UNIVERSIDAD DE VALLADOLID

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The Environment and Renewable Energy

STAND ALONE PVSyst PROJECT REPORT

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ABSTRACT

The main objective of this exercise is to design a stand-alone photovoltaic system using the PVSYST software.

This report is divided, as follows, in three parts:

1. **Inputs**
2. **Procedure**
3. **Output**

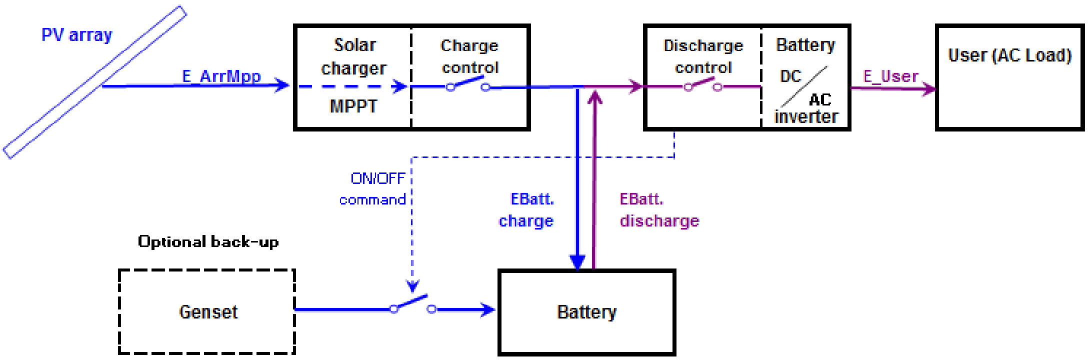
Every part shown will explored in the following report.

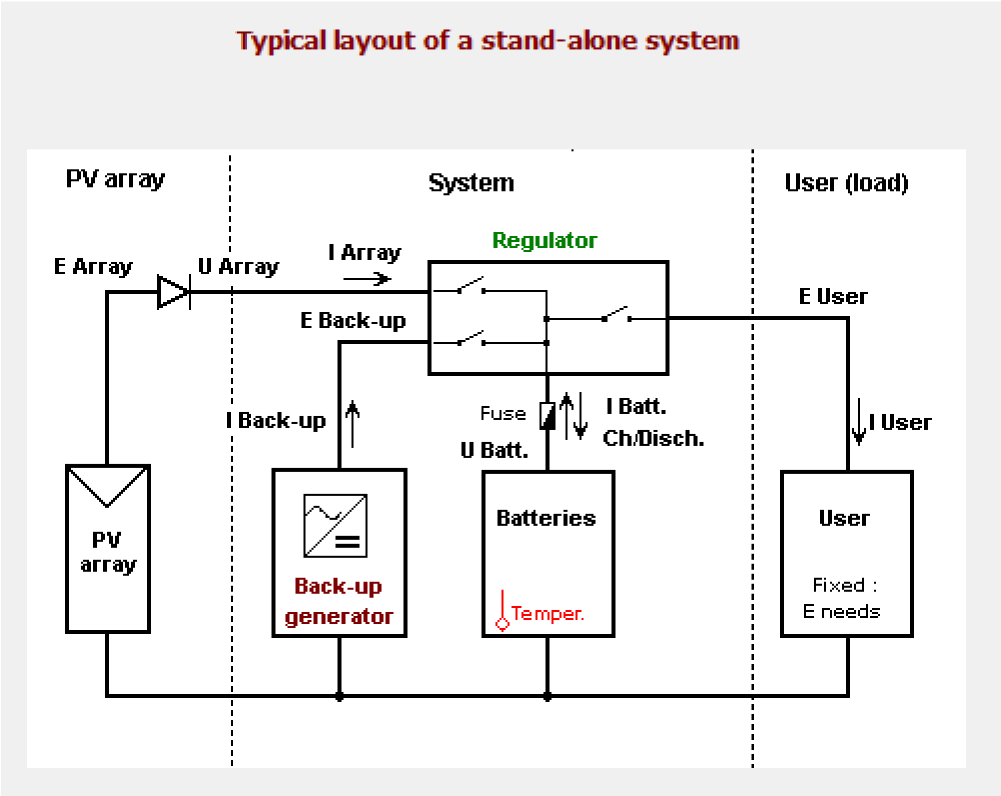
INPUTS

1. Location: the location was set in Canberra; the capital city of Australia and the meteorological values are already provided by PVSyst.
2. PV system components: as an overview the system will include PV module, charge controller and battery bank taken from database.
3. User's needs: these are constant along every day of the year.

HOURLY VALUES							
Hour	Power (kW)		Hour	Power (kW)		Hour	Power (kW)
0:00	25		8:00	38		16:00	19
1:00	25		9:00	38		17:00	19
2:00	25		10:00	19		18:00	15
3:00	25		11:00	19		19:00	6
4:00	25		12:00	19		20:00	6
5:00	25		13:00	19		21:00	45
6:00	25		14:00	19		22:00	25
7:00	32		15:00	19		23:00	25

It is specified that all the equipment is AC type but, PVSyst doesn't have inverter in standalone project at the moment (as said from the online documentation of the program). So, the best way is instead of the first image below (with an inverter) to use a configuration without inverter (already provided by the software) and take into account the losses of the inverter into the user's needs. It is known that the efficiency of an inverter is around 95% so user's needs will be multiplied by 1.05. The following work is developed assuming that this calculus is already done into the given table.

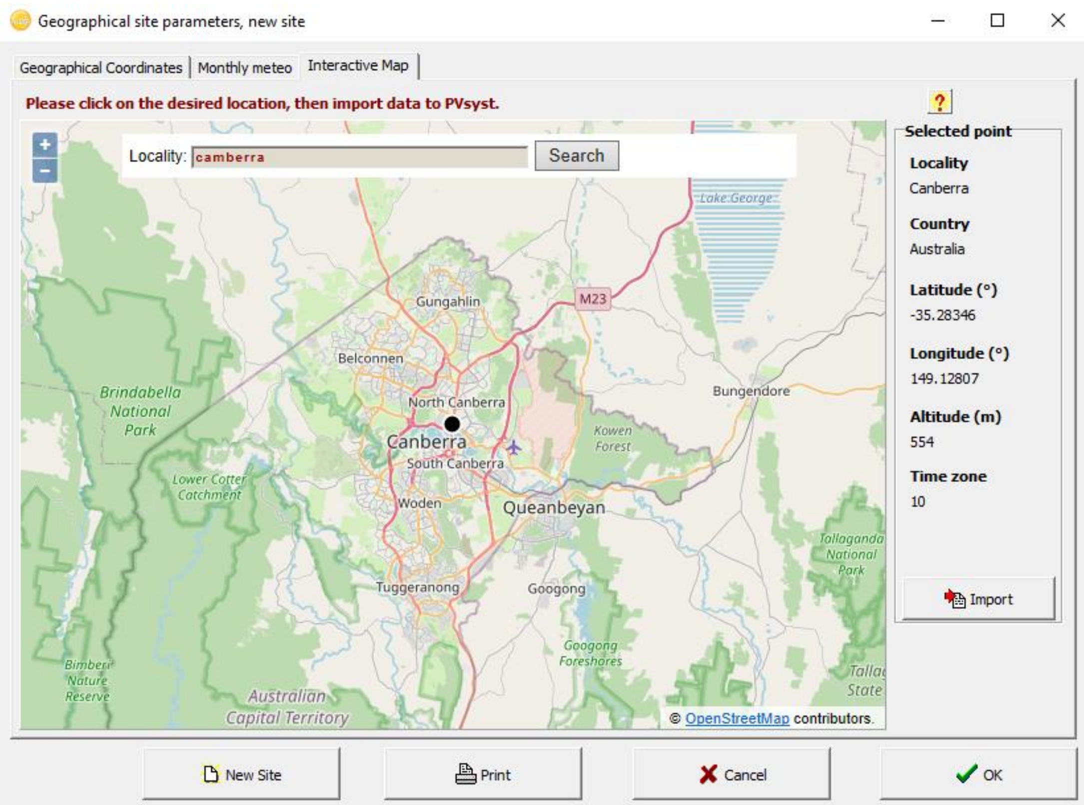


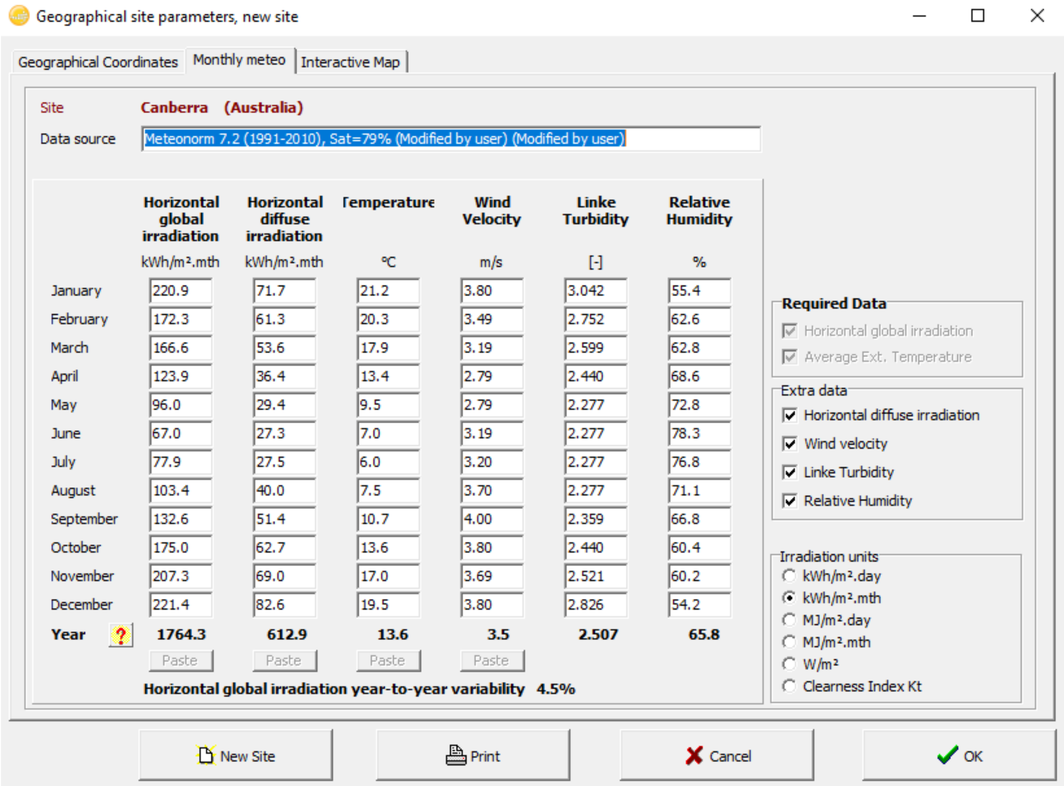


The previous image will be the configuration used in this work.

PROCEDURE

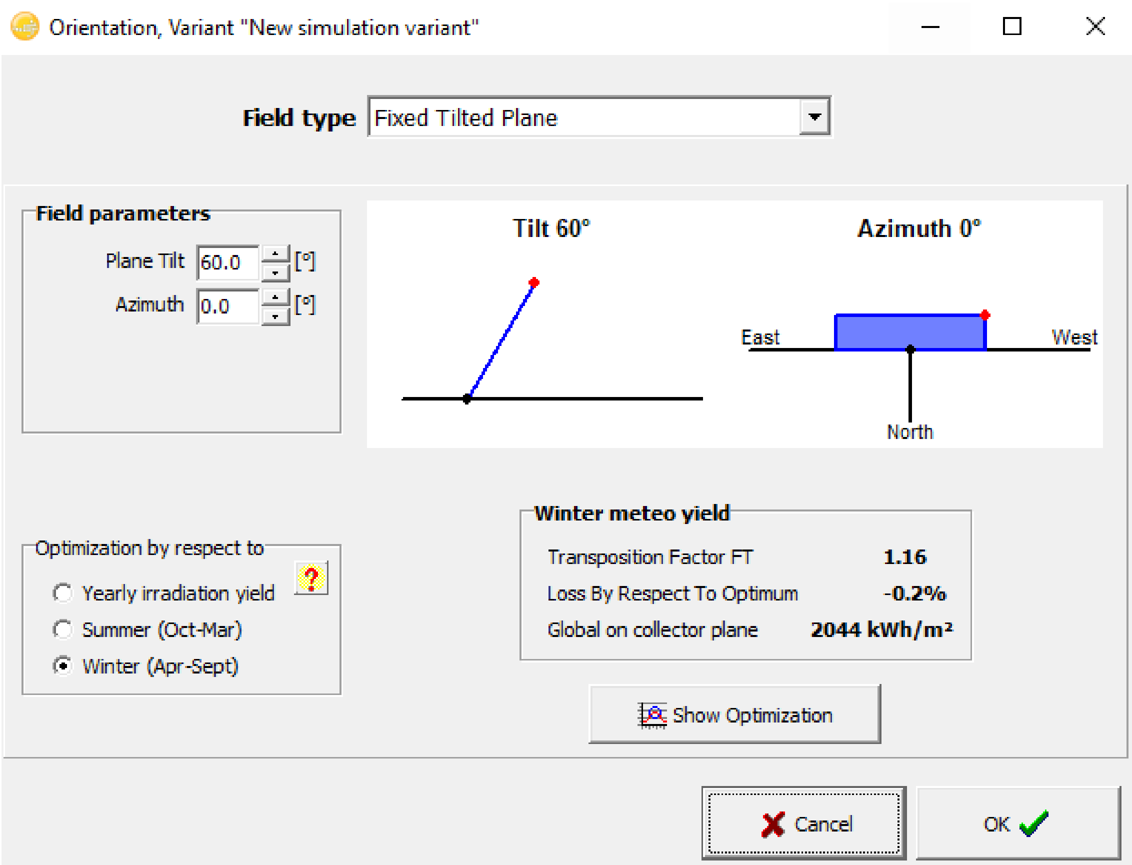
1. *Set the project's destination (Name, Geographical location and weather file)*: in this case the city was not already present into the database. So, it is added during the simulation as new site;

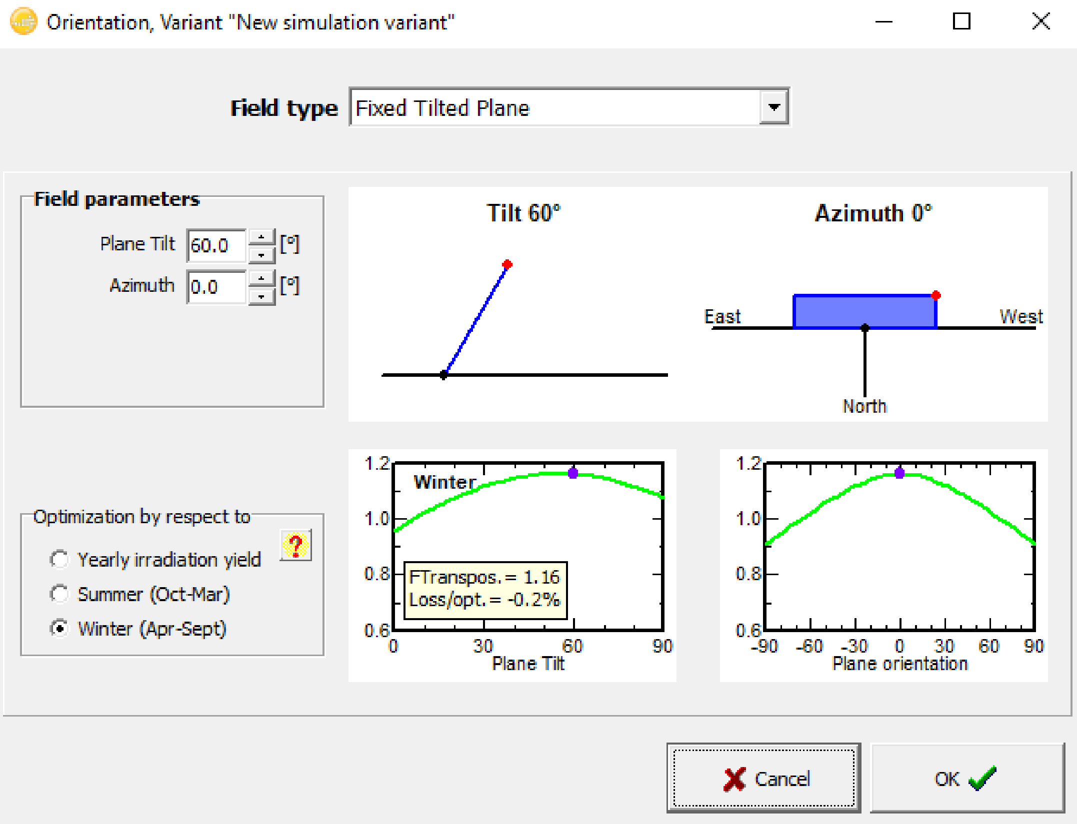




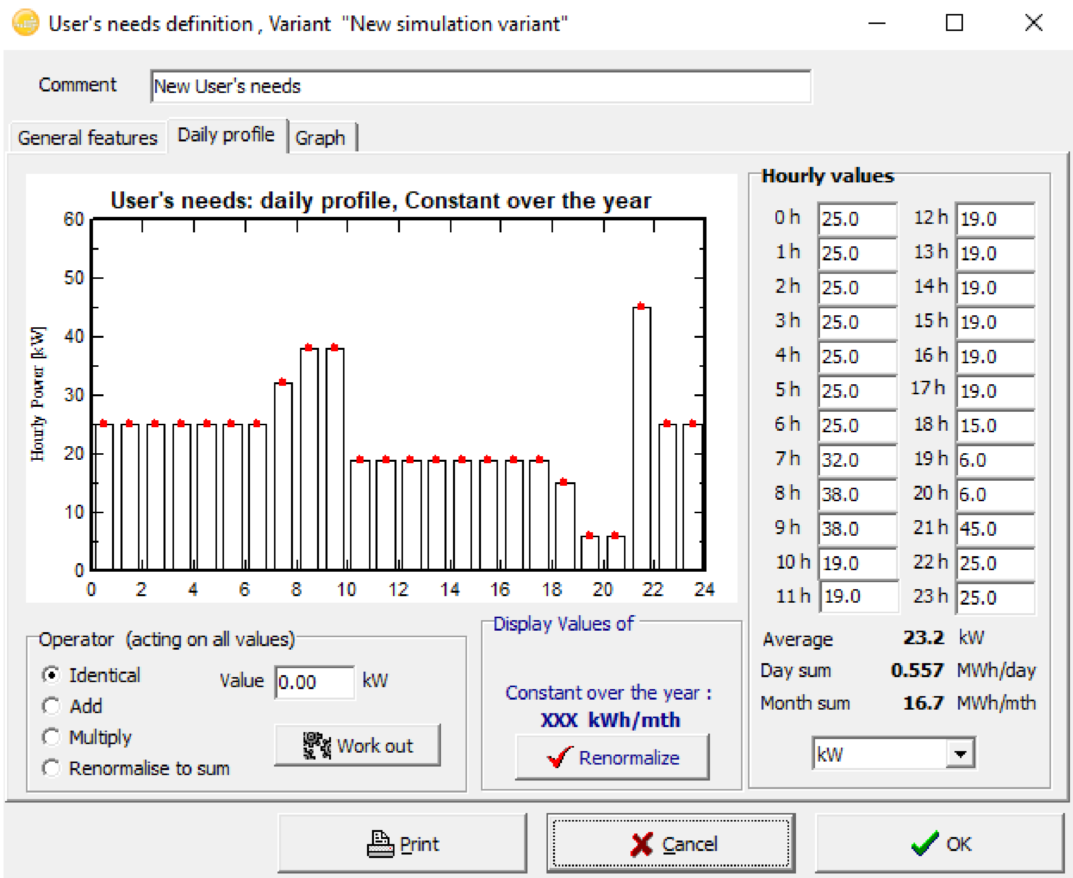
	Horizontal global irradiation kWh/m².mth	Horizontal diffuse irradiation kWh/m².mth	Temperature °C	Wind Velocity m/s	Linke Turbidity [-]	Relative Humidity %
January	220.9	71.7	21.2	3.80	3.042	55.4
February	172.3	61.3	20.3	3.49	2.752	62.6
March	166.6	53.6	17.9	3.19	2.599	62.8
April	123.9	36.4	13.4	2.79	2.440	68.6
May	96.0	29.4	9.5	2.79	2.277	72.8
June	67.0	27.3	7.0	3.19	2.277	78.3
July	77.9	27.5	6.0	3.20	2.277	76.8
August	103.4	40.0	7.5	3.70	2.277	71.1
September	132.6	51.4	10.7	4.00	2.359	66.8
October	175.0	62.7	13.6	3.80	2.440	60.4
November	207.3	69.0	17.0	3.69	2.521	60.2
December	221.4	82.6	19.5	3.80	2.826	54.2
Year	**1764.3**	**612.9**	**13.6**	**3.5**	**2.507**	**65.8**

2. *Set the orientation of the PV module*: tilt angle was taken at 60 degrees to be a ''real'' install angle to cities localized below the equator line and because of the worst month optimization. In this case the worst month was June, so the optimization will be by respect to ''Winter'';





3. *Set the user's need*: in this case in hourly values.



Set the system in terms of: array and pre-sizing of battery, define system components and define the controller;

4. *Array and battery pre-sizing*: In terms of Lost of Load and days Autonomy are taken into account the default values (LOL=5%, Autonomy=4 days) and in terms of system's voltage, it was set at 60V to try to work with a more realistic case (for example: PVSyst doesn't have real controller above 60V but only universal ones);
5. *Define system component*:

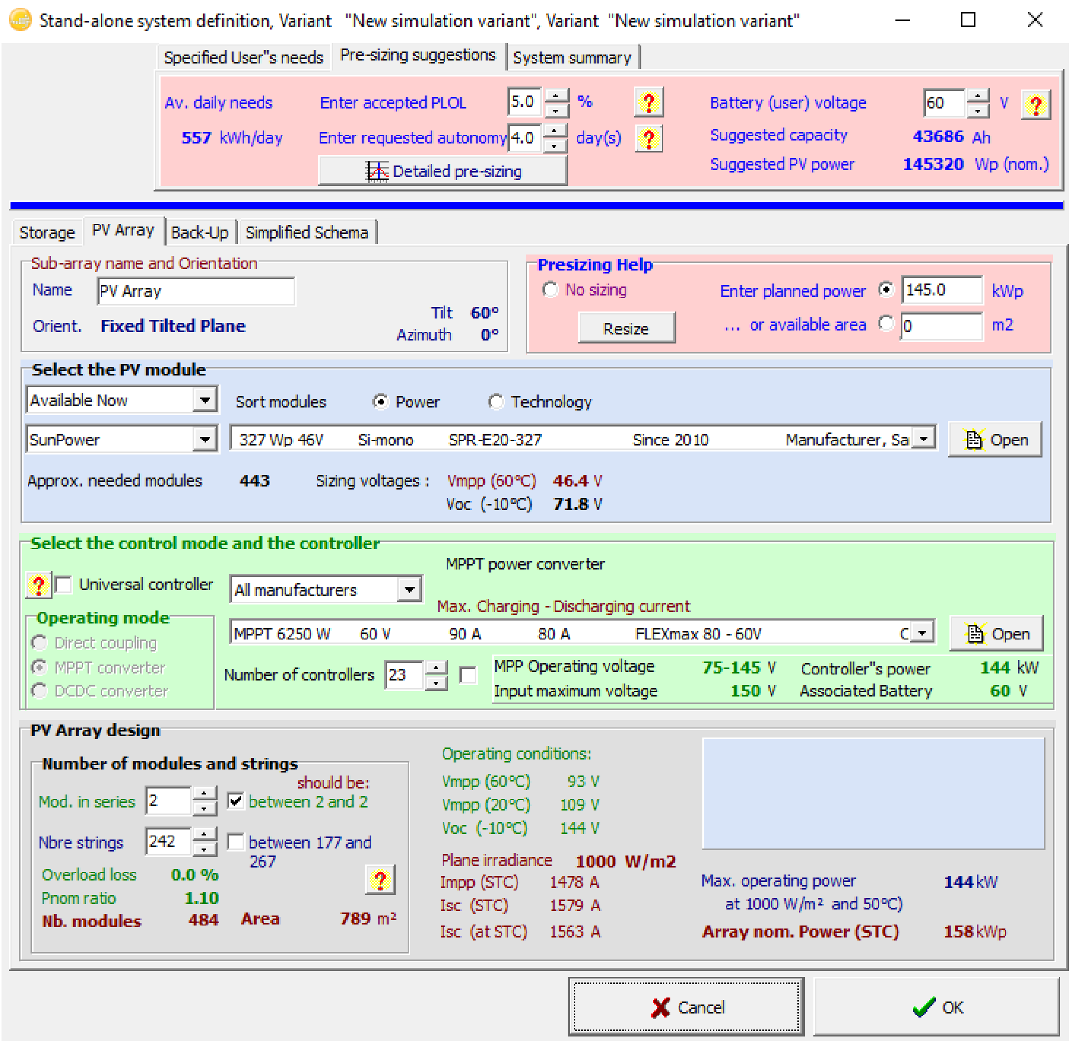
Choose battery	From all the manufacturers the batteries are chosen of 2V with the higher capacity to minimize the number of them.
Choose PV	From all manufacturers modules are chosen those work close or below to 60V to work close to the point of high efficiency.

6. *Define the controller*:

Choose the controller	From all the manufacturers a controller is chosen that: exist, works at 60V and fits with the rest of the system.

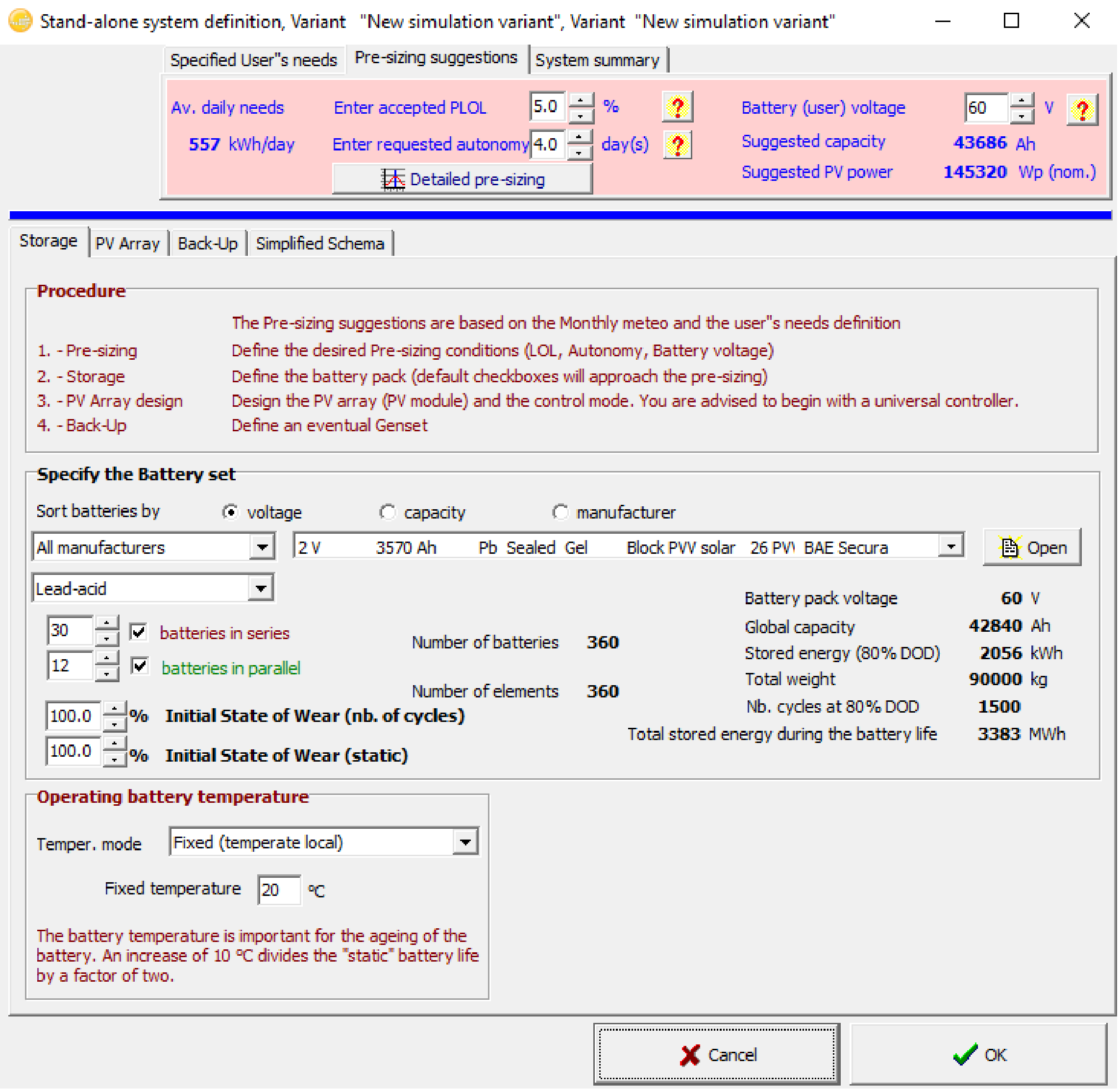
RESULTS

1. *PV array: module selected, orientation selected, number of its, number of strings and related PV voltage.*



The PV modules are taken those work at 46V, of course, this not fix 60V system but it is done to face the problem of fitting the specs of available controller. Using a lower voltage PV module, in serial connection where the voltage over an array is higher, will allow every single module to work at high efficiency near the maximum as will be shown in following results. The drawback of this configuration is having serial connection of the modules in case of shadows. So was selected a PV model that require as max 2 modules in series to fits the requirement of the controller and to get the minimum drawback as possible.

2. *Charge controller: controller selected, related current and voltage*. As shown in the previous image there are 23 controllers to be set between modules and batteries. The one selected works because has: a minimum operating voltage lower than a single array Vmpp (60 Celsius degree) and a maximum voltage higher than a single array Voc (-10 Celsius degree);
3. *Battery bank: battery selected, number of cells and capacity of the bank.*



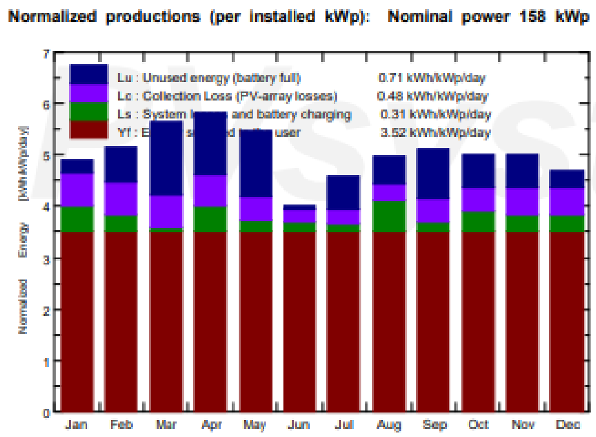
The batteries chosen are ones that have the maximum value of battery capacity but with the drawback of batteries in parallels and this number will become even greater with batteries characterized of lower capacity. In this case the battery requirements are too large, then, the use of batteries in parallel could be difficult in practice.

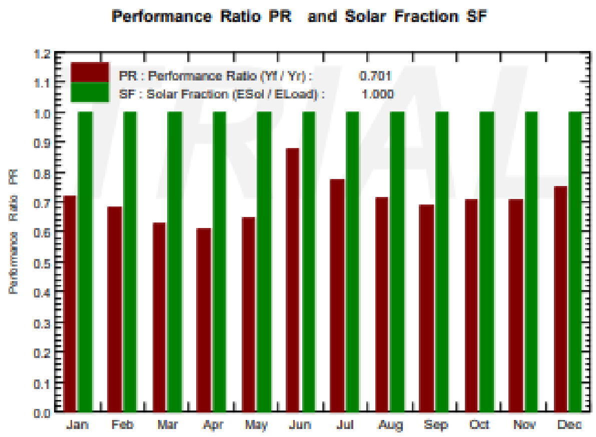
4. *Performance ratio system (monthly and yearly values)*;

Main simulation results

System Production	**Available Energy**	**254202 kWh/year**	Specific prod.	1606 kWh/kWp/year
	Used Energy	203305 kWh/year	Excess (unused)	41056 kWh/year
	Performance Ratio PR	70.13 %	Solar Fraction SF	100.00 %
Loss of Load	Time Fraction	0.0 %	Missing Energy	0 kWh/year
Battery ageing (State of Wear)	Cycles SOW	97.6%	Static SOW	90.0%
	Battery lifetime	10.0 years		

As can be seen, with a Solar Fraction SF of 100%, this configuration will provide all the energy to the user and the Performance Ratio, independent by energy amount, has a high value equal to 70.13%.





Also checking the column about worst month, the system is providing all the energy to the user.

New simulation variant

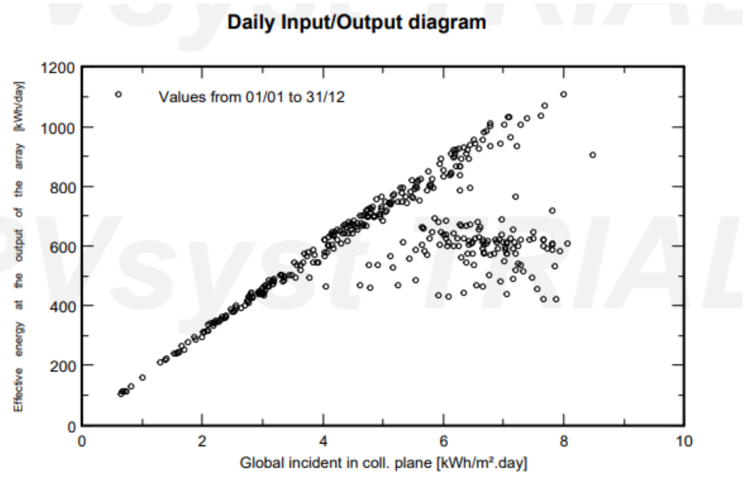
Balances and main results

	GlobHor kWh/m²	GlobEff kWh/m²	E_Avail kWh	EUnused kWh	E_Miss kWh	E_User kWh	E_Load kWh	SolFrac
January	220.9	148.8	20272	1288	0.000	17267	17267	1.000
February	172.3	141.7	19364	3033	0.000	15596	15596	1.000
March	166.6	172.3	23705	6781	0.000	17267	17267	1.000
April	123.9	172.9	24093	5666	0.000	16710	16710	1.000
May	96.0	168.1	23853	6171	0.000	17267	17267	1.000
June	67.0	120.2	17342	439	0.000	16710	16710	1.000
July	77.9	140.9	20387	3062	0.000	17267	17267	1.000
August	103.4	152.5	22108	2554	0.000	17267	17267	1.000
September	132.6	151.5	21489	4497	0.000	16710	16710	1.000
October	175.0	152.6	21483	3060	0.000	17267	17267	1.000
November	207.3	146.7	20451	2926	0.000	16710	16710	1.000
December	221.4	142.1	19654	1579	0.000	17267	17267	1.000
Year	1764.1	1810.4	254202	41056	0.000	203305	203305	1.000

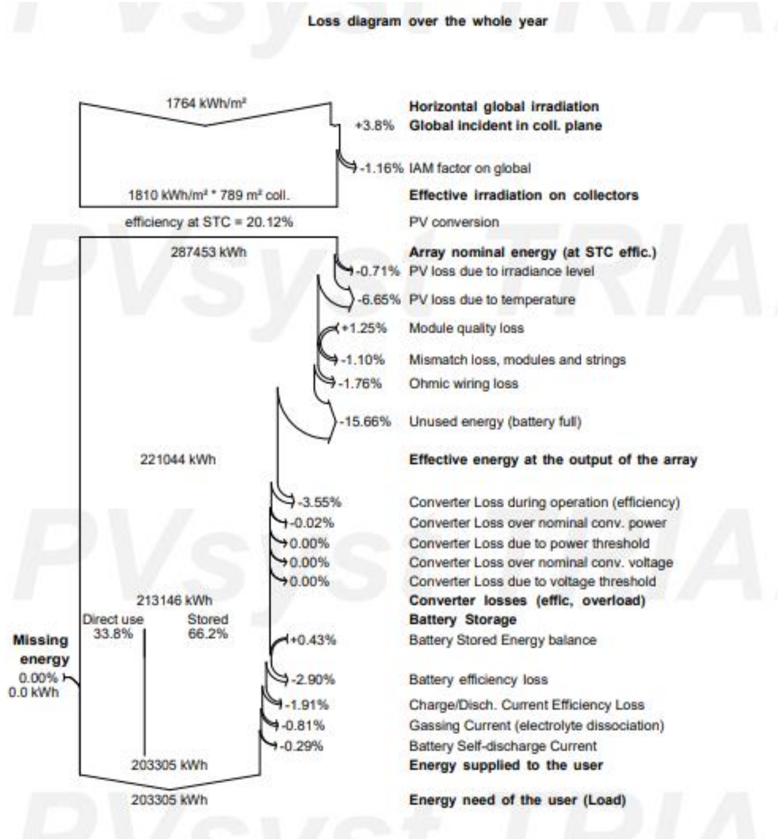
Legends:

GlobHor	Horizontal global irradiation	E_Miss	Missing energy
GlobEff	Effective Global, corr. for IAM and shadings	E_User	Energy supplied to the user
E_Avail	Available Solar Energy	E_Load	Energy need of the user (Load)
EUnused	Unused energy (battery full)	SolFrac	Solar fraction (EUsed / ELoad)

As can be seen there is no Energy Missing and a low quantity of Energy Unused driven from the lower value of June (worst month).



The previous image shows the energy that panel can deliver over the energy available from the sun. A straight line means that PV panel is performing good instead of the flat part of the curve, it is because of temperature effects so: the PV panel is not performing good in some days as well as the straight line and there is a battery usage.



Checking for the efficiency in standard test condition at which every PV module could work in that condition, it is 20,10% that is, of course dependent on the type of the panel but also, it's a high value for this working point. The previous information can be seen passing from *horizontal global irradiation* to the *PV conversion* on the last image. The higher loss is associated with Unused Energy because batteries doesn't fit perfectly the requirement of the installation but also the installation is too big for a stand-alone system (taking other type of batteries different from those chosen will require even greater number of them). The second bigger loss is due to the temperature maybe because of high summer's temperatures that not allow the PV module to work in the best situation.