site File	Dakar/Yoff MeteoNorm 7.2 station Senegal	
Meteo File	Dakar_Yoff_MN72_SYN.MET MeteoNorm 7.2 station Synthétique 0 km 🖂 📿 🤤 🕢	
	Ready for simulation	
Variant	★ New Bave Import ↑↓ Reorder Im Delete	6
Variant n°	VC0 : My first simulation Stand alone system with batteries System kind Stand alone system with batteries	
Main parameters Orientation User's needs System Detailed losses	*	
🔍 System overvi	-E Exit	
	Progression, elapsed time: 1s Executes the simulation by steps of one hour Simulation 20/06/90	

The "Simulation" button is activated, and we can click on it.



A progress bar will appear, indicating how much of the simulation is still to be performed. Upon completion, the "OK" button will get active. When you click on it, you will get directly to the "Results" dialog.



This dialog shows on the top a small summary of the simulation parameters that you should quickly check to make sure that you made no obvious mistake in the input parameters. Below is a frame with six values that summarize at one glance the main results of the simulation. They only give a very coarse 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 only three pages (for simulations with more detail you can get up to 11 pages of report). In this report you will find:

First page: All the parameters underlying this simulation: Geographical site and meteorological data used, plane orientation, general information about shadings (horizon and near shadings), components used and array configuration, loss parameters, etc.

Second page: A reminder of the main parameters, and the main results of the simulation, with a monthly table and graphs of normalized values and the definition of your User's needs.

Main simulation results				
System Production	Available Energy	947.5 kWh/year	 Specific prod. 	1436 kWh/kWp/year
	Used Energy	924.0 kWh/year	Excess (unused)	0.0 kWh/year
	Performance Ratio PR	64.19 %	Solar Fraction SF	84.52 %
Loss of Load	Time Fraction	15.5 %	Missing Energy	169.3 kWh/year
Battery ageing (State of Wear)	Cycles SOW	97.1%	Static SOW	89.6%



Third 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.

My first simulation

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	159.5	179.3	81.07	0.000	8.98	83.87	92.85	0.903		
February	164.7	177.4	80.20	0.000	5.43	78.43	83.87	0.935		
March	207.0	210.7	95.56	0.000	3.76	89.09	92.85	0.959		
April	209.7	200.9	91.37	0.000	0.00	89.86	89.86	1.000		
May	209.2	190.6	85.69	0.000	8.15	84.70	92.85	0.912		
June	188.0	168.9	75.69	0.000	16.76	73.10	89.86	0.813		
July	176.4	160.1	71.34	0.000	24.30	68.55	92.85	0.738		
August	168.7	158.8	70.69	0.000	23.03	69.82	92.85	0.752		
September	161.7	159.5	70.84	0.000	25.24	64.62	89.86	0.719		
October	170.8	178.2	79.16	0.000	14.76	78.09	92.85	0.841		
November	153.1	169.3	75.43	0.000	13.69	76.17	89.86	0.848		
December	137.9	156.7	70.45	0.000	25.16	67.70	92.85	0.729		
Year	2106.7	2110.4	947.48	0.000	169.25	924.00	1093.25	0.845		

The bottom of the third page contains 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)

Part 2: Define User's need – Other profile

1- PVsyst 's model

The software gives you the possibility of recording your consumption profile once it is fully defined (no error in red and the hourly distribution defined).

When you save your consumption profile, it will be reusable for your other projects in your workspace.

To record your "Daily consumptions", click on the "SAVE" button.



Hourly distribution Daily consumptions Number Appliance 1 TV /PC / Mobile 240 W/app 4.0 h/day 0 TV /PC / Mobile 240 W/app 240 W tot 241/day S76 256 Wh 240 W tot 241/day S76 2576 Wh 240 W tot 241/day S76 250 Weck-end or Weekly use 240 Week-end or Weekly use 250 Wapp 250 Use only during 250 Wapp 250 Wapp 250 Whoths		Definition	of daily	househ	old consumpt	tions for the yea	ar.			
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 192 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 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 0 Other uses 0 W/app 0.0 h/day 0 Wh 0 Other uses 0 W/app 1.0 h/day 2995 Wh/day 0 Appliances info Total daily energy 2995 Wh/day 89.9 <	nsumption	Hourly distribution								
4 ↓ Lamps (LED or fluo) 12 W/amp 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 1099 Wh 0 ↓ Dish- and Cloth-washer 0.0 W aver. 0.0 h/day 0 Wh 0 ↓ Dther uses 0 W/app 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 0 ↓ Other uses 0 W/app 0.0 h/day 295 Wh 1 Stand-by consumers 24 W tot 24 h/day 2955 Wh 1	Daily con	sumptions								
1 V V 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 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 0 Other uses 0 W/app 0.0 h/day 0 Wh 0 Other uses 0 W/app 0.0 h/day 0 Wh 5tand-by consumers 24 W tot 24 h/day 576 Wh Image: Appliances info Total daily energy 2995 Wh/day 89.9 kWh/mth Image: One only during Use only during Image: One only during Image: One only during Image: On	Number	Appliance	Power		Daily use	Hourly distrib.	Daily en	ergy		
1 Image Ima		Lamps (LED or fluo)	12	W/lamp	4.0 h/day	OK	192	Wh		
S Domestic appliances 1 Fridge / Deep-freeze 1.10 kWh/day 24 0 0 Other uses 0 W/app 0 h/day 0 W tot 24 W tot 25 Wh/day 89.9 Wh/mth	1 ^	TV / PC / Mobile	240	W/app	4.0 h/day	OK	960	Wh		
Image / Deep-Integer Ind KWI (day Dish - and Cloth-washer 0.0 W aver. 0.0 h/day 0 Wh Image / Deep-Integer Image / Deep-Integer Image / Deep-Integer 0 Wh 0 Wh Image / Deep-Integer Image / Deep-Integer Image / Deep-Integer 0 Wh 0 Wh Image / Deep-Integer Image / Deep-Integer 0 W aver. 0.0 h/day 0 Wh Image / Deep-Integer Image / Deep-Integer 0 W h 0 Wh 0 Wh Image / Deep-Integer 0 W aver. 0.0 h/day 0 Wh Image / Deep-Integer 0 W aver. 0.0 h/day 0 Wh Image / Deep-Integer 0 W tot 24 h/day 576 Wh Wh Wh Image / Deep-Integer Image / Deep-Integer 2995 Wh/day 89.9 kWh/mth 89.9 kWh/mth Image / Deep-Integer Image / Deep-Integer Imag		Domestic appliances	28	W/app	2.0 h/day	OK	168	Wh		
0 User-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 0 Other uses 0 W/app 0.0 h/day 0 Wh Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 89.9 kWh/mth Image: Stand-by consumers Image: Stand-by consumers 2995 Wh/day 89.9 kWh/mth Image: Stand-by consumers 1mage: Stand-by consumers 1mage: Stand-by consumers 1mage: Stand-by consumers 1mage: Stand-by c	1 ^	Fridge / Deep-freeze	1.10	kWh/day	24.0	OK	1099	Wh		
0 0 W/app 0.0 h/day 0 Wh 0 0 W/app 0.0 h/day 0 Wh Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers W tot 24 h/day 576 Wh 595 Wh/day Image: Stand-by consumption definition by Image: Week-end or Weekky use Image: Week-end or Weekky use Image: Week-end or Weekky use Image: Stand S		Dish- and Cloth-washer	0.0	W aver.	0.0 h/day		0	Wh		
Other daes 0 w/app 0.0 n/day 0 wint Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 576 Wh Image: Stand-by consumers 24 W tot 24 h/day 2995 Wh/day Image: Stand-by consumers 24 W tot 24 h/day 2995 Wh/day Image: Stand-by consumers 24 W tot 24 h/day 2995 Wh/day Image: Stand-by consumers 24 W tot 24 h/day 2995 Wh/day Image: Stand-by consumers 24 W tot 24 h/day 2995 Wh/day Image: Stand-by consumers 24 W tot 24 h/day 2995 Wh/day Image: Stand-by consumers W tot 24 h/day 89.9 kWh/mth	0 ^	Other uses	0	W/app	0.0 h/day		0	Wh		
Years Image: Consumption definition by Seasons Week-end or Weekly use Use only during Years Image: Consumption definition by Seasons Image: Consumption definition by Base only during Image: Consumption definition by Base only during	0 ^	Other uses	0	W/app	0.0 h/day		0	Wh		
Appliances into Monthly energy 89.9 kWh/mth Consumption definition by Week-end or Weekly use Years Use only during Seasons 7 \$ days in a week		Stand-by consumers	24	W tot	24 h/day		576	Wh		
Consumption definition by Week-end or Weekly use Years Use only during Seasons 7	🕜 Ar	poliances info								
Years Image: Use only during Seasons 7	•				Mont	nly energy	89.9	kWh/mth		
	Years	15	Use only	during						

Once you have clicked on the "save" button, a personalization popup opens. From this window you can change:

- The name of "Description"
- The File name
- The Directory



🔎 PVsyst	—		x
Save domestic uses as			
Description			
User's needs: DEMO Dakar			וכ
File name			
Dakar_Yoff_Project			
Directory C:\Users\Lazare\Documents\PVSYST\PVsyst7.0_Data\Models			
Geneva_Cointrin_Project.LOD			ר ר
		<u>S</u> ave	

It is important to define the name of the recording so that you can easily find it in the list of records.

When you have finished naming your file, you must click on "Save" in order to save your file and exit this window.

Once the registration is complete, you can find your different models saved as well as the "DEMO Pvsyst" by clicking on the "Load" button.

Please note: You will only have your recordings if you have kept the same workspace during the recording.



	Definition	of daily	househ	old consump	tions for the yea	ar.			
onsumptior	Hourly distribution								
Daily co	sumptions								
Number	Appliance	Power		Daily use	Hourly distrib.	Daily en	ergy		
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	ОК	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		
0				Total da	ily energy	2995	Wh/day		
A 6	ppliances info				hly energy		kWh/mth		
-Consum Years Seaso Montl	ens en	Use only	d or Weel / during ays in a wee						

In the window below you will find three Pvsyst DEMO from Daily Consumptions as well as your previously saved models. To load and use a defined Daily Consumption simply select it by clicking on it then click on the "OK" button.

Choosing User's needs	-		х
Template_Big_SHS_XWh_day.LOD : Enhanced SHS with fidge and little applances, 2.2.KVh_day Template_Household_U1_KVh_day. Template household 12.KVh/hday Template SHS_00Vh_DpJ.COD : Template SHS_12.Binps = Hitter TVPC Datar_10ff_Project.LOD : User's needs: DEMO Datar Generva_Continn ForceLOD : Let 1 :			
Template SIS 400/h DayLOD : Template SIS 2 Januar + Hille TV/PC Data Vide Stocket 1000 : Template SIS 2 Januar + Hille TV/PC Data Vide Stocket 1000 : Template SIS 2 Januar + Hille TV/PC	_		-
Geneva_Contrin_Project.LOD : test 1			
🗙 Cancel		ОК	

2- Other Profile

Several other ways to define the consumption of your receivers are possible.

By clicking on the "Other profile" button, you access the tab below.



Consumption	Hourly distribution								
	sumptions								
Number	Appliance	Power		Daily use	Hourly distrib.	Daily er	nergy		
4	Lamps (LED or fluo)	12	W/lamp	4.0 h/da	ау ОК	192	Wh		
1 0	TV / PC / Mobile	240	W/app	4.0 h/da	ау ОК	960	Wh		
3 🗘	Domestic appliances	28	W/app	2.0 h/da	ау ОК	168	Wh		
1	Fridge / Deep-freeze	1.10	kWh/day	24.0	OK	1099	Wh		
0	Dish- and Cloth-washer	0.0	W aver.	0.0 h/da	зу	0	Wh		
0	Other uses	0	W/app	0.0 h/da	ау	0	Wh		
0	Other uses	0	W/app	0.0 h/da	зу	0	Wh		
	Stand-by consumers	24	W tot	24 h/day		576	Wh		
	opliances info			Total	taily energy		Wh/day		
	phanees mo			Mon	thly energy	89.9	kWh/mth		
Consum Years Seaso Month	ns (2)	Week-en							

From this window you can define your consumption as follows:

- Load a model
- Fixed constant consumption
- Monthly values
- Daily profiles
- Household consumers
- Load values from a CSV hourly / daily file

C User's needs definitionVariant: "My first simulation", Variant "My	/ first simulation"			х
Comment New User's needs				
General features Granh				
Kind of load profile	User's needs: Yearly ene	rgy defined		
O Unlimited load (grid)	Average power	457 W		
O Fixed constant consumption	Yearly energy	4004 kWh/yr		
O Monthly values				
O Daily profiles	Info system: Defined PV			
O Probability profiles	Nominal PV Power	660 Wp		
Household consumers	Estimated system yield PnomPV / PLoad average	1010 kWh/yr 5.73 Pnom ratio		
O Load values from a CSV hourly/daily file 🛛 👔	Thom V / Loud average	500 11001000		
Household profiles				
O Constant over the year				
Seasonal modulation	Domestic energy use defined, You can see t			
O Weekly modulation	"Define hous	ehold".		
Model				
Coad 💾 Save				
		••		_
Sefine household	Print	Cancel	ОК	

Load values from a CSV hourly / daily file:

The most flexible way for defining 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 for the import of 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, give some integrated values, and you can analyze it with plots.

The dialog will ask if you want to:

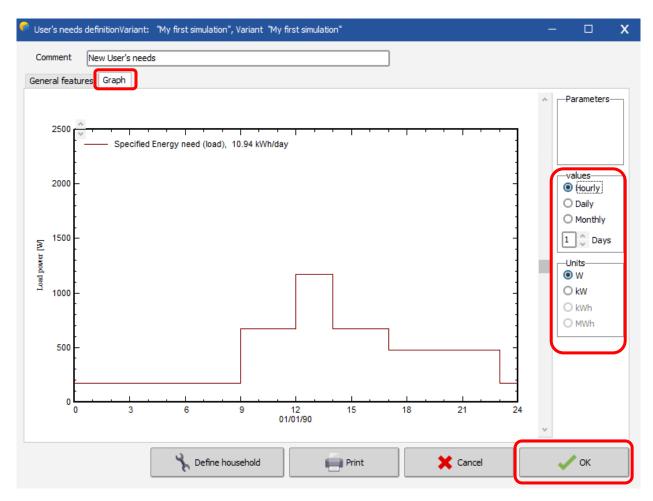
- Read the file at the time of the simulation (may be useful for batch mode),
- Read the file immediately and store it internally in your calculation version as input parameters for the simulation

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.

