Application Note:
Understanding the Solmetric SunEye

Abstract

Thorough site evaluation will not guarantee a successful solar installation, but it can definitely increase the chances.

Solar site evaluation can be a key success factor for solar installers. It requires a thorough knowledge of solar fundamentals as well as up-to-date information on the latest tools and best practices. When performing site evaluation, the solar professional needs to gather data, including:

- Roof orientation, including azimuth and tilt
- Roof area available for solar array
- Shade measurements for energy calculations
- Conduit and inverter locations

If this data is gathered quickly and efficiently, then the time investment is kept to a reasonable level. Perhaps even more importantly, the client is left with a positive impression, and the chances of winning the business are improved. The data must also be thorough, so that all information required to do a system design or proposal is available, without guesswork or without requiring a second site visit. In this article we will discuss some of common site evaluation challenges and some new tools that can help improve the accuracy and efficiency.

Contents

Shade Measurement Tool

Shade measurements are normally performed using a manual reflecting globe, or an integrated automatic approach using a fisheye lens. The automatic fisheye lens approach is used by the Solmetric SunEye™, and can offer significant advantages in accuracy and time-savings. Shade readings are taken from a specific location on the roof and processed immediately to show solar access percentage, and also the time-of-shade, that is what months, and what time of day, surrounding obstructions will cause shade.

Figure 1. Solmetric SunEye has an integrated fisheye lens and touchscreen user interface.

How the SunEye works

The SunEye's integrated digital camera and fish-eye lens capture an image of the entire horizon in 360 degrees. On-board electronics superimpose the paths of the sun throughout the year based on latitude and longitude, detect shade-causing obstructions, and calculate the annual, monthly, daily, and hourly solar access. "Solar access" is defined as the ratio of the insolation in a given location, including shade, to the insolation available at that location without shade.

Armed with this data, the solar system designer can make informed design choices about the optimum location for the solar panels, for example, which section of roof is best for solar energy production. Panels that will be shaded at the same time of day should be grouped together in the same string to maintain the energy production from the other strings. The built-in edit tool can be used to simulate removal or trimming of shade-causing trees. Guesswork and ballpark estimation are replaced with solid data.

The SunEye can store more than 100 site readings, transfer data to a PC for further analysis, or export data into a printable report. The SunEye user can also average multiple skylines together. For example, data from the four corners of the array (or string) is automatically averaged together into a single solar access data set. The associated patent application US 2007/0150198 contains additional details of the technical approach.

Weather Data and the SunEye

The SunEye currently uses one of two different weather models to calculate solar access, the NASA clearness indices (worldwide) and NREL's Typical Meteorological Year 3 (TMY3) data. When the TMY3 weather data is used, the tilt and orientation factor (TOF) and total solar resource fraction (TSRF) can be calculated in addition to the solar access.

Tilt and Orientation Factor (TOF). TOF is the solar insolation at the actual tilt and orientation divided by the insolation at the optimum tilt and orientation, expressed in percent.

Total Solar Resource Fraction (TSRF). TSRF is the ratio of insolation available accounting for both shading and TOF, compared to the total insolation available at a given location at the optimum tilt and orientation and with no shading. TRSF is also expressed in percent, according to the following equation:

TSRF = Solar Access * TOF

Displaying the Data

The SunEye displays annual, seasonal, and monthly solar access percentage factors and details about obstructions (elevation angle vs. azimuth angle of objects that will shade that location). The SunEye can export data to the SunEye desktop software to create solar access and shade reports. The GPS option allows files to be exported and used with Google Earth, so that you can see exactly where the SunEye data was captured. More information for the different views is described below.

Annual Sunpaths View

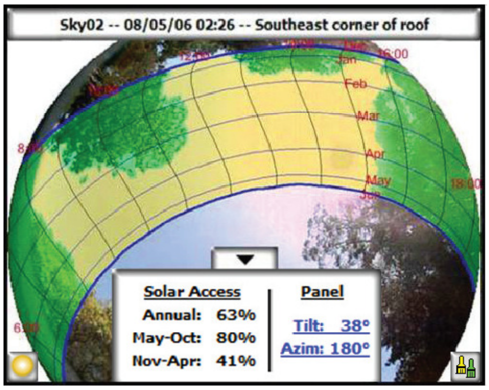

Figure 2: Sunpaths View

This view shows the annual sunpaths drawn on top of the captured skyline. The detected open sky is shown in yellow. The detected shade-causing obstructions are shown in green.

The Results panel in the lower center portion of the display can be configured to show solar access percentages or solar resource percentages.

Monthly Solar Access View

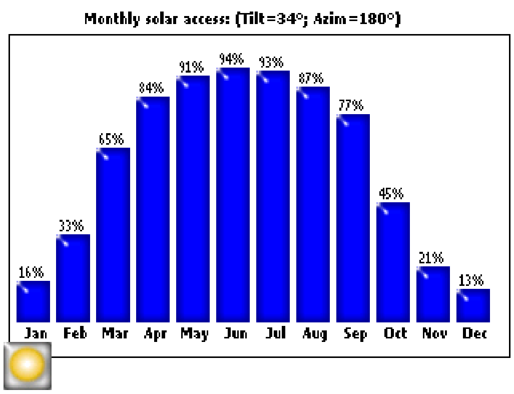

Figure 3. Monthly Solar Access

The Monthly Solar Access View shows the bar chart of the monthly solar access for the location where you captured data. The height of the bars and the numbers at the top of each bar indicate the percentage of solar energy available each month for the site-specific shade conditions. If there were no shade obstructions, the bars would all indicate 100%. If the location was shaded all year round the bars would all indicate 0%.

Obstruction Elevation View

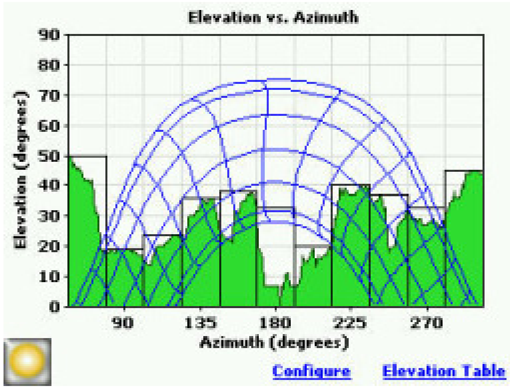

Figure 4: Obstruction Elevation view

The Obstruction Elevation view shows a graph of the elevation angle of the highest obstruction at each azimuth. The Obstruction Elevation view can be configured for a range of azimuth values to display the elevation data trace every one degree, bars showing maximum (or average) data within specified azimuth windows, and sunpaths.

Advanced applications

Recent feature enhancements enable new shade measurement capabilities with the SunEye 210. Several examples are described here.

Finding Shade-Free zones

The SunEye incorporates an electronic compass and level for proper orientation during shade measurements. Direction and tilt are measured continuously, and sun paths for the current location are calculated and drawn on the screen in "Live Preview" mode. As the operator moves, the image updates. This function enables the operator to see where obstructions (chimney, tree, other structure, etc.) will cause shade. By defining a desired "shade-free" window, such as 9am to 3pm year-round, the operator can move to the edge of a shade-free zone, and mark that location on the roof, for example with chalk. When completed, the user can map out an array area that will assure shade free production in this time window. The window can be defined with a start and stop time, and a start and stop month.

Figure 5.. Identify shade-free areas using SunEye window.

Measuring when metal interferes with compass

A compass relies on the earth's magnetic field to its orientation reading. When using the compass near metal, readings can be distorted in an unpredictable way. In this case, SunEye shade readings can still be taken using a reference heading other than the compass, such as the seam of the roof, or the heading of a far away object. The user can enter the reference direction, and the invalid compass readings are over-ridden.

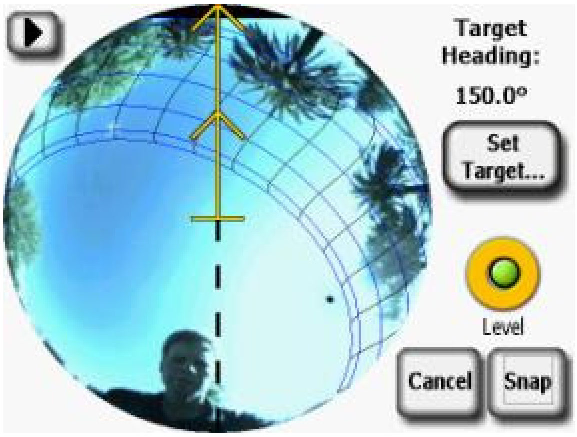

Figure 6. SunEye measurements can be aligned with a known reference when metal interferes with the compass.

Solar Access "Up There"

In many situations, shade measurements are required, but access is not available. For example, in many site evaluations, it may be difficult to access the exact location of the solar array. For example, the roof access may not be authorized at the time of the evaluation or the proper safety equipment may not be available. A new building or solar parking canopy may not be constructed yet, or step ladders may not reach high enough and scissors lifts or boom lifts can be expensive and complex.

For these situations, the SunEye Extension Kit enables the measurements from ground level up to 18 feet. The SunEye is mounted securely on a plate, then raised up on the telescoping pole to the desired level. Measurements are triggered by rotating the pole.

Figure 7. SunEye Extension Kit enables measurements up to 18 feet above ground level.

Using the data

SunEye data can be transferred to other applications for enhancing calculations of energy production of a solar system. In the case of PV systems, programs such as the Solmetric PV Designer can import the SunEye readings, combine with weather, orientation, equipment specifications, and layout information to calculate and display energy production in AC kilowatt-hours. Multiple design scenarios can be compared. An example screenshot is shown below.

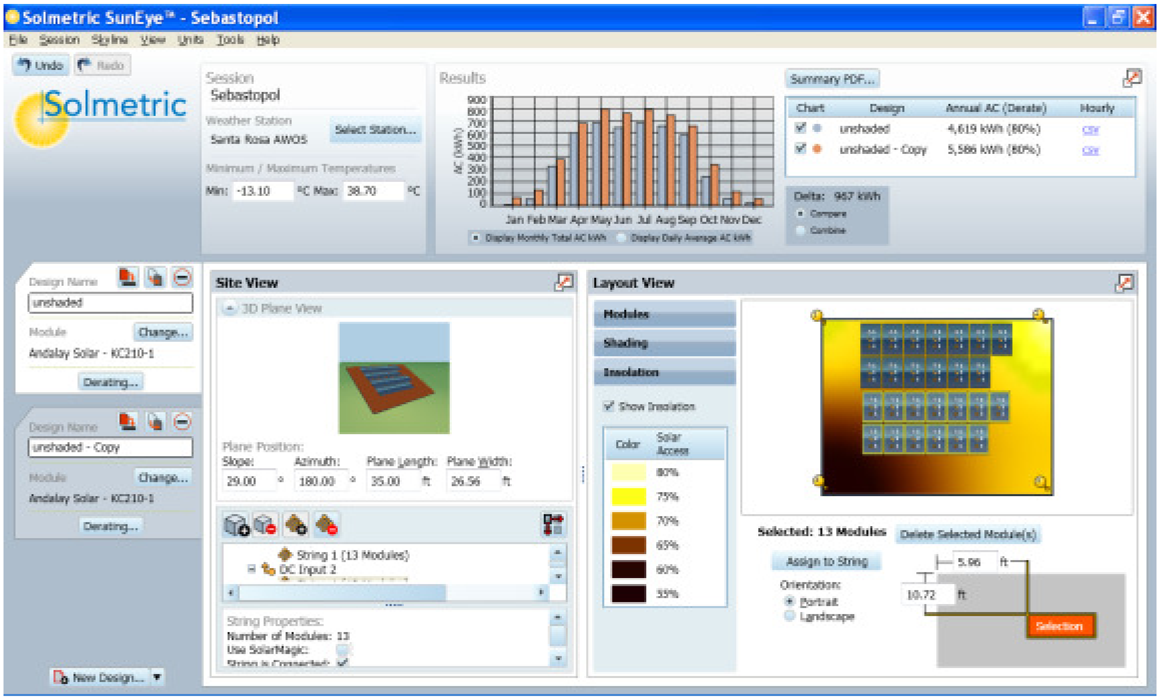

Figure 8. Solmetric PV Designer software screen.

Where to go for additional information:

Additional information is available from the sources listed below:

- Solmetric Corporation website www.solmetric.com.
- Solmetric SunEye User's Guide, available at www.solmetric.com/support-info.html.
- National Renewable Energy Laboratory, TMY3. http://rredc.nrel.gov/solar/old_data/nsrdb/1991-2005/tmy3/.
- University of Oregon Solar Radiation Monitoring Laboratory, Sun Chart Program at http://solardat.uoregon.edu/SunChartProgram.html and Polar Sun Chart Program at http://solardat.uoregon.edu/PolarSunChartProgram.html.
- Photovoltaic Performance Calculator PVWATTS. By National Renewable Energy Laboratory, http://rredc.nrel.gov/solar/codes_algs/PVWATTS/.
- App Note-Using Solmetric SunEye in California Solar Electric Programs-6-May-2010, available at www.solmetric.com/newsletters.html.

- Solar Site Evaluation: Tools and Techniques to Quantify and Optimize Production, By Mark Galli and Peter Hoberg, Solar Pro Magazine Dec-2008-Jan-2009

- Youtube videos related to the SunEye:
  - SunEye demo part 1
    http://www.youtube.com/watch?v=LbJzX-x0Xzs
  - SunEye demo part 2
    http://www.youtube.com/watch?v=DnitoEI9qdU
  - SunEye 210 intro
    http://www.youtube.com/watch?v=JDgtYEQLdxw