Obtaining Accurate Energy Harvest Estimations From SunEdison Modules Using PVSyst v6.23 Solar Simulator

PVSyst is an energy modeling tool used by the solar industry to simulate the energy harvest of a potential project site. The energy harvest is a result of the effects of several parameters in PVSyst. Most of these parameters can be customized to produce a more accurate result.

INTRODUCTION

The purpose of this Technical Note is to provide guidance on using PVSyst in modeling systems with SunEdison Silvantis® solar modules. PVSyst contains parameters that can be customized based on the solar module to be modeled. In this paper, we'll provide details on how to alter specific parameters to deliver an accurate representation of output from SunEdison Silvantis modules.

Note: SunEdison strongly recommends that you become familiar with PVSyst before attempting any simulations.

GIGO: PVSyst uses an input file with the extension ".PAN" that provides specific module parameters as simulation inputs. Simulation input files can be created from measurements of production modules under various conditions of temperature and irradiance. While some manufacturers create their own PAN files, SunEdison's PAN files are created by independent, accredited test laboratories. These labs measure randomly selected production modules, then create PAN files using regression analysis techniques.

PVSYST OUT OF THE BOX

PVSyst contains several detailed models for solar energy output. However, it also assumes a number of default parameters. To fully simulate the capabilities of the SunEdison Silvantis product, many of these parameters must be customized based on the actual capabilities and technical advancements that Silvantis offers.

A default database of PV modules is included in the installation of PVSyst. However, the source of the PAN file is not always known. Even if the database appears to have a PAN file for the Silvantis module to be modeled, SunEdison recommends using PAN files provided directly from SunEdison. Email modules.info@sunedison.com for more details.

Applying the correct parameters to your simulation can have a significant impact on the accuracy of your simulation. After correcting for the technological differences of a Silvantis module, the difference in energy harvest between an out-of-the-box simulation and an accurate simulation is shown in Figure 1. Two different module types were modeled in Santa Maria, California: the SunEdison Standard Al-BSF (F-series) and PERC (R-series) modules. After correcting for the technological advances of Silvantis, results can be up to 7% higher than out-of-the-box results. For more regional analyses, see page 8.

Figure 1: Default vs. Recommended Parameters simulations in Santa Maria, CA
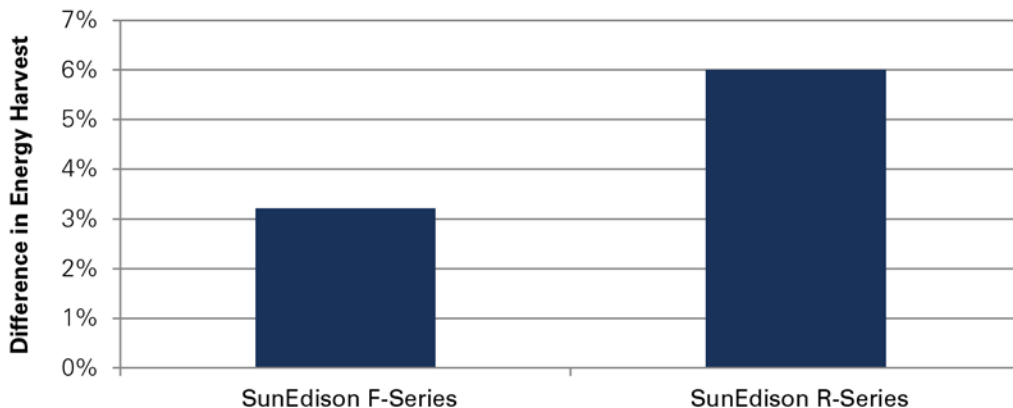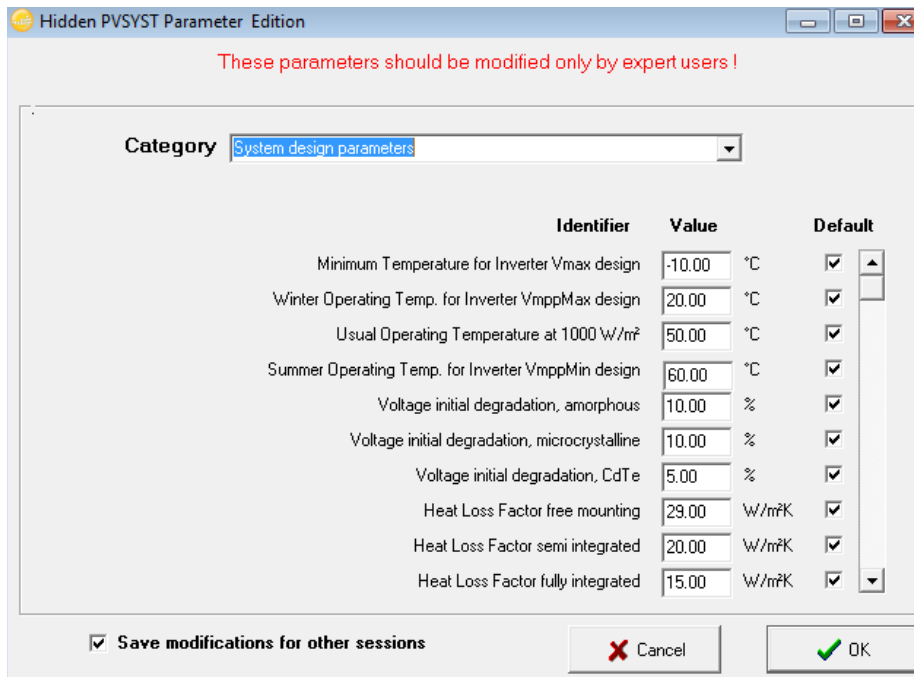
RECOMMENDED MODEL LEVEL PARAMETERS

Once you have loaded the correct PAN files, the next step to setting up an accurate simulation is to customize the simulation model itself. PVSyst offers two models for converting weather data into irradiance on the plane of the module: the Hay Model and the Perez-Ineichen model. The Perez-Ineichen model offers the most accurate representation of irradiance.

Figure 2: PVSyst Preferences (Pathway to Figure) Home Screen → Preferences →
Preferences → Physical Models
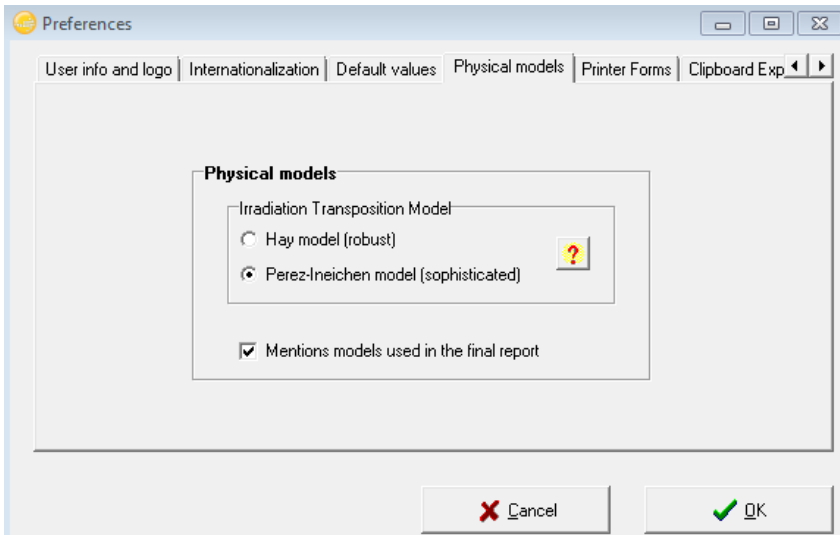
For simulations of systems with high DC:AC ratios, update the system sizing defaults. Under the default sizing parameters, if the DC to AC ratio is too great, the simulation will output an error message. However, for large utility scale projects it is often better to generate more DC than AC capacity due to cost constraints. Loosening the constraints will support simulations with higher DC:AC ratios. After modifying the system sizing constraints, check the mounting configuration of the system.

Figure 3: Hidden Preferences (Pathway to figure): Homescreen → Preferences →
Edit Hidden Preferences → System Design Parameters

RECOMMENDED SYSTEM LEVEL PARAMETERS

If your project includes a North/South single axis tracker, you will need to modify the initial tracking angle to produce accurate results. To accurately simulate a single axis tracker, the initial tracking angle should be set to zero in the orientation menu.

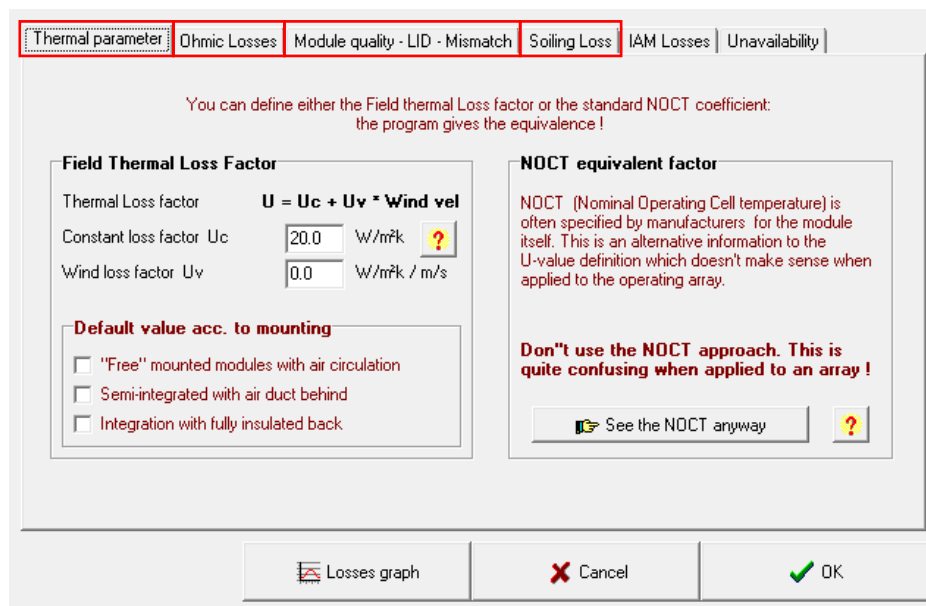If your project employs a different mounting option, no parameter changes are necessary.

Figure 4: Mounting Options (Pathway to Figure): Homescreen → Project Design → Grid-Connected → Orientation
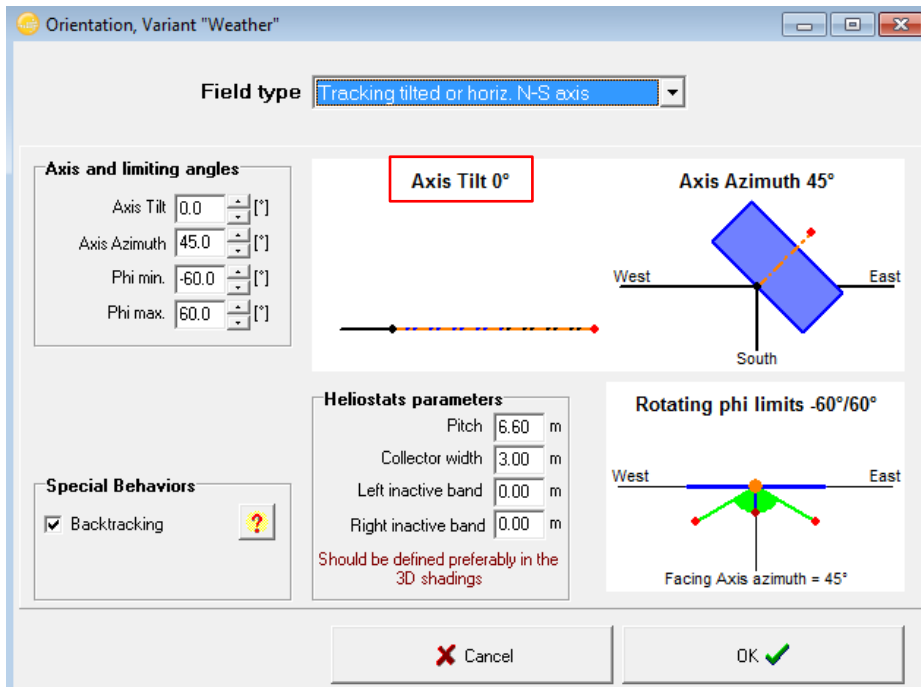
RECOMMENDED OPTIMIZED MODULE LEVEL PARAMETERS

After correctly selecting the orientation of the project site, you'll need to modify the parameters shown on the "detailed losses" page.

Figure 5: Detailed Losses (Pathway to Figure): Homescreen → Project Design → Grid Connected → Detailed Losses

THERMAL FACTOR/NOCT

Operating temperatures can have a significant impact on a module's efficiency. The NOCT (Nominal Operating Cell Temperature) is defined as the temperature reached by the open circuit cells of the module under the following conditions:

- Irradiance on cell surface = 800 W/m^2
- Air Temp = 20°C
- Wind Velocity = 1 m/s
- Mounting = Open Back Side

The higher this temperature, the more performance loss is experienced. In PVSyst, the thermal parameter is equivalent to the NOCT. SunEdison continually strives to improve this parameter, so the PVSyst default NOCT does not accurately represent the actual NOCT of SunEdison modules (Table 1).

Table 1: NOCT Values for Silvantis PV Modules

MODULE	NOCT	U_c	U_K
PVSyst Default	56°C	20.0	0.0
SunEdison P-Series	45°C	27.0	1.4
SunEdison F-Series *Also includes D-Series	46°C	26.0	1.4
SunEdison R-Series	45°C	27.0	1.4

OHMIC WIRING LOSS

Ohmic wiring loss is caused by wiring resistance present in the solar array. The power loss is based on the resistance of the wire times the square of the current flowing through the wire. This loss can be depicted by one resistance parameter for the entire array. SunEdison recommends using the values shown in Table 2 for residential and utility scale projects. **These losses should apply to any solar module being simulated**.

Note: You may elect to design the system with a specific loss in mind. A lower loss can be achieved by using a larger conductor diameter.

Table 2: Wiring loss values for Residential and Utility Scale Projects

TYPE OF SYSTEM	WIRING LOSS
Residential	2.0%
Utility	1.5%

MODULE QUALITY

The module quality factory default is 1.5%. Change this value to 0.0%. This parameter is defined as the deviation of the average effective module efficiency with respect to manufacturer's conditions. While this deviation is not specifically defined, it is influenced by the mean bias in the flash test rating of all modules when tested prior to leaving the factory. However, SunEdison positively bins modules up to +5 W more than nameplate power.

LID

If using a SunEdison PAN file created after 2014, skip this section.

LID, or Light Induced Degradation, is the permanent loss of performance that occurs after exposure to sunlight. LID is related to the type of solar cells in the module and, ultimately, to the wafer from which the cell was made. SunEdison Silvantis modules use P-type monocrystalline solar cells. Use the values shown in Table 3 for SunEdison modules if the PAN file was created before 2014. PAN files produced after 2013 incorporate LID losses.

Table 3: LID Values for Silvantis PV Modules

MODULE	LID
PVSyst Default	0.0%
SunEdison P-Series	2.5%
SunEdison F-Series	2.5%

SOILING LOSS

Over time, solar module surfaces may accumulate a layer of soiling. Dust, debris, and animal excrement on the glass reduce the amount of light that reaches the cells. PVSyst uses a default soiling loss value of 0.0%, which is unrealistic. Based on extensive experience in systems monitoring, SunEdison recommends using the soiling loss shown below. **These losses should apply to any solar module being simulated.**

Note: Some climates merit additional consideration of soiling, including a month-to-month breakdown.

Table 4: Soiling losses and their causes

SOILING LOSS	REASON
1%	Climates that experience >7.5mm of rain in a 24 hour period every 60 days
5%	Climates that have periods (>60 days) of no rain
–2%	An annual 2% reduction in soiling loss with each manual wash, with a limit of 1% for all climates

EXAMPLE SIMULATIONS

To show the amount of influence these parameters have on a potential project site, SunEdison ran a series of simulations using the same PAN files. The simulations compared the default parameters and the SunEdison recommended parameters. Three different locations with significantly different climates were selected. The simulations used SunEdison's standard Al-BSF (Aluminum Back Surface Field) as well as PERC (Passivated Emitter Rear Contact) modules. The project size of these simulations was set at 10MW to reduce inverter and other noise in the simulation to negligible amounts. Using average energy prices of California (21₵/kWh), Seattle (9₵/kWh), and London (24₵/kWh), Figure 6 shows the economic value when the simulation is run using the recommended parameters while figure 7 shows nearly 5% additional energy gained when using the recommended parameters.

Figure 6: Project Modeled was 10MW to Reduce Inverter Noise. Average cost of energy in (California: $0.21, Seattle: $0.096, London: $0.24)

Economic Value of Using Recommended Parameters

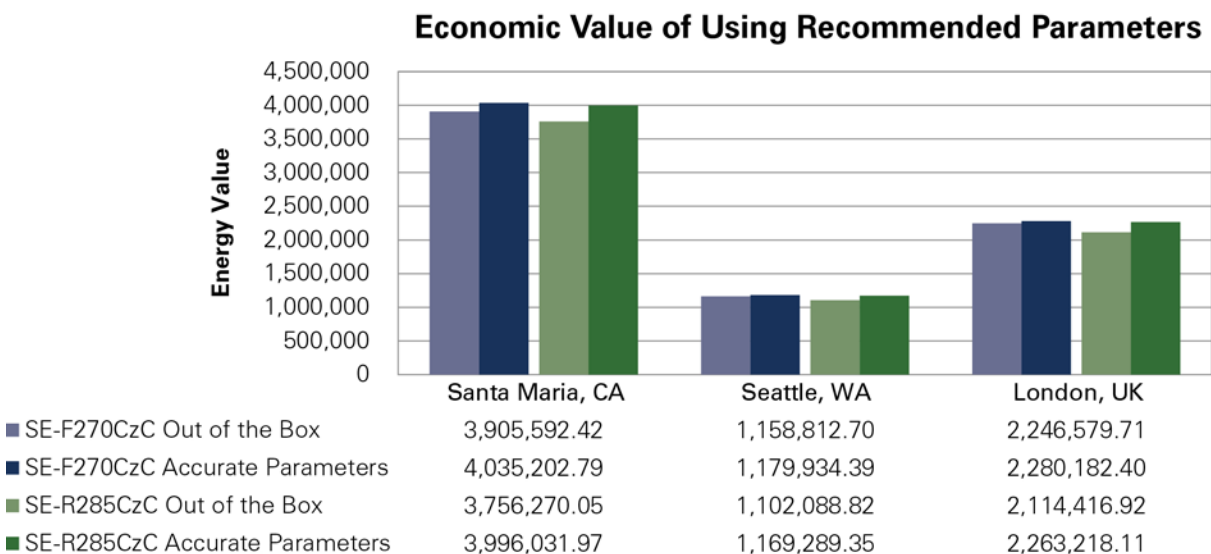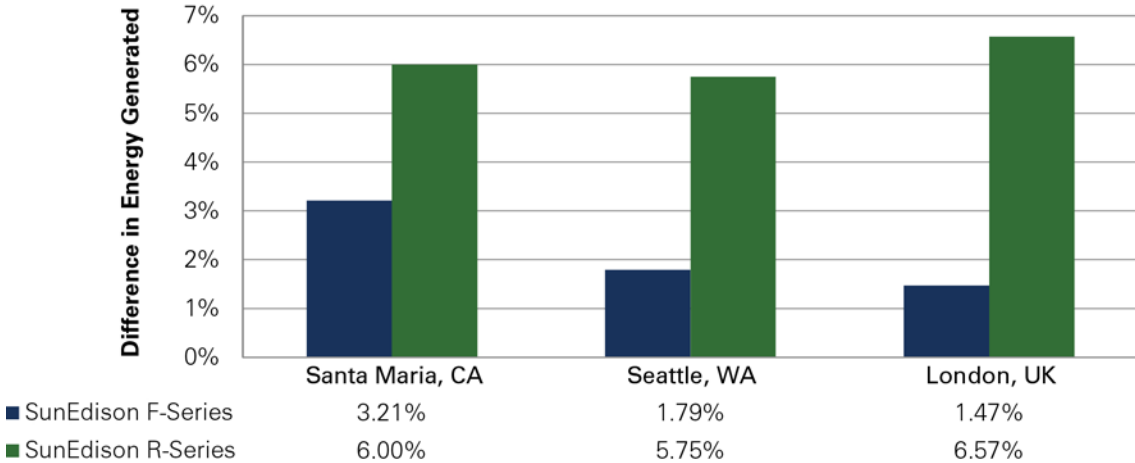|	Santa Maria, CA	Seattle, WA	London, UK
SE-F270CzC Out of the Box	3,905,592.42	1,158,812.70	2,246,579.71
SE-F270CzC Accurate Parameters	4,035,202.79	1,179,934.39	2,280,182.40
SE-R285CzC Out of the Box	3,756,270.05	1,102,088.82	2,114,416.92
SE-R285CzC Accurate Parameters	3,996,031.97	1,169,289.35	2,263,218.11

Figure 7: Depicts Difference in Project Energy Revenue from Figure 5

CONCLUSION

PVSyst is a complex but effective energy modeling tool that can be used to predict energy harvest, provided the above recommendations are followed when modeling systems with Silvantis modules. It includes three types of recommended parameters, including Simulation Model Level, System Level, and Module Level parameters. NOCT, Module Quality Factor, and LID are SunEdison-specific parameters. Soiling Loss and Ohmic Wiring Loss can apply to any system with any solar module.

By applying the recommended parameters for SunEdison Silvantis modules, the user is able to obtain a more accurate energy simulation for the system. These results often reflect improved performance — with energy yield increases up to 3% for F-Series and 7% for R-Series modules when properly modeled. If you have questions or comments regarding SunEdison PAN files or simulations, email modules.info@sunedison.com.

QUICK GUIDE

SUMMARY TABLE			
Check/Verify System Level Parameters			
Type of Model Used	Perez-Ineichen Model		
Thermal Parameter/NOCT—SunEdison Specific			
	NOCT	U_c	U_k
PVSyst Default	56	20	0
SunEdison P-Series	47	25	1.2
SunEdison F-Series	46	26	1.4
SunEdison R-Series	45	27	1.4
LID—SunEdison Specific			
PVSyst Default	0.0%		
SunEdison P-Series	2.5%		
SunEdison F-Series	2.5%		
Module Quality Loss—SunEdison Specific			
PVSyst Default	1.5%		
SunEdison Modules	0.0%		
Soiling Loss—Applies to all solar modules			
1% soiling loss should be used in climates that experience >7.5mm of rain in a 24 hour period every 60 days			
5% soiling loss should be used in climates that have periods (>60 days) of no rain			
An **annual 2% reduction** in soiling loss with each manual wash, with a lower limit of 1% for all climates			
Ohmic Wiring Loss—Applies to all solar modules			
Type of System	**Wiring Loss**		
Residential	2.0%		
Utility	1.5%		