My better sun mirrors

By 11.30 reflected sunlight floods into the patio.

In my blog post "Mirrors to reflect the sun" I described sun mirrors I put up to reflect winter sunlight to warm my house in NSW, Australia. They were just sheets of cooking foil taped to a north-facing courtyard wall, and I had to remove them each summer.

Now I have better and stronger mirrors: hinged panels that function winter and summer. In winter they reflect sunlight, and in summer they give shade.

These simple hinged mirror panels should improve the indoor climate due to my "Heat Control Courtyard". Compared to heliostats (see links in a Note below) they are cheaper and will not set the house on fire!

Materials

The mirror panels

I bought the mirror panels from builders supplies as "FoilBoard insulation panels", 2440 mm X 1220 mm X 20 mm.

These are "aluminium composite bonded panels (ACP)" of rigid cellular expanded polystyrene (EPS) (20 mm) bonded between two layers of aluminium (less than 0.5 mm). One aluminium surface has 97% reflectance; the other is pre-finished in shades of green using a fluoropolymer resin paint system. [Cost of five panels: $230.]

Framing

The fragile FoilBoard insulation panels had to be stiffened with frames of aluminium angle, corner brackets, and braces of aluminium strip. [Cost: $380.]

Hinges

I had the panels mounted on ten "hinges" that allow them to be held in two positions:

(A) flush against the courtyard wall to reflect the sun to the house in winter, or

(B) raised above horizontal to provide shade in summer.

These are standard hardware items called "Whitco Window Stays". [Cost for ten: $430.] Here, they operate as hinges, using friction to secure the mirror panels at any angle. [I must thank my builder, Keith Freeman, for selecting and using them in this way.]

Schedule

Work on the new sun mirror panels began on 1 December 2019 and ended on 24 January 2020. Labour cost about $1800, while materials (given above) cost about $1050.

As soon as the work was done, I set the mirrors to provide summer shade until the end of February 2020. Then I re-set them to reflect winter sunshine until now (2 September 2020).

The finished mirror panels

Photo dates

Because the effect of the mirror panels depends on the seasonal path of the sun, I took separate sets of photos in June, to represent the eight winter months (March to October) when they acted as mirrors and in February, to represent the four summer months (November to February) when they acted as shades. Photos of hinge details were taken in February.

Hinge details

These window-stay hinges are set to support both panels to give summer shade.

These window-stay hinges are set to support panels for winter warmth on the left, and for summer shade on the right.

The first photo shows how the hinges made of Whitco window stays support the panels when all are raised for shade in summer.

I posed the second photo to show the difference in the hinge action between winter and summer. One can see how the top part of the stay extends well above the right panel when it is raised to form a shade. On the left, the top part of the stay is flush with the top edge of the panel that hangs down against the wall to reflect sunshine in winter.

Winter photos (June 2020)

By 10 am in winter early sunlight enters and is reflected in the courtyard.

By 11.30 reflected sunlight floods into the patio.

By 12.35 reflected light spreads over the floors of the patio and nearby courtyard, and the laundry wall.

By 1.45 all the floor of the east courtyard and the patio, and the lower wall of the bedroom are lit.

By 2.50 sun is reflected to the whole bedroom wall and the mulched soil, but not the path.

In these photos, areas lit by reflected sunlight are not as bright as those lit directly. Although 97% of the light is reflected, it is widely scattered by wrinkles in the aluminium.

Direct sunlight enters the courtyard for only part of each winter day, and part of the yard would never see the sun. These five winter photos are taken in sequence from 10:00 am to 2:50 pm. Little sun enters earlier or later in the day. The daily pattern is much the same in each month from March to October, despite the sun being lower and the day being shorter in mid-winter.

Summer photos (February 2020)

Panels, when raised in summer, shade the courtyard wall and path.

Panels set for summer shade reflect the sun to the southern sky.

As shown, when raised in summer, the panels shade the courtyard wall and half of the concrete path. The patio also has awnings set to shade it each summer.

The second photo shows that the aluminium mirror surface faces upward in summer. It sends unwanted summer sunshine back into the southern sky. I chose the slope of the raised panels so that glare would not annoy neighbours.

Operation

The panels have functioned without problems through seven months, mainly in the "down" setting (to reflect winter sun).

In step with other features of the solar-passive house, I change from the winter "down" setting to the summer "up" setting at the end of February, and the reverse at the end of October. These scheduled changes require care to avoid stressing the friction hinges. At some other times, the panels must be adjusted because they drift away from their seasonal settings. When they are "up" they drift down, mainly due to the weight of rain-water. Surprisingly, they also drift away from their "down" setting against the wall, due to the weight of the panel affecting the hinge.

If storms are likely, I protect the panels from wind and hail damage by setting them flush against the wall.

The hinges can bear a load of 12.3 kg. That is far more than the weight of a polystyrene panel (1.2 kg) but loads due to wind can be higher.

Reflective area

To fit, the new panels have been trimmed to 2310 mm X 1210 mm. With one panel further trimmed by 660 mm X 180 mm to clear a post, the total area of mirror surface is 13.9 m^2. The aluminium cooking foil used in the earlier trials had the smaller area of 11.3 m^2 for the winters of 2017 and 2018, and only 3.6 m^2 for the winter of 2016. No mirrors were installed during winter 2019.

Temperature data

I began to collect comprehensive temperature data on the operation of the courtyard five years ago, in November 2015. I tabulated daily maximum and minimum values for a dozen thermometers: in the courtyard, in the soils and in the house. Some are shielded in Gill screens. Readings can be related to the seasonal settings of the mirrors and of other features of the house, and whether the solid courtyard gates were open or closed (alternate months). From 5 November 2019, the heat pump of a Sanden Hot Water Service has been cooling the air in the courtyard near mid-day.

My solar-passive house

These mirror panels are part of recent experiments aimed at making my house more comfortable by absorbing heat in winter and rejecting heat in summer. This modest house, built to a solar-passive design in 1988, has achieved comfort with very low energy use. The page in this blog "Climate by Surly/Indoor Climate/My House Page" gives details of the design and operation of the house, and its performance as shown by temperatures recorded over 20 years.

Notes

Heliostats: mirrors that track the sun

I don't think my courtyard needs mirrors that are heliostats that will track the sun, like the ones described in these links:

A long-running DIY project.
A town in Norway now gets sun.
Another DIY project.
A Sydney high-rise steals more sun.