Solar Home Thoughts

Some folks have asked various questions regarding solar home choices, selection processes, getting started and heat performance. I will try to provide some ideas and caveats around those topics.

I think the starting point in making a decision for a solar home is a commitment to energy cost management. Whether the motive is financial, environmental or some combination of these, the commitment is what will carry one through the confusing process of learning about and selecting from a variety of non-standard building techniques and perhaps altered sense of esthetics.

Currently in Maine real estate sales, solar homes are discounted in the marketplace. In other areas of the country, they bring a premium. This may slowly change due to energy prices. I think the reason solar homes in Maine do not sell as well as they should is one of esthetics. Contemporary home designs of any sort in Maine do not attract buyers as well as the standard cape, colonial, or farmhouse colonial with ell and carriage house. Of course, beauty is in the eye of the beholder, but it doesn't change economic realities. The only way to address this concern, is to build a 'stealth' solar home hidden within one of the more sought after styles. We have spoken with people who have had difficulty obtaining financing when building passive solar homes due to the lender's concerns about resale value. Lenders and insurance companies also shy away from homes without standard central heating systems. Hopefully this becomes less of an issue over time.

If you decide to go ahead with a solar home, know how to find solar south, have chosen a building site with a good southern exposure you can control and so forth, the first step would be to learn about the various approaches to solar construction, decide which are non-starters due to location, materials or climate. I think most people in the northeast will gravitate towards active or passive designs which are buildable with locally available standard construction materials using the building techniques that are mostly familiar to local builders.

Active versus passive solar design is a huge topic. An active design may use external collector panels, blowers, pumps, water reservoir tanks, powered vents, heat pumps, etc. to capture, store, regulate and distribute solar-derived heat. A passive design uses the building structure, materials and format to achieve the same results. Within the passive category, there are sub-categories of direct gain and indirect gain. A purely passive direct gain solar design is much more difficult to implement within a house that looks 'standard' from the outside. A direct gain passive design is only suitable for locations receiving sufficient sunshine in winter. It is a proven, workable design for Central Maine; we live near Farmington, Maine.

After sorting through some of the above issues, we decided on the direct gain passive solar approach. This may not be the right choice for many people, but in our case it is what worked for us. We appreciate the charm of traditional home designs but didn't feel we had to own one. We visited three direct gain passive homes - none of which had a central heating system - whose owner's had lived in them for a number of years. This gave us a chance to ask questions and get a feel for the interior atomosphere of such houses. We initially worked with the solar contractor who designed and or built these homes. That relationship ended after building our 28' x 48' garage the year before we began house construction, due to some trust issues.

Using information and experience gained through the garage construction - which is a bermed passive solar design - and reading many books, articles and online

resources, we set about with our own design process for our house. I have some building experience, did not need bank financing, and had the time to be able to do this. I am not an engineer of any flavor, the concepts are not too complex for the average person to grasp; but you will have to educate yourself a bit. On the other hand, home construction is an expensive and time consumuing undertaking; you get one chance to get it right. If that is beyond your comfort level, it will pay to find and work with an experienced solar contractor or designer.

The overall criteria for our house design were minimal heating costs, single floor living and accessibility, low maintenance and 'right' sizing. We are approaching 60 years of age, so these things begin to be important. I think it is very important that you write down your goals and refer to that list often as you work out a design. Sometimes it is easy to get side tracked or lost in details.

For a direct gain passive solar home, the 'heating system' is made up of south-facing glass, thermal mass, reasonable interior air circulation, moisture control, correct width overhangs, and insulation.

The amount of glass and thermal mass need to be in an approximate balance. Too much south-facing glass and your home will overheat on sunny winter days. Too little south-facing glass will not admit enough sunlight to warm the thermal mass, leaving your house too cool overnight. West and east facing glass will not provide any appreciable winter heat at our latitude, they will make unwanted heat in summer. North facing glass will lose lots of heat in winter, but is fairly neutral in summer months. Our home uses clear, double pane glass on the south side. we have no west or north-facing windows or doors. We have one door angled 20 degrees to the east (from south). On the south wall of our house, we have ten fixed windows that are 46" x 72", four casement windows 24" x 48", and three doors with full glass. Having lived in our house for just over a year, I would say we could have used about 15% less glass area, but sunlight is a highly variable input. There are rules of thumb to use as a guide to selecting the amount of glass needed for a given floor area and thermal mass.

Part of our thermal mass is provided by the earth berms on the north, east and west sides. These berms cover the bottom six feet of those walls. Our interior ceilings are 8 foot 6 inches high. The berms are also a form of insulation. I think they are important although some people have had good results using super insulated double stud walls that are 12 inches or more in width. Your choice to berm or not may depend on your site. Without a southern slope to set your foundation into, it takes an enormous amount of soil to build berms that are high and wide enough. The berms should be at least 16 feet wide before they begin to taper down to grade level. One advantage to bermed concrete exterior walls is the building should never get cold enough to allow pipes to freeze, even without added heat.

Our house uses concrete to provide the more thermally active portion of it's thermal mass. The floor slab is 12 inches thick, the exterior walls are 8 inches thick, poured with standard basement wall forms. We have roughly 60 feet of interior partition concrete walls, also 8 inches thick. The house is 28 feet wide by 88 feet long including an oversized one car garage. All of this concrete means it takes a long time and many BTU's to change the interior temperature of the house.

Our temperature fluctuations range from the mid-60's to mid 70's for the most part. On a sunny day in winter, the temperature can reach 80+ degrees, but in late afternoon shortly before sunset, it will drop quickly back to the mid-70's. This indicates the air was very warm, but the concrete's temperature didn't really change very much. For comfort, we have to use suplemental heat to make up for

cloudy days. On a good day in late December, you can only get about 4-5 hours of direct sunshine in any case. We do not need supplemental heat as long as the days are sunny. There are usually two or three weeks during summer here when fans are needed, and another three to four weeks when fans are nice to have. After a week of hot humid weather, the house is hot and humid.

Direct gain passive homes function better thermally with an open floor plan. I have seen this taken to an extreme, but it isn't necessary. We have completely enclosed bedrooms and bathrooms, those areas do tend to be cooler, winter and summer, than the open living/dining/kitchen area, but for bedrooms at least, that is a plus. Our four casement windows provide sufficient air movement for warm winter days and through summer. A bermed and well sealed house has such a small amount of air infiltration that for any appliance needing air to work; wood burner, gas heater, clothes dryer, bathroom or kitchen exhaust fan, you will need to provide outside make up air and plenty of it. If you are building this style of house, you must plan to provide sufficient outside air. Otherwise, your kitchen exhaust fan will happily pull smoke down your wood burner's chimney.

Our overhangs are 28" wide. This seems to work well for our latitude of 44 deg. No direct sun enters the house around the summer solstice (June 21) and it penetrates 13 feet into the house around the winter solstice (December 21). That is the way it should be. A narrower overhang will allow more sun in during spring and fall, and possibly in mid-summer. A wider overhang will have the opposite effect; there will be a longer period in summer where no direct sunlight enters the building.

Moisture under the slab or against the exterior walls will wick heat away from those structures and is to be avoided at all costs. To combat this below the floor slab, we put a stone drainage bed down first with 4" dia. plastic foundation drain pipes every 15 feet. These pipes take moisture and ground water to the perimeter drain of the frost wall on the south side of the building. The perimeter drain has a 'daylight' outlet down the slope from the house. If radon gas is a concern in your building area, you will also need to put the radon abatement piping in the stone drainage bed and provide riser pipes to bring it up inside an interior wall and eventually through the roof. The gravel bed is covered with three layers of 6 mil black poly. On top of the poly is 2" of extruded styrofoam insulation, the same as is used to insulate basement walls. Above the 2" styrofoam is a half-inch thick layer of a Low-E product called 'slab sheild'. This is a triple layer material that is like very fine/tough bubble wrap with an aluminum foil in the middle layer. Next, half-inch rebar on a 14" square grid. For thicker slabs you may need to special order the rebar stools to get stools of the proper height. The rebar should be near the center of the slab, top to bottom, so for a 12" thick slab, you need a rebar stool height of at least 4-1/2 inches. The PEX tubing for a radiant heat system, if used, would be installed at this point. Next, insulate the slab to be from all vertical concrete walls by glueing 1" thick extruded styrofoam to the vertical walls cut in strips which are equal to to the thickness of the slab. For radon control, this is weak point and you may need to set this stryofoam about 1" below where the finished top of the slab will fall to allow space to seal the slab to vertical wall joint. Finally, pour the concrete slab! The goal is to have the finished slab insulated and sitting high and dry above any ground moisture.

The exterior concrete walls also have three layers of 6 mil black poly draped across the outside from the top of the wall to the bottom of the footer. A perimeter drain in a stone bed is installed after the poly. Last, 2" extruded styrofoam covering the plastic. Backfill with good draining sand two feet thick from the bottom of the wall to the top. All perimeter drain stone should be covered with filter cloth to prevent backfill from washing into the drainage stone

and pipe. This all works to keep moisture off the exterior side of the concrete walls. Finally, there is an apron of 2" styrofoam covered by 6 mil black poly around the perimeter of the house laid at grade level. This apron should be at least 8 feet wide. This apron directs roof water away from the foundation and it prevents frost penetration into the ground near the foundation.

Our supplemental heat is supplied by a soap stone wood burning stove. It looks like we will use 1.5 to 2 cords of firewood this year. We also run oil-filled elecric radiators in our shower bathroom and the end bedroom as needed. These rooms are on the west end of the house and far from the wood burning stove. In cloudy weather they will cool to 63-64 degrees. The heaters are rated at 600 watts and have thermostats to hold a steady temperature. Eventhough we have radiant heat, it is by far cheaper to use the electric heaters in spot areas as needed and allow the rest of the house to fluctuate a bit more. Propane costs $2.56 per gallon currently from our supplier. When our 90,000 btu boiler runs for one hour, that is one gallon of propane or $2.56. Running a 600 watt electric heater continuously for one hour costs (0.6KW X $0.15/KWH = $0.09) nine cents. It's a no brainer, even if the boiler only runs 15 minutes out of each hour that is still $0.63 worth of propane. I don't think I would build a solar heated house without some sort of supplemental system. There will always be several four or five day stretches in the winter where sunshine is very scant. On the other hand, it is clearly not necessary to invest in a central heating system.

The ideas above are meant as food for thought and to share some passive solar experience. I focused on the concrete, moisture, insulation, air flow and window aspects since most of the remaining building techniques are as for any other wood frame house. The interior finish materials applied to the concrete should be masonry types. Ceramic or slate floor tile and plastered concrete walls for example. The concept being to not insulate the interior concrete surfaces from the sunlight that will strike them in winter.

If you have further interests in details or to learn more, these are books I found most helpful. There are many others.

"The Solar House, Passive Heating and Cooling"; Daniel D. Chiras

"The Passive Solar Design And Construction Handbook"; Steven Winter Associates

Active solar heating is a whole other topic of which I have no experience to share. And, there are many other design types for passive solar heating described in various books which may be more suitable in given situations or by personal preference. A primary thought to keep in mind; the experience of living in a passive solar heated home is natural and and variable like nature. It does not rely on, nor does it take advantage of, mechanical systems to control your home's interior environment.