THE 100% SOLAR HEATED HOME

By Paul Shippee

On a clear sunny day in Southern Colorado the sky is turquoise and there is enough solar radiation falling on your home to supply all your domestic energy needs.

To examine the feasibility of a 100% solar heated home, we'll focus here on how to achieve that for your space heating needs and hot water supply, leaving aside solar electric for now.

The south side opens up to the sun in this Sunspace passive solar design.

While it is possible to supply 100% of your heat energy needs with solar, conventional economics says this is not feasible. However, "conventional economics" has been famously termed by radical economist Hazel Henderson as a form of brain damage. To me, this statement has been an invitation to think outside the box and approach solar design as an innovative art, to design with an expansive mind and practical skills applied to architecture.

The economic feasibility question has to do with the problem of laying out extra money (or financing) for the extra solar collectors to get you to 100% solar heating during the two coldest months of the year, then they sit idle for the other ten months, unused and not needed. Therefore, one is advised to provide only 70% solar heating fraction, with the remaining 30% supplied by fossil fuel. While this is reasonable when narrowly applied to solar "equipment" (i.e., active systems), it does not strictly apply to passive solar homes where the building itself is a solar collection and thermal storage system, as well as displaying attractive architectural features.

The basic principles of solar home design are quite simple, cost effective, and can be arranged in architecturally pleasing ways. These principles require solar designers to pay close attention to a few basics:

- The siting, shape, and orientation of the home
- The quantities of heat loss from walls, windows, roof, floors, and unsealed cracks
- The selection from a variety of passive solar system types that allow solar warmth and heat to naturally enter the building
- The type and quantity of thermal mass used to store the daytime solar heat collected for night time use, without overheating the rooms during the day
- The type and effectiveness of moveable insulation or thermal shades employed as night insulation on large south-facing windows

To these passive solar building components can then be added considerations for active solar thermal equipment: flat plate collectors, pumps, controls, piping, heat exchangers, thermal storage tanks, etc. These "active" components can supplement the passive solar heat supply and provide domestic hot water year round. Solar collectors are typically mounted on the roof, or on the ground near the home, and tilted at an angle to optimize winter and summer heating needs. They can utilize either plain water, anti-freeze liquid, or air as the heat transport medium.

Here are some solar heating and energy conservation design guidelines for the Colorado climate, including an emphasis on the two keys to passive solar design: large volumes of ***thermal mass***, and ***night insulation*** for large south windows. These are qualitative and general guidelines. For specific rules of thumb and engineering quantitative numbers please consult my CRESTONE SOLAR SCHOOL website: http://www.crestonesolarschool.com

Siting, Shape, and Orientation

The optimal house shape will generally be twice as long as it is wide, with the long side facing solar south (or a few degrees east of south) with no shading obstructions year round to block solar rays.

House Heat Losses

It is usually 2-3 times more cost effective to prevent excessive heat loss, by providing good insulation (high R value), rather than to provide extra solar gain. Low E glass should be used on the smaller north, east and west windows, but not on large south-facing windows. Sealing all building cracks is good energy conservation practice. As opposed to burning fuels, you pay only once for insulation and it works beautifully for you year after year.

Tall containers of water serve as thermal mass heat storage in this open design solar home.

An interior adobe wall absorbs solar warmth, reduces daytime overheating, and releases heat slowly during winter nights.

Passive Solar Types

There are four basic passive system types; direct gain, water wall, Trombe wall, and sunspace. These are all techniques for using the building as a solar collector. *Direct gain* simply lets the sun shine in through large south windows. Overheating and fading fabrics are a liability here unless heat storage, also known as thermal mass, is provided.

To block some of the intense direct gain sun, heavy, dense materials **(thermal mass) can be placed behind south-facing glass to absorb the** materials like adobe, concrete, or rammed earth can be used in various configurations to make a *Trombe wall*. An attractive indoor climate -a *sunspace* or food and heat producing greenhouse- can be created by placing the thermal mass materials several feet away from the solar glass.

Thermal Mass

Thermal mass can be used in innovative ways – rammed earth interior wall molded into an attractive arch doorway.

The function of heavy thermal mass materials (water or earth) placed inside the building is to moderate day-night temperature swings, and to store daytime solar heat gain for slow release on cold winter nights. However, most people are skeptical and are surprised to learn how much thermal mass heat storage is actually passive solar home system that approaches 100% solar heating fraction. (Again, consult my website for engineering numbers and quantitative rules of thumb.) Consider this question: how much is it worth to you to eliminate the use of high-energy fossil fuels (oil, gas, electricity, coal) for your low-energy, low-temperature home heating and hot water needs? A general rule I like to consider is: you can't have too much thermal mass. Everything has its price, and life-cycle cost/benefit analysis should always be used when evaluating solar investments, comparing first cost with long term benefit.

Night Insulation

Moveable insulation placed on large south windows on cold winter nights is the key to obtaining high solar performance in passive solar homes. There are many types of moveable night insulation ranging from foam boards, shutters, the popular and attractive cellular (honeycomb) thermal shades, bubble wrap, blanket layers, draperies, beadwall (see photo), sliding doors, and roman R values ranging from R1 to R20.

Styrofoam beads blown in between south-facing glass panes, spaced 4" apart, provide super insulation, preventing excessive heat loss during winter nights from solar gain windows.

In some solar homes I have designed and built, I've found two different ways that work to approach very close to 100% solar heating; both employ lots of thermal mass for the interior and exterior walls of various configurations. One way is to open up the long south side of the building with windows to solar south, and deploy night insulation there with R 15-20 (e.g., beadwall). This is not easily done but technical innovations will make it a more attractive option in the near future.

The other way is to combine ***passive and active*** solar heating components to make a hybrid system, using easily available R 4-5 night insulation such as thermal shades. In this system, passive south windows let in sunshine, while roof-mounted collectors actively pump solar heated water directly into pipes embedded in a thick radiant floor slab, from which heat is released slowly into rooms at night. This active system is highly efficient because the low, low operating temperatures of a floor slab allow the roof collectors to maximize their operating efficiency by running cooler. Domestic hot water can then be heated as a parallel circuit off the main radiant floor thermal system. For a schematic diagram of this system please consult my website: http://www.crestonesolarschool.com