



Photovoltaics Optimized for Stationary Wide-Angle Concentrator PV System

Cooperative Research and Development Final Report

CRADA Number: CRD-16-604

NREL Technical Contact: Bill McMahon

**NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC**

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Contract No. DE-AC36-08GO28308

Technical Report
NREL/TP-5900-74581
August 2019



Photovoltaics Optimized for Stationary Wide-Angle Concentrator PV System

Cooperative Research and Development Final
Report

CRADA Number: CRD-16-604

NREL Technical Contact: Bill McMahon

Suggested Citation

McMahon, Bill. 2019. *Photovoltaics Optimized for Stationary Wide-Angle Concentrator PV System: Cooperative Research and Development Final Report, CRADA Number CRD-16-604*. Golden, CO: National Renewable Energy Laboratory. NREL/TP-5900-74581. <https://www.nrel.gov/docs/fy19osti/74581.pdf>.

**NREL is a national laboratory of the U.S. Department of Energy
Office of Energy Efficiency & Renewable Energy
Operated by the Alliance for Sustainable Energy, LLC**

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

Contract No. DE-AC36-08GO28308

Technical Report
NREL/TP-5900-74581
August 2019

National Renewable Energy Laboratory
15013 Denver West Parkway
Golden, CO 80401
303-275-3000 • www.nrel.gov

NOTICE

This work was authored by the National Renewable Energy Laboratory, operated by Alliance for Sustainable Energy, LLC, for the U.S. Department of Energy (DOE) under Contract No. DE-AC36-08GO28308. Funding provided by the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office. The views expressed herein do not necessarily represent the views of the DOE or the U.S. Government.

This work was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, nor any of their contractors, subcontractors or their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or any third party's use or the results of such use of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof or its contractors or subcontractors. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof, its contractors or subcontractors.

This report is available at no cost from the National Renewable Energy Laboratory (NREL) at www.nrel.gov/publications.

U.S. Department of Energy (DOE) reports produced after 1991 and a growing number of pre-1991 documents are available free via www.OSTI.gov.

Cover Photos by Dennis Schroeder: (clockwise, left to right) NREL 51934, NREL 45897, NREL 42160, NREL 45891, NREL 48097, NREL 46526.

NREL prints on paper that contains recycled content.

Cooperative Research and Development Final Report

Report Date: 3/20/19

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

Parties to the Agreement: Glint Photonics, Inc

CRADA number: CRD-16-604

CRADA Title: Photovoltaics Optimized for Stationary Wide-Angle Concentrator PV System

Joint Work Statement Funding Table showing DOE commitment:

Estimated Costs	NREL Shared Resources a/k/a Government In-Kind
Year 1	\$.00
TOTALS	\$.00

Abstract of CRADA Work:

Under this CRADA, NREL will cooperate with Glint on highly-efficient photovoltaic cells optimized for integration into Glint's concentrator panels. These cells will be based on NREL's unique expertise in four-junction cell design and fabrication, and will be optimized to match the spectral, temperature, and geometric requirements of the Glint panels.

Summary of Research Results:

The original plan for this project changed significantly in response to interim results and, as a result, NREL's role in the project continually changed.

In the original plan, Glint planned to design and fabricate a concentrating photovoltaic (CPV) module, and NREL would design and grow the required solar cells, then measure the performance of the module.

During the first phase, NREL modeled the performance of 4-junction solar cells under expected module conditions (temperature and irradiance) provided by Glint's modeling of their prototype module. Once this was done, the need for two design changes became apparent:

- (1) 3-junction solar cells would be more appropriate, because the acrylic lenses used in the Glint module would absorb much of the long-wavelength light utilized by the fourth (low bandgap) junction.
- (2) The cell size should be greatly reduced. As originally envisioned, NREL would supply a few large (cm-sized) cells, but thermal analysis of the module by Glint and cell modeling by NREL showed that

this would lead to unacceptable cell heating. Glint therefore re-designed their module to utilize much smaller cells, but this also greatly increased the number of cells needed.

These two design changes led to the first major change in the direction of the project. Instead of supplying solar cells, NREL would help design cells to be produced by a commercial vendor better suited for the production of large numbers of small cells. The budget and scope of NREL's portion of the project was adjusted accordingly.

The second major change in direction for this project occurred near the end, when it was decided (in concert with the project sponsor, ARPA-E) that Glint's research would shift from PV module production to LED module production. Once this decision was made, measurements of a CPV module were no longer needed, so the NREL portion of the project was terminated and remaining funds were returned to Glint.

The PI of this project also changed in year 1 from Ryan France to Bill McMahon, to accommodate Ryan's need to work off-site for a research-exchange program. Bill continued as PI for the remainder of the project.

The results of the modeling are further discussed in the joint publication between NREL and Glint : “J. Lloyd, M. Pavilonis, C. Gladden, C. Casper, K. Schneider, W. McMahon, *et al.*, "Performance of a prototype stationary catadioptric concentrating photovoltaic module," *Optics Express* **26**, A413 (2018).”

Largely due to the changes of direction during the project, much of the other work performed by NREL was advisory or preparatory, and therefore unpublished.

Subject Inventions Listing:

None

ROI #:

None

Responsible Technical Contact at Alliance/NREL:

Bill McMahon

Name and Email Address of POC at Company:

Peter Kozodoy, peter@glintphotonics.com

DOE Program Office:

Office of Energy Efficiency and Renewable Energy Solar Energy Technologies Office (SETO)