Report on temperature testing of Monocrystalline PV solar Panel: Installation onto caravan – with air gap versus no air gap

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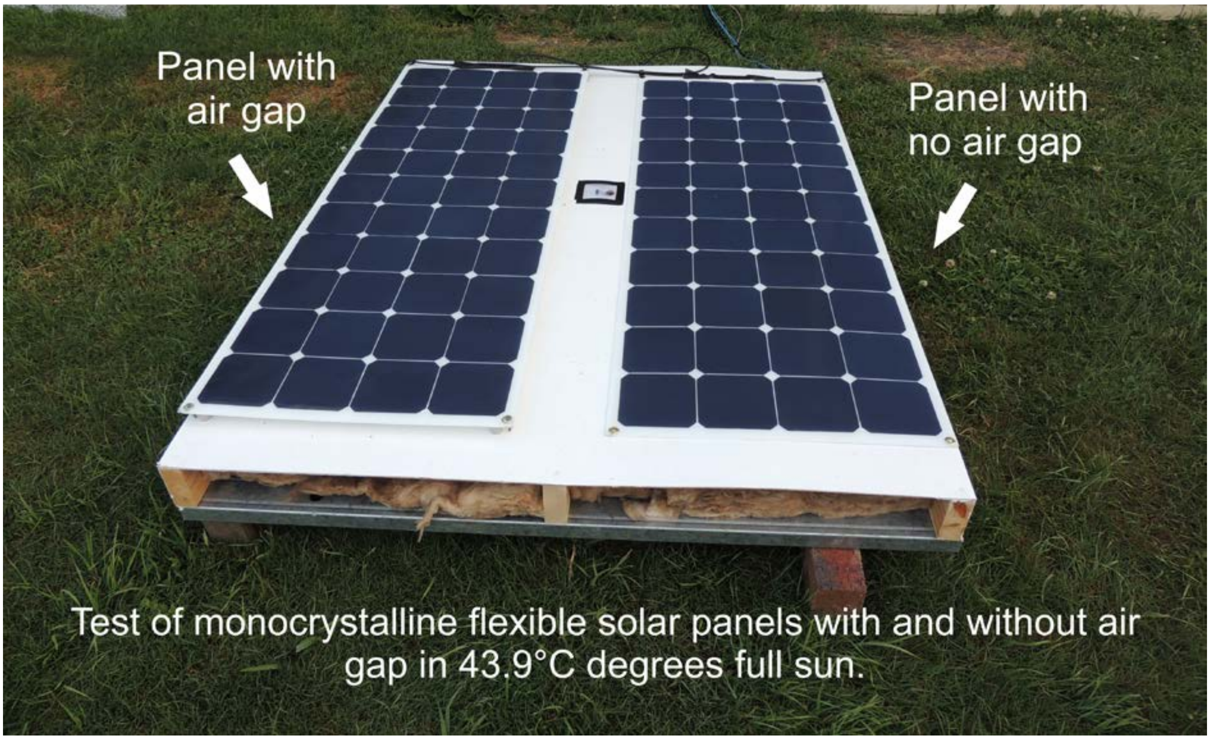
Synopsis

PV Panels are typically installed with an air gap underneath, so that natural air flow dissipates heat. However, Monocrystalline semi-flexible panels are intended to be mounted to an underlying solid surface using polyurethane adhesive which results in higher module temperature.

Prior to offering the panels for sale to customers, Solar 4 RVs conducted testing with two identical flexible panels mounted next to each other directly onto a simulated caravan roof; one panel having an air gap underneath and the second with no air gap.

The testing under extreme summer sun with an air temperature approaching 44°C showed the efficiency of the panel with no air gap was reduced by approximately 9% compared to the panel with an air gap. This is an extreme worst case, and normal weather conditions will not result in much or any power loss.   With the sun at a lower elevation later in the day the temperature difference was reduced.

Given that surplus power is typically generated in summer, the reduction in power is not significant and confirms that the semi-flexible panels are suitable for mounting directly onto RV and caravan roofs.



Test of monocrystalline flexible solar panels with and without air gap in 43.9°C degrees full sun.

Report

The flexible solar panels were tested by Solar 4 RVs to confirm their suitability for permanent installation on the roof of an RV.

The performance of a 135W semi- flexible PV panel mounted on the roof of an RV was found to be acceptable under almost the worst case conditions in Australia, ie 43.9°C under full sun.

Two identical panels with 135 W peak power, and SunPower E20 series cells were laid on a white painted plywood with insulation under rated R 3.0 to simulate the PV panels being located on the roof of an RV.

Panel 1 had a 21 mm gap under which was created using plastic stand-offs.

Panel 2 was laid directly onto the plywood.

Multiple calibrated temperature sensing channels, comprising thermistors and analogue to digital converters on an RMS-200 (http://www.remotemonitoringsystems.ca/rms200/) were used, plus several Yoctopuce Temperature sensors. The thermistors and Yoctopuce temperature sensors (http://www.yoctopuce.com/EN/products/usb-environmental-sensors/yocto-temperature) were taped to the underside of the panels. The top surface temperature was measured using an infra-red thermometer.

Each panel was connected via equal length (13.85m) cable to a load comprising two 10 ohm power resistors in parallel, carefully matched so that both panels had a load resistance of 4.97 ohm at 20°C and measured at 5.08 ohm at ~200°C. 0.2 ohm was calculated for the loss due to cable, connectors and an isolating switch.

Under full-sun and the air temperature rising to 43.9°C the maximum surface temperature of Panel 1 was 63°C (air gap under), whilst the top surface temperature of Panel 2 went to at least 83°C (no air-gap under).

Under these conditions the following PV panel voltage and currents were measured:

	PV Panel Voltage Output (V)	Current (A)	Power (W)	Temperature under panel (°C)	Measured Reduction in Performance	Calculated Reduction in Performance based on SunPower specified power temperature coefficient (0.38%/°C)
Panel 1 (with air gap)	23.6	4.5	105	54		
Panel 2 (no air gap)	22.6	4.3	96	78	8.6%	9.1%

Comparing the two panels, Panel 2 has approximately 9% lower power output which agrees with the predicted reduction using SunPower's power temperature coefficient of 0.38%/°C. Under full sun conditions, it would be expected that excess solar power is available, thus this reduction in power is not significant. Under milder temperatures the reduction will be reduced.

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