

Guide to Modeling Enphase Microinverter Systems with PVsyst v6

This document provides guidance for installers and designers using PVsyst v6 (www.pvsyst.com) to model Photovoltaic (PV) system expected performance using Enphase Microinverters.

All software representations in this document are property of PVsyst. Intellectual and industrial property rights to PVsyst are owned by the University of Geneva on the software, to which PVsyst SA owns the licensing rights.

Solar electric PV systems with Enphase Microinverters have one utility-interactive microinverter per PV module that converts low voltage DC to utility grid-compliant AC output. The Enphase Microinverter System out-performs string or central inverters (with or without optimizers) by eliminating the limiting impact of module mismatch losses and shade experienced by string and central inverter systems.

Project developers and system design engineers around the world widely accept PVsyst expected PV system performance calculations. While using the software is generally straightforward for central or string inverter PV system architectures, it requires special model input parameter considerations when you use microinverter module-level power electronics (MLPE) in a system design.

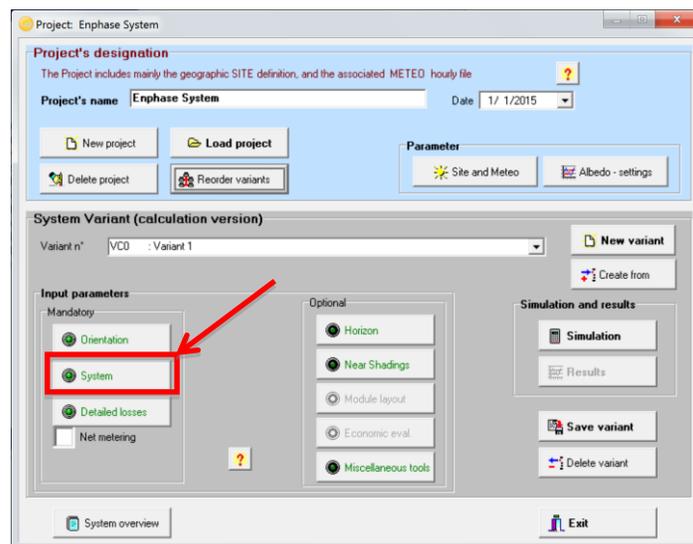
The PVsyst software model input adjustments described in this document allow the calculations performed by the model to more accurately reflect the improved energy harvest from PV modules that are individually controlled by a single microinverter.

The following assumes user familiarity with the PVsyst software and is not a complete PVsyst guide.

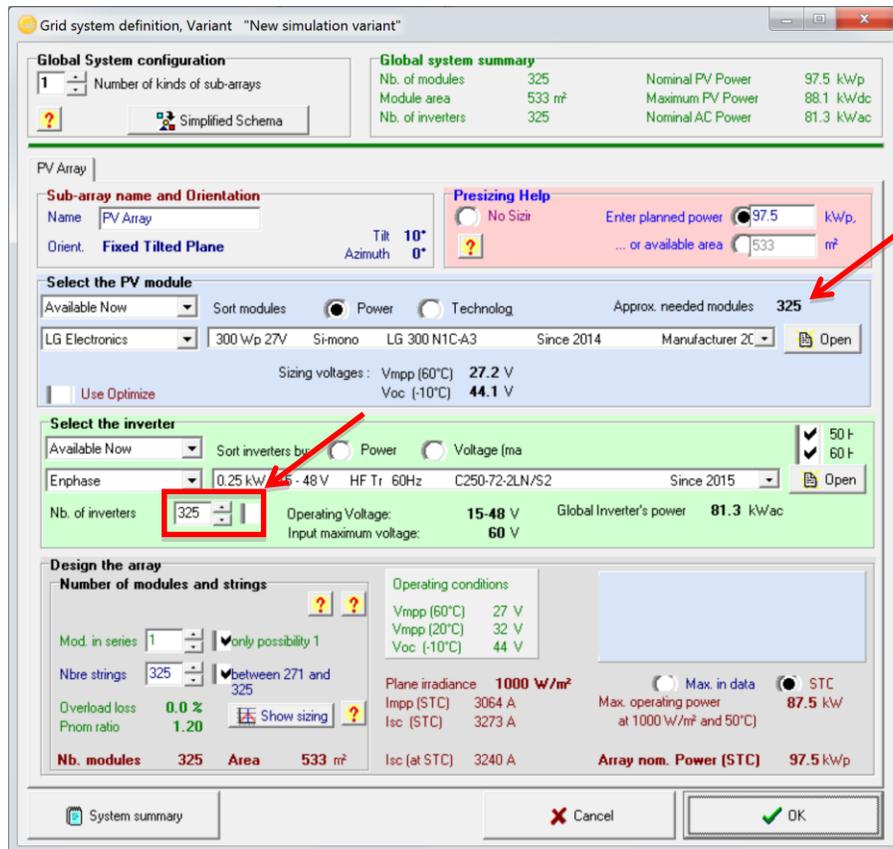
Note: Always make sure to download the latest module and inverter database from PVsyst to ensure that your model is using the latest technical data.

System Sizing

When sizing an Enphase System in PVsyst, make sure that the number of inverters and modules match in the **System** input parameters.



Project overview – Click **System** to adjust input parameters

System definition – Set **Nb. of inverters** equal to number of modules

Hidden Parameters

PVsyst requires adjustment of the following **Hidden PVsyst Parameters** for Enphase system modeling.

Low Limit Power Threshold

Enphase Microinverters can convert available energy of a PV module at very low power levels with higher conversion efficiency due to a feature called “burst mode”. This feature captures the available energy from a PV module at very low light levels (for example, during dawn and dusk) and bursts this energy into the grid when enough energy is available for one or more full AC cycles. This takes advantage of the available PV module energy when the light conditions are too low to operate the microinverter in the MPPT operating range. PVsyst has a hidden parameter that discards any power production in the model output that is below a certain low limit threshold of the nominal power rating of the inverter. The default value in PVsyst is 0.5%.

Set the **Power Threshold / PNom lower limit** parameter to 0.01% so that the PVsyst calculations include power production to essentially zero output for Enphase systems.

- From the main page click on **Preferences** and select **Edit hidden parameters**.
- Select the **Regulators and converters** from the **Category** drop down menu.
- Scroll to the bottom and change the **MPPT converters: Power Thresh./ PNom lower limit** value to 0.01 %. The default check mark will disappear.

Set this value back to default when modeling non-Enphase systems.

Maximum DC to AC Ratio

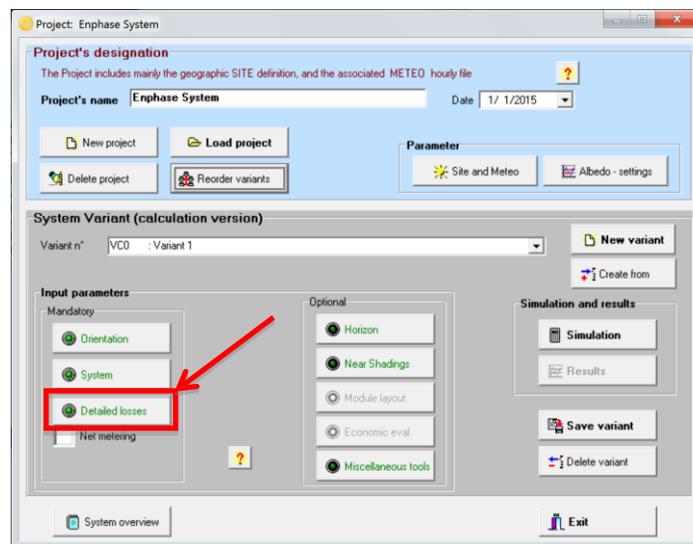
When modeling systems with a DC to AC ratio of greater than 1.3 of PV module STC rating to nominal microinverter output power, you must adjust the **Maximum PnomRatio for inverter sizing** parameter. The default value in PVsyst is 1.3.

- From the main page click on **Preferences** and select **Edit hidden parameters**.
- Select the **System design parameters** from the **Category** drop down menu.
- Adjust the **Maximum PnomRatio for inverter sizing** parameter to a higher value (for example, 1.5 or 1.6).

Detailed Losses

After you have defined your System input parameters:

- Click **Detailed Losses** to modify the input values to accurately represent performance calculations when using Enphase Microinverters.



Project Overview – Click **Detailed losses** input parameter

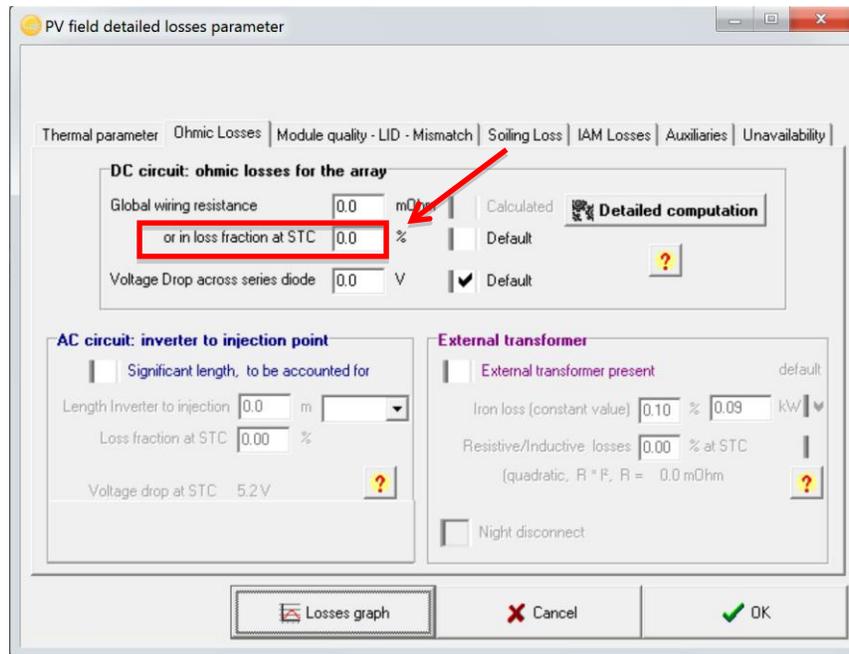
Adjust Ohmic Losses

Since each microinverter converts the DC source from one PV module to AC at the location of the module, the electrical collection and distribution from the array to the point of interconnection is no longer using direct current (DC), but instead alternating current (AC). You must adjust the ohmic losses to accommodate for this difference from traditional string and central inverters systems.

DC Circuit Losses

Because one Enphase Microinverter is connected to each PV module and mounted directly under the module, there are no long DC runs to the inverter. This eliminates any DC wire losses. To adjust for this:

- Click on the **Ohmic losses** tab in the **Detailed losses** parameter window.
- Adjust the value for **DC circuit: ohmic losses** for the array to 0%. This causes the **Default** check box to become unchecked automatically.
- Adjust the **Global wiring resistance** value to 0 mOhm.



Ohmic losses – Set the DC circuit: ohmic losses to 0%

AC Circuit Losses for Microinverter Systems

AC circuit ohmic losses are unique to every system and based on conductor selection (type and size) and on distances from the AC connections within the array and the interconnection point. PVsyst deals with AC ohmic losses with a single adjustment factor. It is therefore necessary to use an average loss factor of the system's AC distribution system.

- To adjust the model for AC circuit losses, in the **Ohmic losses** tab, select the check box **Significant length, to be accounted for** in the **AC Circuit: inverter to injection point** section.

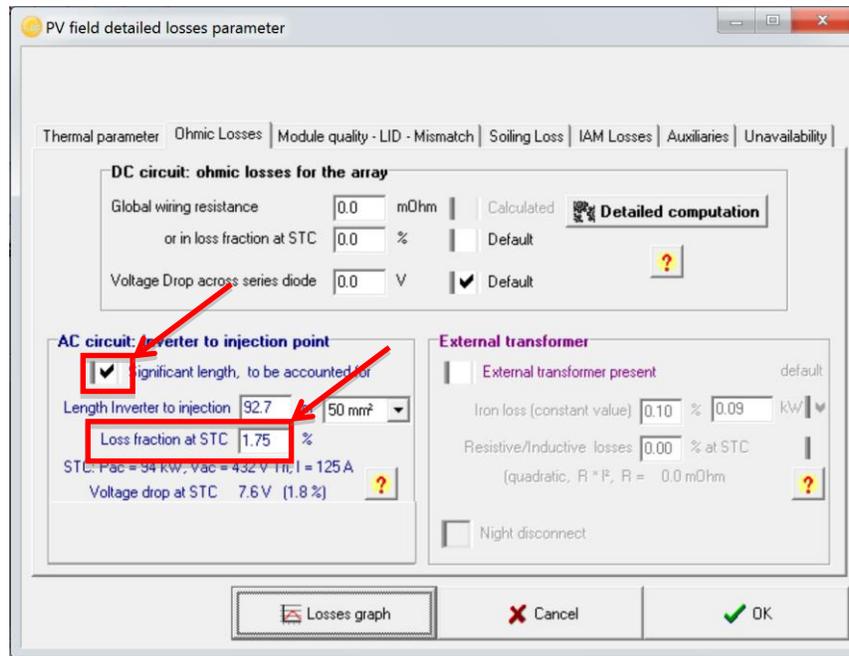
General Approach

- For preliminary analysis, enter 1.75% for **Loss fraction at STC**.

PVsyst equates the **Loss Fraction at STC** to "Voltage drop at STC". We always recommend Enphase systems to be designed and installed with a 2% or lower AC voltage drop from the last microinverter on an AC branch circuit to the point of interconnection (injection point, per PVsyst).

Since the highest recommended voltage drop is 2% for the furthest AC branch circuit from the injection point and since there are AC branch circuits in any system with shorter wire runs (adequately sized conductors and lower losses), we recommend entering 1.75% or lower for **Loss Fraction at STC**.

- If the exact voltage drop, averaged across all AC branch circuits, is known for your design, use this number in this field.



Ohmic losses – Set the AC circuit losses to 1.75% or less

AC circuit loss considerations for string or central inverter systems

When running a performance model for a **string (with or without optimizers) or central inverter system**, designers should enter a general AC loss fraction of 1.0% unless the specific AC circuit losses are known. Keep in mind that the AC circuit losses depend on the total current, size of the conductors, and wire distances of that AC circuit.

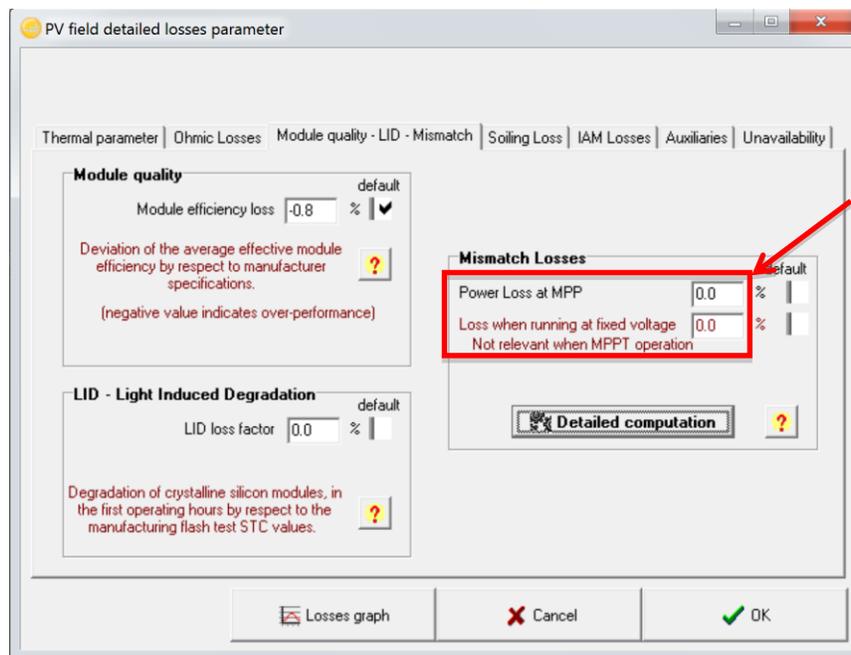
External Transformer Losses

You need to adjust the **External transformer** parameters only for PV systems with external transformers between the inverter and interconnection point. Isolation transformers and auto-transformers are different types of transformers with different loss fractions. Auto-transformers have much lower losses than isolation transformers. Check with the manufacturer about losses to expect from a transformer used in the specific system application.

Adjust Module Mismatch Losses

Enphase Microinverters eliminate the PV module mismatch losses that otherwise affect a string. Since one module is connected to one inverter in an Enphase Microinverter system, the maximum amount of energy can be harvested from each module. String or central inverters operate PV modules in series strings, in which the lowest performing module limits the performance of all the other modules in its string and parallel strings that are connected on the same DC input bus.

- To adjust the module mismatch losses for an Enphase System, in the **Module quality - LID - Mismatch** tab, and the **Mismatch Losses** section, enter 0 (zero) in the **Power Loss at MPP** field.
- Both **Module Quality** and **LID** parameters are limitations of the module. Leave these values at the module manufacturer's default settings.



Module Mismatch Losses – set the **Mismatch Losses** to 0 %

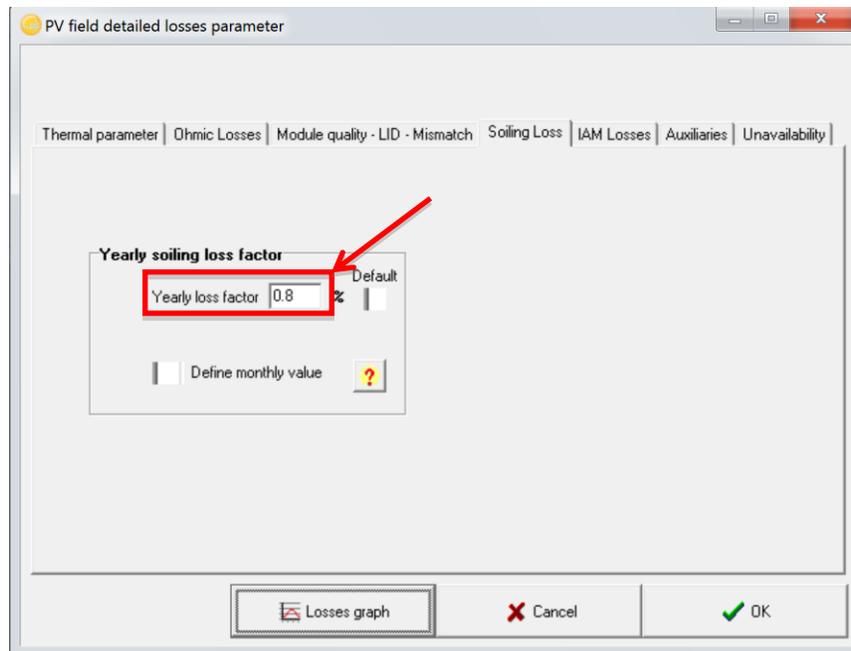
Adjust Soiling Loss

PV module soiling depends on the geographic region and the local environment. While an Enphase System does not impact the degree of soiling on a module or string, it does mitigate some of the loss by maximizing the performance of each individual module independently and preventing modules compromised by snow, dirt, or debris from dragging down the performance of other modules.

Enphase assumes that soiling in a PV system can be largely non-uniform. Such variance in soiling across a string or entire array creates module mismatch much like direct shading. Accordingly, to capture the impact of Enphase Microinverters on soiling mitigation, we recommend designers take into account the impact of mismatch due to soiling and roughly halve the losses. A representative table of soiling losses changes for different soiling rates follows:

| Soiling Loss Factor for String Inverter | Enphase-Adjusted Soiling Loss Factor | Difference |
|---|--------------------------------------|------------|
| 2 % | 0.8 % | -1.2% |
| 5 % | 3 % | -2 % |
| 8 % | 4.8 % | -3.2 % |
| 10 % | 6 % | -4 % |

- To adjust this parameter, select the **Soiling Loss** tab and change the **Yearly loss factor** to the adjusted loss factor.



Soiling Loss – Set **Yearly loss factor** to the adjusted value