California Energy Commission

STAFF PAPER

Staff Review and Analysis of the Solesca Solar Assessment Tool

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ABSTRACT

The California Energy Commission (CEC) adopted the 2022 California Energy Code (California Code of Regulations, Title 24, Part 6, and Associated Administrative Regulations in Part 1, as well as associated Reference Appendices) that went into effect on January 1, 2023. Reference Appendices, Joint Appendix JA11.4.1 requires that solar assessment tools be certified by the CEC Executive Director according to the following requirements:

(1) The solar assessment tool shall calculate the annual solar access percentage of each individual solar array and a weighted average of the photovoltaic (PV) system as a whole. The calculation shall include all known obstructions, including any tree that is planted on the building lot or neighboring lots or planned to be planted as part of landscaping for the building.

(2) The solar assessment tool shall not include horizon shading in the calculation by default.

(3) The solar assessment tool shall produce a shade report with a summary of the PV system, including the address of the project, individual array panel count, orientation, annual solar access percentage, and a weighted average of the PV system as a whole.

(4) If the solar assessment tool model shading condition is based on satellite or aerial images, the annual solar access percentage values shall be comparable to on-site measurements, and documentation shall be provided to CEC as proof.

On July 7, 2025, Solesca Energy, Inc. submitted a request to the CEC to add their Solesca solar design & proposal tool to the CEC's list of approved solar assessment tools. CEC Staff reviewed the application and the supporting documentation and determined that the Solesca assessment tool satisfies all applicable requirements of solar assessment tools listed in Reference Appendices, Joint Appendix JA11.4.1. Staff recommends that the Executive Director certify the Solesca solar assessment tool for the 2022 Energy Code.

Keywords: Solar PV requirement, Solar, Photovoltaic, PV, Solar assessment tool, Solar access roof area, SARA, Building Energy Efficiency Standards, 2022 Energy Code, Solesca Energy, Inc., Solesca, OpenSolar.

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TABLE OF CONTENTS

LIST OF TABLES

Page

CHAPTER 1: Background

2022 Energy Code Photovoltaic Requirements

On August 11, 2021, the California Energy Commission (CEC) adopted the 2022 Building Energy Efficiency Standards (2022 Energy Code), which include new solar photovoltaic (PV) requirements for all newly constructed single-family, low-rise and high-rise multifamily buildings and certain nonresidential buildings in §150.1(c)14, §170.2(f) and (g), and §140.10 respectively. These requirements, along with the rest of the 2022 Energy Code, went into effect January 1, 2023.

The Energy Code solar PV requirement sections define solar access roof area (SARA) as follows:

A. SARA includes the area of the building's roof space capable of structurally supporting a PV system, and the area of all roof space on covered parking areas, carports, and all other newly constructed structures on the site that are compatible with supporting a PV system per Title 24, Part 2, Section 1511.2.

B. SARA does NOT include:

- Any roof area that has less than 70 percent annual solar access. Annual solar access is determined by dividing the total annual solar insolation, accounting for shading obstructions, by the total annual solar insolation if the same areas were unshaded by obstructions.
- Sections 140.10 and 170.2(g) also state: For all roofs, all obstructions, including those that are external to the building, and obstructions that are part of the building design and elevation features may be considered for the annual solar access calculations.
- Section 150.1(c)14 and 170.2(f) also state: For steep-sloped roofs only shading from existing permanent natural or manmade obstructions that are external to the dwelling, including but not limited to trees, hills, and adjacent structures, shall be considered for annual solar access calculations. For low-sloped roofs, all obstructions including those that are external to the dwelling unit, and obstructions that are part of the building design and elevation features shall be considered for the annual solar access calculations.
- Occupied roof areas as specified by the California Building Code Section 503.1.4.
- Roof area that is otherwise not available due to compliance with other building code requirements if confirmed by the CEC Executive Director.

Also, Reference Appendices, Joint Appendix JA11.4.1 requires that solar assessment tools shall be certified to the CEC Executive Director according to the following requirements:

1. The solar assessment tool shall calculate the annual solar access percentage of each individual solar array and a weighted average of the PV system as a whole. The calculation shall include all known obstructions, including any tree that is planted on the building lot or neighboring lots or planned to be planted as part of landscaping for the building.

2. The solar assessment tool shall not include horizon shading in the calculation by default.

- The solar assessment tool shall produce a shade report with a summary of the PV system, including the address of the project, individual array panel count, orientation, annual solar access percentage, and a weighted average of the PV system as a whole.

- If the solar assessment tool model shading condition is based on satellite or aerial images, the annual solar access percentage values shall be comparable to on-site measurements, and documentation shall be provided to CEC as proof.

Summary of Solesca Energy, Inc.'s Application

Solesca Energy, Inc. advances solar energy integration through tools and software solutions. Solesca Energy, Inc.'s solar assessment tool, Solesca, is designed to use algorithms and high-resolution data to simulate energy yield prediction and shading analysis. Solesca's solar assessment tool uses National Renewable Energy Laboratory's (NREL) System Advisory Model (SAM) to run the energy simulation of a building. The SAM Simulation Core (SSC) is a software library developed by NREL that forms the core simulation engine for SAM. It contains the algorithms and modules used to simulate renewable energy systems and projects. The Solesca solar assessment tool accounts for complex shading scenarios from surrounding structures, trees, panel row-row shading and other obstructions and forecasts energy production. The tool is capable of handling a wide range of project sizes and types, from small residential systems to large-scale commercial installations and generates comprehensive reports detailing shading analysis and energy production estimates to support project proposals and decision-making.

On July 7, 2025, Solesca Energy, Inc. submitted an application to CEC requesting to add the Solesca solar design & proposal tool to the CEC's list of approved solar assessment tools.

The application includes:

- An analysis of Solesca's shading calculations compared to those generated by OpenSolar, a competing solar assessment tool certified by the CEC. The analysis compares results from the Open Solar and Solesca tools for five detailed project examples in California as described below:
    - 1 Residential Rooftop Project
    - 1 Flush Mount Rooftop Project, shown with and without trees and shading features
    - 3 Fixed Tilt Rooftop Projects, one in Los Angeles and two in San Francisco

Each example includes:

- **Project Location:** California
- **System Details:** Number of modules, tilt, azimuth, and list of different arrays.
- **Shading Analysis:** Visual representations and data from both Solesca and OpenSolar.
- **Energy Production Comparison:** kWh output estimates from both Solesca and OpenSolar.
- **Detailed Notes:** Observations and comparisons between results from the two tools.

1. A sample shade report generated by Solesca.
2. A copy of the National Renewable Energy Laboratory's (NREL's) Cooperative Research and Development Final Report.

- The SAM code was directly integrated into the Solesca platform and NREL ensured the correct implementation of the SAM interface and a proper mapping of Solesca's inputs to SAM's inputs.
- Solesca Energy, Inc.'s supporting documents state that the Solesca tool does not use satellite or aerial images to perform the shading calculations. Instead, all shading analysis is performed purely based on the location of the panels, obstructions, trees, the earth and the sun for all days of the calendar year. The approach is purely math-based.

CHAPTER 2: Staff Analysis

CEC staff reviewed all the documents provided by Solesca Energy, Inc. and their findings are summarized below.

Results from Solesca and OpenSolar tools are comparable

Staff reviewed Solesca's shading calculations compared to those generated by OpenSolar, a competing solar assessment tool certified by the CEC, to determine if the Solesca solar assessment tool is accurate in modeling the effects of shading on solar PV systems. The submitted Solesca results represented five sample sites in California, which feature flush mount and rooftop commercial projects, some of which are surrounded with or are in the center of obstructions for heating, ventilation and air conditioning (HVAC) units and trees, as well as a sample Solesca shade report for a single-family building. These examples also demonstrate how Solesca can model exterior obstructions as required by Reference Appendices, Joint Appendix JA11. To compare solar access values between competing solar assessment tools, consistent values were utilized for inputs including same number of modules, height, obstructions, tilt, and azimuth. The Solesca tool also includes a "set shade cutoff" feature that allows a user to set a shade percent cutoff for the year, which removes modules with percentage shaded area above a given value.

The report included solar access values, tilt & orientation factors, and total solar resource fraction values for these sample sites, see Table 1.

Table 1. Comparison of Solar Access Value (SAV) results from Solesca and OpenSolar tools

Project type	Project location	System details	Solesca (%)	OpenSolar (%)	Difference (%)
Residential Project	1045 West 59th Street, Los Angeles, CA 90044 USA	2 rooftops, one with 18 panels and one with 9 panels	94.6	94	<1%
Flush-Mount Commercial Project	6020 South Figueroa Street, Los Angeles, CA 90003 USA	2 rooftops, one with 144 panels and one with 98 panels	99.7	100	<1%
Flush-Mount Commercial Project	6020 South Figueroa Street, Los Angeles, CA 90003 USA	2 rooftops, one with 144 panels and one with 98 panels	98.6	99	<1%
Flush-Mount Commercial Project-Extreme shading	6020 South Figueroa Street, Los Angeles, CA 90003 USA	2 rooftops, one with 144 panels and one with 98 panels	87	86	1%
Rooftop Commercial Project	27118 Silver Spur Road, Rolling Hills Estates, CA 90274 USA	1 rooftop, 270 panels	88.5	92	3%
Rooftop Commercial Project	21121 Cabot Boulevard, Hayward, CA 94545 USA	1 rooftop, 2,599 panels	97.3	97	<1%
Rooftop Commercial Project	Frank H. Ogawa Plaza, Oakland, CA 94612 USA	1 rooftop with 86 modules at 40’ tall roof surrounded by skyscrapers	81.5	78.9	<3%
Rooftop Commercial Project	615 12th Street, Oakland, CA 94607 USA	1 rooftop with 64 modules at 20’ tall with a skyscraper to the left	61.7	63.3	<2%

The calculated results of annual Solar Access (%) between Solesca and OpenSolar differ by ±3% at the highest. The Solesca Energy Inc. application states that minor differences in shading calculations are expected between design tools, owing to weather datasets used by each tool as well as OpenSolar models circular obstructions used by OpenSolar(compared to obstructions of any shape used in Solesca models). The corners of the obstructions are likely not taken into consideration by OpenSolar's model. Still, differences of less than 3% of solar access between the two tools indicate similar and consistent results.

OpenSolar and Solesca use similar weather resources, suggesting that discrepancies are unlikely to derive from these resources. Solesca can handle different weather file resources, including SolarGis, SolarAnywhere, Solcast, and custom uploaded weather files. By default, Solesca uses data from the closest National Solar Radiation Database (NSRDB) location unless the user selects otherwise. For the purposes of this analysis, no resource was selected and therefore NSRDB was used for all projects. OpenSolar uses a combination of OpenWeather and NSRDB for their projects. For this analysis, OpenSolar used the National Renewable Energy Laboratory-Physical Solar Model (NREL-PSM) file.

Note, Solesca Energy Inc's supporting documents state that the Solesca tool does not use satellite or aerial images to perform the shading calculations, thus the requirement of Reference Appendices, Joint Appendix JA11.4.1(d) does not apply.

In summary, the analysis confirmed that Solesca adequately estimates the weighted average solar access of a PV system as a whole. The close match between results from the Solesca and OpenSolar tools further suggests that the Solesca tool meets the requirements of Reference Appendices, Joint Appendix JA11.4.1(a) and (b), including not representing known obstructions and horizon shading. Additionally, since the Solesca tool does not use satellite or aerial images to perform the shading calculations, the requirement of Reference Appendices, Joint Appendix JA11.4.1(d) does not apply.

Sample residential shade report meets JA11 requirements

The sample Solesca residential shade report submitted to the CEC by Solesca Energy, Inc. confirmed that the Solesca tool can calculate the monthly and annual solar access percentage of each individual solar array. The Solesca report has the weighted average solar access for the entire system as well as the average solar access for each subsystem. The sample shade report included the following:

- The address of the project,
- Individual array panel count
- Array orientation – azimuth, pitch, tilt, and orientation factor
- Annual solar access percentage
- Weighted average solar access of the PV system as a whole.

In summary, the Solesca tool meets the requirements of Reference Appendices, Joint Appendix JA11.4.1(c).

Other documents further validate equivalency of Solesca results with other CEC-approved tools

Solesca Energy, Inc. also provided a copy of NREL's Solar Performance and Financial Modeling, Cooperative Research and Development Final Report. NREL assisted Solesca Energy, Inc. in improving their solar modeling platform by providing documentation, code review, code integration assistance, and unit tests. NREL recommended resources including the PV Performance Modeling Collaborative guidelines (Sandia, 2023) and the SAM technical reference manual (Gilman et al, 2018). The NREL team advised Solesca Energy Inc. on the integration of solar resource data from the National Solar Radiation Database and Solar Anywhere platforms, including how to calculate probability of exceedance values based on multiple years of weather data. SAM performs external shading using the Binary Space Partitioning Trees algorithm (Naylor, 1998). Given how the SAM code is partitioned, the Solesca Energy, Inc. team had to implement this algorithm directly in their graphical user interface (GUI). They were then able to utilize the outputs from the algorithm to provide inputs to SAM's shading models, and compute shading from trees, buildings, and equipment on the simulated arrays. The NREL team developed JSON files based on inputs to SAM that the Solesca software typically utilizes, and outputs including annual energy based on running those inputs in SAM. The Solesca software implementation successfully produced the same outputs, as expected, since the underlying energy model is the same. The Solesca Energy, Inc. team integrated these tests into their continuous integration platform, meaning the tests will automatically re-run as Solesca's code changes and is deployed.

Finally, the NREL team assisted with interpreting comparisons between Solesca's output and PVSyst, and helped identify the sources of discrepancies.

The close match between results from the Solesca and SAM simulations suggests that the Solesca tool meets the requirements of Reference Appendices, Joint Appendix JA11.4.1(a) and (b), including representing known obstructions and horizon shading.

Summary of Findings and Recommendation

The Solesca solar assessment tool successfully produced the same outputs as SAM, as expected, since the underlying energy model is the same. Staff has validated that Solesca's shading reports are statistically equivalent to reports from currently approved solar assessment tools (OpenSolar) and has determined that the Solesca solar assessment tool meets the applicable requirements of Reference Appendices, Joint Appendix JA11.4.1. Staff recommends that the CEC Executive Director certify the Solesca solar assessment tool for the 2022 Energy Code.