

Application Note - How to Simulate a SolarEdge PV System in PVsyst

PVsyst supports the design and simulation of SolarEdge systems. This application note details the SolarEdge-specific design steps for PVsyst V7.

This document explains the unique SolarEdge design concepts as they are realized in PVsyst and guides the user through the setup of a shading scenario using the SolarEdge system.

Introduction

The process of designing a SolarEdge system in PVsyst includes the following basic steps:

- Step 1: Project – define the location and meteorological data.
- Step 2: Orientation – define module azimuth and tilt.
- Step 3: System – choose the PV modules, inverters and electrical design.
- Step 4: Module Layout – create the electrical string connections according to the 3D scene.
- Step 5: Detailed Losses – mismatch. Ensure the mismatch loss is set to 0% for a SolarEdge system.
- Step 6: Simulation – view a summary of the system's energy output.



NOTE

PVsyst versions 6.64 and above use different SolarEdge inverter OND files. To ensure correct results, delete any existing SolarEdge OND files from the PVsyst inverters folder.

The folder location is: C:\Users\<USERNAME>\PVsyst7.0_Data\ComposPV\Inverters.



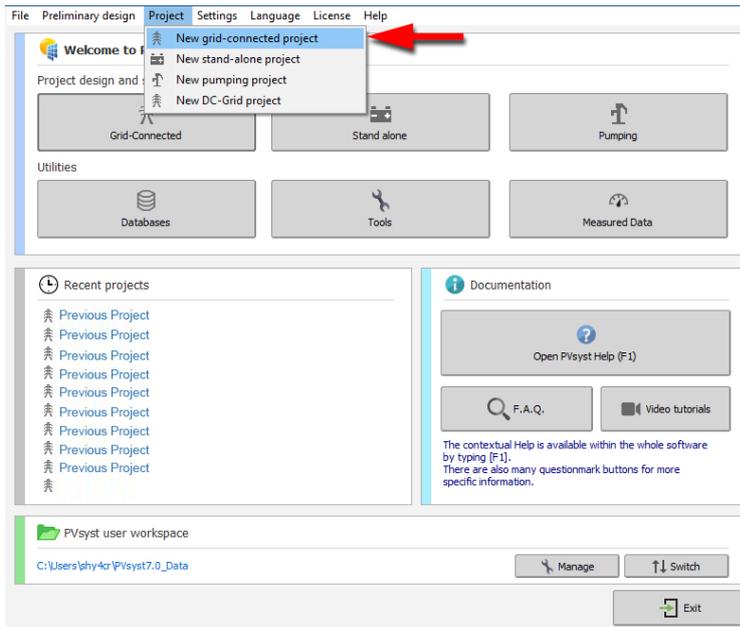
NOTE

1. While PVsyst offers basic system validation, it is recommended that you always use the SolarEdge Site Designer software for design verification.

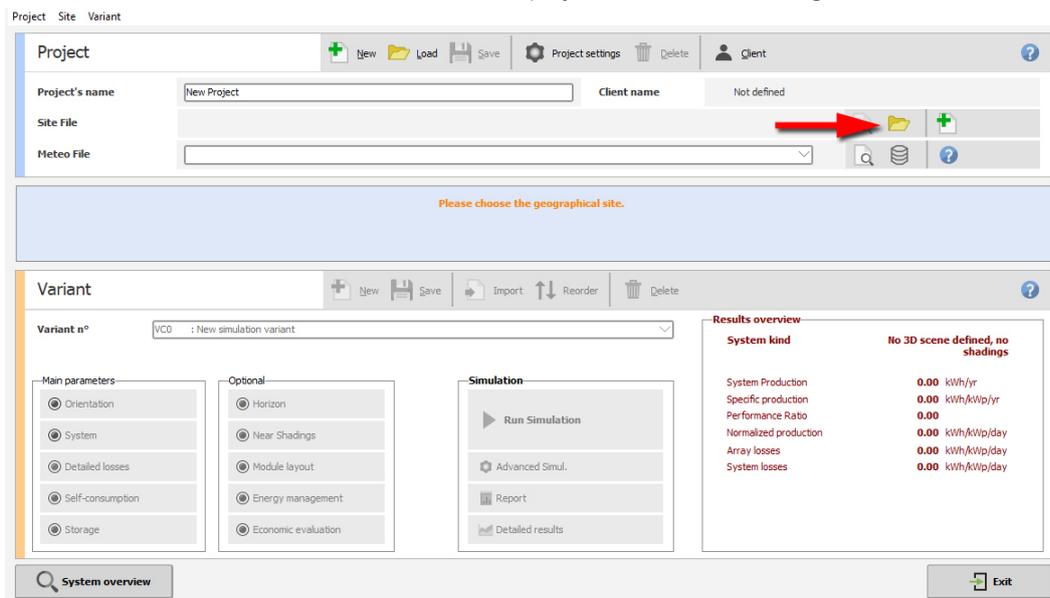
2. This application note assumes the reader has prior knowledge of the basic use of PVsyst.

Step 1: Project

1. Open the **Project** menu and select **New Grid Connected Project**.



2. Click the **Choose Site** button to select the correct project site and meteorological file.



Step 2: Orientation

Once the geographical location and climate file have been chosen, you can define the array's azimuth and tilt. PVsyst offers different options for various types of projects, including simple fixed tilted plane, multiple orientation, seasonal tilt adjustments, 'unlimited sheds' for large systems, sun shields (modules mounted to facades of buildings) as well as various kinds of tracking arrays, both single and double-axis.

Step 3: System

Here you can set the main system parameters, such as modules, inverter, DC size, string lengths, etc.



NOTE

To allow a DC oversizing ratio above 135%, go to the main program screen and select **Settings-->Edit advanced parameters**. In the search box, enter 664, which will bring up the hidden parameter for the max allowed oversizing. Enter the desired maximum oversizing. For HD Wave inverters, search for parameter 665 instead.

Basic Design

After choosing a PV module in the light-blue area, check the **Use Optimizer** checkbox and select an appropriate power optimizer from the drop-down menu. Then, in the light-green area, select the SolarEdge inverter applicable for your

project. In this example, we show how to design a system with three strings of 36 440W modules connected to an SE40K inverter using P950 power optimizers.



NOTE
Do not alter the "Nb. Concerned inv." Field: this will be automatically filled in by PVsyst in the next steps.

Select the inverter

Available Now Output voltage: 480 V Tri 50Hz

SolarEdge 40 kW Fixed 850 V TL 50/60 Hz SE40K-EU-APAC/AUS Since 2020

Nb. concerned inv.: 1

Operating voltage: 850 V Inverter power used: 120 kWac

Input maximum voltage: 1000 V SolarEdge Architecture

Array Design for SolarEdge architecture

Optimizer input Inverter input

Nb. optimizers in series: 18 (range 14 to 24)

=> 1 string = 36 modules, Pnom = 14800 Wp
i.e. Part of the inverter capacity: 11 %

Nb. strings in parall.: 3

Pnom ratio: 1.11 Overload loss: 0.1 %
nb. modules: 108 Area: 240 m²

Reference for sizing

Max. power: 822 W / optimizer (acc. to max. irradiance)

Plane irradiance: 1000 W/m²

Max. in data (at 1000 W/m² and 50°C): 43.1 kW

Array nom. Power (STC): 47.5 kWp

If you plan to connect more than one module per optimizer (as is the case in most commercial systems as well as in this example), use the **Optimizer input** tab shown below to specify how many modules to connect and the type of connection (series/parallel):

Array Design for SolarEdge architecture

Optimizer input Inverter input

Nb. modules in series: 2 (max 2)

Nb. modules in parallel: 1 (max 1)

=> PV power per Optimizer: 880 Wp STC
=> Isc current per Optimizer: 11 A STC
=> Vmp voltage per Optimizer: 83 Voper

details

The **Inverter Input** tab shows the number of power optimizers per string, not the number of modules. So, in the example below, when connecting two modules per power optimizer, the string length will be 18 power optimizers = 36 modules:

Array Design for SolarEdge architecture

Optimizer input Inverter input

Nb. optimizers in series: 18 (range 14 to 24)

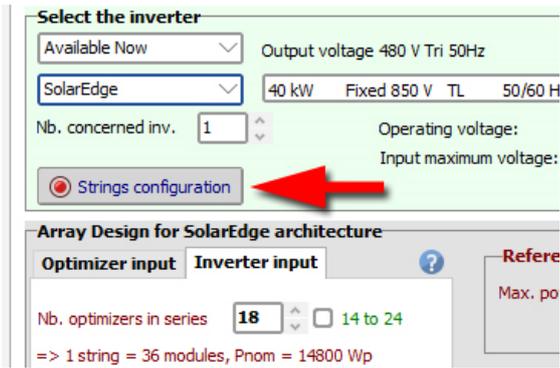
=> 1 string = 36 modules, Pnom = 14800 Wp
i.e. Part of the inverter capacity: 11 %

Nb. strings in parall.: 3

Pnom ratio: 1.11 Overload loss: 0.1 %
nb. modules: 108 Area: 240 m²

Now that you have specified the string length and number of strings in the system, PVsyst must determine how many inverters your system requires. In order to accommodate the SolarEdge system's design flexibility, PVsyst has added a **SolarEdge-specific Strings Configuration** screen. This screen allows the allocation of any string to any inverter, according to the project needs and system design limits.

To allocate strings, click **Strings Configuration**.



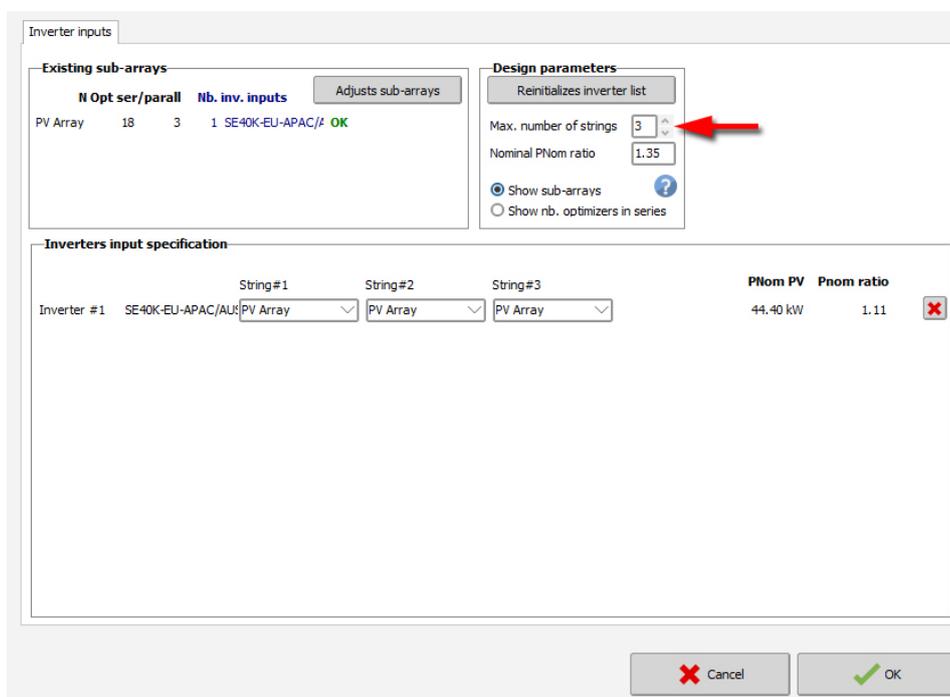
The interface allows an automatic design according to the number of strings you specified in the previous step.

To automatically design a system, click **Reinitializes inverter list** and then **Adjusts sub-arrays**.



NOTE

The **Max number of strings** is the intended maximum per inverter, not for the entire system (in the example below, there is but one inverter so the system does have only three strings).



Click **OK** to return to the **System** screen.

Additional System Design Examples

Unlike a traditional inverter, the SolarEdge system introduces a high level of design flexibility. A common limitation of a traditional system is that all strings connecting to an MPP tracker must be of the same length. The SolarEdge system has no such limitation since MPPT is performed at the module level using the SolarEdge power optimizers. Multiple strings can be connected to one inverter, regardless of length, module azimuth, tilt or module type.

The following three examples show how to create electrical designs with the SolarEdge system.



NOTE

Currently, only homogeneous strings may be designed with PVsyst. A string is considered homogeneous, if it contains only one orientation, tilt and module type. In reality, the SolarEdge system can be designed with non-homogenous strings, meaning that different orientations, module tilts and module types can be accommodated within a string, increasing system flexibility and ease of design

Example 1

Consider a SolarEdge SE6000H inverter with 19 modules divided into two strings: one with nine modules, and one with ten modules. For this design, you will create two PVsyst Sub-arrays: one for each string. Each Sub-array will have one "concerned inverter", because both Sub-arrays concern (connect to) the one SE6000H. One Sub-array will have a string of nine P505 power optimizers, and the other Sub-array will have a string of 10 P505 power optimizers. The Sub-arrays will look like this:

Click **Strings Configuration** to ensure that the system is designed correctly. If needed, click **Reinitializes inverter list** and **Adjusts sub-arrays** to verify the design:

Note that the **Max. number of strings** is set to 2 in this case, because only two strings are connected to the inverter. The **Inverters Input Specification** area shows the strings are listed correctly: one string from PV Array and one string from Sub-array #2. *PV Array* is the default name PVsyst gives the first Sub-array.

Example 2

Consider a SolarEdge system with one SE40K inverter connected to 116 x 440W modules. In this example, a P950 power optimizer is connected to two modules in series. This results in a design of three strings as follows: two strings with 19 power optimizers (38 modules), and one string with 20 power optimizers (40 modules). The Sub-arrays will look like this:

As in the previous example, each Sub-array will have one concerned inverter, because both Sub-arrays connect to the same inverter.

The **Strings Configuration** screen shows the following details:

Example 3

Consider a 160 kWp commercial system with one SE120K inverter connected to 364 440W modules. In this example, a P950 power optimizer is connected to two modules in series.



NOTE

The Synergy inverters such as the SE120K are represented in PVsyst by their respective units. For example, the SE120K inverter is comprised of 3xSE40K units. Thus, in order to select 120kW AC, you we need to select three 40K units, as in the example below.

The chosen design for this project is:

- SE120K Units 1 and 2: three strings of 20 P950 for each inverter (total of 6x40 modules)
- SE120K Unit 3: one string of 20 P950 and two strings of 21 P950 (1x40 plus 2x42 modules)

Although there are three-unit inverters, there are only two string lengths, so we can design the system in two Sub-arrays, as follows:

The System screen shows the following details:

Note how the SE120K inverter is actually rated at 40kW. This happens because each one of the SE120K inverters in PVsyst represents a 40kW units of the larger inverter. Thus, for a system with one SE120K inverter, the PVsyst report will show 3xSE120K units.

Note that the number of concerned inverters in this PV Array is 3. This is because the 40-module strings connect to all three of the inverters (three per each of the first two units, and one string connected to the third unit).

In the **Strings Configuration** screen, click **Reinitializes Inverter List** and **Adjusts Sub-arrays** to distribute the strings to their respective inverter units. If all sub-arrays are marked by a green "OK", the design is valid.

The result should look like this:

Existing sub-arrays			
	N Opt ser/parall	Nb. inv. inputs	SE120K/SE80K uni
PV Array	20	7	3 SE120K/SE80K uni OK
Sub-array #	21	2	2 SE120K/SE80K uni OK

Inverters input specification		String#1	String#2	String#3	PNom PV	Pnom ratio	
Inverter #1	SE120K/SE80K unit	PV Array	PV Array	PV Array	49,33 kW	1.23	✘
Inverter #2	SE120K/SE80K unit	PV Array	PV Array	Sub-array #2	50,16 kW	1.25	✘
Inverter #3	SE120K/SE80K unit	PV Array	PV Array	Sub-array #2	50,16 kW	1.25	✘

The strings connected to inverter units 1 and 2 are all from PV Array.

The strings connected to inverter unit 3 are from PV Array (2 strings, 20xP950) and from Sub-array #2 (1 string, 21xP9500).

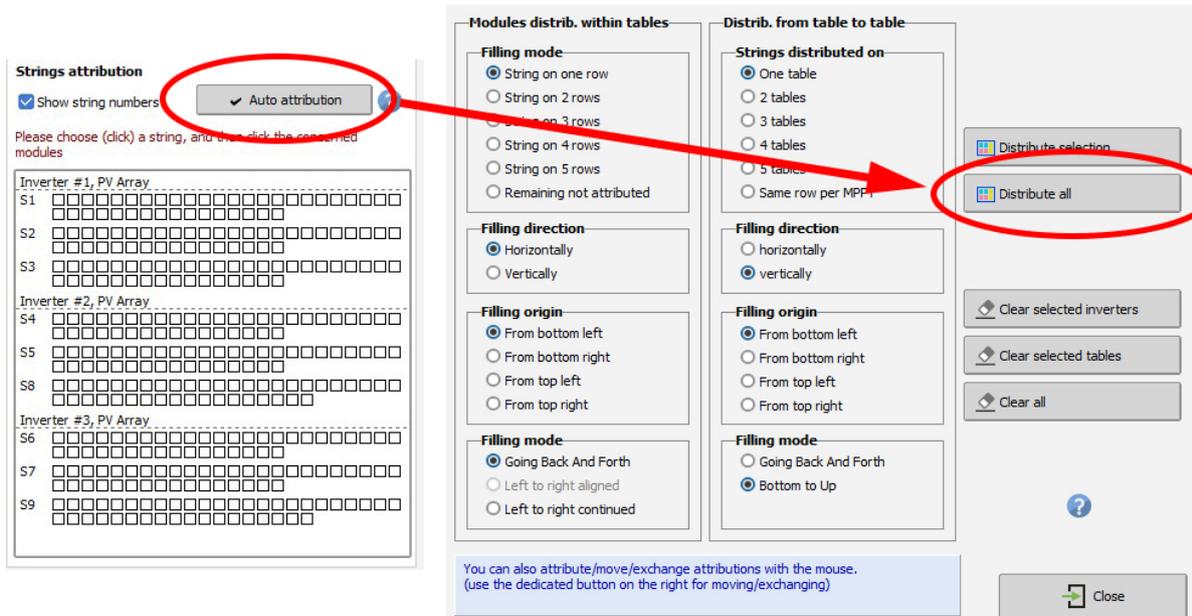
Step 4: Module Layout

The SolarEdge system minimizes the energy loss due to partial shading when compared to a traditional inverter. If the system in question has shading of any kind (trees, chimneys, inter-row shading) the 3D physical system layout should be designed to account for the energy loss due to shade. An accurate shading simulation will ensure the SolarEdge advantage is reflected in the annual energy output of the system. If needed, you can refer to the PVsyst help files for assistance in constructing a 3D shading scene.

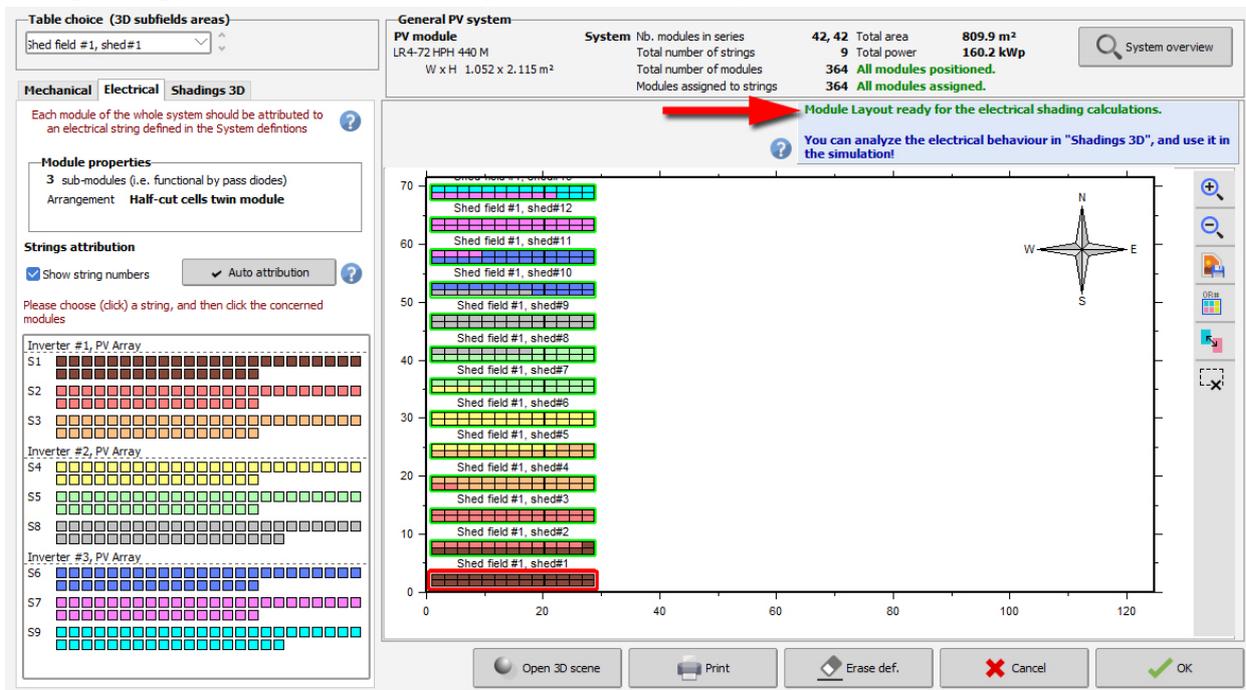
Unlike a traditional system, in which the production of entire strings may be affected by partial shading of as little as a few cells of one module, SolarEdge confines the effects of partial shading to the shaded modules only, thanks to its module-level MPPT. The module-level optimization in PVsyst is taken into account when using the Module Layout method for calculating shading electrical losses.

→ **To activate the Module Layout functionality:**

1. Once the 3D scene is constructed, click the **Module Layout** button in the main interface:



- Once the modules are assigned to their respective strings (and colored), click **Close**. Make sure you see the green message letting you know that the module layout is correct and ready for the simulation. Click on **OK** to exit.



Step 5: Detailed Losses – Mismatch

SolarEdge eliminates all losses that result from mismatch, compared to a 2% first-year loss in a traditional system. Mismatch losses are caused by the manufacturing tolerance of the modules, temperature differences during operation, uneven soiling and other environmental factors such as overcast weather conditions, partially melted snow, fallen leaves, etc.

When selecting a SolarEdge inverter, PVsyst automatically sets the mismatch losses to zero. For traditional systems, the default value is 2% for the modules and an additional 0.1% for the string voltage mismatch.

This parameter should always remain 0% in a SolarEdge system (the default setting for a SolarEdge system).

Concerned sub-array: PV Array [Apply to all sub-arrays]

Thermal parameter | Ohmic Losses | **Module quality - LID - Mismatch** | Soiling Loss | IAM Losses | Auxiliaries | Aging | Unavailability | Spectral correction

Module quality (default)

Module efficiency loss: % [?]

Deviation of the average effective module efficiency with respect to manufacturer specifications.
(negative value indicates over-performance)

Module mismatch losses (default)

Power Loss at MPP: % [?]

Loss when running at fixed voltage: % [?]

Module-level optimizers: no Mismatch Loss

[Detailed computation]

LID - Light Induced Degradation (default)

LID loss factor: % [?]

Degradation of crystalline silicon modules in the first operating hours with respect to the manufacturing flash test STC values

Strings voltage mismatch (Default)

Power Loss at MPP: % [?]

[Detailed study]

[Losses graph] [Cancel] [OK]

Step 6: Simulation

Once the system parameters have been defined, click on **Run Simulation**. Upon completion of the simulation, a report will be available for viewing and printing. In addition, the Simulation Settings screen allows you to change the time frame of the simulation (from one day to one year), as well as exporting hourly values of various parameters including energy, inverter efficiency, PV array's electrical behavior and more. Depending on the complexity and size of the system, the simulation process may take from a few seconds to over an hour.

Project Site Variant

Project [New] [Load] [Save] [Project settings] [Delete] [Client] [?]

Project's name: SolarEdge Project in Aberdeen Client name: Not defined

Site File: Aberdeen/Dyce MeteoNorm 7.2 station United Kingdom [?] [?] [?]

Meteo File: Aberdeen_MN71_Synthetic.MET MeteoNorm 7.1 station Synthetic 9k [?] [?] [?]

Ready for simulation

Variant [New] [Save] [Import] [Reorder] [Delete] [?]

Variant n°: VC3 : SE120K

Main parameters

- Orientation
- System
- Detailed losses
- Self-consumption
- Storage

Optional

- Horizon
- Near Shadings
- Module layout
- Energy management
- Economic evaluation

Simulation

[Run Simulation]

[Advanced Simul.]

[Report]

[Detailed results]

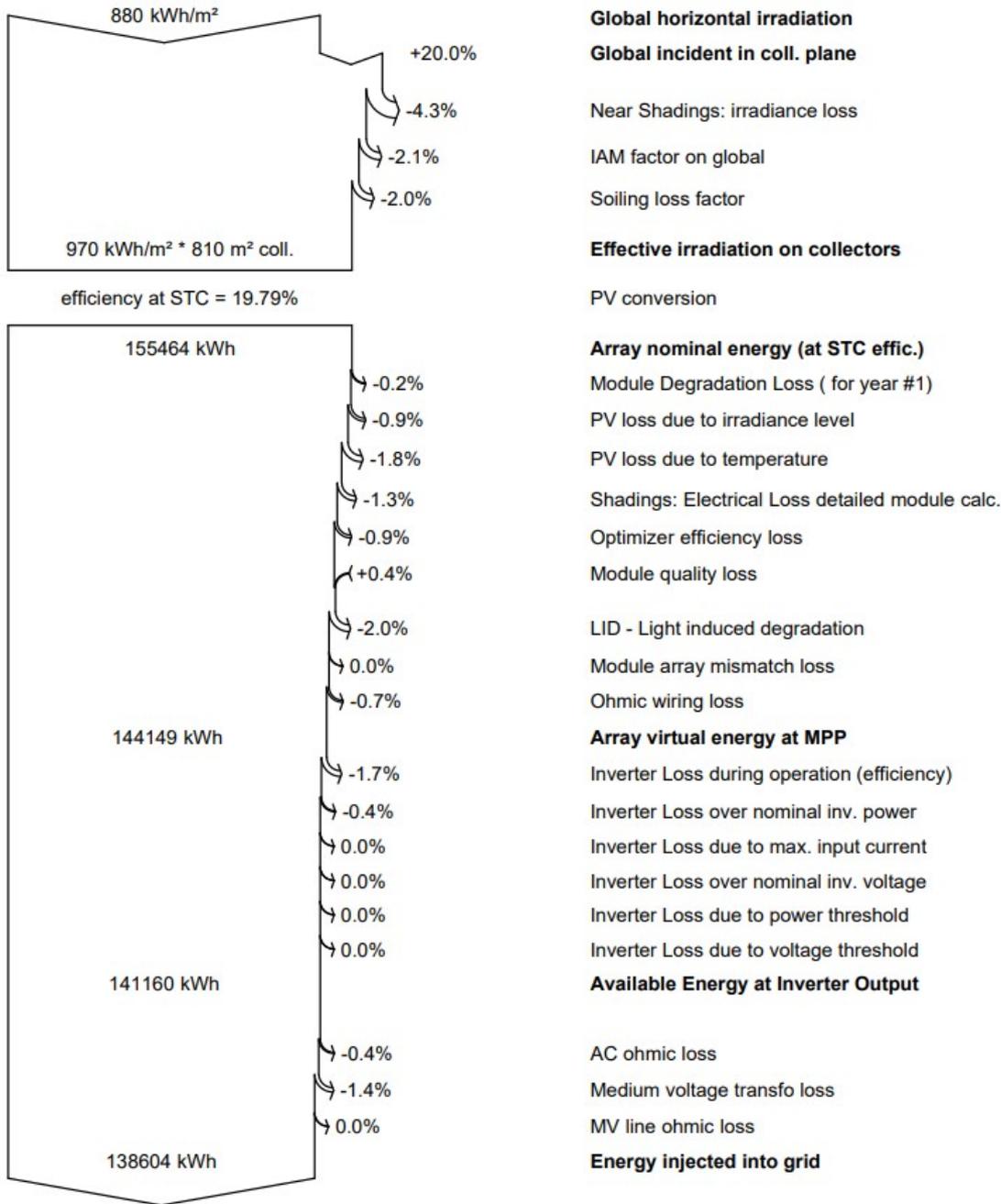
Results overview

System kind	Sheds, single array
System Production	0.00 kWh/yr
Specific production	0.00 kWh/kWp/yr
Performance Ratio	0.00
Normalized production	0.00 kWh/kWp/day
Array losses	0.00 kWh/kWp/day
System losses	0.00 kWh/kWp/day

[System overview] [Exit]

Appendix B: PVsyst Loss Parameters

PVsyst calculates several loss parameters during the simulation, as shown in the loss diagram below. This diagram appears at the end of each PVsyst report. Following is an overview of the loss parameters, calculated successively.



- Global Horizontal Irradiation:** a combination of the global diffuse irradiance and the global beam irradiance calculated hourly over one year on a horizontal surface.
- Global incident in collection plane:** using a transposition model (either Perez or Hay), PVsyst increases or decreases the horizontal global irradiation depending on the azimuth and tilt. This is the actual irradiation reaching the module.
- Near Shading: irradiance loss:** the loss due to direct shading (affecting the beam component of the irradiance) and diffuse shading (affecting the diffuse component of the irradiance. For example: nearby objects such as the next row of modules in a ground mount system reduce the diffused light, even if they do not cause direct shading).
- IAM factor on global:** IAM (Incidence Angle Modifier) relates to the decrease of irradiance reaching the PV cell due to the sun rays' refraction when passing through the PV module antireflective coating and glass. The higher the incident angle (with respect to the sun's position) the higher the loss.
- Soiling Loss Factor:** any expected loss due to soiling (dust, snow, fallen leaves, etc.).
- Effective irradiance on collectors:** the remaining irradiation following the previously detailed losses, multiplied by the PV area (the module area as defined in the PAN file).

- **PV Conversion:** the module efficiency at STC.
- **Module Degradation Loss:** the aging of the modules.
- **Array nominal energy (at STC efficiency):** the PV conversion efficiency multiplied by the effective irradiance on collectors.
- **PV loss due to irradiance level:** calculates the reduced module efficiency in low light conditions.
- **PV loss due to temperature:** reduced module performance due to temperature change. The module's temperature coefficients as well as the thermal loss factor affect this loss. The thermal loss factor is not a scientifically determined value; rather it is set by the user according to experience and previous estimations. A value of 20 W/m²k is acceptable for most systems. If the modules are embedded into a roof structure, the value can be set to 15. When the modules are free-standing in a cool and windy location, the value can be set to 29.
- **Optimizer efficiency loss:** the efficiency associated with the operation of the power optimizers.
- **Shading: electrical loss detailed module calc.:** in addition to the Near Shading irradiance loss, this represents the energy lost due to the electrical effect of shading. For example, in a traditional system with strings connected in parallel, one shaded module can cause a whole string to be bypassed due to a voltage mismatch (in a SolarEdge system, the loss is confined to the shaded module only).
- **Module quality loss:** This parameter makes use of the manufacturing tolerance values in the PAN file. The formula used is: The lower tolerance plus a quarter of the difference between lower and higher tolerance. So for example, for a module with a ±2% tolerance, the resulting quality loss is $[-2\% + (0.25 \times 4\%)] = -1\%$.
- **LID Loss:** This is a loss of performances arising in the very first hours of exposition to the sun with Crystalline modules. Once the loss is introduced, it is permanent.
- **Module array mismatch loss:** The energy loss due to mismatch between modules in a string. The 2% mismatch for traditional string inverters stems from manufacturing tolerance, un-even soiling, temperature differences between modules, tilt or azimuth differences within the string, etc. For SolarEdge systems this loss will always be 0%.
- **Ohmic wiring loss:** The voltage drop due to wiring resistance is calculated as one value for the whole system, set by the user. The default value of 1.5% loss from STC is recommended. This translates to a reasonable actual loss of around 0.7% on the DC side for most systems.
- **Inverter loss during operation (efficiency):** The inverter's DC to AC conversion efficiency, weighted for variance in power levels over the year.
- **Inverter loss over nominal inv. power:** The power clipping in overloading conditions (where the array produces more DC power than the maximum AC output of the inverter).
- **Inverter loss due to power threshold:** The loss of energy when the array operates below the inverter's minimum power threshold (defined in the OND file).
- **Inverter loss over nominal inverter voltage:** The energy loss when the array is producing voltage below the inverter's MPP voltage range.
- **Inverter loss due to voltage threshold:** The energy loss when the array is producing voltage above the inverter's MPP voltage range.
- **AC ohmic loss:** As with the DC wiring loss, a recommended value of 1% AC loss with respect to the STC value will produce around ~0.5% actual energy loss.
- **External transformer loss:** Unless actual parameters are available, the default 0.1% iron loss and 1% resistive loss are recommended.