A 100% Solar Heated Home

In the Fall of 2010, Paul Shippee of Colorado Sunworks and the Crestone Solar School http://www.crestonesolarschool.com designed and installed an eight-panel active thermal system on a new home in Salida, Colorado. The homeowners are the Rebecca Owens family and the building contractor/architectural designer was Steve Holmes. The complete solar system is designed to provide 100% of the space heating and hot water and most of the electricity usage.

Paul also designed the interior and exterior passive solar elements of this home including a generous and attractive SunSpace greenhouse on the south side featuring water-white (no iron) glass, super-insulation all around, radiant floor solar heating, lots of interior thermal mass in the form of attractive adobe walls, concrete floor, earth berming up to the eaves (no windows) on the entire north side, and triple low-E glazing on modest sized west and east windows. All these features – passive solar, active solar, and plenty of energy-conserving features - combine to deliver a comfortable fossil fuel-free winter heating performance as well as comfortably cool summer temperatures.

In a recent interview Paul answered some solar related questions:

Q: How do you design a home to be 100% solar heated?

PS: Well, the sun does the heating. You just have to place a building in its path that has the optimum balance of solar collection, thermal mass heat storage, orientation to the sun, and rather high insulation levels for this cold Rocky Mountain winter climate, that fortunately has lots of sunshine. Working with Rebecca and her mother was such a pleasure during the home design stage. They might be the first clients I have worked with who were willing and able to implement all the passive solar design details and insulation suggestions that I asked for. This included plenty of south facing windows of clear glass, lots of properly-sized interior thermal mass, very conservative insulation levels like R55 in the ceilings and R20+ walls that were also mostly earth-bermed. This home combines both passive and active solar heating to achieve 100% with no need for fossil fuel consumption. An efficient central wood-burning stove was included to add an edge of comfort during those brief cold cloudy spells in Salida winters. I consider wood to be a non-fossil solar energy resource.

Q: Can you describe in more detail some of the main solar features of this home?

PS: Sure. From the Salida home photo you can see the four solar targets incorporated into this powerful performing solar home. Starting at the rear there is a 3Kw solar electric array (installed by Eco Depot) mounted on a pole on the north side, then eight

Heliodyne 4x8 solar thermal collectors mounted on the reverse slope roof, then a row of clerestory windows that bring winter sun into the north side of the interior, then at the front (south side) a handsome embedded SunSpace with curved water-white glass wall, interior adobe walls and water columns for thermal mass. These four solar targets complete the solar design strategies. Note the three skylight windows in the SunSpace roof to admit a little summer sun to nourish plants when the sun is high in the sky. One of the preferences for this spacious subdivision is that the large mechanical solar panels (both thermal and electric) not be visually obtrusive from the road; this requirement determined, in part, the shape of the house rooflines. More details

Q: What was the solar design process like for you?

PS: What I liked best about this solar design process was being involved very early on in the planning. For instance, I was asked to participate in the choosing of the lot to assure good southern exposure. The owners settled on a lot that sloped to the south and this resulted in an ideal situation for earth-berming on the north and west sides, an important energy conservation feature. Then I was fortunately involved in designing the floor plan arrangement with the owner as this is another important aspect of achieving optimal passive solar performance. By a specifying which rooms go where according to the sun's seasonal movements across the sky we gave consideration to winter heating, summer cooling, energy conservation and the needs and preferences of the owner's lifestyle choices.

Q: Anything else about the design process you would like to add?

PS: Well, another enjoyable aspect of the design process for me was the teamwork that evolved. After the owner understood all the

floor plan options with respect to passive solar and energy conservation features to be obtained by shrewd and knowledgeable room placements, then the builder, Steve Holmes, was brought in to add his construction knowledge and his considerable aesthetic expertise. Steve helped to determine the rooflines and finalize all the many details to coordinate building needs and solar requirements into the construction plans that he drew up. It was a great pleasure for me to work as part of this team where we all learned something from each other.

Q: How is the house performing?

PS: The first news that things were working well was last January and February when the carpenters exclaimed this was the warmest house they ever worked in; and this was with doors open a lot of the time to air out the dust. They commented that the temperatures never dropped below about 64 degrees with no backup heat being used. This was confirmed by the owner during the first few cold spells of this fall.

Q: What about the cost for all this superior performance?

PS: Well, this is a high-end beautiful home nestled into a south-facing hillside overlooking a small sweeping valley with amazing mountain views in all directions. So, the owners were willing to spend the money to get good quality all around. Fortunately, the investment they made in all the various solar and energy conservation features will easily pay off nicely in fuel savings for decades to come. So, perhaps it is best to look at the money spent as investment rather than cost. It's probably one of the best places to put your money these days. Plus they qualified for hefty rebates and tax credits, financial incentives for both the solar thermal and solar electric…in the range of 30% effective discount all around.

Q: Do you have any advice, basic information or general guidelines to help others approach the design of a solar home?

PS: Yes, here is a list of things to consider when planning your new solar home. Some of these may also apply to retrofit projects as well:

1. *Floor plan*. Solar heating should be well considered early on in the design phase. Expert solar consultation at this phase is worth hiring.

2. *Percent solar vs. back up heating*. Consider whether you want 30%, 50%, 70% or 100% solar contribution, and also carefully choose an appropriate backup heat source.

3. *Budget:* how much are you willing to pay up front in order to secure energy cost savings into the future. Compare this investment with the risk and return of other investment options.

4. *Insulation levels*. It is said that one dollar spent on energy conservation measures saves $3-5 on solar electric or thermal equipment. This applies up to some level of diminishing returns for added insulation and very expensive appliances.

5. *Windows*. The type and placement of windows, as well as the deployment of night insulation on these windows, is a high priority concern to reduce heat loss.

6. *SunSpace*. Do you want to grow food or plants and provide a tropical winter environment attached to your home by adding a south room that will mitigate heat loss and add pleasure and comfort bathed in the joys of winter sunshine?

7. *Passive solar/active solar*. Your house can act as a solar collector with windows placed on the south side. Some homes do well with just this much technology. Adding solar thermal collectors on the roof, or on the ground, can pump warm water into a radiant floor distribution system.

8. *Heat distribution*. A radiant floor solar heat distribution system is the most efficient application of solar thermal collectors.

9. *Ventilation*. When you seal up a house to make a tight envelope with no heat-robbing air leaks then you lose the benefit of needed fresh air. Installing a heat recovery ventilation system costs extra but recovers the heat from outgoing stale air while providing warm fresh incoming air.

10. *Cooling*. Air-conditioners are rarely needed in our Rocky Mountain climate with its cool nights. Passive solar homes can be designed to cool the home by only circulating cool night air and shading windows to keep out summer sun.

If you want to learn more about solar heating and solar electric design applications consider attending the Crestone Solar School http://www.crestonesolarschool.com to gain a thorough working foundation in the principles of solar design.