Solar Performance and Financial Modeling

Cooperative Research and Development Final Report

CRADA Number: CRD-23-23746

NREL Technical Contact: Brian Mirletz

NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
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Contract No. DE-AC36-08GO28308

Technical Report
NREL/TP-7A40-92254
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NOTICE

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Cooperative Research and Development Final Report

Report Date: November 18, 2024

In accordance with requirements set forth in the terms of the CRADA agreement, this document is the CRADA final report, including a list of subject inventions, to be forwarded to the DOE Office of Scientific and Technical Information as part of the commitment to the public to demonstrate results of federally funded research.

Parties to the Agreement: Solesca Energy, Inc.

CRADA Number: CRD-23-23746

CRADA Title: Solar Performance and Financial Modeling

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Sponsoring DOE Program Office(s):

Office of Energy Efficiency and Renewable Energy (EERE), Solar Energy Technologies Office

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources a/k/a Government In-Kind
Year 1	$75000.00
TOTALS	$75000.00

Executive Summary of CRADA Work:

Solesca is working to enhance the energy and financial modeling components of their real-time solar project design platform. In collaboration with NREL, they aim to improve the accuracy and reliability of their software by integrating best practices and knowledge from NREL.

CRADA benefit to DOE, Participant, and US Taxpayer:

- Uses the laboratory's core competencies, and/or
- Enhances U.S. competitiveness by utilizing DOE developed intellectual property and/or capabilities.

Summary of Research Results:

NREL will assist Solesca with implementing solar performance and financial modeling best practices through documentation, software integration, software tests, and code review.

Task 1: Documentation of solar modeling best practices.

a) Solesca to review Photovoltaics Performance Modelling Collaborative (PVPMC) guidelines and develop a list of terms that need definitions.

b) NREL to provide a report with definitions of these terms.

c) The report will include links to open source implemented versions of PVPMC guidelines in SAM Simulation Core (SSC).

Task 1 established a shared baseline of PV performance modeling terminology. NREL recommended resources including the PV Performance Modeling Collaborative guidelines (Sandia, 2023) and the SAM technical reference manual (Gilman et al, 2018). The Solesca team reviewed these and asked 28 questions on modeling best practices. The NREL team reviewed the questions and provided answers on topics including but not limited to transposition models, soiling, temperature coefficients. These conversations and definitions contributed to decision making in other tasks, especially task 3, and are shown in Figure 1.

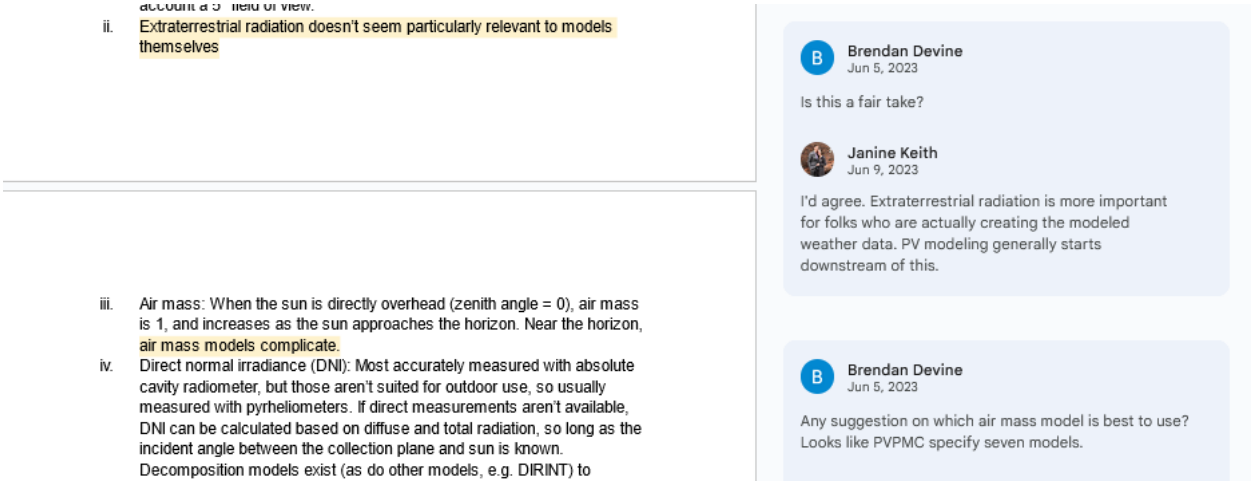

Figure 1: The collaborative document discussing solar modeling best practices.

Task 2: Software test suite for Solesca's model

The focus of task 2 changed somewhat during the agreement during the integration of the SAM code directly into Solesca's platform (see task 3). Since the SAM energy models are already supported by extensive tests, the main focus for tests developed under this agreement shifted to ensuring the correct implementation of the SAM interface in rust and a proper mapping of Solesca's inputs to SAM's inputs. To this end, the NREL team developed JSON files based on inputs to SAM that Solesca's 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 team integrated these tests into their continuous integration platform, meaning the tests will automatically re-run as Solesca's code changes and is deployed. A local version of the tests is shown in the screenshot in Figure 2.

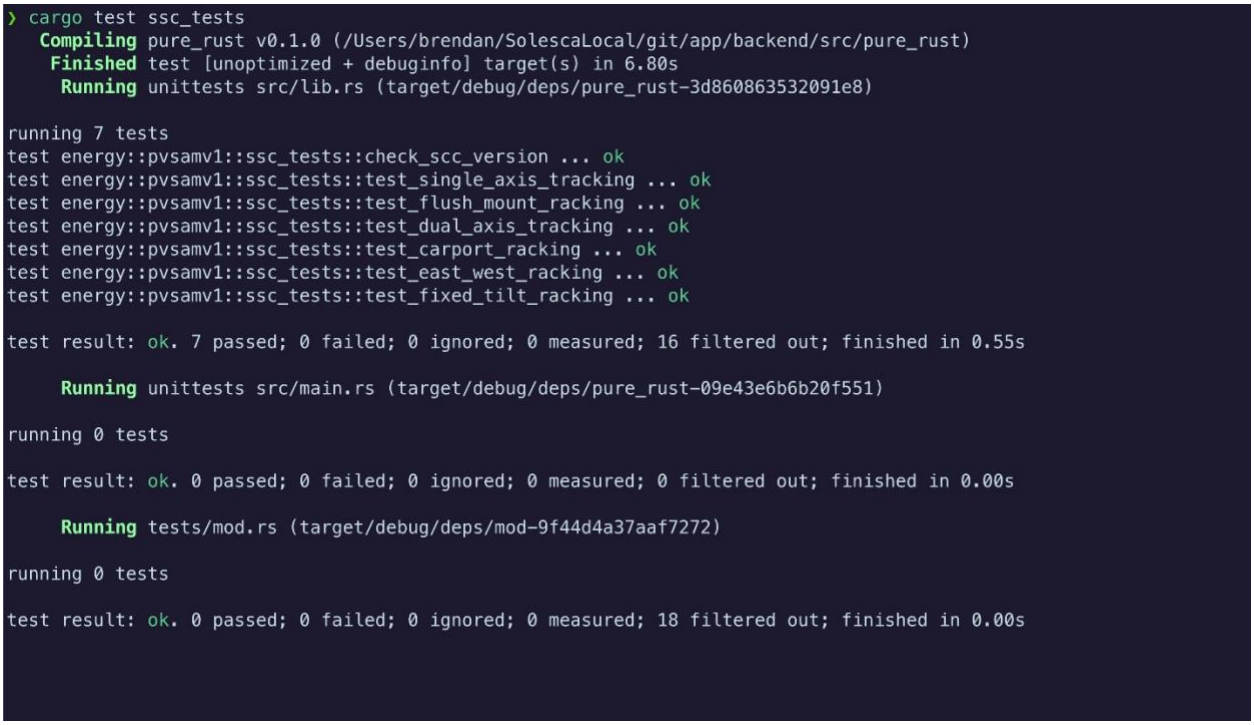

Figure 2: Test results of the Solesca-SAM integration, run on a local device.

Task 3: Code review and recommended improvements

NREL conducted a code review of Solesca's original modeling code in June 2023, and upon discussing their findings both parties agreed that best path forward to improve the model was to directly integrate SAM's pvsamv1 detailed PV performance model, as this would be the fastest way to integrate best practices and additional features in SAM's models.

The first issue to overcome with integrating SAM into Solesca's software was language compatibility. SAM is written in C++, whereas Solesca's backend software is written in Rust. The Solesca team was able to integrate the SAM C++ shared libraries into their Rust software via Node.js libraries and a JSON integration with the SAM model specification, allowing access to all modeling features in the latest version of SAM. Results of this integration are shown in Figure 3.

The NREL team also advised on software mappings from Solesca's GUI to the pvsamv1 model, including the California Energy Commission (CEC) module and inverter models. Ultimately the integration allows Solesca's software to import data from the CEC into their software and run the underlying models in SAM.

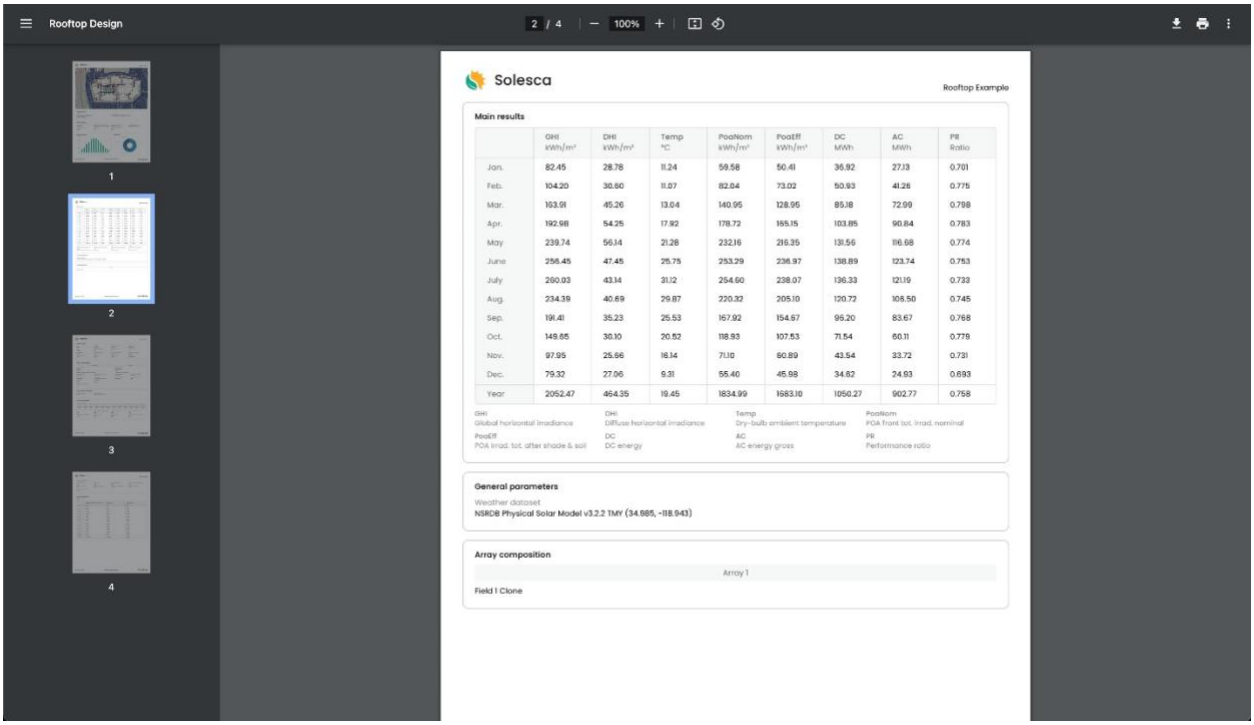

Figure 3: SAM energy modeling results displayed in Solesca's GUI

Task 4: CRADA Final Report

This report serves to meet the requirement for the CRADA Final Report with preparation and submission in accordance with the agreement's Article 4.

Task 5: Additional Tasks

The earliest additional task in the project was the Solesca team assisting the NREL team with getting the Solesca platform running locally on the NREL team's laptops. This provided the Solesca team with feedback on how to improve building instructions and troubleshooting on additional platforms.

The NREL team assisted Solesca with integrating external shading into their platform. SAM performs external shading using the Binary Space Partioning Trees algorithm (Naylor 1998). Given how the SAM code is partitioned, the Solesca team had to implement this algorithm directly in their GUI. Tests of this algorithm are shown in Figure 4. 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. Solesca's GUI implementation is shown in Figure 5.

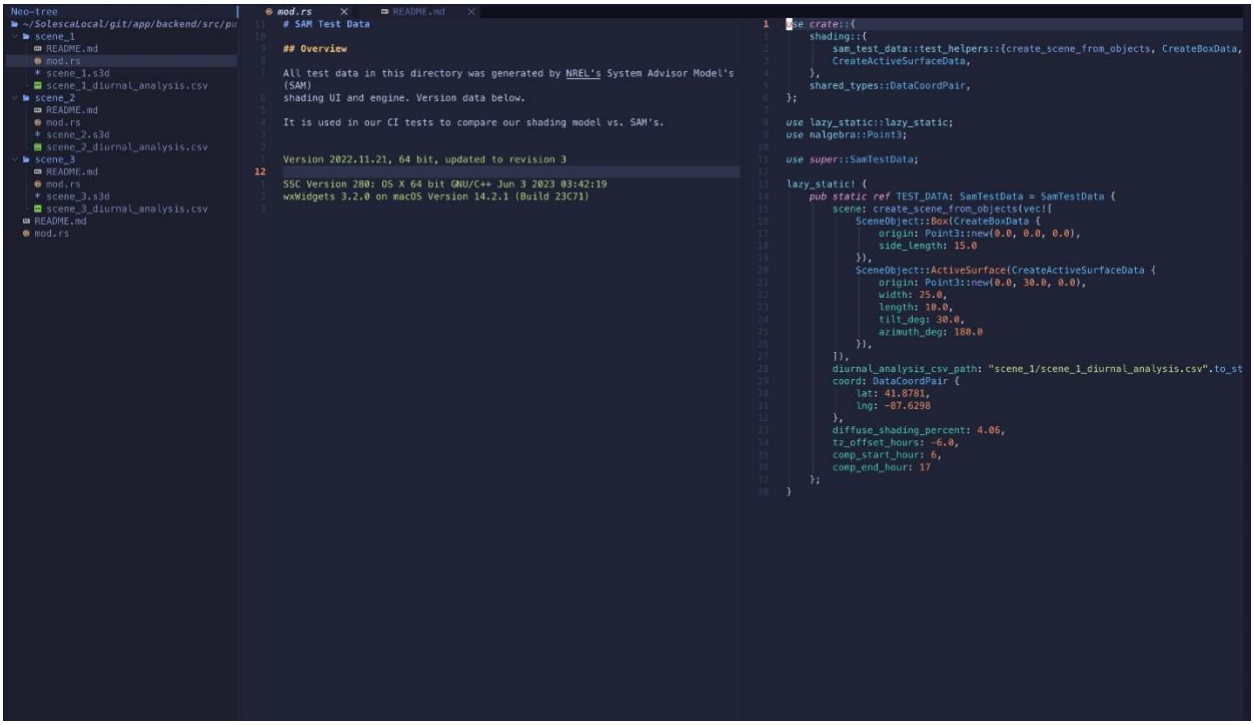

Figure 4: Unit tests of Solesca's shading model.

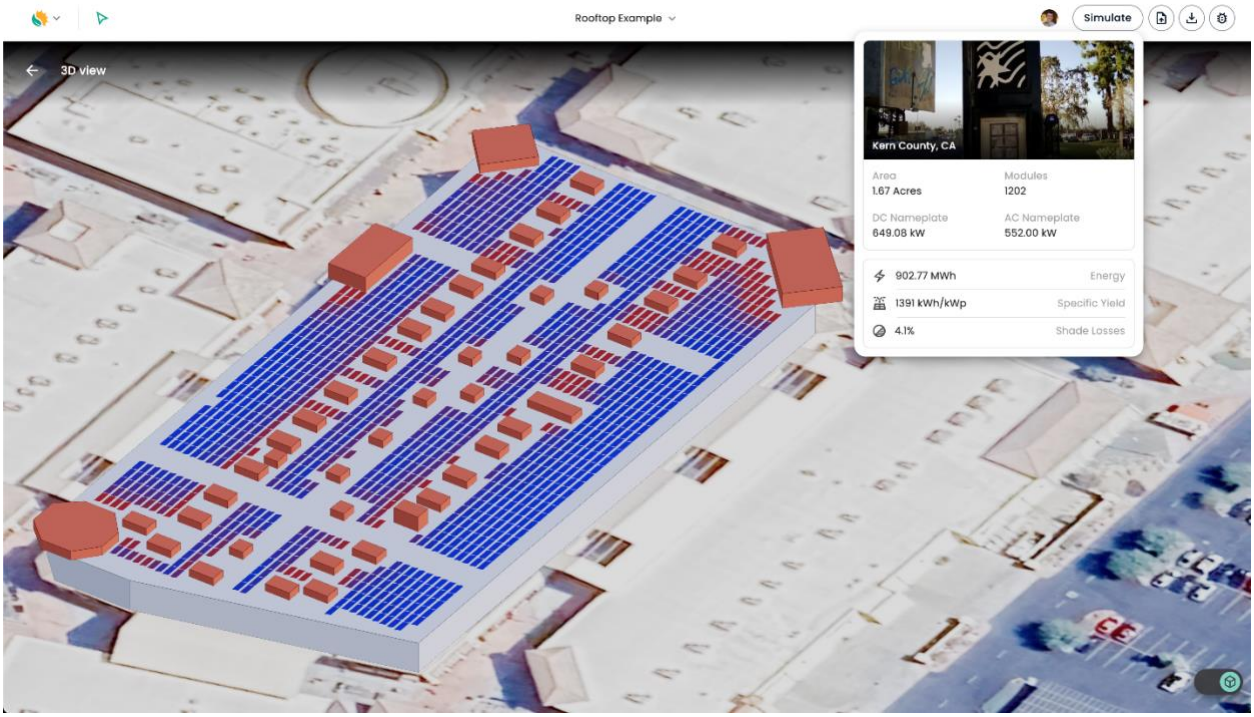

Figure 5: Solesca's GUI for creating shading data.

The NREL team advised Solesca 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.

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

Summary Conclusion:

NREL assisted Solesca in improving their solar modeling platform by providing documentation, code review, code integration assistance, and unit tests.

References:

Sandia National Laboratories. (2023, June 9th) PV Performance Modeling Collaborative Modeling Guide https://pvpmc.sandia.gov/modeling-guide/

Gilman, Paul, DiOrio, Nicholas A., Freeman, Janine M., Janzou, Steven, Dobos, Aron, and Ryberg, David. 2018. "SAM Photovoltaic Model Technical Reference 2016 Update". United States. https://doi.org/10.2172/1429291. https://www.osti.gov/servlets/purl/1429291

Naylor, Bruce F. "A tutorial on binary space partitioning trees." ACM SIGGRAPH, 1998.

Software Record (SWR):

Technology from *NREL* SWR-16-02, was successfully transferred to Solesca's collaborative solar design software https://www.solesca.com/

Subject Inventions Listing:

None.

ROI #:

None.