

KEEP ON THE SUNNY SIDE

Lower your utility bills with passive solar techniques

By Jon Allen Gardzelewski and Anthony Denzer

Taking advantage of the sun's heat in sunny and cold Wyoming just makes good old-fashioned sense.

Ever since the early 1940s, architects have understood that a few elementary passive solar building techniques – proper orientation, window placement, and shading – can produce savings of 30-40 percent on heating bills and make your home more comfortable to boot. Passive solar houses use the structure itself – the windows, floors, and walls – to capture and distribute the sun's heat. Whereas an active solar house uses mechanical equipment – usually panels on the roof – to create heat or electricity. In the next issue, we'll offer some tips for active solar systems.

If interested in building a passive solar house, or in remodeling an existing house to use the sun's heat, you should first make investments in energy conservation measures (superinsulation and supertight construction). Conservation measures are the best energy saving investments in most structures. Think of it this way: if outside wearing a shirt on a bitter winter day, you'd want to put on a parka first then go stand in the sun. Think about passive solar only after your house is well-insulated and airtight. After making that initial investment, you can now turn your thoughts to passive solar. Here are some tips from the University of Wyoming's Building Energy Research Group (BERG) to help take advantage of Wyoming's

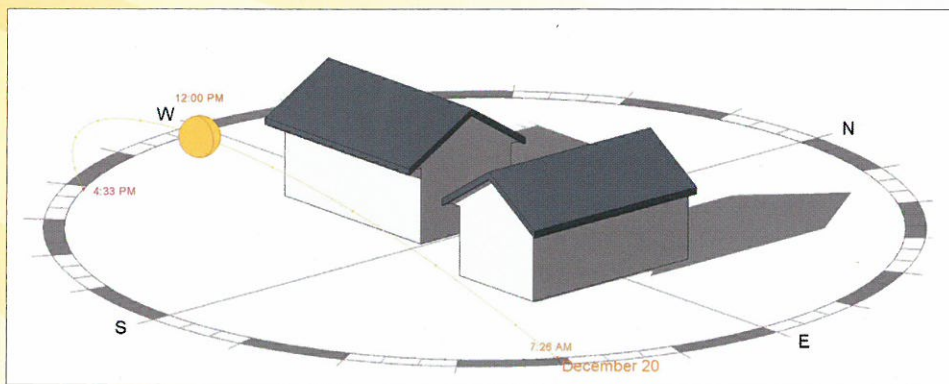


Figure 1: Solar exposure in the wintertime along south-facing walls. An east-west orientation provides the maximum opportunity for solar gain and solar heat penetration into the house.

bountiful solar resource.

DO: Understand solar geometry and windows.

Passive solar heating comes from south-facing windows in winter, so plan your house to be long and narrow, if possible, with all major rooms facing south. For a wide range of angles between southeast and southwest, your windows will capture more solar heat in the winter than they will lose at night. For all other orientations, windows will lose more heat than can be gained because windows are poorly insulated relative to walls.

DON'T: Forget to shade in the summer.

Passive solar houses can overheat if poorly designed. Windows facing south are very easy to shade in the summer with either a roof overhang or horizontal shading devices. Windows facing east or west, however, are nearly impossible to shade

without covering them entirely. With careful analysis, you can determine a shade length that blocks the sun in the summer but not in the winter. Shading length should be optimized by considering all seasons.

DO: Consider both sun and wind

Houses with significant exposure to wind can lose heat just as fast as they gain it from the sun by wind-driven air infiltration. As mentioned, make your house as airtight as possible, but you can take further steps to counter the adverse effect of wind. Locate your garage to block prevailing winter winds without creating snowdrifts that block the doors, and consider planting a windbreak that doesn't interfere with your passive solar strategies. Also consider that windbreaks may create snowdrifts and should be properly located. Rotating your house so the long axis is parallel to the prevailing winter winds works if that wind is coming from the east or west.

DON'T: Treat all four sides the same or use a stock house plan

It's a mistake to place lots of windows on the east, west, and north walls because these will lose more heat than they gain. Triple-glazed windows are great for those orientations, but not for the south, where that extra pane of glass cuts out more solar gain than it prevents in terms of heat loss. Instead, install heavy curtains for your south-facing windows to keep heat in at night. Stock plans may or may not be designed with orientation in mind. However, they generally only have one sunny space, while the rest of the windows and roof shapes are designed purely for aesthetic purposes. It's very difficult to get serious performance out of any stock design but don't think for a second that high performance solar homes have to be ugly.

DO: Store the heat.

In winter, your house needs the most heat when there's no sun at all – at night. Concrete floor construction (with no basement) works best for passive solar heating because the floor can collect the heat all day and give it back at night. The floor has **thermal mass**, and this phenomenon is called **thermal lag time**. Of course, a concrete floor should be well-insulated underneath. You can finish the floor with heavy tile or brick, but carpet or vinyl defeats the purpose. If the rooms are not too large and the sun will strike the back walls in winter, then those walls should have thermal mass as well.

DON'T: Block the views with storage walls.

One method for passive solar heating is called a Trombe wall. French engineer Felix Trombe developed the method in the 1950s. It consists of a south-facing glass wall, with

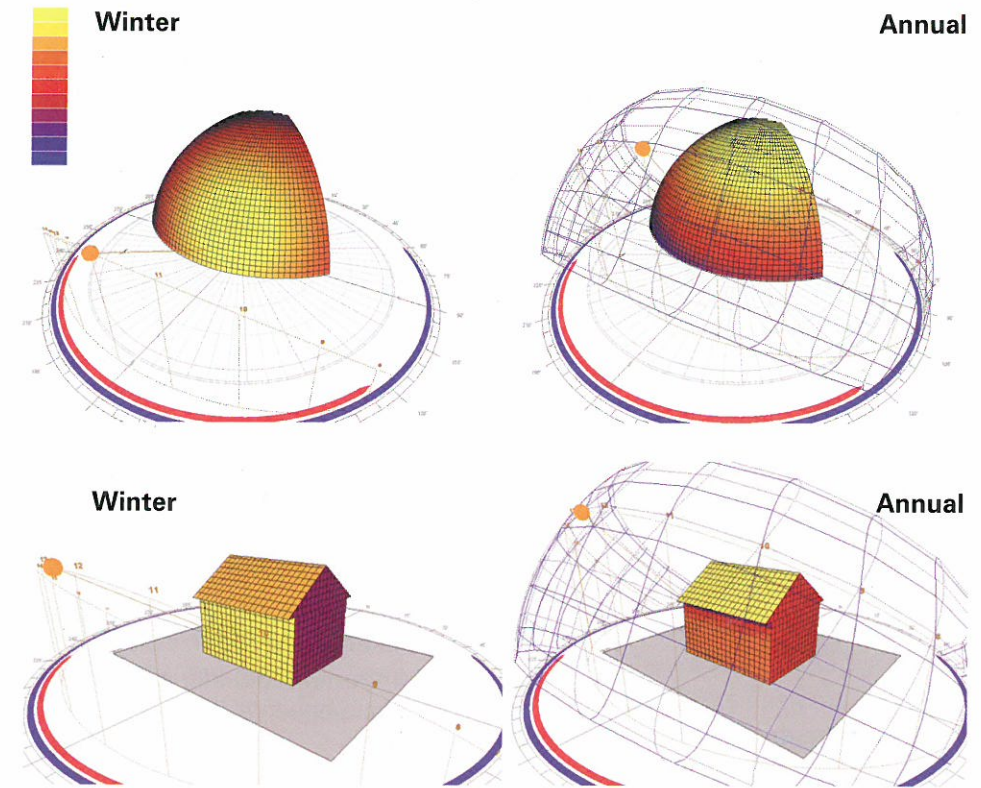


Figure 2: The amount of solar energy reaching surfaces varies with different tilts and orientations, and these levels also vary seasonally. The images display the range of solar values between a winter condition (more sun hitting a south-facing, vertical wall) and an annual condition (more sun hitting a surface that is nearly horizontal). Color gradients are used to visualize optimal and applied solar energy levels. Note that the scale values are not consistent between annual and winter conditions during which annual total values would be much greater than winter values.

a thick concrete wall a few inches behind the glass. The main rooms then sit behind the concrete wall. Trombe walls do work – they create hot air and radiate solar heat into the interior rooms – but they're not very efficient, they create dark interiors, and they block views to the south.

DO: Have a backup heating system.

100-percent passive solar heating is not feasible in most ordinary houses. To collect that much heat, you need such large windows you'll have overheating in the spring and fall. Plus, there might be stretches of cloudy days where there isn't enough

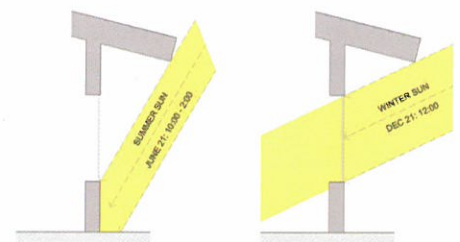


Figure 3: Overhead projections should be designed to block all of the sunlight in the summer while admitting all possible sunlight in the wintertime. Simulations should be utilized to optimize the projections for performance in the swing seasons – fall and spring.

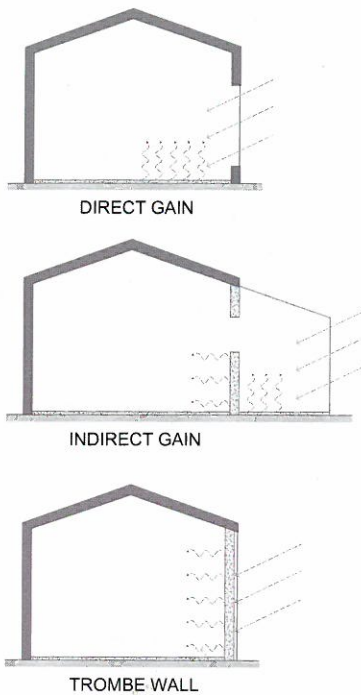


Figure 4: Solar heating strategies including direct gain, indirect gain (sunspace), and a Trombe wall. Consider the advantages and disadvantages of each strategy, and for all strategies try to minimize the width of the house – heat does not travel laterally well.

Figure 5: Stock houses built from generic home plans may be attractive but rarely function successfully as solar houses. These homes are designed in a way that prevents them from being able to accommodate much south-facing glass without sacrificing function and appearance.

sun to heat the house. But, especially in new construction, heating needs may be reduced enough to consider eliminating the furnace. For instance, houses built to Sweden's building codes can be heated with the equivalent of a hair dryer! A wood-burning stove may be a good backup system.

DON'T: Expect a sunspace to be comfortable.

A sunspace (or indirect-gain system) is a room attached to the south side of the house whose purpose is to collect solar heat for the rest of the house and to be a buffer. Often, they are all-glass, attached greenhouses. It's a valid technique, although hard to get right because heat does not move laterally very well. What's most important to understand is that a sunspace is not meant to be

comfortable: it will be very hot in the late afternoon and cold in the early morning.

DO: Consult an expert to get the details right.

What is an expert? Someone with experience performing energy simulations so that you get the details right. Common questions include: Do you really need all that glass? Is it really okay to not insulate under the slab? Will I have overheating in the spring and fall? Through computer simulations, these questions and others can be quickly answered in terms of the energy impacts and allow homeowners to spend their money where most needed. Today's simulation programs are very accurate in predicting building energy use for multiple design options.



Jon Gardzelewski is a lecturer and **Anthony Denzer** is an associate professor in the Department of Civil and Architectural Engineering at the University of Wyoming. Gardzelewski can be contacted at (307) 766-4386 or at jgardze1@uwyo.edu. Denzer can be reached at (307) 766-2186 or at tdenzer@uwyo.edu.