UNIVERSIDAD DE VALLADOLID

International Semester in Industrial Engineering

Academic Year 2022/2023

The Environment and Renewable Energy

GRID CONNECTED PVSyst PROJECT REPORT

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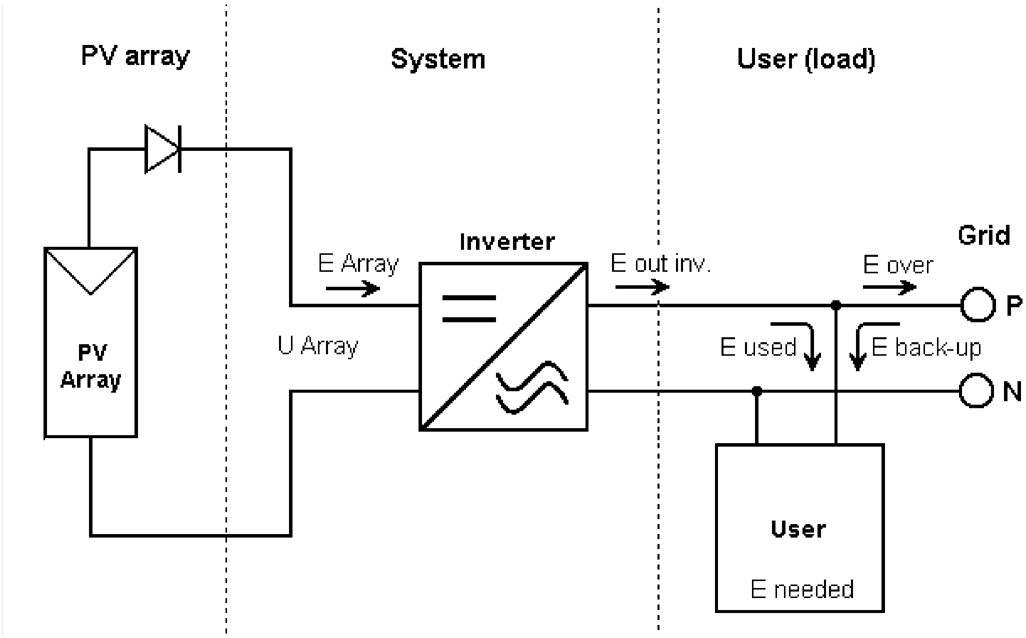
ABSTRACT

The main objective of this exercise is to design two grid connected photovoltaic systems using the PVSYST software. The first located in IndUva Building, Valladolid and the second located in our own country Bari, Italy.

The two projects will have a planned power of 55kWp and the orientation of the PV modules will be the best for the different location. To compare the performances of the two installation PV panel model and inverter model was already given. In addition will be taken in account losses to obtain more realistic results.

In the case of a grid connected system, of which scheme is shown following, it will be simpler than a grid connected one because it does not need batteries or charge controller:



The previous image will be the configuration used in these two projects.

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

1. **Inputs of first report**
2. **Procedure of first report**
3. **Inputs of second report**
4. **Procedure of second report**
5. **Outputs**

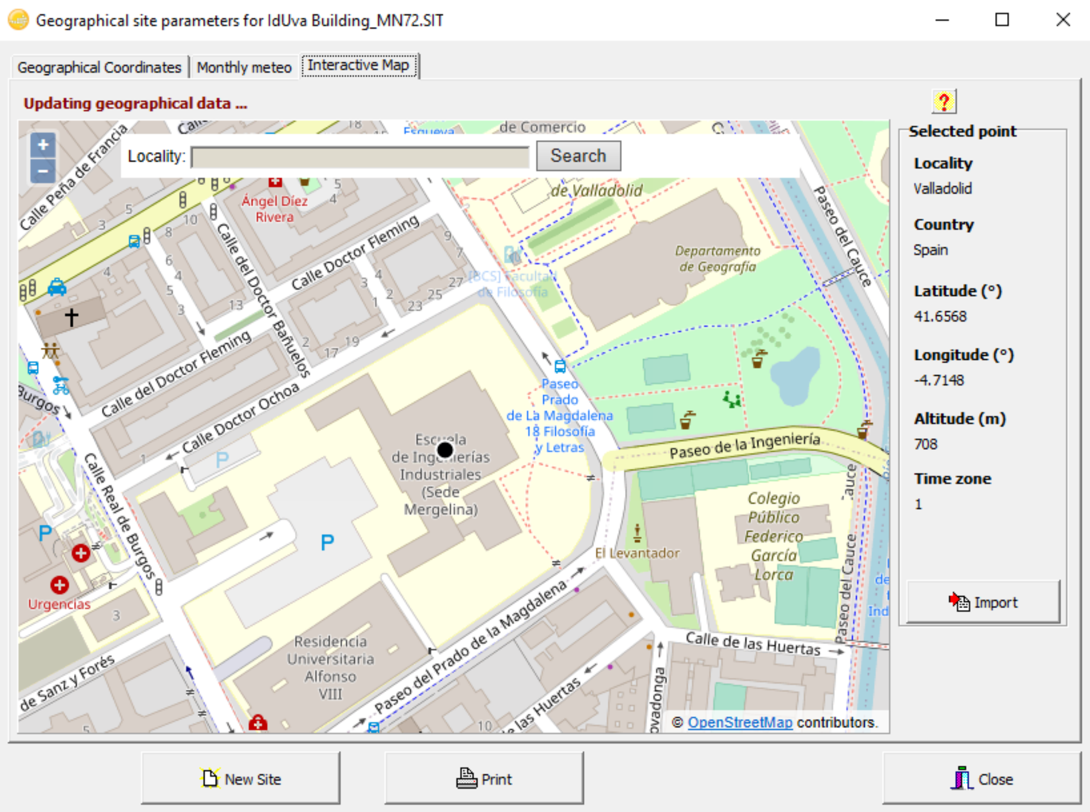
Every part shown will explored in the following report.

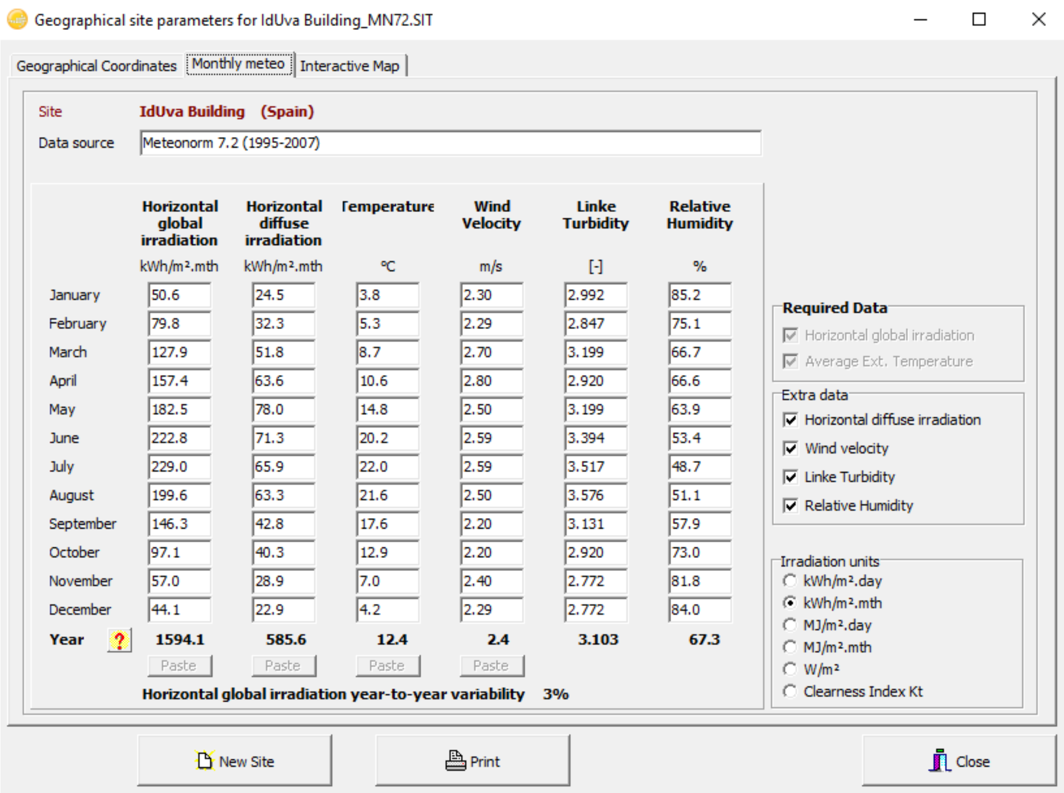
INPUTS OF THE FIRST REPORT

1. Location: the location was set in IndUva Building, the university of Valladolid, and the meteorological values are already provided by the map of PVSyst.
2. PV system components: as an overview the system will include PV modules and inverter taken from database.
3. User's needs: a planned power of 55kWp.

PROCEDURE OF THE FIRST REPORT

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

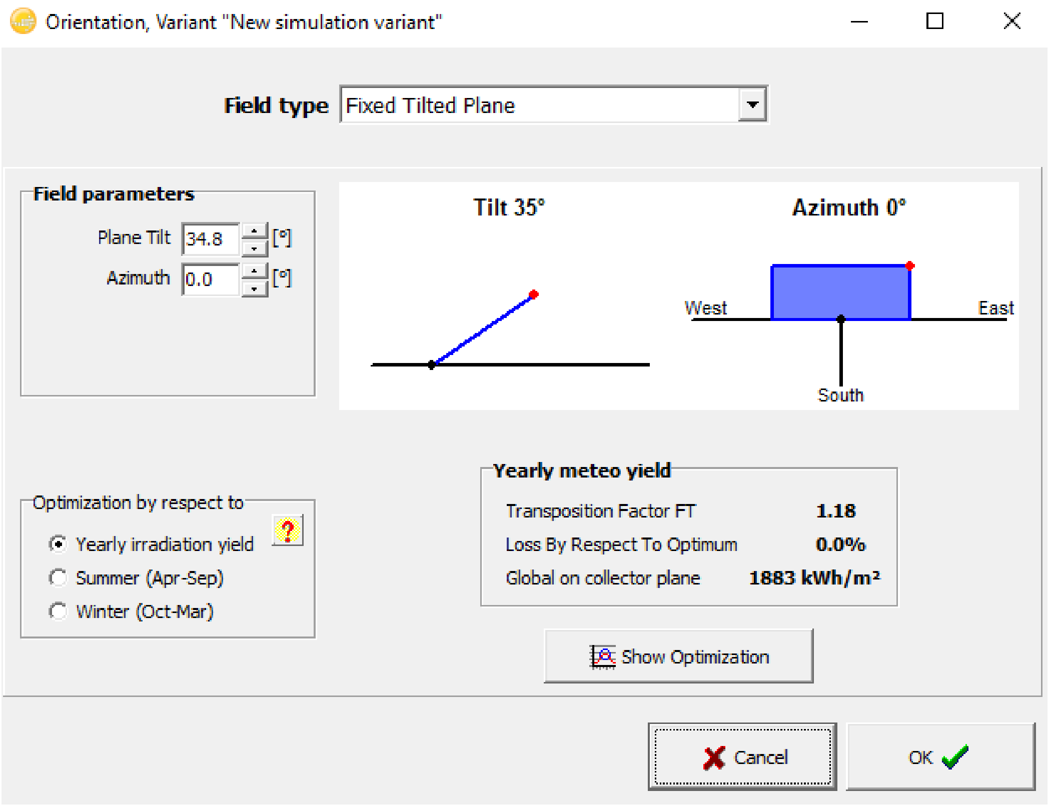


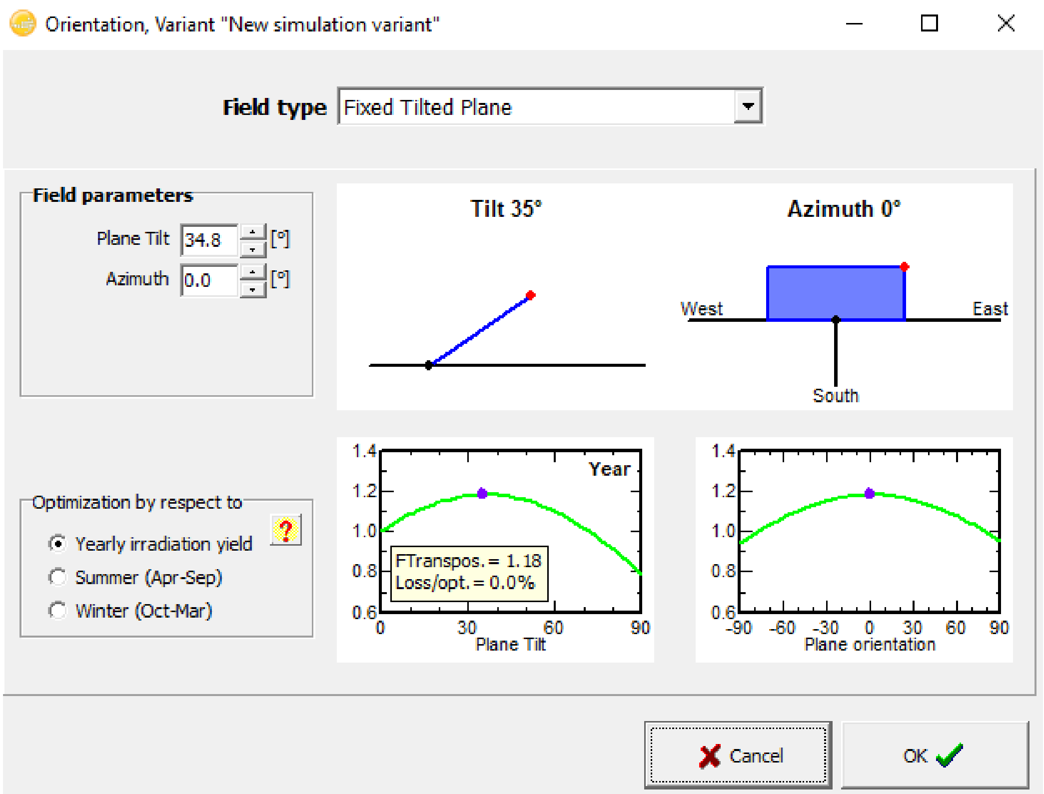


	Horizontal global irradiation kWh/m².mth	Horizontal diffuse irradiation kWh/m².mth	Temperature °C	Wind Velocity m/s	Linke Turbidity [-]	Relative Humidity %
January	50.6	24.5	3.8	2.30	2.992	85.2
February	79.8	32.3	5.3	2.29	2.847	75.1
March	127.9	51.8	8.7	2.70	3.199	66.7
April	157.4	63.6	10.6	2.80	2.920	66.6
May	182.5	78.0	14.8	2.50	3.199	63.9
June	222.8	71.3	20.2	2.59	3.394	53.4
July	229.0	65.9	22.0	2.59	3.517	48.7
August	199.6	63.3	21.6	2.50	3.576	51.1
September	146.3	42.8	17.6	2.20	3.131	57.9
October	97.1	40.3	12.9	2.20	2.920	73.0
November	57.0	28.9	7.0	2.40	2.772	81.8
December	44.1	22.9	4.2	2.29	2.772	84.0
Year	1594.1	585.6	12.4	2.4	3.103	67.3

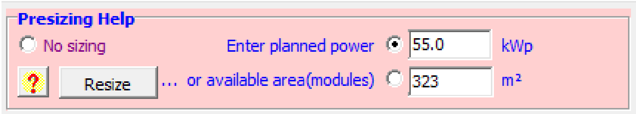
Horizontal global irradiation year-to-year variability 3%

2. *Set the orientation of the PV module*: as specified before the tilt and azimuth angle will be taken as the optimal, as optimization method was chosen the one that take an average between winter and summer needs (called: *yearly irradiation yield*) this because a grid connected system aims to produce all the possible energy and feed the electrical grid and not perfectly satisfy a building demand;





3. Set the user’s need: in this case a planned power of 55kWp.

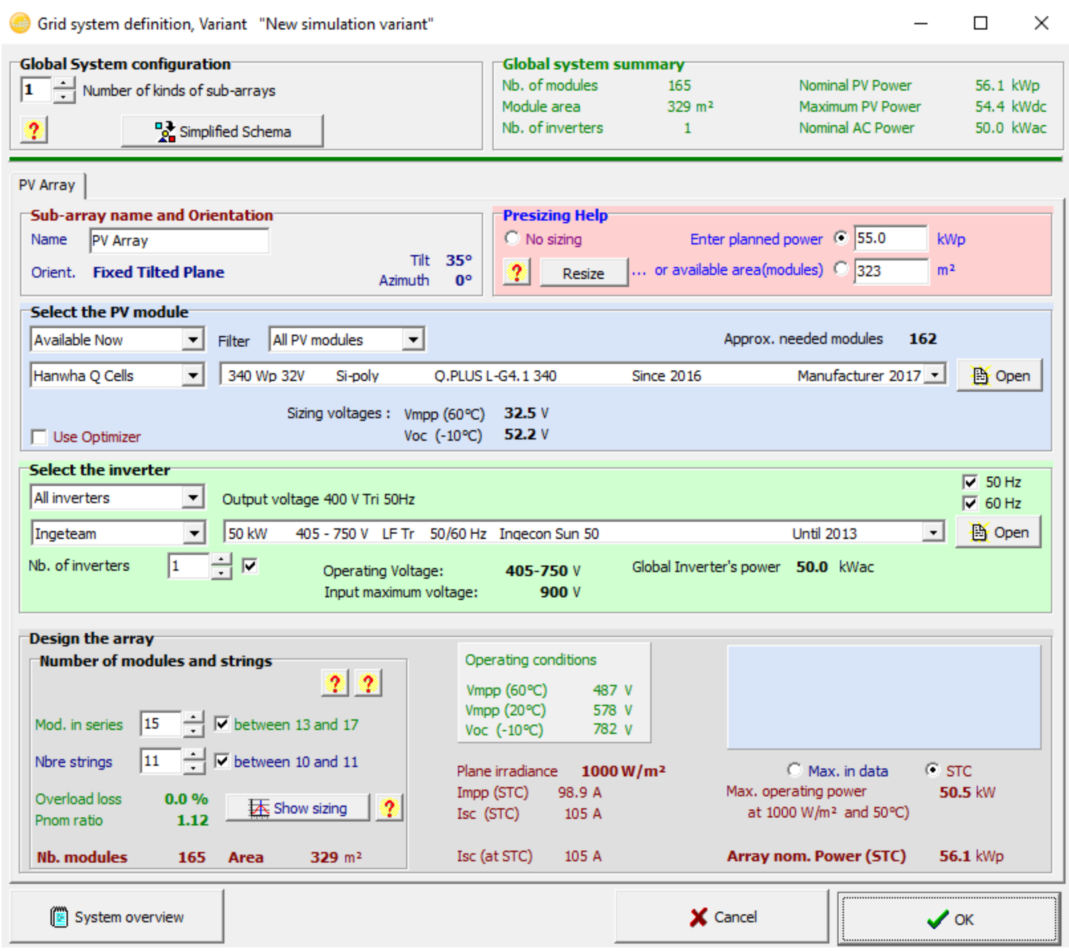


Set the system in terms of: array and pre-sizing of inverter, define system components and define losses;

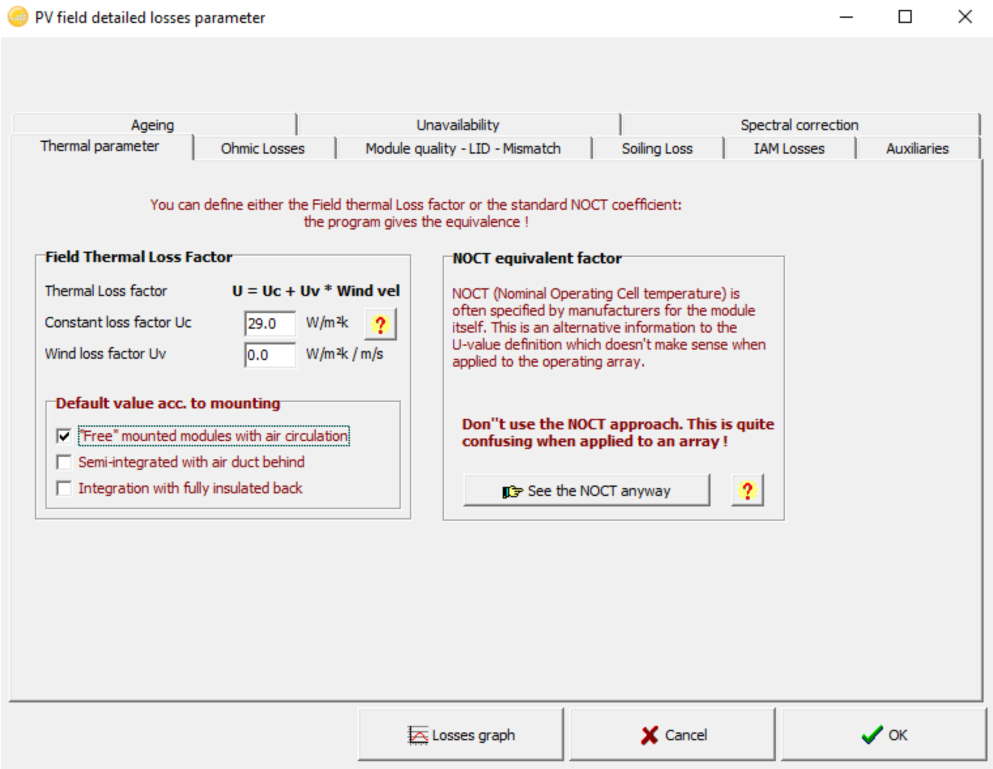
4. *Array and inverter pre-sizing*: typically, there is an oversizing of the PV panels’ total power respect to inverter power about 10-20% because inverter allows overload. In the first time the inverter was selected as an intersection of its operative voltage with the voltage of an array of PV panels in serial connection (Vmppp 20 Celsius degree).
After this, the minimum voltage of a single array dependent on the higher temperature of the location (Vmpp 60 Celsius degree) and it has to be higher respect the minimum voltage of the inverter
The maximum voltage of a single array dependent on the minimum temperature of the location (Voc -10 Celsius degree) and it has to be lower than input maximum voltage of the inverter;
5. *Define system component*:

Chosen inverter	It was given, this to have a low number of degrees of freedom in the problem
Chosen PV	It was given, this to have a low number of degrees of freedom in the problem

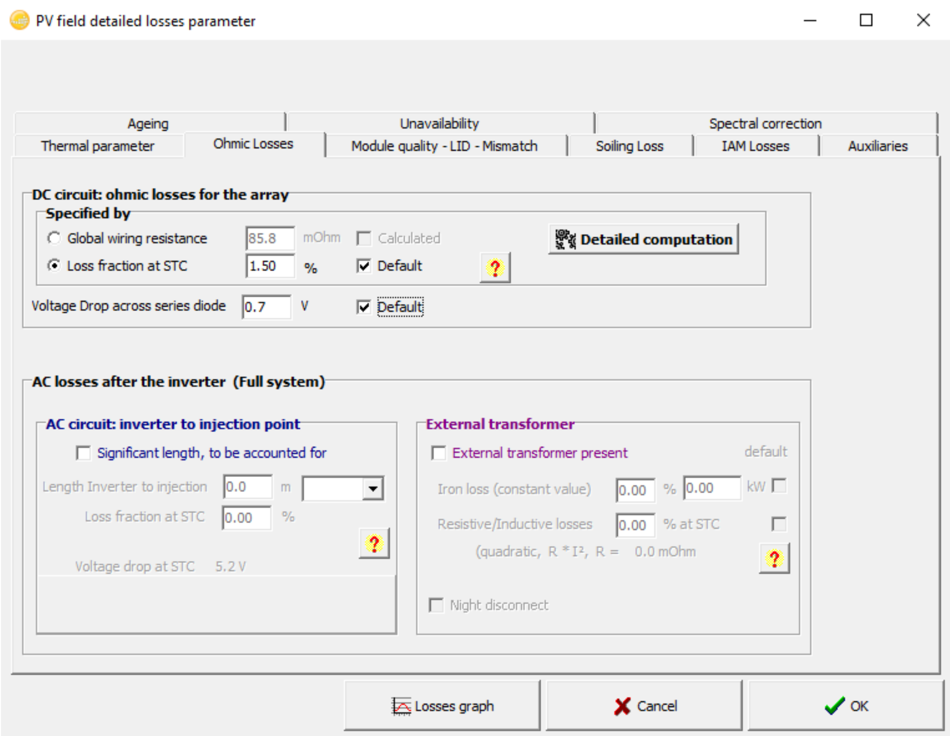
So, as follows:



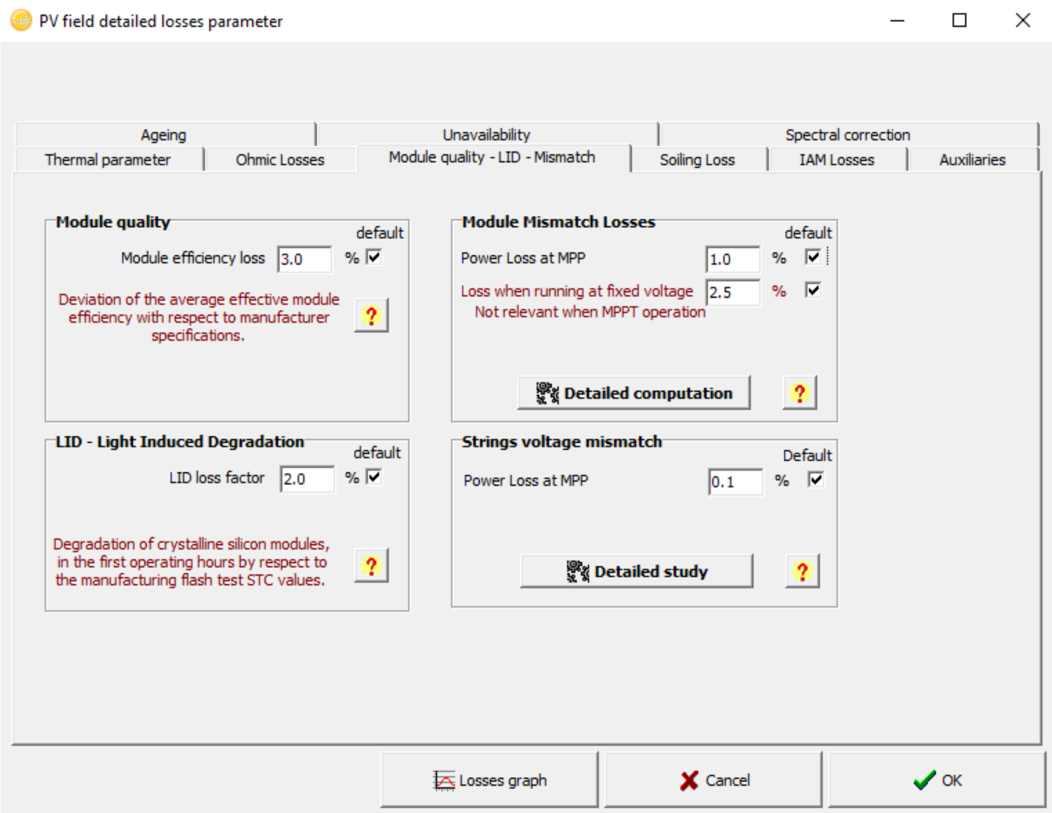
6. Define losses: will be taken in account losses to obtain more realistic results, such as the following. They will be explained losses that were added on standard losses during simulation classroom:



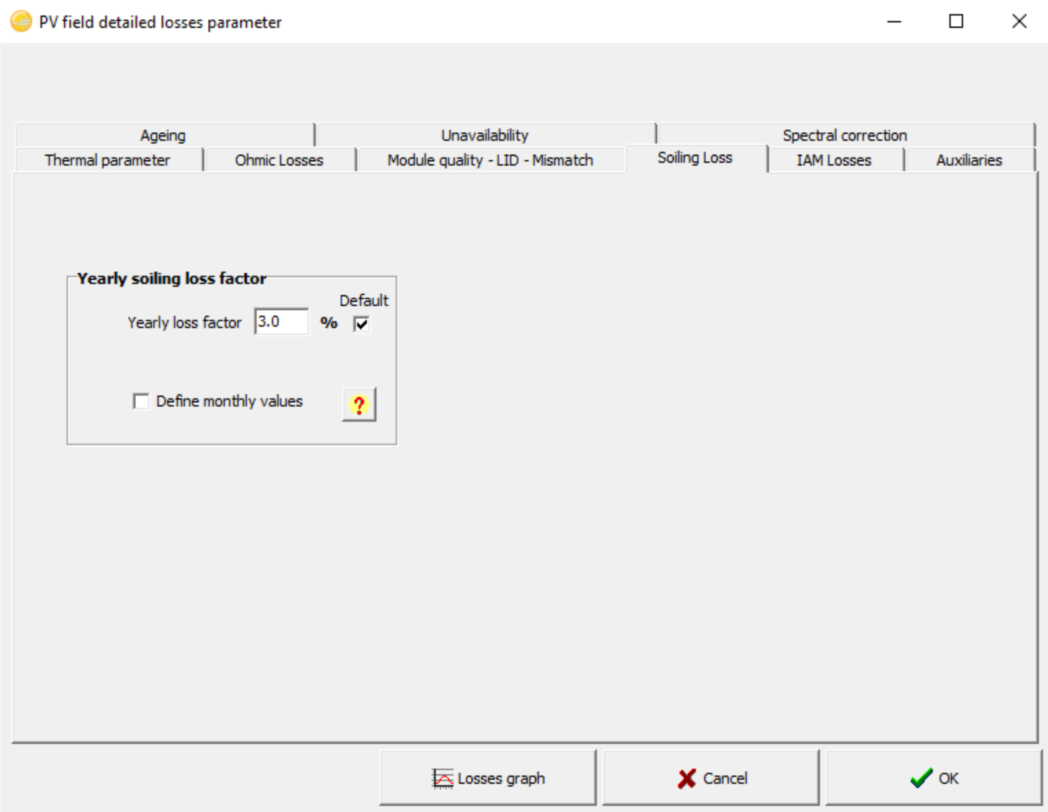
Thermal parameter: to take in account the type of the installation. A “free mounted” installation means that there is enough space under the PV panel to allow air flow and the best dissipation of heat than others mounting system.



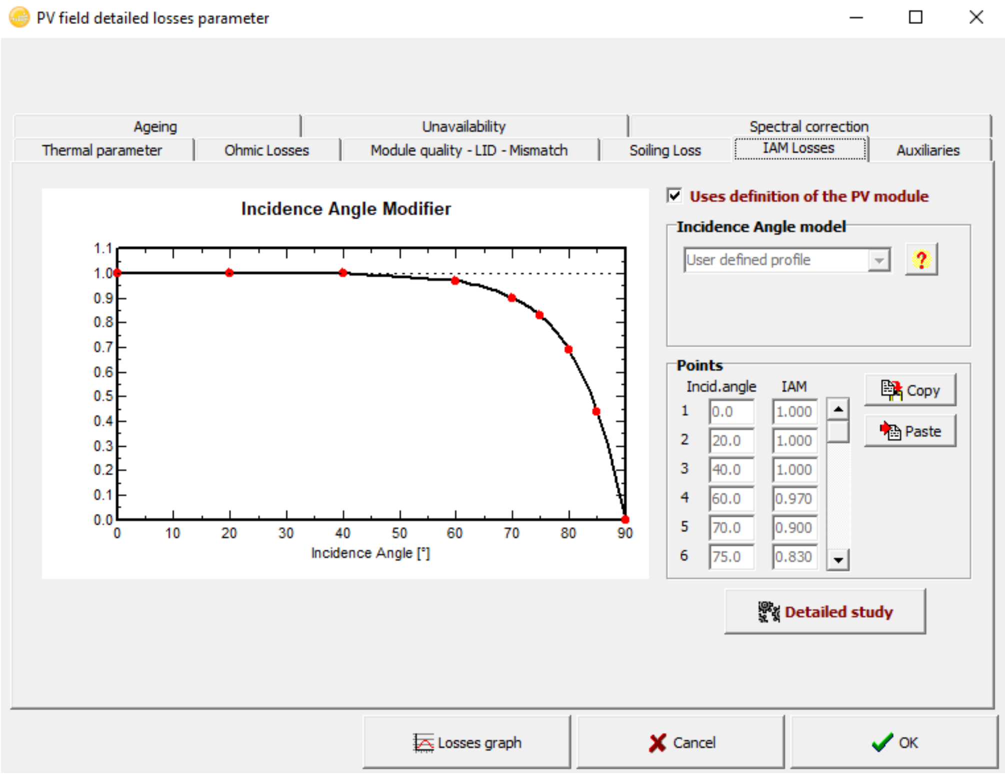
Voltage drops across series diode: Each diode causes a voltage drop of almost 0.7 Volt. Diodes are typically used to transport electricity from one string to another.



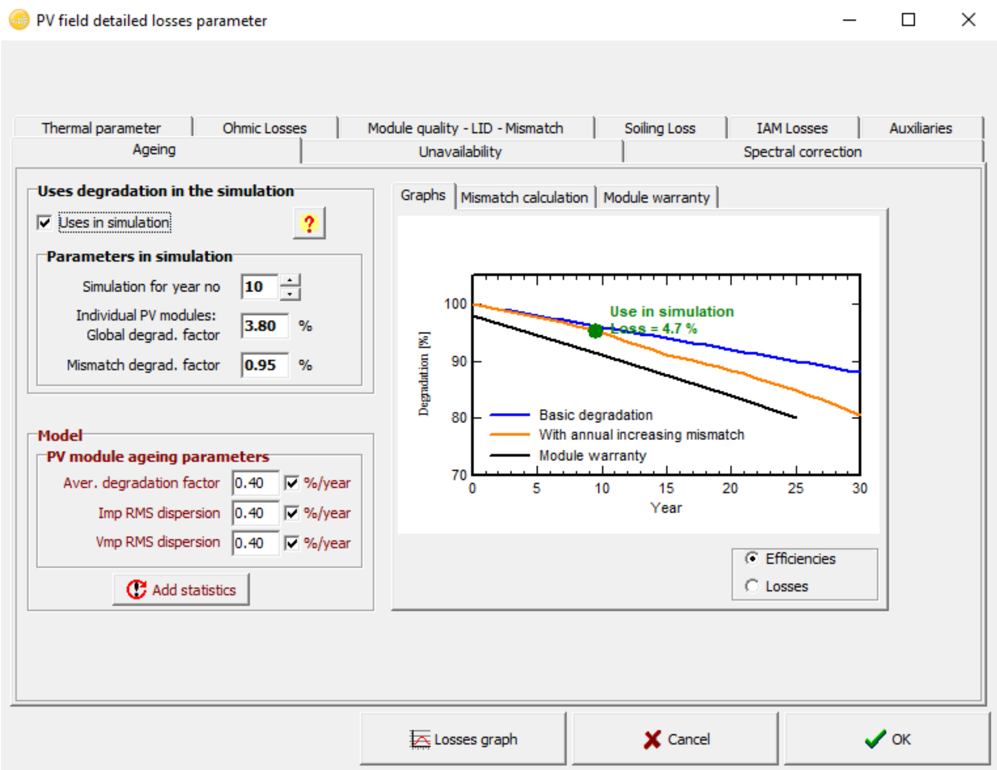
Light Induced Degradation: as is already shown from the software, take in account the degradation of crystalline silicon modules in the first operating hours by respect to manufacturing test in standard test condition.



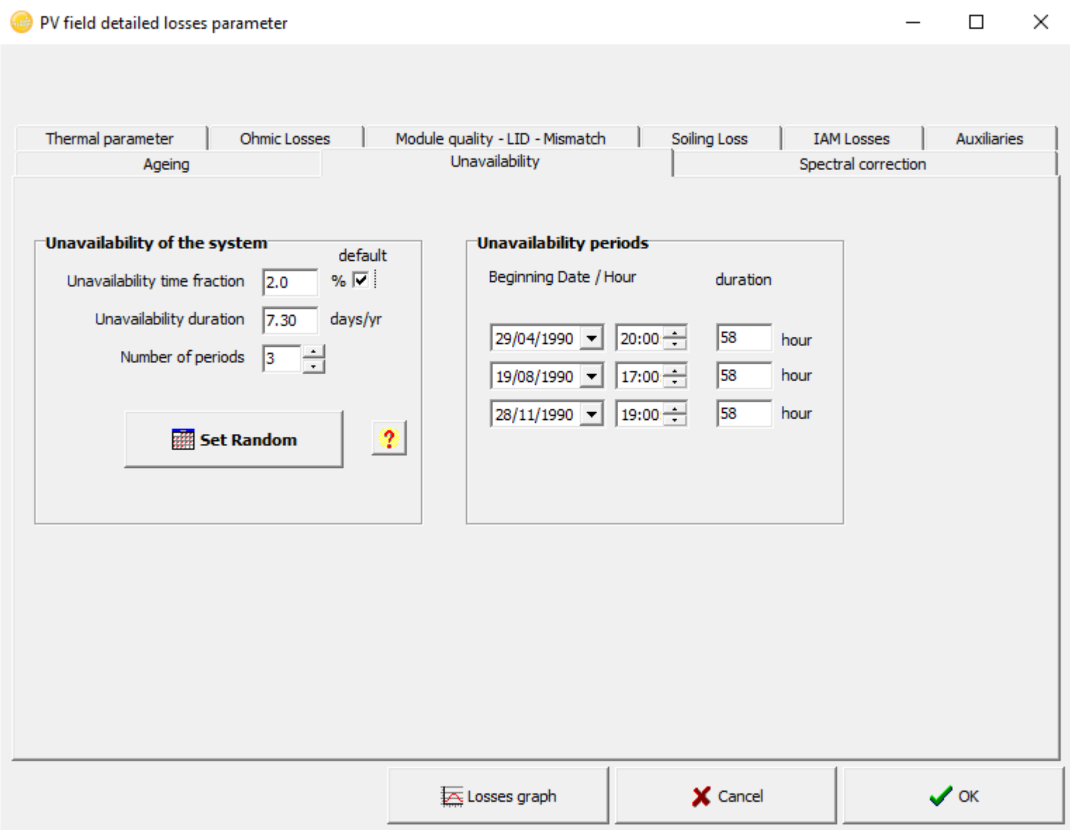
Yearly soiling loss factor: to take in account accumulation of dirt and its effect on the system performance of the PV panel.



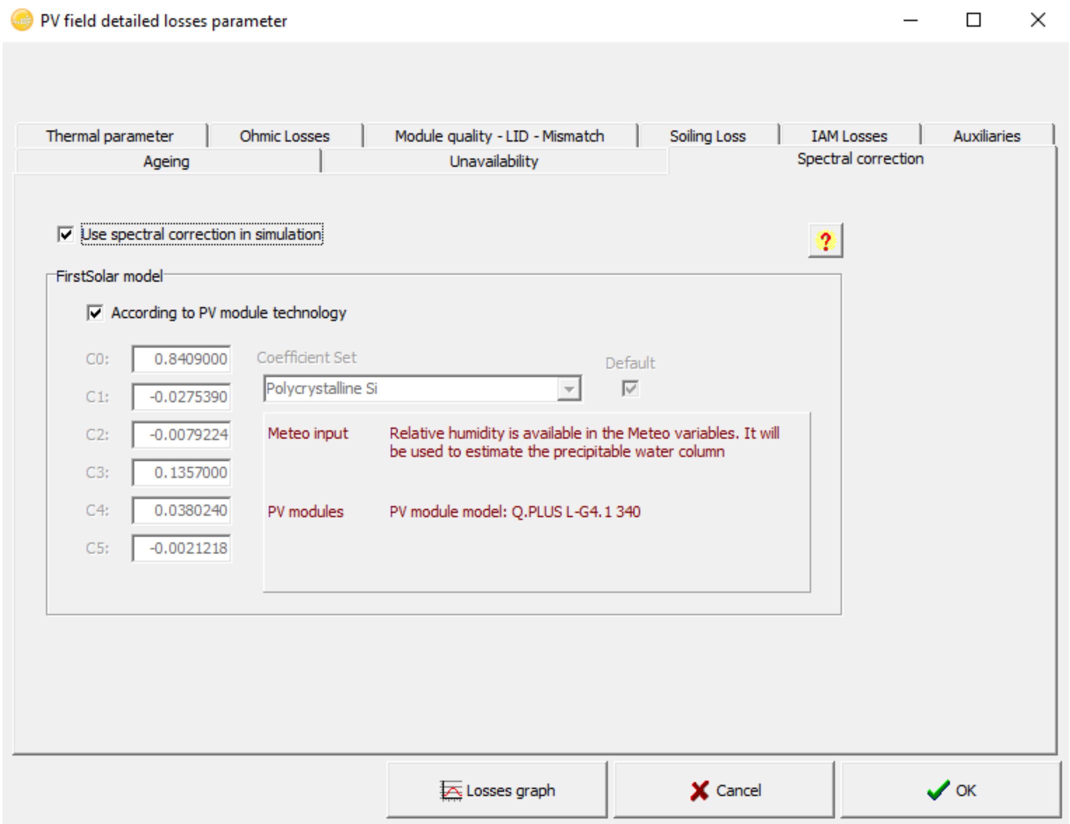
Incidence Angle Modifier: to take in account the incidence effect corresponds to the decrease of the irradiance really reaching the PV cells' surface, with respect to irradiance under normal incidence. This decrease is mainly due to reflections on the glass cover, which increases with the incidence angle.



Ageing: to take in account the lost of the performance of the PV panel as time goes by. The simulation will be performed after 10 years of usage of the panel.



Unavailability of the system: to take in account the time while panels will be turned off for maintenance operations.



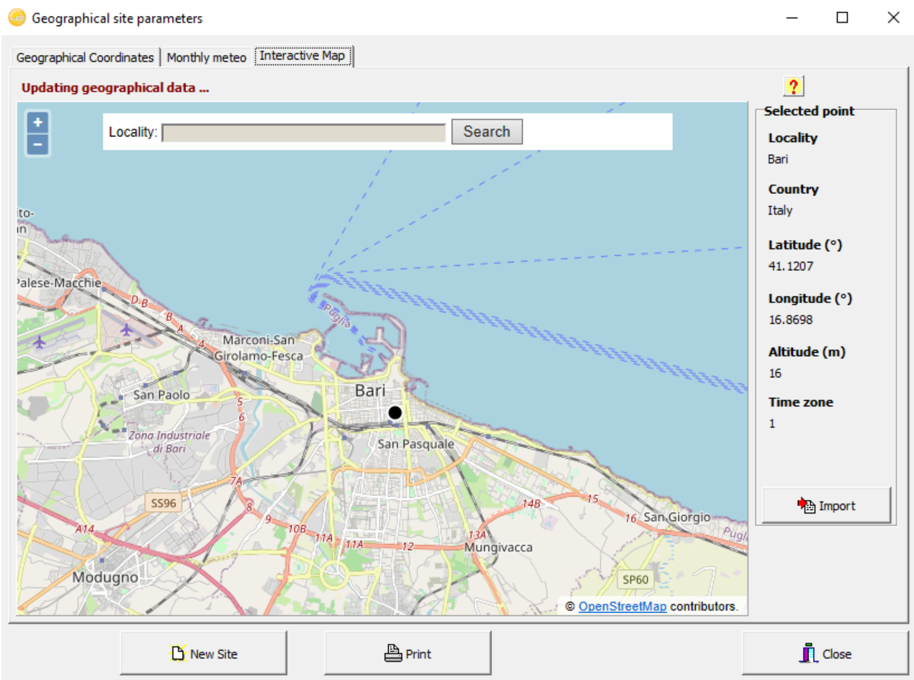
Spectral correction: to take in account changes in the solar spectrum due to scattering and absorption in the atmosphere that changes its characteristics.

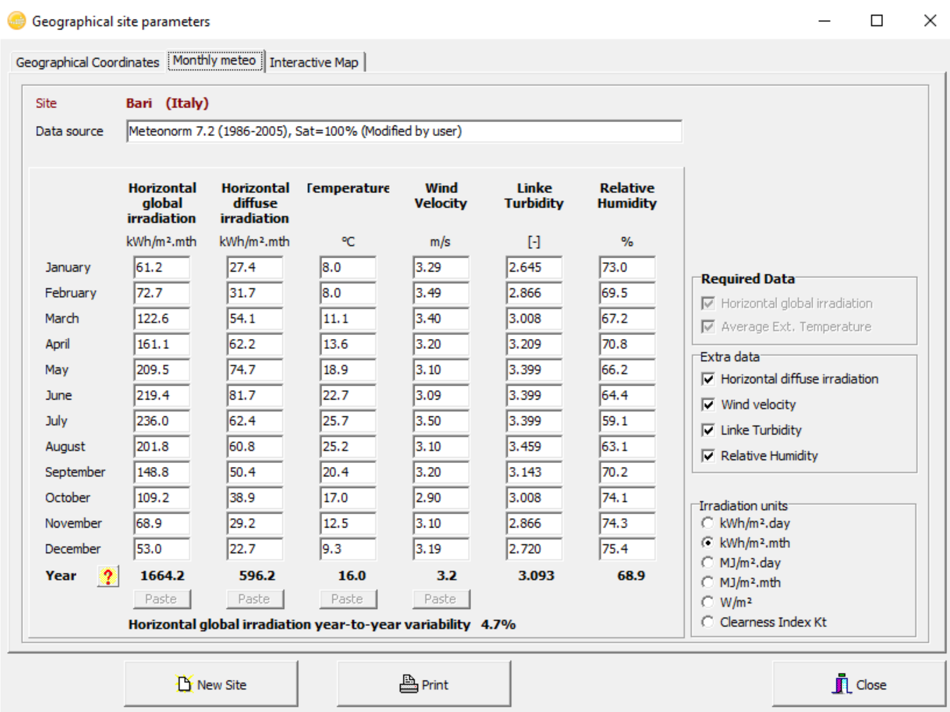
INPUTS OF THE SECOND REPORT

1. Location: the location was set in Bary, the bigger country in the South of the Italy, and the meteorological values are already provided by the map of PVSyst.
2. PV system components: as an overview the system will include PV modules and inverter taken from database.
3. User’s needs: a planned power of 55kWp.

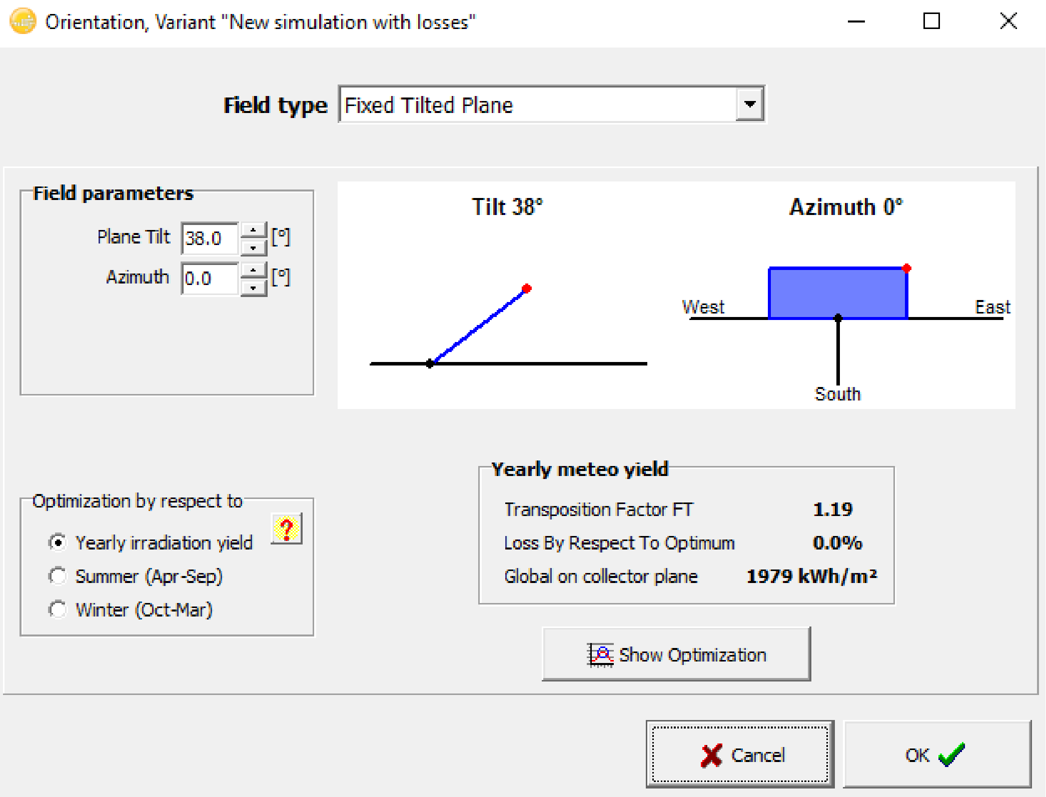
PROCEDURE OF THE SECOND REPORT

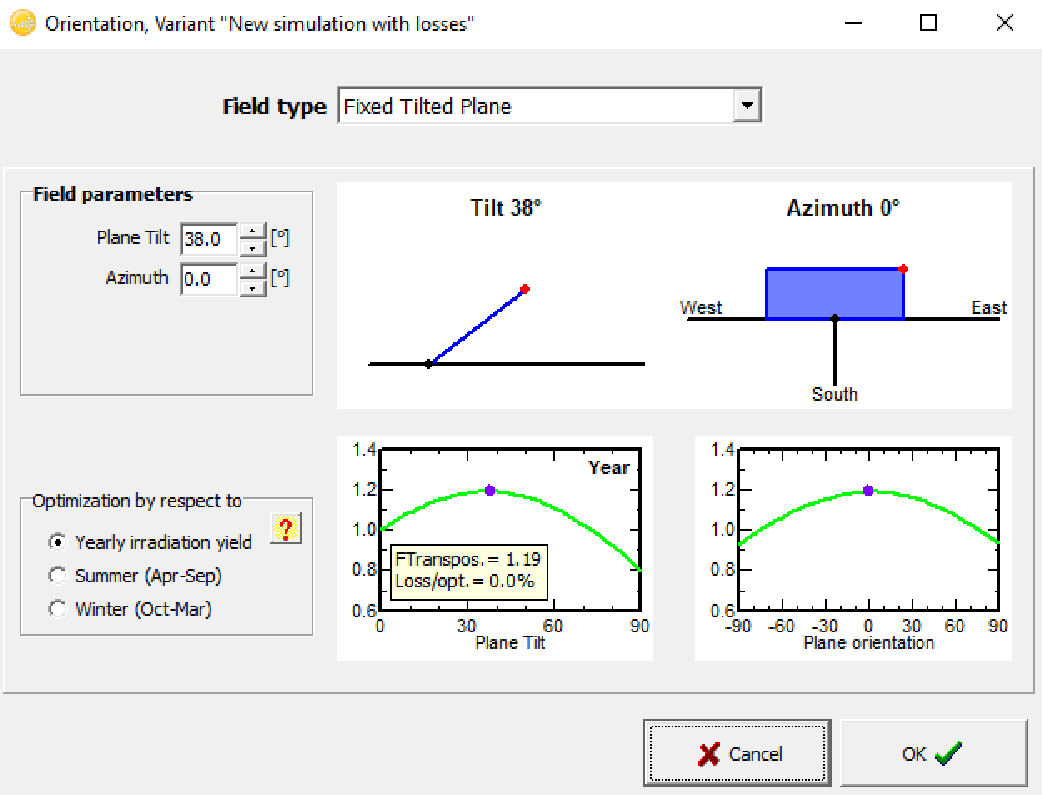
1. *Set the project’s destination (Name, Geographical location and weather file)*: in this case country was not already present into the database. So, it was added during the simulation as new site;



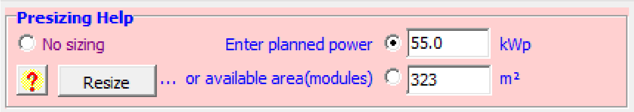


2. *Set the orientation of the PV module*: as specified before the tilt and azimuth angle will be taken as the optimal, as optimization method was chosen the one that take an average between winter and summer needs (called: *yearly irradiation yield*) this because a grid connected system aims to produce all the possible energy and feed the electrical grid and not perfectly satisfy a building demand;





3. Set the user's need: in this case a planned power of 55kWp.



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

4. *Array and inverter pre-sizing*: typically, there is an oversizing of the PV panels' total power respect to inverter power about 10-20% because inverter allows overload. In the first time the inverter was selected as an intersection of its operative voltage with the voltage of an array of PV panels in serial connection (Vmppp 20 Celsius degree).
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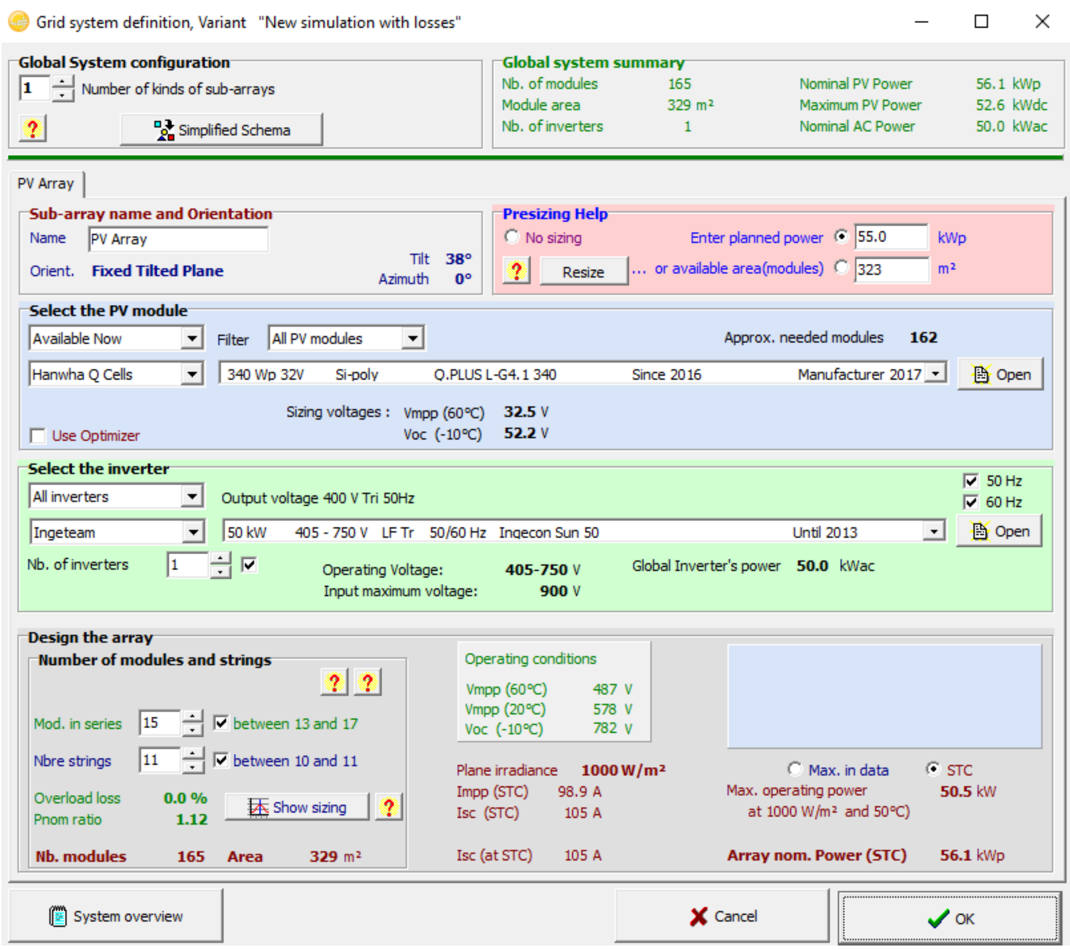


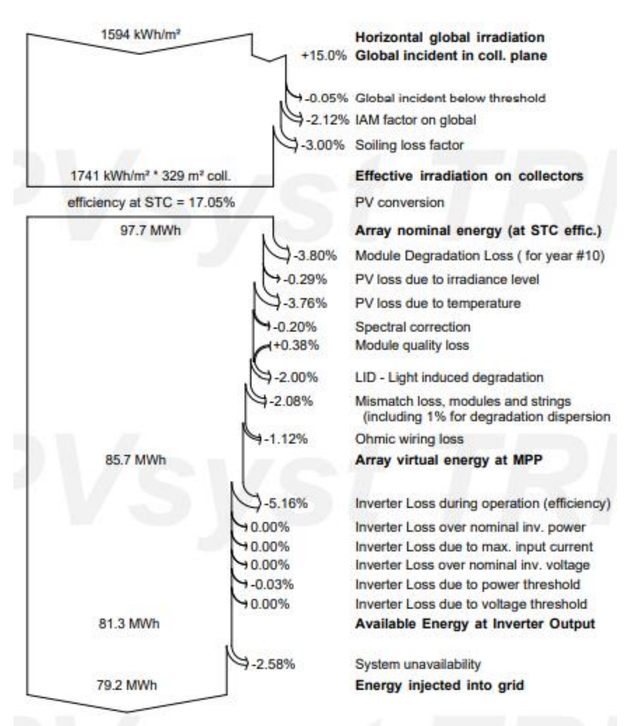
6. Define losses: will be taken in account losses to obtain more realistic results, such as: *Thermal parameter, Voltage drops across series diode, Light Induced Degradation, Yearly soiling loss factor, Yearly soiling loss factor, Incidence Angle Modifier, Ageing, Unavailability of the system* and *Spectral correction*. They will be the same as the losses of the first project.

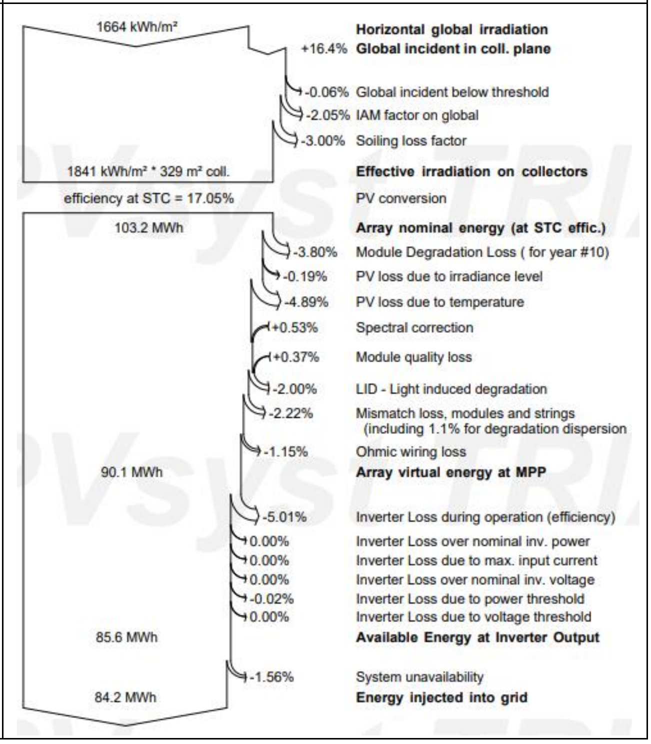
OUTPUTS

The main important results are:

1. Produced energy;
2. Specific production: The produced energy divided by the Nominal power of the array (Pnom at STC). This is an indicator of the potential of the system, taking into account irradiance conditions (orientation, site location, meteorological conditions).
3. Performance Ratio: is the ratio of the energy effectively produced (used), with respect to the energy which would be produced if the system was continuously working at its nominal STC efficiency. Unlike the "Specific energy production" indicator, expressed in [kWh/kWp/year], this indicator is not directly dependent on the meteo input or plane orientation. This allows the comparison of the system quality between installations in different locations and orientations;
4. Loss diagram over the whole year: that allow us to recognize the most affecting losses on our systems.

IndUva, Valladolid, SPAIN	Bari, ITALY
Produced Energy **79.16 MWh/year** Specific prod. 1411 kWh/kWp/year Performance Ratio PR 76.93 %	**Produced Energy** **84.24 MWh/year** Specific prod. 1502 kWh/kWp/year Performance Ratio PR 77.51 %





Comparing the two locations only by the higher value of specific energy production, Bari is the best location for this type of system because of higher value higher values of horizontal global and horizontal diffuse irradiation. Taking into the account the performance ratio: Bari is also the best location because of a higher value of performance ratio independently of meteo input or plane orientation. But, looking for losses, Bari has the higher losses due to the temperature. This is maybe because the colder temperature reached in Valladolid morning allows the PV modules to work better instead higher average temperature in the south of the Italy.