Solar Deck Canopy – How Well Does It Let Light Though During Winter?

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We had a solar heat gain problem on in the master bedroom – too warm to sleep at night during the summer. The "south" wall (it actually faces SSW) is very exposed to the sun, and the charcoal gray siding absorbs plenty of heat on the outside of the bedroom wall. The other end of that same wall stays much cooler – it has a second-story deck (which shades the lower story) with a deck canopy made of SunTuf panels to shade the deck and the upstairs wall (the kitchen). The house overhang is 3 feet wide, and the canopy adds another 6 feet of somewhat translucent material, for a total of 9 feet of "overhang".

The master bedroom, upstairs on far right, benefits from sunlight in the winter. But in the summer, it gets hot and stays hot even when we'd like to sleep.
The SunTuf canopy, upstairs on left, shades the kitchen and outdoor eating area on the deck.

The solution to the heat gain in the bedroom was simple – extend the deck to shade the lower story, and add a deck canopy to shade the upper wall (bedroom). By making the new deck canopy from solar panels, we could add capacity to our PV system[1] and get the shading at the same time – a double win[2].

The remaining concern was the winter months – would the bedroom be too dark (and therefore gloomy) in the low-lighting conditions of a Pacific Northwest winter?

[1] PV is short for photovoltaic, meaning something which generates electricity from light. We have a solar PV system, installed in late 2009, on the roof of the house. It was designed electrically to accommodate the addition of more panels at a later date. Other homeowners may find that a deck or patio canopy is an easy way to begin a PV system.
[2] Design considerations for the PV canopy are a topic for a separate article.

SunTuf Solar Gray polycarbonate panels transmit about 35% of the incident light. Our panels are mounted on a open-frame wooden structure painted white. Esthetically the kitchen didn't seem gloomy in winter, so we used the lighting conditions under the SunTuf canopy as a baseline for acceptable performance.

However, solar PV panels are not spec'd for light transmission – they are, of course, intended to absorb the light and turn it into electricity. So we had to figure that out for ourselves. Armed with a C.E.M. DT-1301 light meter and a digital camera, we visited the Northwest Solar Expo (Portland, OR), the Solar Fest (Shoreline, WA), and various Home Shows (Seattle, WA, Tacoma, WA). We took photos of and light readings through any display of PV panels which we could safely stand behind or under. Finally we decided that if we chose panels which had some "white space" between the PV cells, the light transmission would be acceptable. The light loss during the winter would be more than offset by the major gain of a cooler bedroom during the summer.

Underside of Solar World SunModule 255 Mono panels, showing "white space" around PV cells within the panels.
The PV-module electrical cables seen here were not yet connected at the time of the photo.

After looking at various solar-cover structures and weighing the merits of building a wood structure to approximately match the existing SunTuf canopy, we selected an aluminum deck canopy structure from American Patio Covers. Our PV panels are 31mm thick, the same thickness as one of the polycarbonate canopy choices from American Patio, meaning that there is little deviation from the typical canopy installation procedure.

Putting the finishing touches on the canopy structure and PV panel installation (right side of photo). The SunTuf canopy is on the left side of the photo, over the railing replacement work.

The structure and panels were installed in December 2011. Working in the winter isn't ideal, but it gave us an immediate sense of winter lighting on the deck and in the bedroom.

Underside of Solar World SunModule 255 Mono panels, showing the translucent polycarbonate spacer between the house eave and the near edge of the PV panels.
The PV-module electrical cables seen here are connected to the micro-inverters.

	*Finished canopy, just waiting for some outdoor furniture…*

After 6 weeks, we are very happy with the amount of light which we get on the new deck and inside the bedroom. We got out our light meter an took more readings – during January 2012, the deck under the solar PV canopy had 35% MORE light than the other end of the deck under the SunTuf Solar Gray canopy. So, no, a properly designed deck canopy made from solar cells does not make the interior of the house dark!

For those of you who like details, there are explanations and charts of actual light measurements following the bird photo.

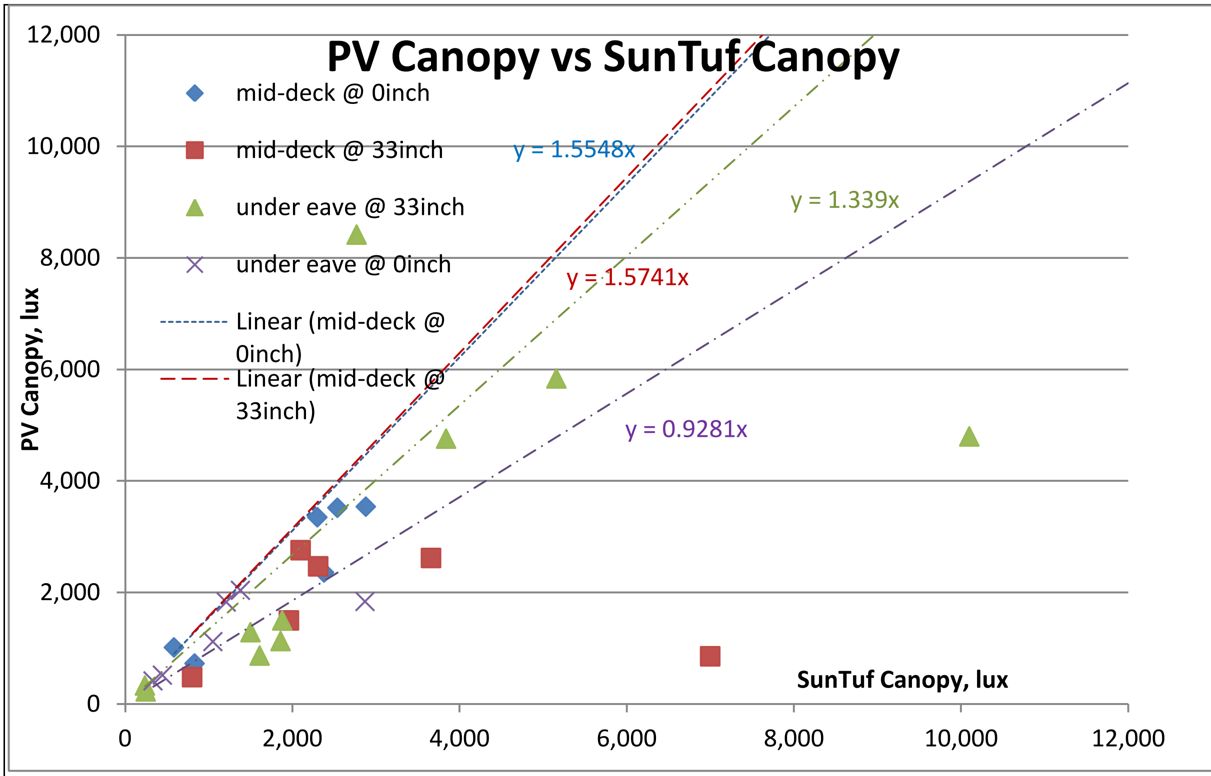
	*The hummingbird feeder is hung, and …*

"King Henry", our dominant male Anna's Hummingbird, approves of the new installation, although he wasn't too happy about the disruption during construction.

Measuring Winter Performance

Beginning in November, 2011, we measured light levels at six positions on the deck: two under open sky, two under the SunTuf canopy, and two under the location of the PV canopy (some of these were taken before canopy installation). Three positions were midway between the house siding and the deck rail, while the other three were near the house. Each position was measured twice, once directly on the decking and once at picnic-table height.

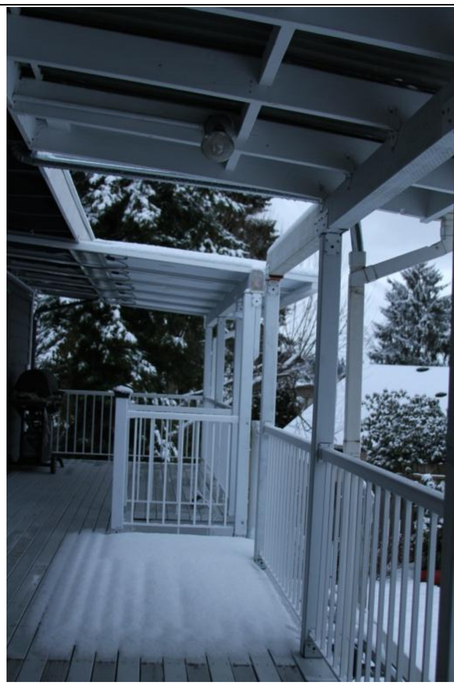
The results were partly as expected, and partly surprising. When we plotted readings taken under the PV canopy against the matching readings from under the SunTuf canopy, we found that under normal winter conditions, we actually have about 35% MORE light under the PV canopy.



Plotting the data at various observation locations shows the deck under the PV canopy has, on average, 36% more light than under the SunTuf Canopy.

Even more surprising, on those five days in January 2012 when both canopies were covered with 5+ inches of snow[3], the lighting difference between the area under the PV canopy and the area under the SunTuf was even more pronounced – more than 40%.

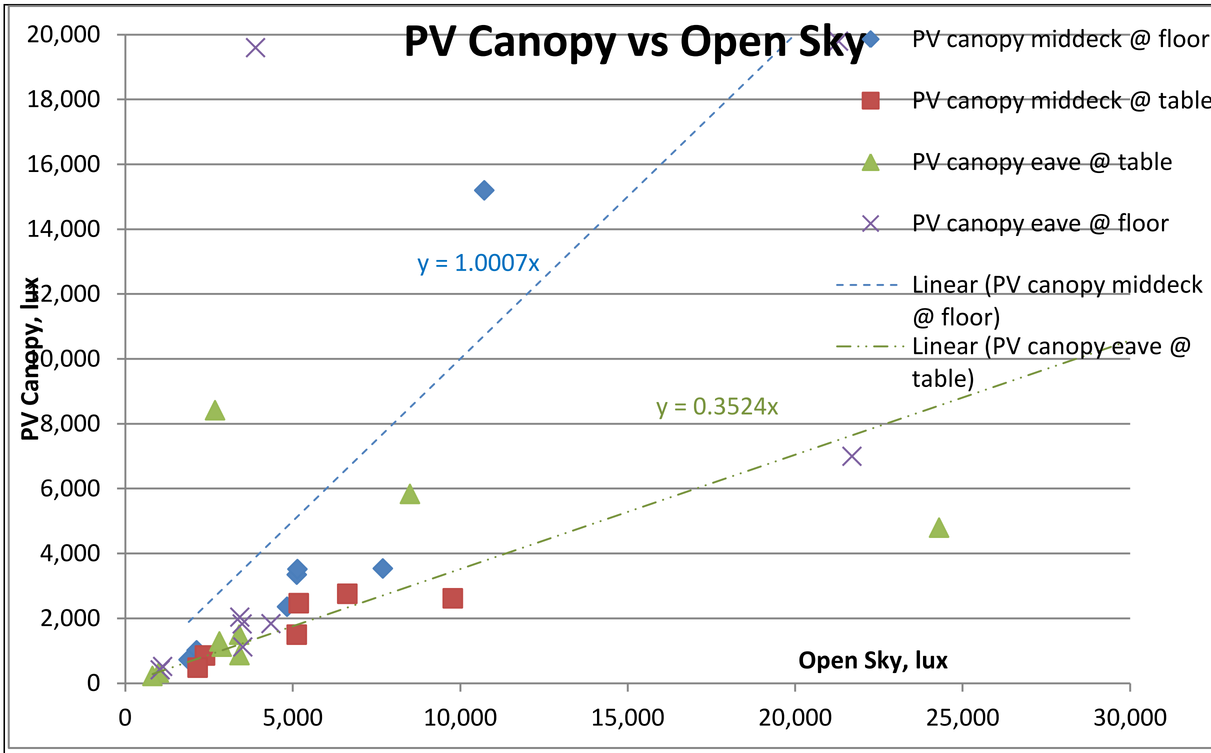
[3] Remember the calculations for a completely opaque canopy? The snow gave us just that – no light transmitted through the canopy, and no electricity output from the PV panels, either.

	The Big Snow of January 2012 – standing under the SunTuf canopy, we can see the lighter conditions under the PV canopy.

The good low-light performance of the PV canopy can be attributed to several factors: 1) because the PV panels are 5.5 feet long, we needed to add a spacer so this canopy would match the 6-foot width of the SunTuf canopy. We used 31mm 3-layer, polycarbonate from American Patio Covers, and put the spacer between the house eave trim and the PV panels. 2) The underside of the PV panels is light-colored and smooth, so they reflect more ambient light onto the deck than do the wavy gray underside of the SunTuf panels[4]. 3) The dark, smooth top surface of the PV panels and their sunlight-absorbing characteristic meant that the snow melted off the PV canopy a full day before it melted off the SunTuf canopy. One additional note: While the snow cover darkens the area under the PV panels a little, it has a more pronounced effect on the SunTuf canopy area, increasing the perception of gloomy darkness under the SunTuf canopy in addition to the actual measured results of less light.

We also revisited the question of how much light is transmitted through the PV canopy.

[4] The combination of a light-colored deck surface and a smooth, light-colored underside of the canopy is called a "light shelf" by architects.



Under low light conditions, in the dimmest location measured (table height against the house siding under the eave), the PV canopy "transmits" about 35% of the incident light. However, the mid-deck floor readings (blue diamonds on the graph) show "transmission" of quite a bit more.

The graph shows that the absolute worst case – low winter lighting and dimmest location, the PV canopy "transmits" about 35% of the incident light, essentially equivalent to the SunTuf Solar Gray polycarbonate. Other locations, notably the mid-deck floor-level readings show higher numbers. I say "transmits" in quotes because these readings get both transmitted light and the light reflected off the deck surface and underside of the canopy.

Professionals on this project

Electrical design: Amy F Heidner, PE

Structural analysis: Dibble Engineers, Kirkland, WA

Canopy structure and installation: American Patio Covers, Marysville, WA

Electrical work: Northwest Sound Electric, Woodinville, WA

Homeowners (analysis, manual labor, contractor supervision): Dennis Heidner, Amy Heidner