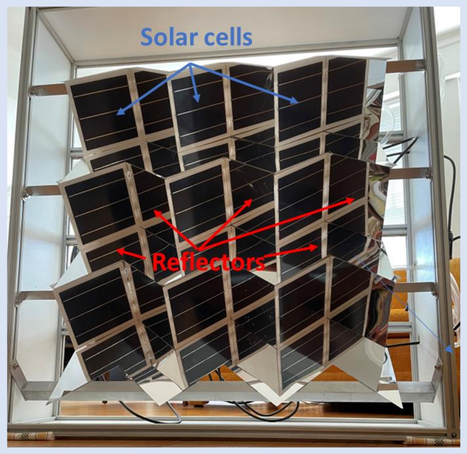
Dual Hybrid 3D Solar Module and Test Results

Poster presentation prepared for ASES Conference June 2022
by Daniel Simon with test data from report by SolarPTL

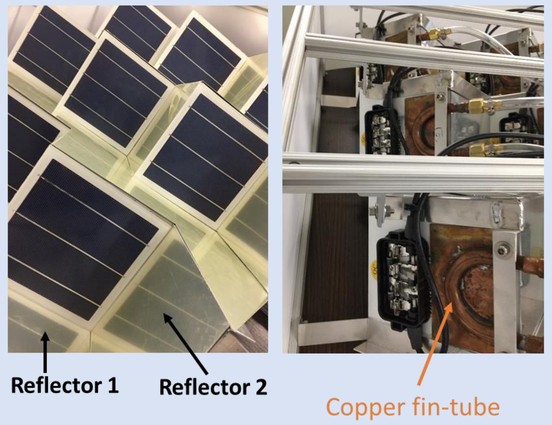
Dual Hybrid Module uses solar concentrator and solar thermal design elements

Dual Hybrid 3D Solar Module Design



- Hybrid module concentrates light and removes heat
- Employs reflectors to **double** the **sunlight hitting each cell**
- **Copper fin-tube** on back collects & **removes thermal**/heat energy
- Optical gain + heat removal improves cell performance 5x

Add sun in front; remove heat in back



- Left photo shows solar cells and reflectors; each cell has two flat aluminum reflectors arranged perpendicular to it
- Right photo shows back side of cell with **copper fin-tube** and large junction box
- Large “module size” junction box limited area available for copper fin-tube.

Hybrid Module and “control” cell tested by Solar PTL in Arizona

Performance Test Data reported by SolarPTL

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Test Data

Performance test – Side by side, as measured on November 3, 2021.

Test Date (MM/DD/YYYY):			11/03/2021				
Test method			☐ Simulator ☒ Natural sunlight				—
Irradiance [W/m²]			1000 ± 50				
Sample no.	Average I_{sc} [A]	Average V_{oc} [V]	Average I_{mpp} [A]	Average V_{mpp} [V]	Average FF [%]	Average P_{max} [W]	—
3DS0001	11.6	0.6	9.7	0.4	55.9	3.7	—
3DS0002	8.8	0.5	6.7	0.3	43.0	2.1	—

Supplementary information: For sample 3DS0001, all measurements taken with cooling fluid (water) flowing thru the target cell. Raw data available upon request.

Sample 3DS001 = cell in hybrid module
Sample 3DS002 = single control cell

- Cell in hybrid module produced **75% higher electrical output**
- Single cell inside hybrid module generated **3.7 W** (Average Pmax)
- Control cell generated **2.1 W**
- Power boost includes benefit of both optical and thermal gain.

Solar Thermal Data measured by SolarPTL

Solar Thermal – Data Summary

Test Date (MM/DD/YYYY):		11/03/2021		
Test method		☐ Simulator ☒ Natural sunlight		—
Irradiance [W/m²]		1000 ± 50		
Sample no.	Average T_{in} [C]	Average T_{out} [C]	Average Flow-rate [GPM]	—
3DS0001	31.92087	33.200786	0.18716	—
				—

Supplementary information: For sample 3DS0001, all measurements taken with cooling fluid (water) flowing thru the entire 9-cell sample.

Average T_{in} = 31.9C

Average T_{out} = 33.2C

Change in Temperature ~ 1.25C

- The inlet water temperature = 31.9C; the exit water temperature = 33.2C; flow rate = 0.187 GPM
- The water temperature increased **1.25C** (2.25F) from inlet to outlet.
- Captures the thermal energy collected from all 9 cells in the hybrid module
- ~62 W of thermal power collected by all 9 cells (aka ~6.9 W per cell)

SolarPTL Test Arranged on 2-axis Tracker

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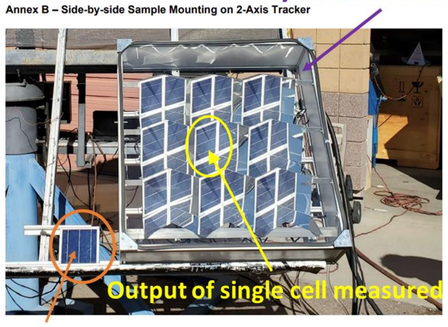
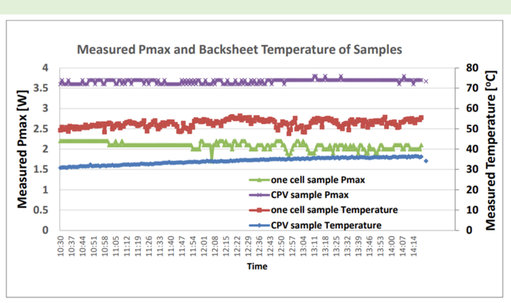
Annex B – Side-by-side Sample Mounting on 2-Axis Tracker



- Test performed by Solar PTL (Tempe, Arizona) outdoors on 2-axis tracker
- Tested output of a single cell inside hybrid module, and compared with single cell “control” (on lower left)
- Measured water temperature at hybrid module input and output

Hybrid module generated 75% more electrical power & 5x the total output (electrical + thermal)



Blue plot/right axis = temperature of cell in module
Red plot/right axis = temperature of control cell

- Cell in hybrid module produced 3.7W (electrical) + 6.9W (thermal) = **10.6W** which is 5 times the 2.1W (electrical) the control cell produced
- Despite a warm (~32C/90F) cooling temperature, the cell in the hybrid module (blue plot) operated at a much lower temperature than the uncooled “control” cell (red plot)
- Using water below 90F for cooling would logically increase both the electrical and thermal output of the Dual Hybrid 3D Solar Module.