American-Made Solar Prize -- Technical Assistance Request

Project: PV Robotics™ Automated Solar Installation

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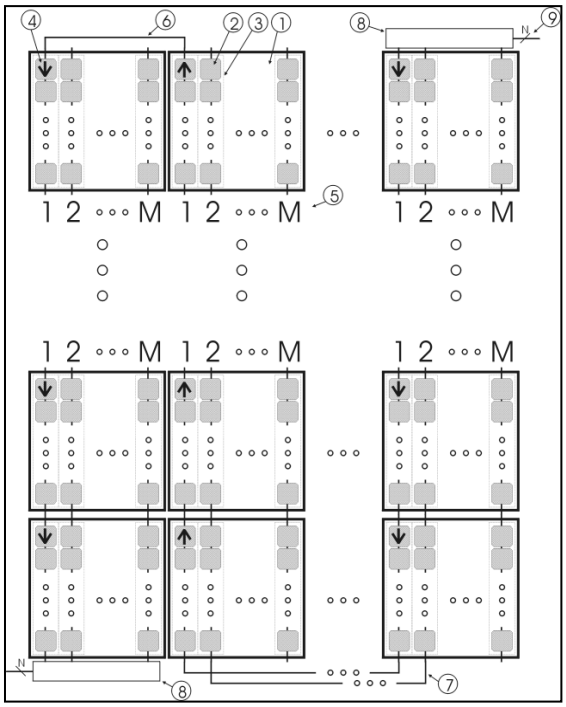
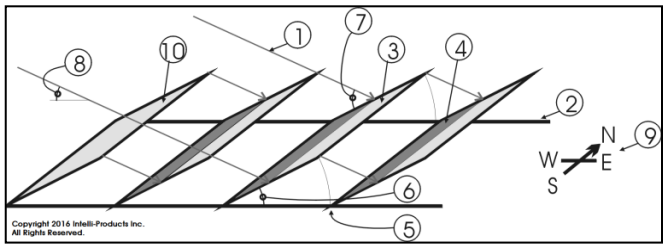
We tested a PV Cell in part and full shade conditions, and discovered that the power output in "full shade" conditions was about 54% of that in full-sun. By full-shade, we mean in complete shade but with a clear bright sky view. The cell used was fairly old and blue in color.

Based solely on that finding, we proposed a Shade-Common intra-panel parallel wiring scheme as shown at right to allow densely spaced 1-axis tracking with greater power output. A mathematical analysis (below graphic and results table) was completed based on the experimental output potential of 54% for shaded cells in densely spaced tracking arrays on the

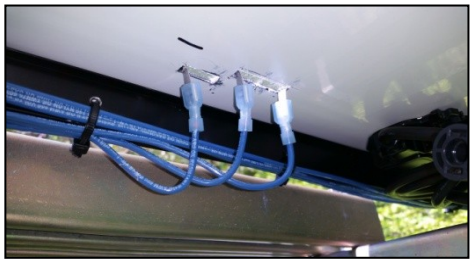




assumption that the power output from each row of commonly shaded PV "cells" could be optimally converted --i.e., different Voltage/Current (V-I) characteristics hence separate Maximum Power Point Tracking (MPPT). Such a configuration would, as a minimum, require that each cell row within the panels be separately wired by some means, combined with equally-shaded cell rows, and only then converted to useable power (e.g., AC).

Panel Configuration	Upper Tilt Limit	East-West Gap	North-South Gap	Cover	Relative Output per Panel	Relative Output per Acre (re Flat)	Relative Output per Acre (re Pole)	Analysis: Combined 50%/50% Panel/Acre Output
Flat to ground	N/A	0%	0%	100%	100.0%	**100.0%**	227.0%	**100.0%**
1-axis strings	N/A	0%	40%	71%	118.8%	84.9%	192.7%	101.9%
2-axis on pole	90°	100%	80%	28%	158.6%	44.0%	**100.0%**	101.3%
2-axis on pole	90°	125%	80%	25%	161.3%	39.8%	90.4%	100.6%
Advanced PV	60°	0%	0%	100%	148.7%	148.7%	337.6%	148.7%
Advanced PV	**75°**	**0%**	**0%**	**100%**	**150.1%**	**150.1%**	**340.8%**	**150.1%**
Advanced PV	80°	0%	0%	100%	150.3%	150.3%	341.1%	150.3%

To test this paradigm, we constructed a Densely Spaced Tracking Test Rack as shown in the top photo next page. Two rows were used to ensure we can obtain the necessary full-sun/full-shade capability as can be seen in this photo (note panel shadows on right hand row). One of the panels on the left tracking row is active (data collected), and the two panels on the right tracking row are the specially adapted panels for the Shade-Enabled circuit testing.



To achieve the necessary test capability involving individual cell-rows within the panels, the two panels on the right-hand row were modified as shown in the 2nd photo at right such that individual "cell rows" are accessible to the test equipment. These somewhat basic connections were made by carefully cutting away the backsheet, and then cutting and pulling up a portion of each cell row circuit at the end of the panels. This technique has worked except that we have a couple of connections that are flakey. Before proceeding with future tests, we will solder these connections rather than depend on the quick connects as show here. Further, we completed a circuit selection, shunt testing, and control and data collection system. A relay "circuit selection" rack was constructed to allow individual circuit testing as well as combined testing in both series and parallel circuit patterns.

We found two significant results. First, we observed that the "black" panels we obtained from our EPC associate do not behave the same as the "blue" PV cell we originally experimented with, showing a far lower full-shade output. This suggests further testing with other cells is needed, especially focusing on cells known to have a good 'clear sky' output which is likely related to the UV response.

The second significant finding made that we appear to be seeing is that when a fully sun lit cell row and one fully in shade (on a bright sun day) are wired in parallel, the current output is larger than the sum of the two cell rows tested in isolation. We know of no possible cause for this other than that the added bias voltage from the fully lit cell row must be affecting the power output from the shaded cells. If this is true, then it is a potentially significant finding for the PV field. We have done a brief search of the readily available research and have not found anything that would support this observation. We will need to enhance our data collection somewhat before we can confirm and characterize this result.

There is a potentially new finding here that warrants further research. We would gladly team with an appropriate DOE lab for that work. Our sole limitation is that we have no funds available, and thus must have at least some funding or we can devote no time to this innovation. We do have pending patents filed for this.