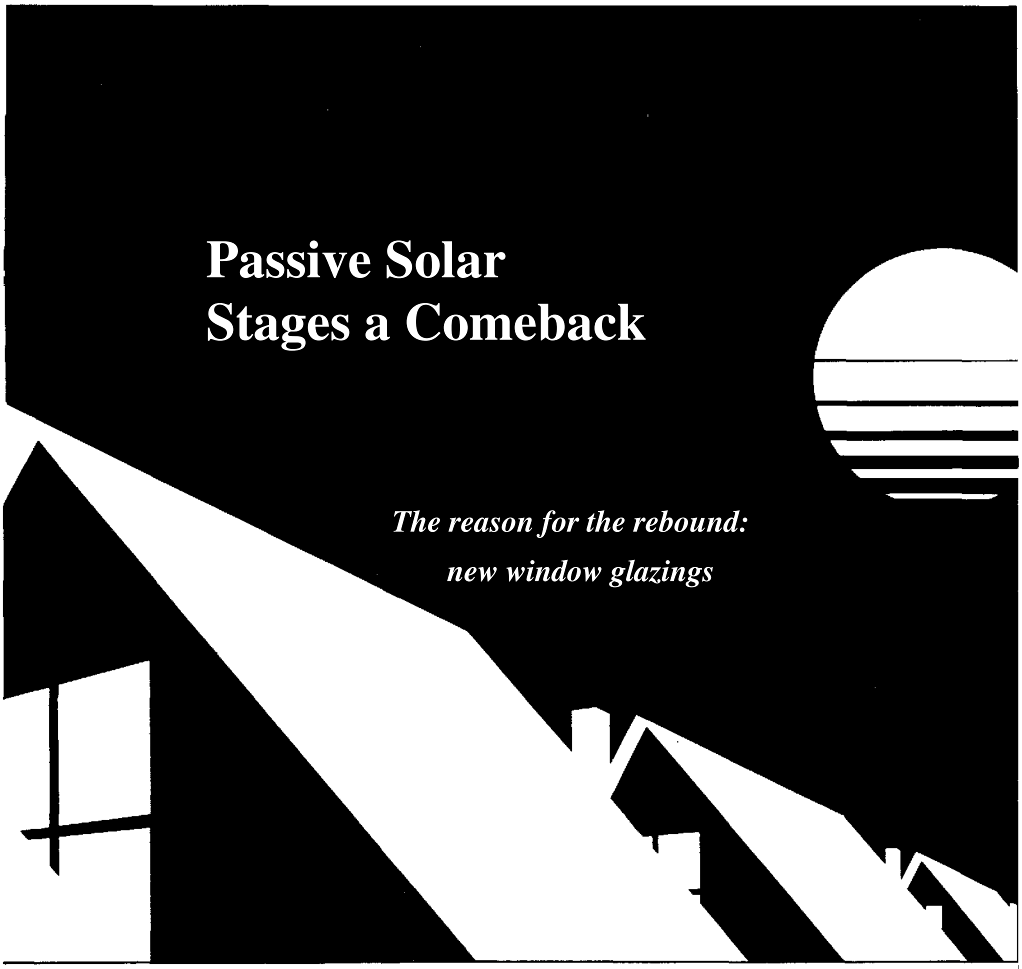
Passive Solar Stages a Comeback

The reason for the rebound: new window glazings



by Harris Hyman

I look at solar-heated buildings as belonging to several "generations," or design eras. The first-generation buildings were outright experiments conducted prior to 1974: the Thomaston Solaris system, the Trombe-Michel house, the four Hottle systems developed by the Massachusetts Institute of Technology, and similar projects.

The second generation began after the OPEC meeting of 1973 and attracted serious adherents who sat in the gas lines of 1974 thinking things over. (I was one of them.) Second-generation buildings were serious efforts at doing *something* to help with a worldwide energy crisis.

The buildings constructed during this time were a wonderful combination of folk art and heavy science, often in the same building. People such as Doug Balcomb, with his infinite number of Los Alamos computers, and Lee Butler, with his magic convection loops (remember them?), claimed to have *the* solution. It was a fun time in construction and design, with everybody on the cutting edge testing, scheming, computing, arguing and working.

The Impact of Superinsulation

But, like most parties, it ended abruptly; in this case, it ended in the '80s with the introduction of the superinsulated house.

The big lessons of the second generation were the importance of the efficient use of sunshine and the need for heat storage to protect against overheating. But heat-storing capacity was clumsy and expensive, and it involved some features many home owners consider undesirable, such as bottles of water in front of windows or masonry floors in the bedroom. The superinsulated house solved the heat-storage problem by creating a structure with such a low heating load that the furnace could be eliminated, and it really didn't matter where the fuel came from.

Notwithstanding some rather severe measures to achieve three-digit R-values, and some complex experiments on how to seal out infiltration and moisture, superinsulation made a lot of sense and was easy to understand: just cut down on heat loss. It appealed to both the contractor and the home owner, because buildings still looked the same and were built the same way. *This* was the solution.

In 1981, a study by the National Association of Home Builders (NAHB) on the effects of south-facing glass helped to justify superinsulation even more. The report described a number of computer simulations in which well-insulated houses were analyzed with varying amounts of south-facing glass. The computer experiments showed that the overall seasonal energy demand did not vary much with different amounts of south glazing. This conclusion was somewhat out of line with the findings of computer experiments at Los Alamos, which came out much more in favor of conservation than solar systems, but it was completely in keeping with the real-life experiences of several houses constructed in New England.

Both the experiments and the principle behind the superinsulated house indicated the same thing: it simply doesn't matter how much south-facing glass you have. What a break for builders and developers! No more worrying about solar orientation and thermal mass; houses could look like houses *should* look, without big expanses of glass.

Finally, at about the end of 1984, the venerable chronicler of the Solar Era, Dr. William Shurcliff, proclaimed solar dead, marking an important step in the evolution of the Superinsulation Era.

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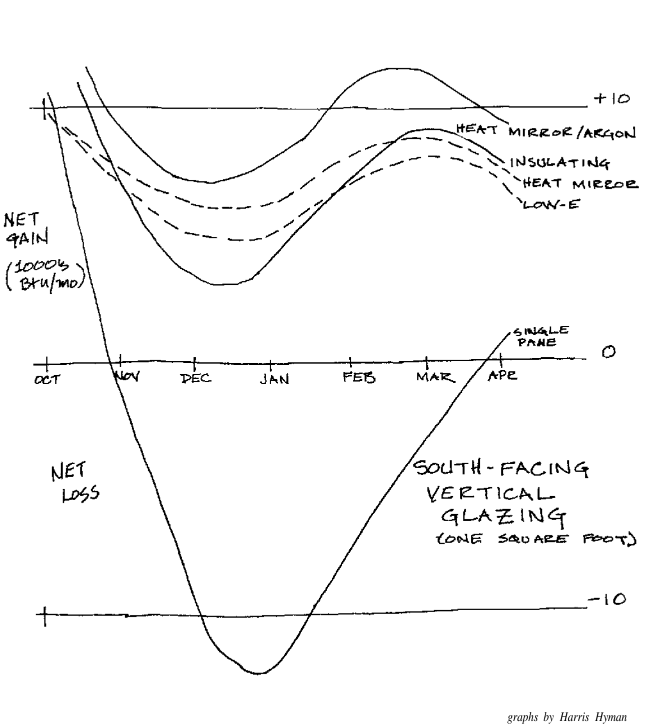


graphs by Harris Hyman

Solar Makes a Comeback

If solar ever *did* die, however, it is about to make a comeback. New window glazings that admit and hold solar heat through the hard months of winter suggest that solar heating will get another look in the years ahead. These glazings have far more even performance than ordinary insulating glass, and they work best during the most severe months.

At the time of Shurcliff's proclamation, I had two projects under construction that involved "Heat Mirror" windows, which finally had made their way into local building-supply stores. These windows give an R-value of 4 or higher while transmitting 54 percent of the incident solar radiation; ordinary insulating glass has an R-value of 1.8 and transmits 81 percent radiation. Heat Mirror allows two-thirds of the radiation with less than half of the heat loss.

Here was a clear advantage. Perhaps the windows could be made larger to pick up some solar heat, making a house both warmer *and* brighter. Maybe Dr. Shurcliff, who almost always is right, had spoken too soon.

Evaluating Window Glazings

I use a concept called "net marginal solar gain" (NMSG) to help me understand what happens with glazing. NMSG is calculated as the solar energy transmitted through *one square foot* of glazing in one month, minus the month's heat loss through the same square foot. It is the *total* overall effect of the window, allowing for radiant heat coming in and heat loss out.

If more heat is lost than gained by the square-foot window, the NMSG is negative, suggesting very small windows; if more heat is gained than lost, the NMSG is positive, and it might be a good idea to increase the glazing. If it is *too* positive, however, the sun becomes a burden.

The NMSG depends on the orientation of the window, the latitude and climate of the area, and the time of year. It drops in the winter and rises in the spring, and it is much higher for south-facing windows than for windows facing north. And it is higher in warmer, sunny places. The same building design on two different sites can have radically different NMSGs for the same windows.

Look at the first graph of NMSG over the heating season. This graph shows the effect of a vertical, south window with several different glazings. The vertical scale shows thousands of Btu lost or gained from each square foot over the month. The middle line is zero, which is the break-even point between heat loss and gain.

The lowest curve is for single glazing. This window gains a lot of heat in October and loses *lots* of heat from November to April. The next curve up is double insulating glass, which gains heat throughout the season, but not very much in December and January.

The new glazings—Heat Mirror and low-emissivity glass—are shown as dashed curves. These curves are flatter, as the glazings have the same gain in warmer months but substantially more gain in cold months. Heat Mirror is a somewhat better performer, with *double* the NMSG of ordinary insulating glass during the very cold months.

The top curve is for double-glass Heat Mirror filled with argon gas instead of air. This is a somewhat exotic glazing that is just coming onto the market. The "paper" performance of this glazing is quite spectacular, but its true, long-term performance will not be known for several years.

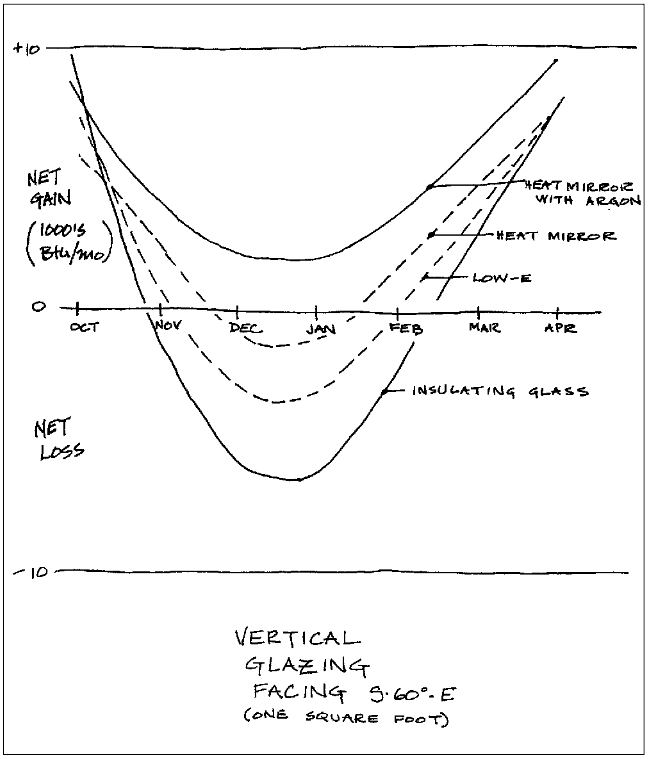
The first graph shows the effects of south-facing glass. When the building is turned 60 degrees east of south, the exotic glazings get better and better, as indicated by the second graph.

Insulating glass at this orientation loses heat for most of the season, and Heat Mirror almost breaks even during the middle of winter. But Heat Mirror with argon gains heat all through the season, even facing this far to the east. There are some interesting prospects here for solar design.

An even more exotic glazing uses two layers of glass with two internal layers of Heat Mirror and an argon fill to get reputed R-values of about 9. This glazing really is not much different in overall performance from the much less expensive low-E glazing; the increased R-value is offset by the lower solar transmission, which is about 39 percent.

(Incidentally, these graphs are plotted to coincide with the climate on the coast of Maine. More sunshine shifts the curves up, more cold shifts them down.)

The newer windows reduce the total heat demands of a residence by another 20 percent or so. Lower heating requirements such as these cry out for a lower-intensity heat source—and solar is available to answer the call. So, Dr. Shurcliff, in the not-too-distant future, we once again may find ourselves shifting toward the sun in our quest for the ideal conservation/solar mix. ■



The newer windows significantly reduce the total heat demands of a residence. These lower heating requirements cry out for a lower-intensity heat source—and solar is there to answer the call.

Harris Hyman is a "rural G.P. engineer" in Lamoine, Maine.