Application Note:

Using Solmetric SunEye results in California's solar electric incentive programs

Abstract

In California, there are two state sponsored solar electric incentive programs: the New Solar Homes Partnership (NSHP) for new residential construction and the California Solar Initiative (CSI) for all other market segments. NSHP and CSI are for installations only in investor owned utility territories. There are other solar electric incentive programs available in publicly owned utility territories. The incentive amount is calculated using a program specific incentive calculator, either the CSI EPBB Calculator (CSI Calculator) or the NSHP CECPV Calculator (NSHP Calculator). Incentives are adjusted for shading, that is, more shading leads to less incentive. The two calculators estimate the impact of shading in different ways: the CSI Calculator uses solar access data and the NSHP Calculator uses the elevation angle of obstructions. The Solmetric SunEye measures both solar access and obstruction elevation angles so it provides the data necessary for either calculator. This application note describes the details of how to extract the SunEye data and input it to either the CSI Calculator or the NSHP Calculator.

Contents

Introducing the Solmetric SunEye

The Solmetric SunEye is a handheld tool for solar site evaluation. It uses a Fish-eye lens and a digital camera to capture the entire sky in a single image (Skyline). The SunEye is available in two models, the 110 and the 210, shown below. The Skyline image is processed to detect obstructions, and the image is overlaid with green where the obstructions are detected, and yellow, where open sky is detected. Data can be viewed on the device or in the companion desktop software, which also enables reports and printouts. For additional information, see www.solmetric.com.

Figure 1. SunEye 210 is a more recent model with more advanced electronic orientation.

Figure 2. SunEye 110 is the original model, available since 2006.

Each SunEye Skyline reading is taken from a single point. Typically solar professionals use multiple readings to more accurately reflect the shade impacts over the area of the solar array. In both the CSI and NSHP programs, a "minimal shading" criterion is defined as when the ratio D/H>2, where D is the distance from an obstruction to the nearest point on the array, and H is the height of the obstruction above the array. For the ratio D/H to be greater than two, the obstruction elevation angle must be less than 26.6 degrees. If the minimal shading criterion is met, then the measurements are not required for the program calculators.

If the minimal shading criterion is not met, measurement readings must be entered into the program calculators. Readings are required at the major corners of the array, not farther apart than 40 feet. The multiple readings must then be processed before they are entered into the calculators. The CSI Calculator requires average solar access readings, and the NSHP program requires worst case obstruction elevations. Please see the program handbooks, available at http://www.gosolarcalifornia.org/documents/ for more information.

Note: Each installation company may also have a set of best practices that blend the CSI and NSHP requirements with their own implementation. The following instructions could be an example of a company's policy on how installers should perform shade measurements:

> *"Take SunEye readings at all major corners of the array, plus take readings at points on the array that are closest to the obstructions in view. If necessary, take additional*

readings to ensure that readings are less than 20 feet apart. Record the location of each skyline reading on a basic map of the array area."

Note that the above example guidelines would allow the data to be used for either the CSI or the NSHP Calculator, and also allow evaluation of whether the minimal shading criterion has been met. Also note that the SunEye 210 can be used to measure Azimuth and Tilt, which are used in both calculators, in addition to the shading data.

Viewing Solar Access data

For a single Skyline:

After a SunEye Skyline is taken, the data is by default displayed in the Annual Sunpath view shown below. This display shows Annual Solar Access, as well as half-year Solar Access, Jun-Dec and Dec-Jun. Monthly solar access for each individual Skyline can be viewed by selecting "Monthly solar access" from the View menu. An example is shown below.

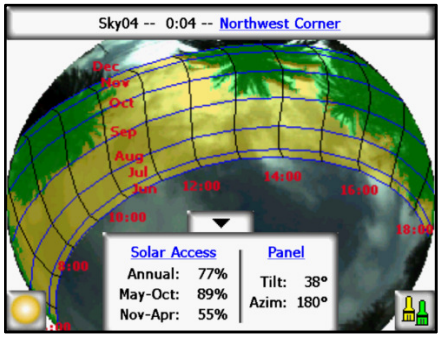


Figure 3. Annual Sunpaths view

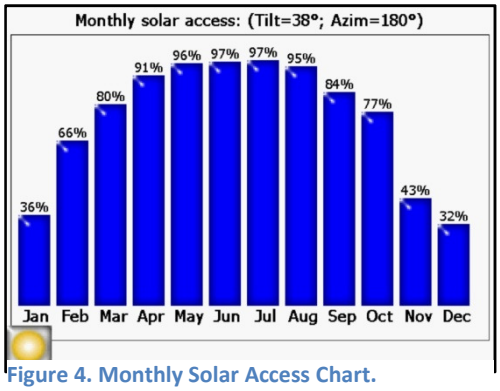
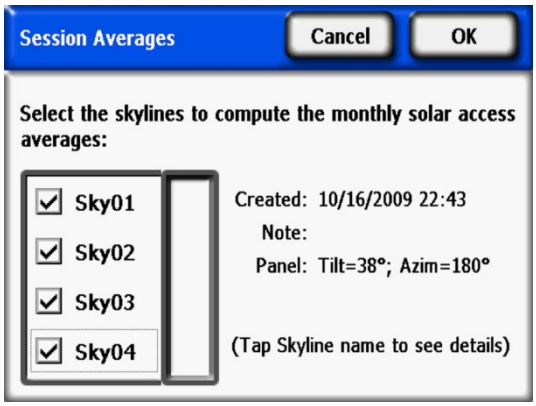
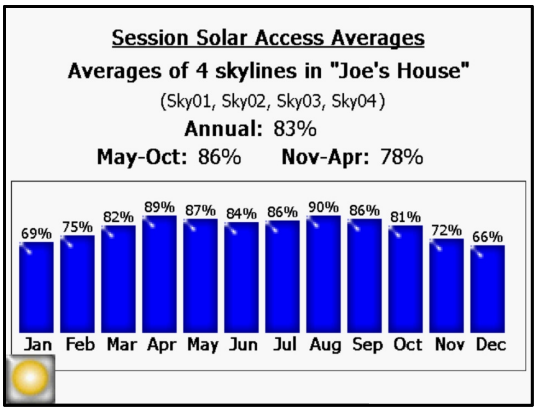


Figure 4. Monthly Solar Access Chart.

For multiple Skylines:

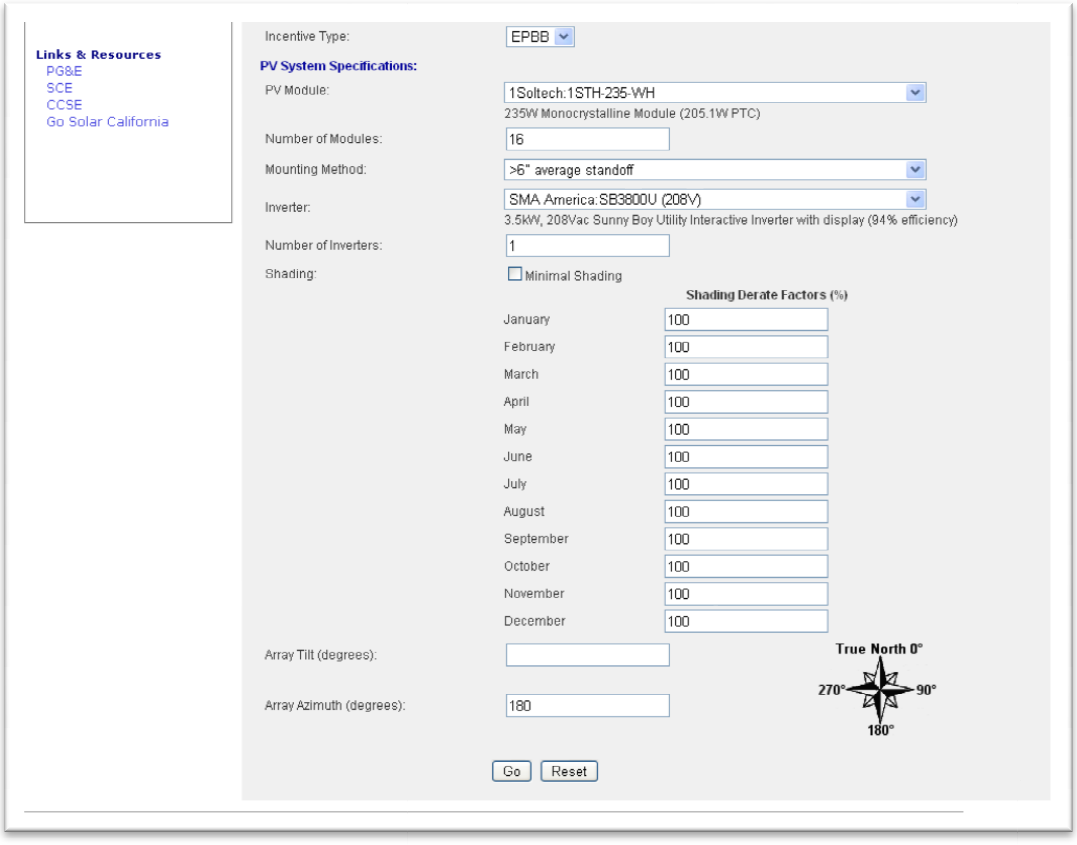
With multiple Skylines in a session, you can view the average solar access of multiple skylines. Select "Session Solar Access Averages" from the "Session" menu. Check the Skylines to be included in the averaging, and uncheck those that will be excluded. Select OK and the average solar access will be displayed in bar chart format. An example is shown below.





Entering the data into the CSI Calculator:

The Session Solar Access Averages provide the twelve monthly numbers to be entered into the CSI Calculator. An example screenshot is shown. Note that Monthly Solar Access are not required in the calculator if the "Minimal Shading" requirement is checked, defined as a Distance to Height (D/H) ratio that is greater than 2:1. This corresponds to an obstruction elevation angle of 26.6 degrees. If the Minimal Shading box is checked in the Calculator, then the monthly Solar Access inputs disappear, and it is not possible (or necessary) to enter the Solar Access. The following section will describe more about how to use the SunEye to evaluate obstruction elevation data to see whether the minimal shading requirement is met.



Viewing Obstruction Elevation data

For a single Skyline:

For the case of a single Skyline, the obstruction elevation data is available from the SunEye device directly (with software version 2.8 or higher). After taking a skyline photo, the Annual Sunpath view will be displayed. Select the Obstruction Elevation view from the View menu. An example of this view is shown below. Note that the green data shows the obstruction elevation angle in degrees for every one degree of azimuth.

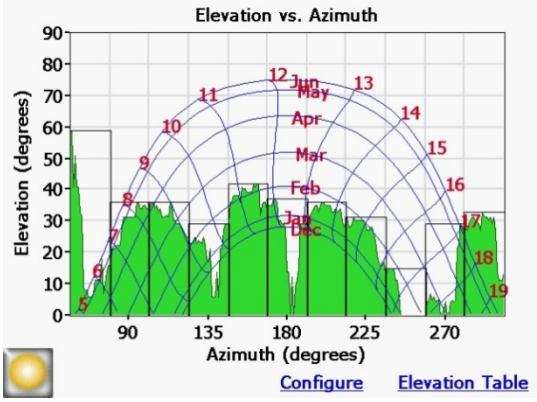


Figure 5. Example obstruction elevation view.

In addition, an overlay shows a bar chart showing the average or maximum elevation value over a window of azimuth. The window size and number of points can be adjusted by selecting “Configure” when in the Obstruction Elevation view. Select the “Azim Range” tab. For NSHP, select Azimuth Center of 180 degrees, Number of Windows to 11, Azimuth Window 22.5 degrees, and Maximum. This will automatically show the worst case obstruction elevation over the eleven azimuth windows needed by NSHP. The results can also be displayed in a table by selecting “Elevation Table” in the Obstruction Elevation view.

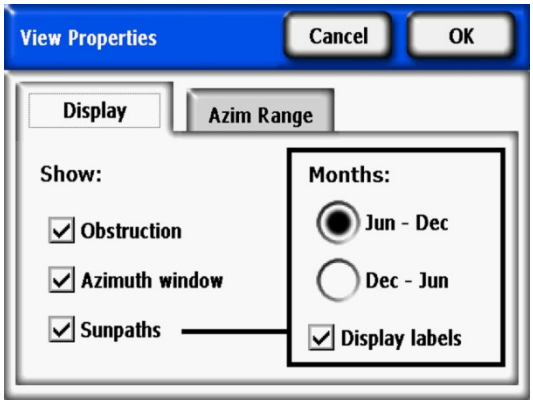


Figure 6. View Properties for obstruction elevation view ("Configure")

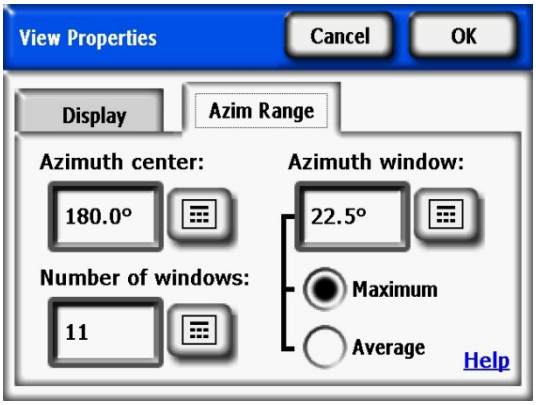
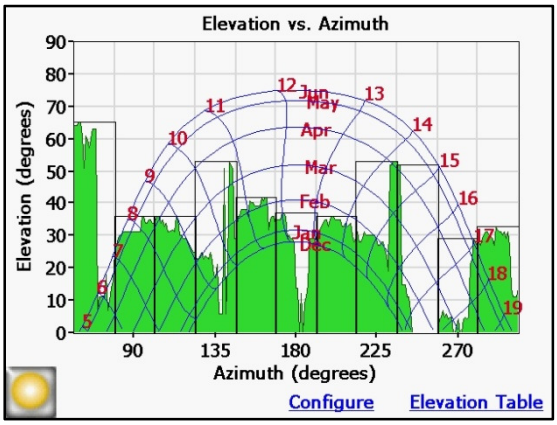


Figure 7. View Properties for obstruction elevation view ("Configure")

Ensuring valid obstruction elevation data:

In some situations, obstruction elevation data may contain artifacts from the image processing algorithm used in the SunEye. These artifacts may be very small in the annual sunpath view, and therefore may be insignificant in the solar access calculations. But the obstruction elevation data is the maximum value at each azimuth, and therefore a single (incorrect) obstruction data point is interpreted as an obstruction from the horizon up to that point. In some cases, it may be necessary to erase the effects of the user who appears in the Skyline by editing from obstruction (green) to open sky (yellow).



5 Artifacts can appear in the obstruction elevation view.

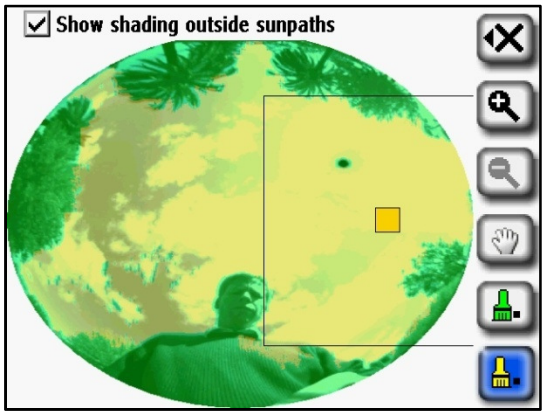
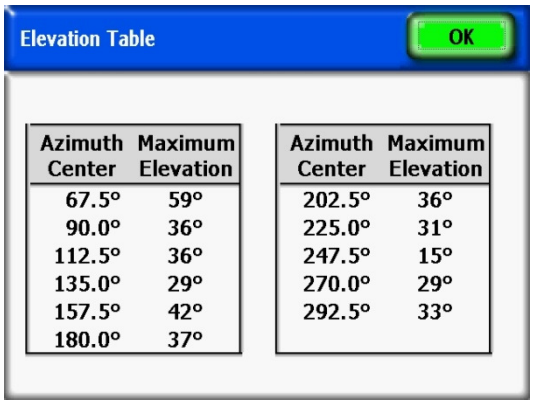


Figure 9, To remove artifacts, use the skyline edit mode and ensure that open sky is all yellow.

To ensure valid obstruction elevation data, use the edit mode. Select “Annual Sunpath” in the View menu, and select the paintbrushes at the lower right in the display. This will take you into Edit mode. Check “Show shading outside sunpaths”, and use the yellow paintbrush to remove any artifacts that may incorrectly show green where there is no obstruction. All artifacts must be removed from the horizon (outside) to the middle of the display (90 degrees elevation), over the full azimuth range of the sunpaths. This may require several iterations in edit mode and evaluating the data in Annual Sunpaths and Obstruction Elevation views.



Azimuth Center	Maximum Elevation	Azimuth Center	Maximum Elevation
67.5°	59°	202.5°	36°
90.0°	36°	225.0°	31°
112.5°	36°	247.5°	15°
135.0°	29°	270.0°	29°
157.5°	42°	292.5°	33°
180.0°	37°		

Figure 10. Tabular view of eleven obstruction elevation points

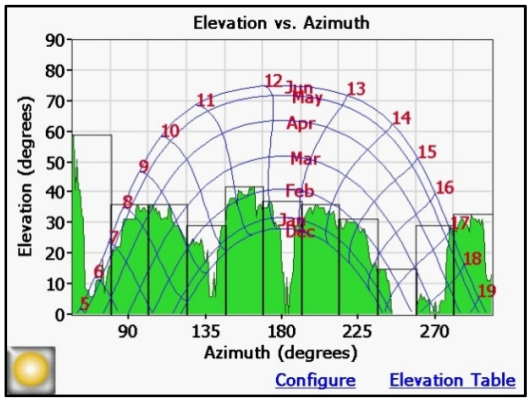


Figure 11. Graphical view of obstruction elevation with Maximum Obstruction Elevation in Azimuth Windows.

Checking Minimal Shading

Note that the Elevation Table can be evaluated vs. the minimal shading criterion. If the Maximum Elevation angles is 26.56 degrees or less, then minimal shading is met for that Azimuth Window. If minimal shading is met for all Azimuth Windows, then the minimal shading criterion is met for the whole skyline.

For multiple Skylines:

Obstruction elevation data for multiple skylines is processed only in a report generated by the SunEye desktop, and is not currently available in the device. Transfer the session from the device, then choose File, Export Session Report and Data. The export wizard will guide the Export Session Report process. Fill in the Client data, Creator data, choose which Skylines to include in the report, then enter the Azimuth scale settings as shown below for NSHP. Select Export and the exported report is generated and is an html file that can be viewed by a web browser. Choose View Report Now to view the report in the default web browser. The Report includes a cover page, a session summary, and details of each of the selected Skylines.

The obstruction elevation data from all the selected Skylines in included in the "WindowedObstructionElevations.csv" file within the session summary portion of the report, normally on the second page. Clicking on this link will open the default spreadsheet program, normally Microsoft Excel. This file shows a session summary, then the Obstruction Elevation data. The first column shows the center of all of the Azimuth Windows in degrees, eg. 67.5, 90, 112.5, etc. Columns three and greater show the maximum elevation reading within each Azimuth Window for each skyline. The second column shows the maximum value of all the Skylines for each Azimuth Window, that is, the Maximum worst case of all the Skyline Maximum values for each Azimuth Window.

Column labels may be shortened and not readable. To view the column labels, select Row 15, right click and select Format Cells, Alignment tab, check Wrap Text, and press OK. If necessary, increase the column width. An example is shown below.

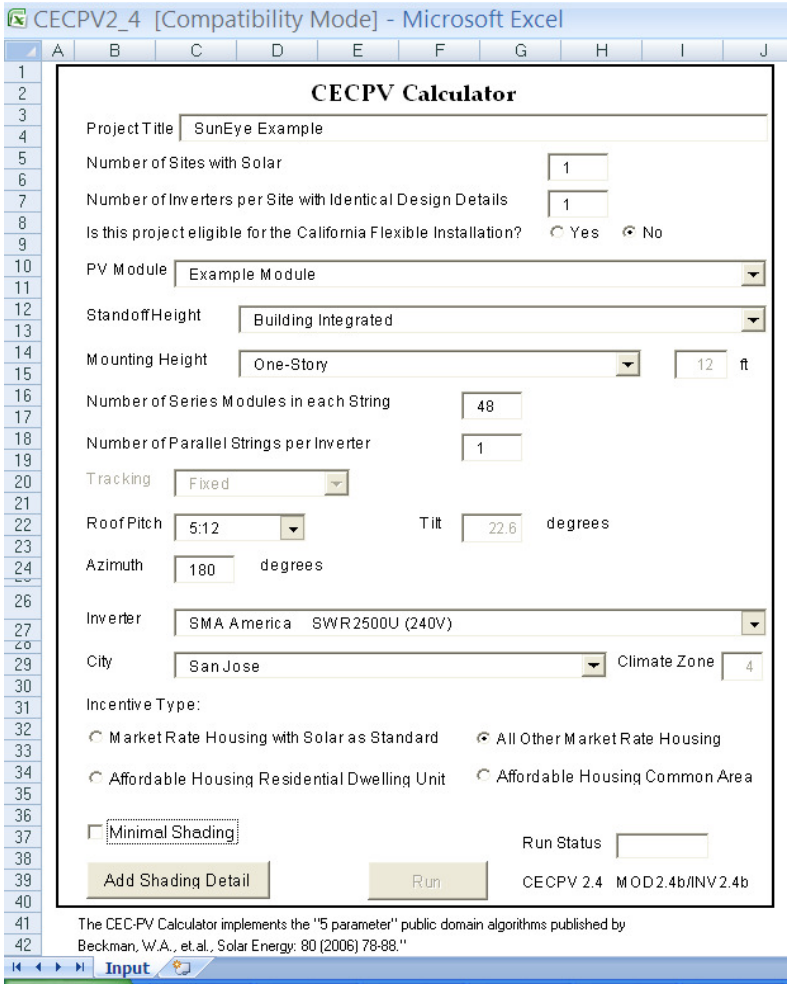
Azimuth Window Center (North=0; East=90)	Maximum Elevation (0-90) MAXIMUM	Maximum Elevation (0-90) SKY01	Maximum Elevation (0-90) SKY02	Maximum Elevation (0-90) SKY03	Maximum Elevation (0-90) SKY04
67.5	24	24	22	22	20
90	24	17	19	21	24
112.5	35	22	26	29	35
135	39	30	32	25	39
157.5	62	62	50	43	22
180	55	40	43	45	55
202.5	55	40	36	55	52
225	55	25	53	55	28
247.5	51	20	25	28	51
270	52	48	52	33	52
292.5	42	37	42	33	37

Checking Minimal Shading

Note that the Windowed Obstruction Elevation Table can be evaluated vs. the minimal shading criterion. If the Maximum Elevation angles is 26.56 degrees or less, then minimal shading is met for that Azimuth Window. If minimal shading is met for all Azimuth Windows, then the minimal shading criterion is met for the whole array.

Entering the data into the NSHP Calculator:

The Session Maximum Obstruction elevation angles in Column Two of the WindowedObstructionElevations.csv file can then be entered into the NSHP calculator. To enter the values into the worksheet, select “Add Shading Detail” at the bottom of the CECPV Calculator page (see below).



Note that Minimal Shading at this level should be checked if and only if ALL of the values in the Windowed Obstruction Elevations file are all 26.56 degrees or less.

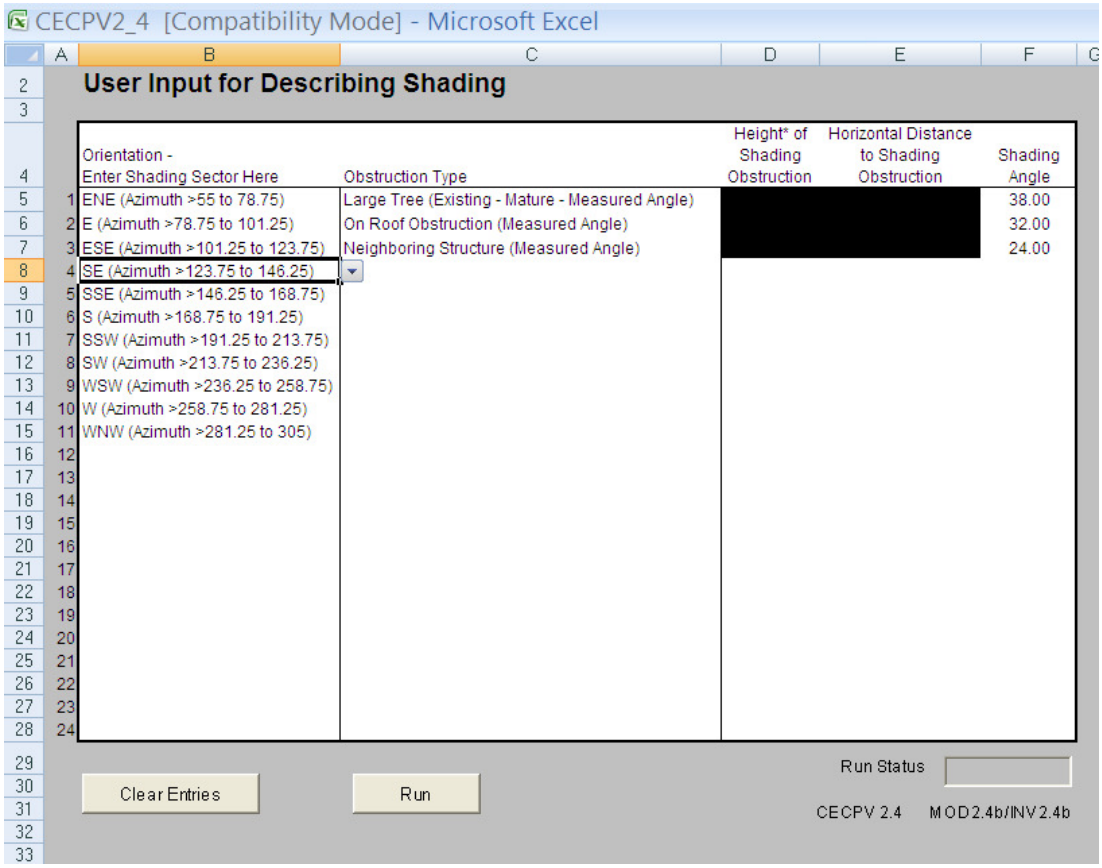
In the Add Shading Detail worksheet, enter values for each of the eleven azimuth windows as required. Obstruction Elevation data should be entered in Column F Shading Angle. To enter Shading Angle, the Obstruction Type must be one of the following:

- Large Tree (Existing - Mature - Measured Angle)
- On Roof Obstruction (Measured Angle)
- Neighboring Structure (Measured Angle)

Note that if the Obstruction Elevation Angle is 26 degrees or less, then no entry is required for that Azimuth Window because the minimal shading criterion is met. However, it may be easiest to just enter all values with a "cut and paste", and the NSHP Calculator will treat any Azimuth Window with a maximum obstruction elevation of 26.56 degrees or less as meeting the minimal shading criterion. Note that the Azimuth Window labels under Add Shading Detail are different than for the SunEye Windowed Obstruction Elevation file. The table below shows how they correlate.

NSHP Calculator Add Shading Detail	SunEye Windowed Obstruction Elevation
ENE (Azimuth >55 to 78.75)	67.5
E (Azimuth >78.75 to 101.25)	90
ESE (Azimuth >101.25 to 123.75)	112.5
SE (Azimuth >123.75 to 146.25)	135
SSE (Azimuth >146.25 to 168.75)	157.5
S (Azimuth >168.75 to 191.25)	180
SSW (Azimuth >191.25 to 213.75)	202.5
SW (Azimuth >213.75 to 236.25)	225
WSW (Azimuth >236.25 to 258.75)	247.5
W (Azimuth >258.75 to 281.25)	270
WNW (Azimuth >281.25 to 305)	292.5

A partially complete Add Shading Detail page is shown in the following screenshot.



For more information, please contact Solmetric via phone at 877-563-5026, email at support@solmetric.com, or visit the web site at www.solmetric.com.