Modeling Ampt String Optimizers in PVsyst

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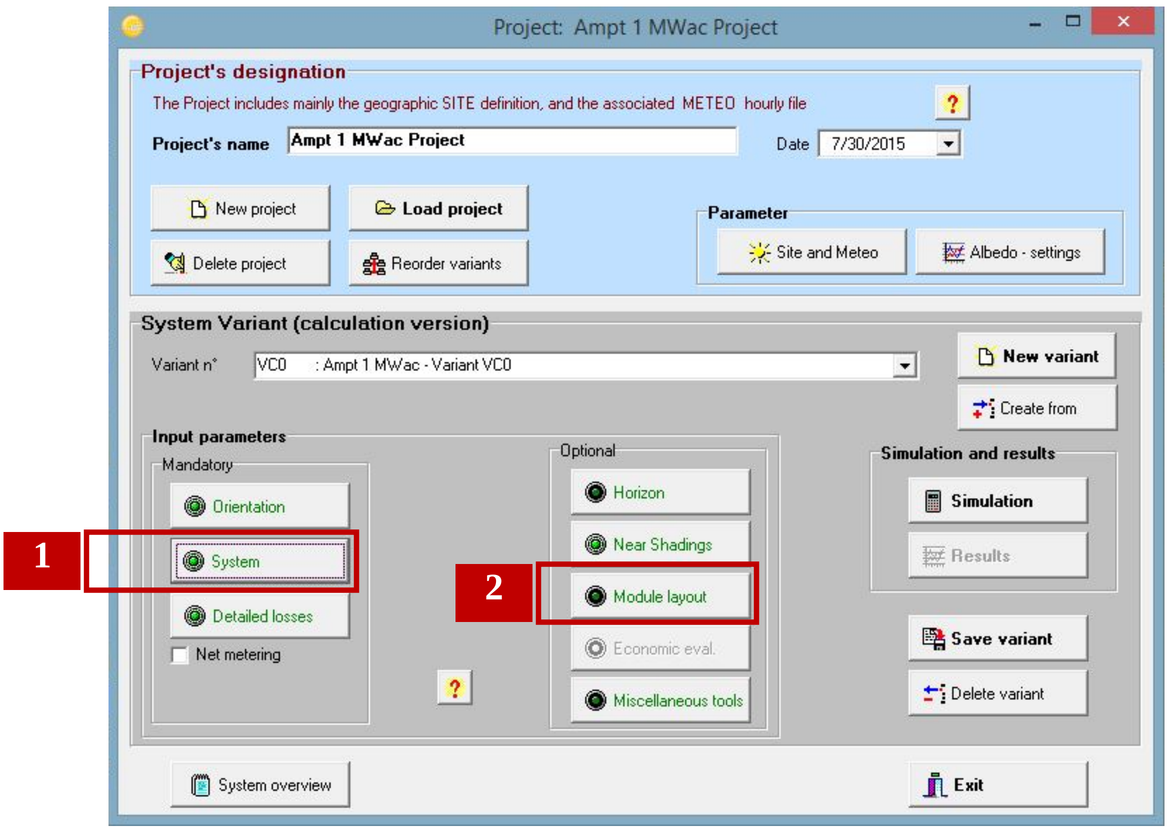
1 Introduction

This document applies to PVsyst version 6.43 and greater and assumes that the reader is already familiar with Ampt's design guidelines and creating PVsyst simulations. Therefore, only the differences when using Ampt are addressed.

2 *Grid system definition* screen

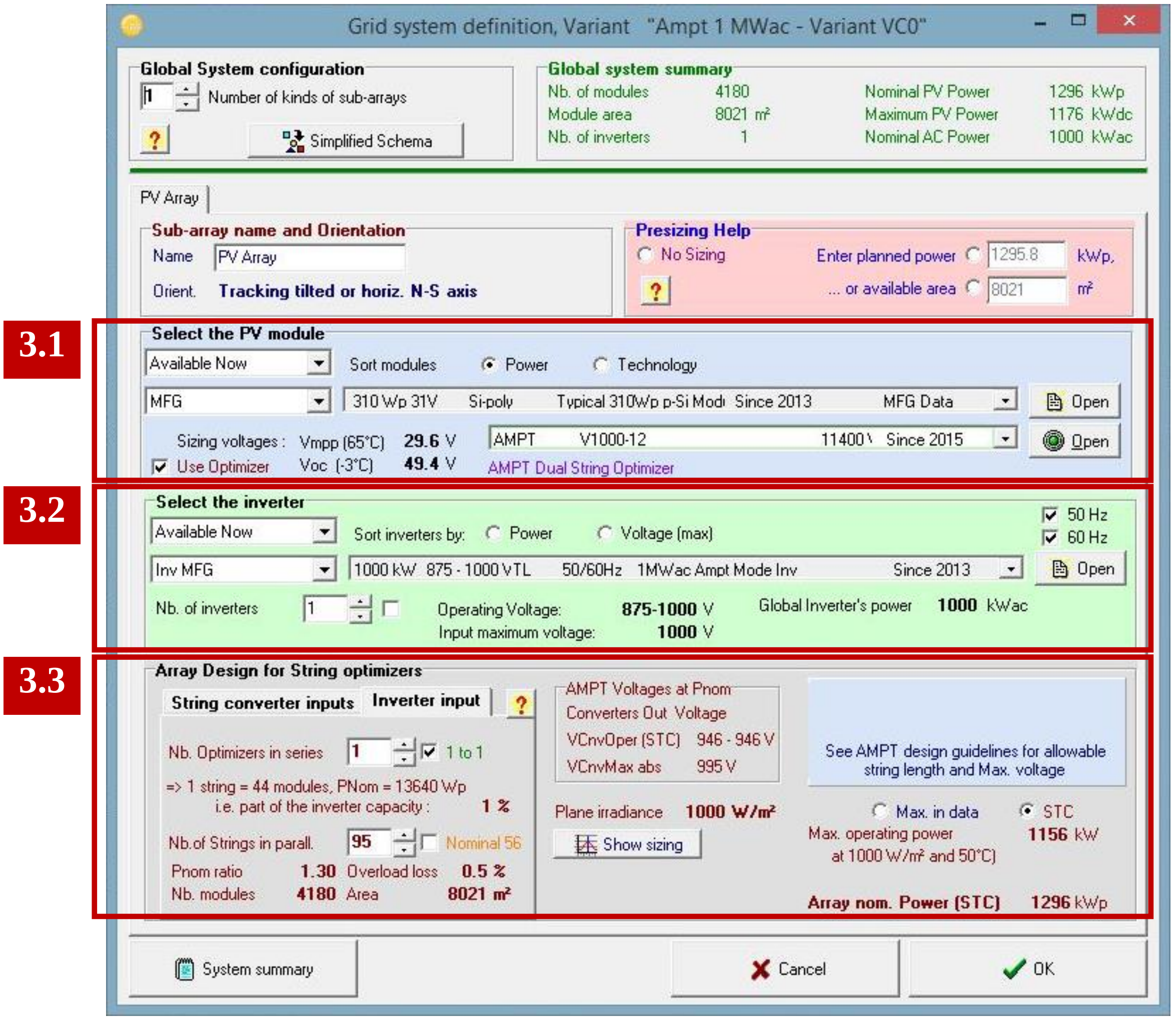
Open the project, select the site, and set the orientation as normal.



1. *System* input parameters are different with Ampt. See details in section 3.
2. The order that modules are assigned to strings in the *Module layout* section impacts the accuracy of the simulation. See details in section 4.

3 *System* input parameters

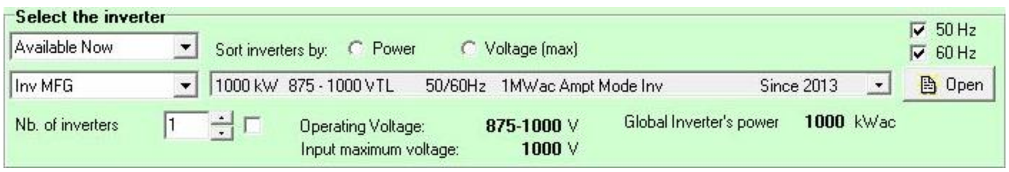
Select the system sizing and modules as normal.



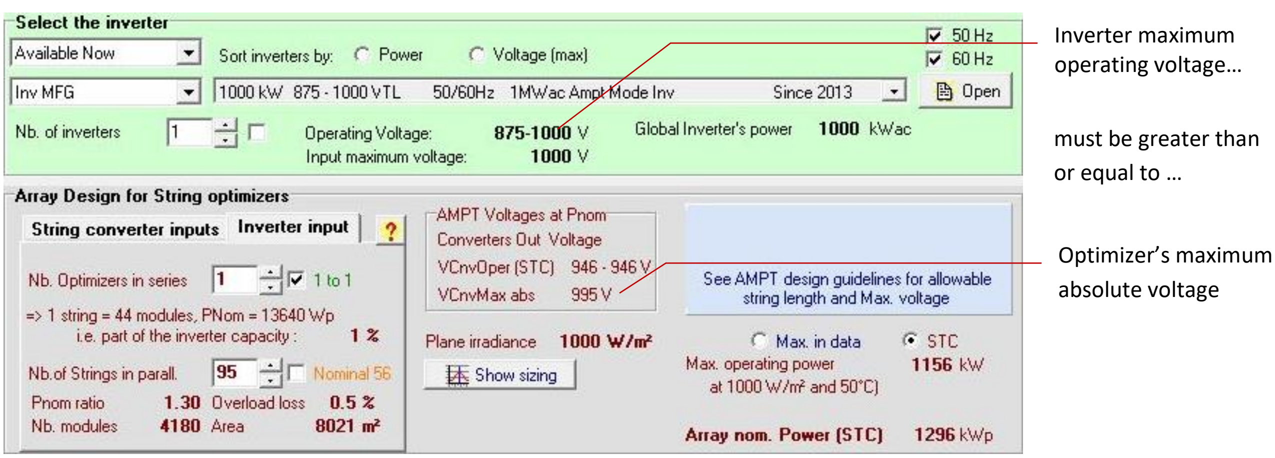
3.1 *Select the PV module* sections settings

1. Select the PV modules as normal.
2. Check the *Use Optimizers* checkbox in the *Select the PV Module* section.
   a. This changes the *Design the array* section on the bottom of the screen to *Array Design for String optimizers*. These settings are addressed in section 3.3.
3. Select the appropriate model of Ampt optimizer from the drop down list.

3.2 *Select the inverter* section settings

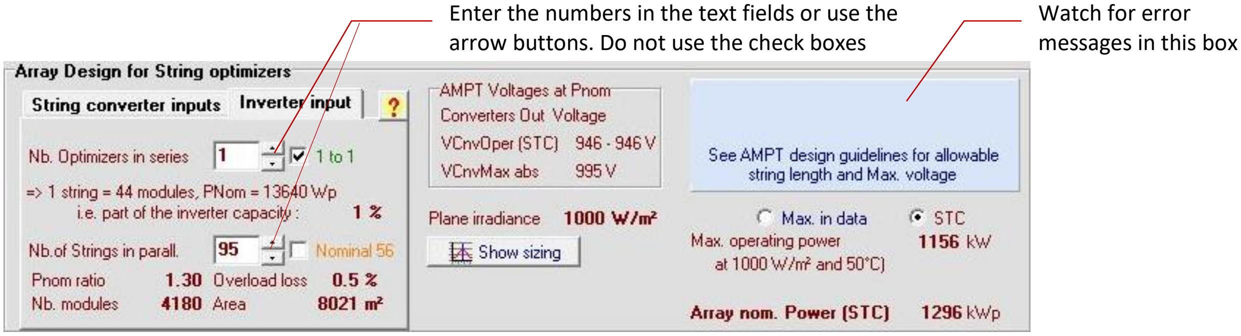


1. Select your inverter as normal.
   a. Inverters with Ampt Mode® are preferred.
2. For the simulation to run properly, see the image below to verify that the inverter maximum operating voltage is greater than or equal to the optimizer's (converter's) maximum absolute voltage (*VCnvMax abs*).
   a. See the Appendix for more details.



3.3 *Array Design for String Optimizers* section settings

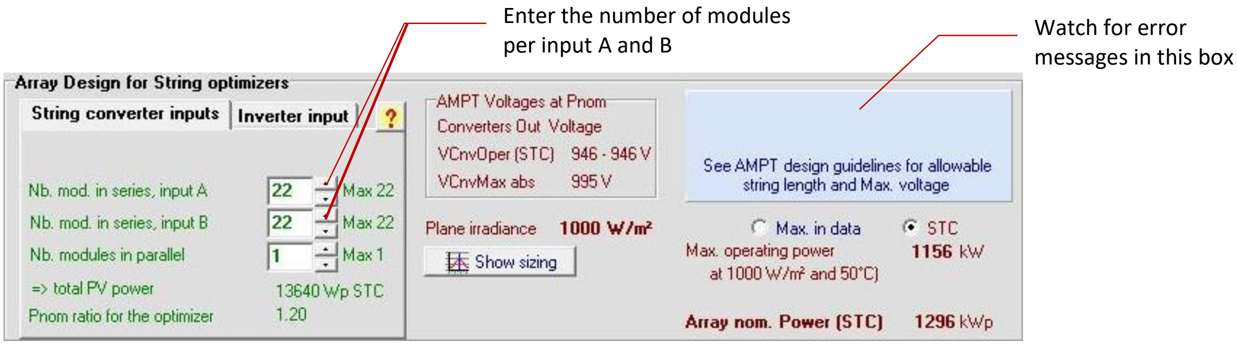
3.3.1 *Inverter input* tab



Note: Type in the field or use the arrow buttons for the next settings. Do not use the checkboxes.

1. Make sure the *Nb. Optimizers in series* field is set to 1.
2. Enter the number of parallel strings for your system design.

3.3.2 *String converter inputs* tab



1. Enter the number of modules in series for Inputs A and B of the String Optimizer in the *Nb. Mod. in series, input A/B* fields.
    a. The maximum number of modules shown to the right of these fields may not be allowed at a given minimum site temperature and maximum system voltage.
2. Leave *Nb. Modules in parallel* at 1 for 60- and 72-cell modules. If you are using different modules, please contact Ampt.

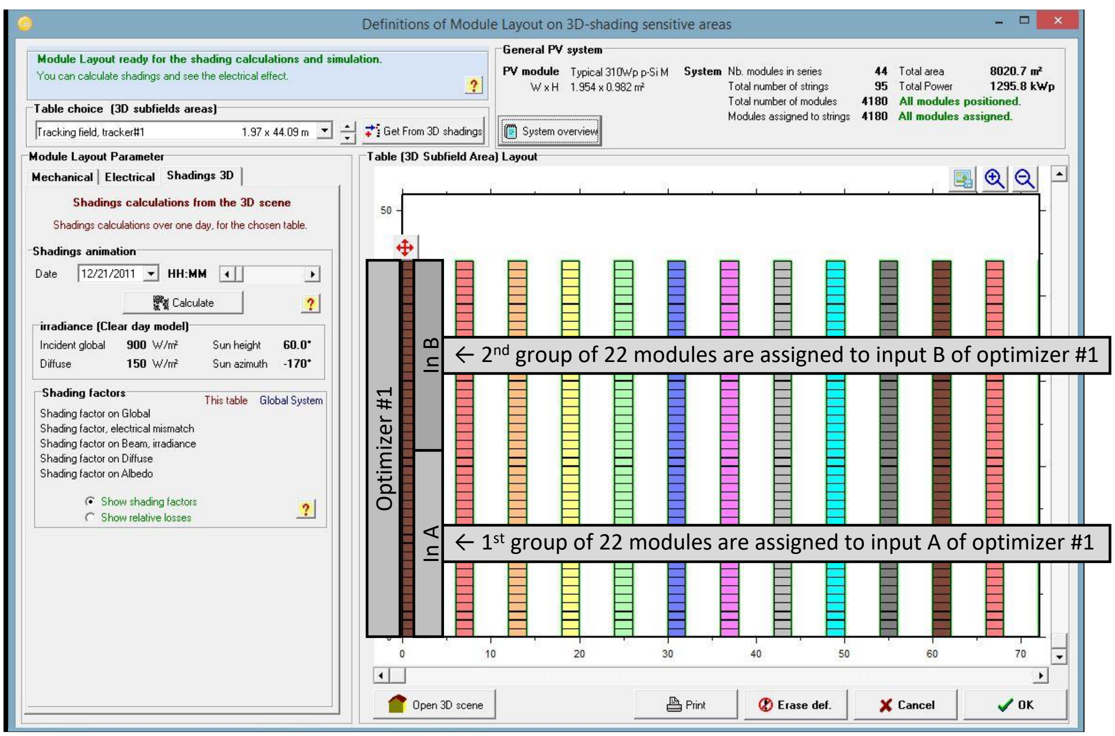
4 *Module layout* screens

4.1 Assigning modules to optimizer inputs

For traditional designs without Ampt, it is important for each module to be assigned to the appropriate string in PVsyst. Similarly, for PV systems with Ampt, it is important for modules to be assigned to the appropriate input of each optimizer.

With Ampt, each string has one optimizer and each optimizer has two inputs. The first modules assigned (either manually or automatically), go to Input A of the optimizer in the first string until the number of modules assigned equals the *Nb. Mod. in series*, *input A/B* setting in section 3.3.2. PVsyst then assigns the next modules to Input B of that optimizer. PVsyst populates the next string the same way and so on.

The example below shows module assignments for an optimizer that has 22 modules on each input.



5 Interpreting PVsyst reports with Ampt

Differences in PVsyst reports with Ampt are noted below

5.1 *Simulation parameters* differences

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Grid-Connected System: Simulation parameters

Project :	**Ampt 1 MWac Project**				
Geographical Site	**Bakersfield Meadows Field**			Country	**United States**
Situation		Latitude	35.4°N	Longitude	119.0°W
Time defined as		Legal Time	Time zone UT-8	Altitude	149 m
		Albedo	0.20		
Meteo data:		**Bakersfield Meadows Field**	TMY - NREL: TMY3 hourly DB (1991-2005)		

Simulation variant :	**Ampt 1 MWac - Variant VC0**				
		Simulation date	04/12/15 09h34		

Simulation parameters					
Tracking plane, tilted Axis		Axis Tilt	0°	Axis Azimuth	0°
Rotation Limitations		Minimum Phi	-45°	Maximum Phi	45°
Backtracking strategy		Tracker Spacing	6 m	Collector width	1.97 m
Inactive band		Left	0 m	Right	0 m
Models used		Transposition	Perez	Diffuse	Imported
Horizon		Free Horizon			
Near Shadings		Detailed electrical calculations	(acc. to module layout)		
PV Array Characteristics					
PV module	Si-poly	Model	**Typical 310Wp p-Si Module**		
Custom parameters definition		Manufacturer	MFG		
AMPT String Optimizer		Model	**V1000-12**	Unit nom. power	11400 W
PV modules on one Optimizer		in series	44	in parallel	1
No. of Optimizers		In series	1	In parallel	95 strings
Total number of PV modules		Nb. modules	4180	Unit Nom. Power	310 Wp
Array global power		Nominal (STC)	**1296 kWp**	At operating cond.	1156 kWp (50°C)
Array operating characteristics (50°C)		U mpp	1414 V	I mpp	818 A
Total area		Module area	**8021 m²**	Cell area	7325 m²
Inverter		Model	**1MWac Ampt Mode Inv**		
		Manufacturer	Inv MFG		
Characteristics		Operating Voltage	875-1000 V	Unit Nom. Power	1000 kWac
Inverter pack		Nb. of inverters	1 units	Total Power	1000 kWac
PV Array loss factors					
Thermal Loss factor		Uc (const)	20.0 W/m²K	Uv (wind)	0.0 W/m²K / m/s
Wiring Ohmic Loss		Global array res.	11 mOhm	Loss Fraction	1.5 % at STC
Module Quality Loss				Loss Fraction	-0.4 %
Module Mismatch Losses				Loss Fraction	1.0 % at MPP

The combined number of modules on inputs A and B for a single optimizer

The unit nominal power is the maximum rated output power of a single optimizer

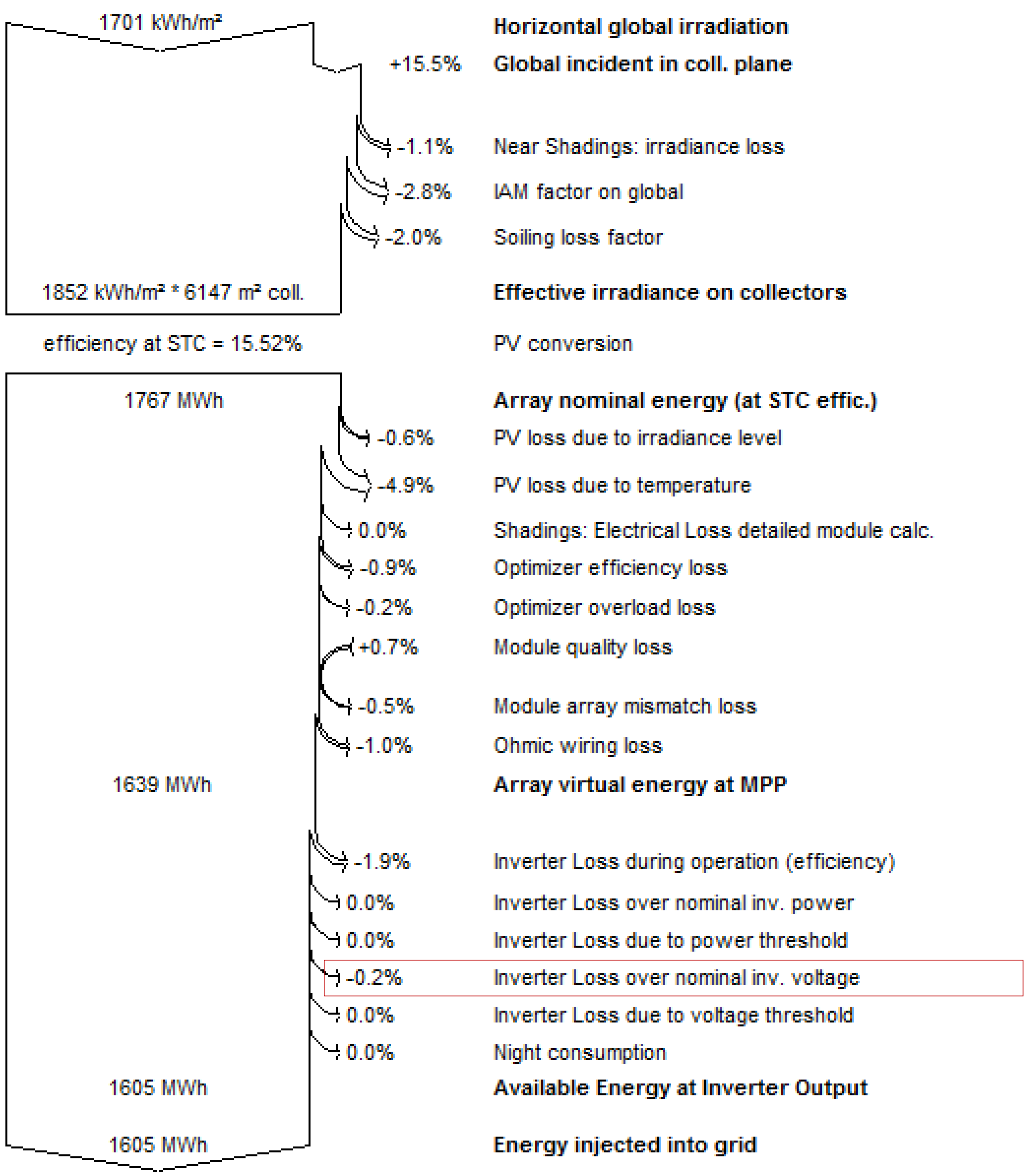
Calculated as Imp per module x number of strings (has no physical meaning)

Umpp is calculated as the sum of Vmp of all modules on both inputs. This has no physical meaning as the inputs are not in series.

5.2 *Loss Diagram* differences

5.2.1 Inverter Loss over nominal inv. voltage

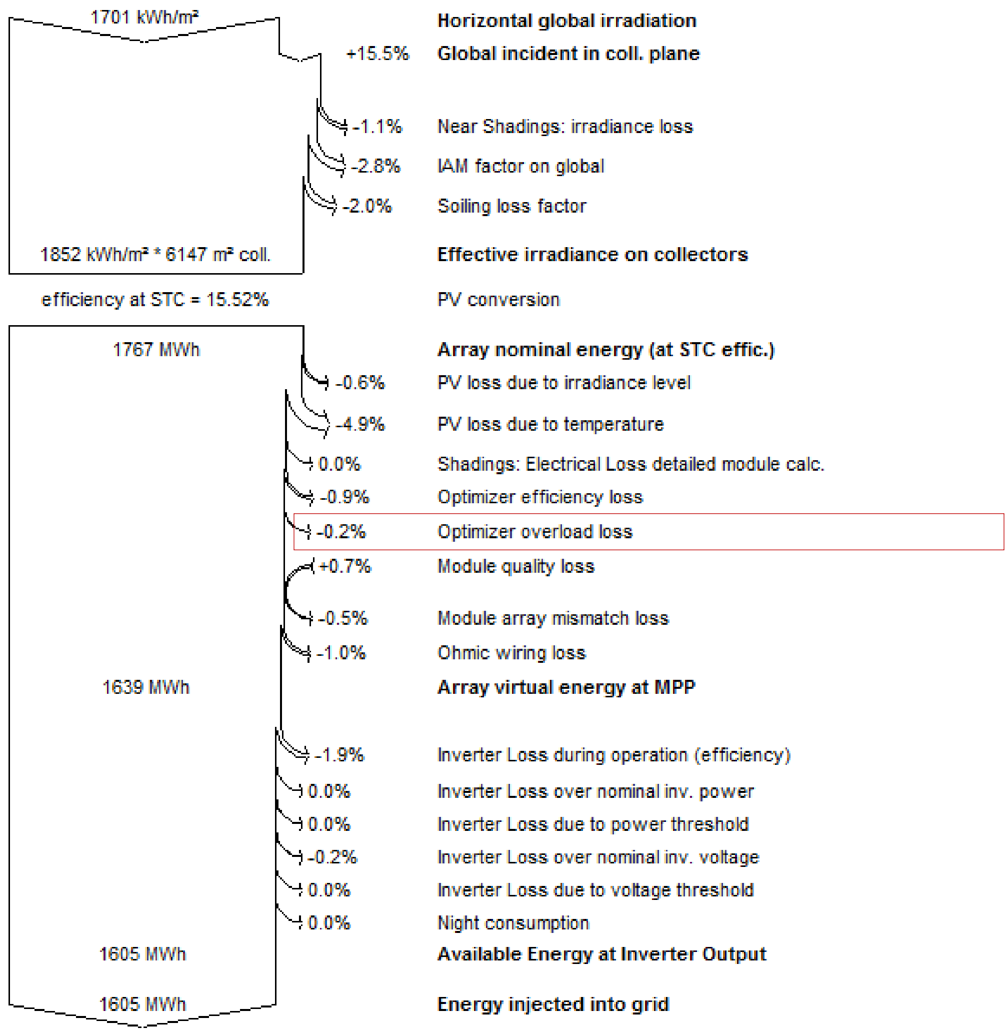
The Loss Diagram below is from a unique project to illustrate this concept.



It is uncommon for the *Inverter Loss over nominal inv. voltage* to be a value other than 0.0%. If it is not equal to 0.0%, then verify that the inverter maximum operating voltage is greater than or equal to the optimizer's maximum absolute voltage as described in section 3.3.1. To understand why this condition is important, see the Appendix.

5.2.2 *Optimizer overloaded loss*

The Loss Diagram below is from a unique project to illustrate this concept.



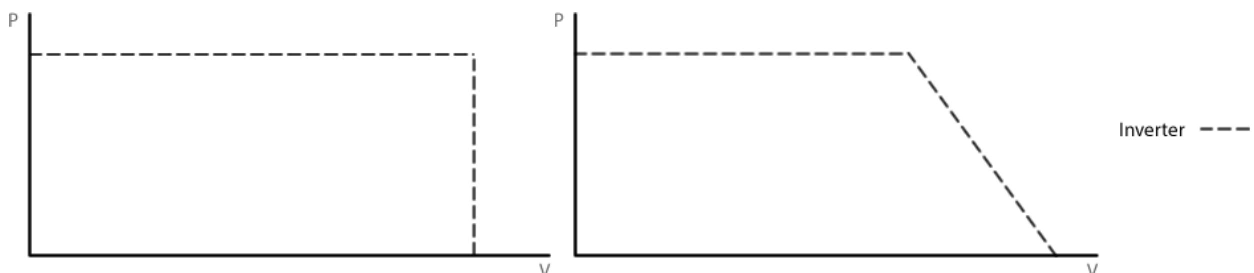
An *Optimizer overload loss* that is not 0.0% indicates that the output power of the optimizer has been exceeded under certain operating conditions. In other words, the optimizer is clipping power before the inverter which does not follow Ampt's recommended design practices. If the *Optimizer overload loss* is not 0.0%, verify that the string sizing and choice of optimizer are in accordance with Ampt's design guidelines. Also, make sure the input parameters for PVsyst are entered correctly.

Appendix

PVsyst's inverter max operating voltage behavior

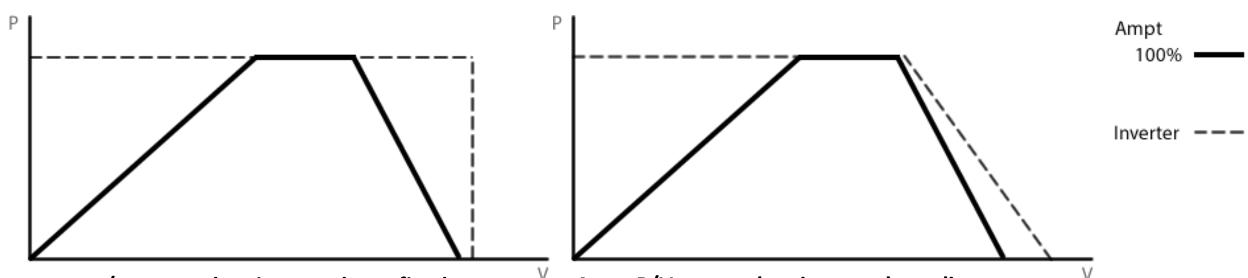
When running a simulation in PVsyst with Ampt String Optimizers, it is important for the *inverter maximum operating voltage* to be greater than or equal to the *optimizer's maximum absolute voltage* as described in section 3.2 so that artificial losses are not introduced in the Loss Diagram report.

To explain why this is, first consider the following representative P/V curves for two different inverters. Some inverters deliver full power up to a fixed voltage (a), while others have a linear derate as a function of voltage (b).



(a) **(b)**

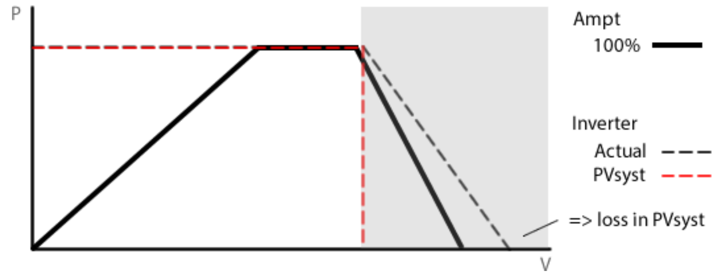
Ampt's design guidelines accommodate both inverter behaviors to ensure that the P/V curve of the Ampt array fits within (or "to the left of") the inverter's maximum operating range.



Ampt P/V curve when inverter has a fixed maximum voltage limit to full power

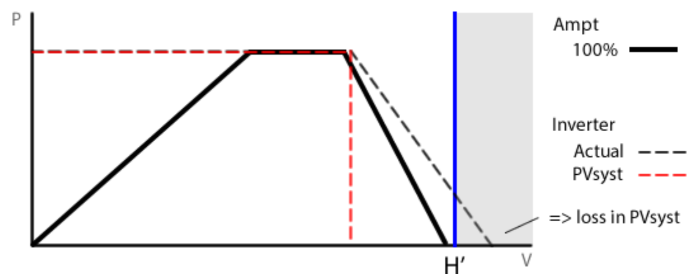
Ampt P/V curve when inverter has a linear voltage derate to limit full power

However, PVsyst models inverters with a linear voltage derate as an inverter with a fixed voltage limit. This introduces artificial losses to the PV system simulation at times when Ampt systems are operating outside PVsyst's recognized maximum.



PVsyst models inverters with a linear voltage derate as an inverter with no derate which introduces artificial losses

To work around this, Ampt recommends having the inverter manufacturer change the OND file so that the inverter's maximum operating voltage is 5 volts higher than the maximum operating voltage for your Ampt optimizer model (H') to ensure that the losses reported by PVsyst are real.



Change OND file to ensure that the losses reported by PVsyst are real

Please contact Ampt with any questions you may have.

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