A Simple, Elegant Solar Hot Water Drain-Back System

(for home heating and domestic hot water)

story & photos by Paul Shippee

The seven solar thermal collectors (hot water) on the author's home provide domestic hot water and radiant (adobe) floor heating.

We live in a climate perfectly suited for solar heating of homes: cold winters with lots of sunshine. Yet most of us, including new homes, still use propane or electric for home heating and hot water needs. That large propane tank sitting in the yard must soon give way to a heating source that is more stable, cheaper in the long run, and less vulnerable to world market fluctuations and distant resource wars.

To help with the transition to a more reliable, cheaper, distributed, cleaner, and saner energy source people are waking up to solar energy. Using today's sun today, rather than drawing down our fossil fuel bank account, makes wonderful sense --especially for low temperature applications.

In addition to uncertain fossil fuel energy prices, interruptible supplies, and immoral resource wars, consider the ecological impact of the peak oil era we are now entering. Using high energy sources of energy (like propane and electricity) for home heat is a sin (ie, misses the mark). This is because the capacity to do high energy work is permanently lost by burning up our high energy finite fossil fuel supply to do low temperature jobs like heating homes and domestic hot water. We can no longer afford such extravagant mistakes.

One economic difference between using fossil fuels and using solar energy is that one is an ongoing cost whereas the latter is an investment, a hedge against future uncertainties.

There are simple technologies that have existed for a long time proven to be effective and a good investment for heating homes and domestic hot water with the sun. The simplest and most efficient active solar system I have found for heating homes, after thirty years of designing them, is to combine regular flat plate solar thermal collectors with a thermal mass radiant floor heat distribution system. The marriage of these two simple technologies yields a low temperature operating system that produces the highest solar collection efficiency of any alternative. It also provides a comfortable and silent heat distribution floor system.

What I am talking about here is an active solar system that utilizes a pump to circulate water through outdoor thermal solar collectors mounted, let's say, on the roof. The water is pumped up

to the solar collectors where it collects heat from the sun during the day, and is circulated directly through pipes embedded in the thermal mass floor where the solar heat is released and stored for night time distribution off the surface of the floor as needed. The stored heat will only come out of the floor as the room cools, thus the term “as needed”.

The high efficiency factor in this simple system is due to the fact that since floors naturally have large areas, then the temperatures needed to heat a room to 65-70 can be quite low. Solar heat collection efficiency then is quite high because the system runs cooler and less solar heat is lost to the outdoor cold winter air through the collector glass during sunny daytime hours.

Passive solar systems, where south windows admit sunshine directly into the house interior are, of course, much simpler –and these can be used in conjunction with an active system to provide attractive views and sunlight on winter days. In our climate passive south facing windows require night time thermal shades for comfort and increased efficiency. This prevents the heat from going out those cold south windows on long winter nights.

When using solar thermal collectors in our climate the freeze hazard must be addressed. The liquid used to transfer solar heat from the collectors to the radiant floor is subject to freezing. One method is to mix antifreeze into the water just like in your car engine. Antifreeze is toxic, requires replacement maintenance with aging, corrodes copper piping causing leaks, and transfers less heat than plain water.

For all these reasons, it is preferable to use plain water as the heat transfer liquid. But plain water will freeze when left in the solar collectors on cold winter nights. In this case, the freeze proofing method is to design the system plumbing so that the water circulating between the solar collectors and the radiant floor tubing “drains back” into the warm home interior at the end of the day when the pump turns off. Thus the name: drain-back system. This all requires, of course, some simple electronic controls which are beyond the scope of this article.

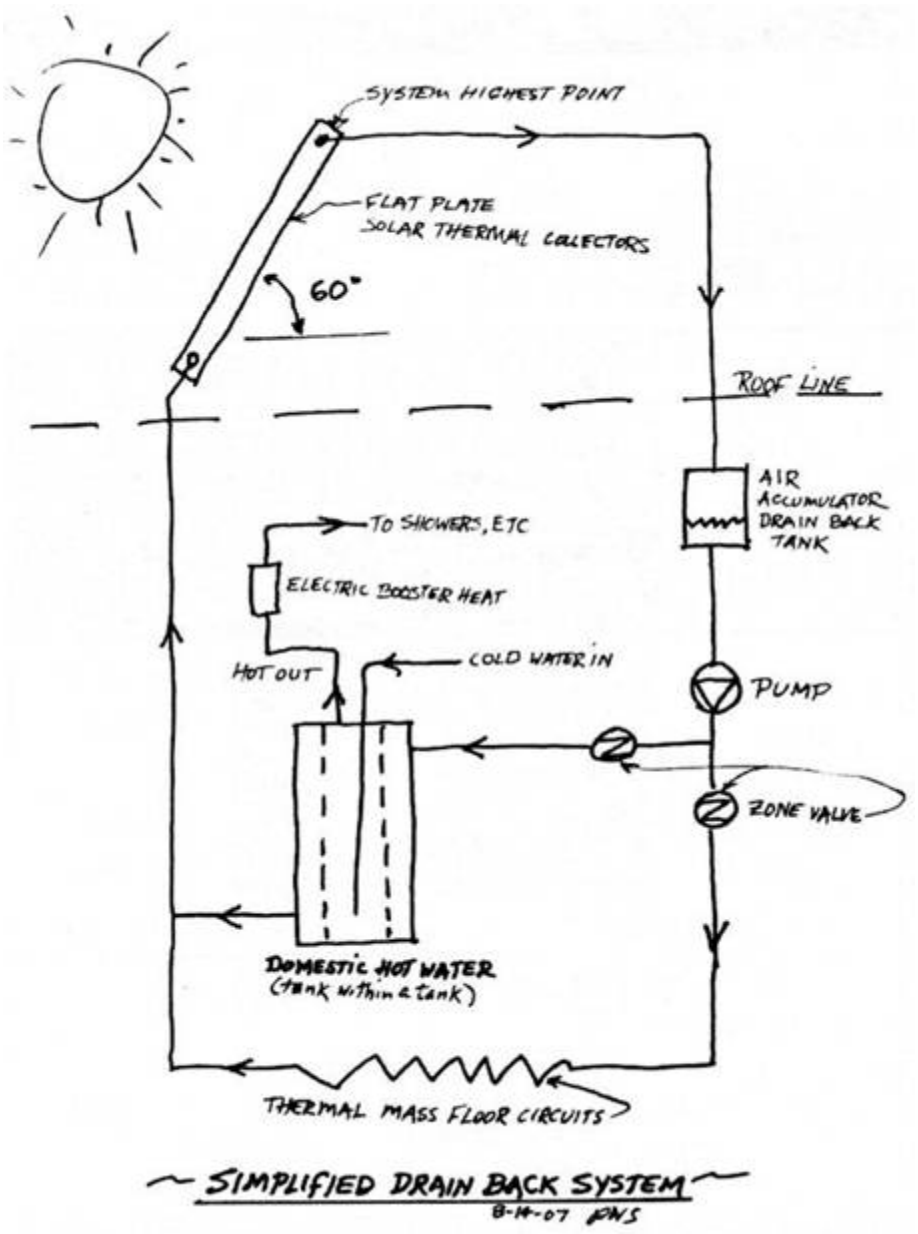

Figure 1

Figure 1 shows a schematic layout of the plumbing aspects of a simple, elegant drain-back solar heating system for home heating and domestic hot water. Notice in this configuration that only one pump is required to operate the entire system for solar heat collection, space heating distribution, as well as domestic hot water. This is one aspect of why it is simple and elegant when compared to some antifreeze systems that use up to five pumps to accomplish the same function.

The system requirements to achieve this simplicity are the following:

1. Solar collectors are mounted higher than the radiant floor and domestic hot water thermal storage tank.
2. The radiant floor has high thermal mass of earth or concrete materials.

3. The hot water back-up temperature booster (electric or gas) is located downstream from the domestic hot water storage tank. That is, the back-up energy should not be used to heat the solar thermal storage.
4. This storage tank is a passive heat exchanger consisting of a tank within a tank design (commercially available) of about 80 gallons.
5. Two zone valves are used in conjunction with a timer to direct water to the radiant floor thermal mass OR to the domestic hot water tank according to a specified control schedule.
6. A small drain-back accumulator tank is provided high up in the circulation line. It contains enough air to replace the water in all the collectors when the system drains back each time the pump turns off.
7. All piping, including the collectors, are tilted slightly to facilitate the drain-back operation.

This 12 gallon tank, located in a warm space under the roof, holds enough air to fill the solar collectors during system drain back on winter nights. Air does not freeze!

Mechanical room shows the single pump that operates solar collection, domestic hot water heating, and radiant floor heat distribution. The large tank on left incorporates a passive heat exchanger. No antifreeze is used in this drain-back solar system.

Michael Wasserman deserves acknowledgement for the significant collaboration on this system design and installation (especially on the electronic solar controls.)

The cost of such an installation might range somewhere in the neighborhood of $100 per square foot of collector area. However, a cost estimate to suit your specific situation is best obtained from a solar designer, installer, or contractor. This cost may be substantially offset by various tax and rebate incentives offered by state and federal agencies. To keep up to date on these changing

subsidies visit http://www.crestonesolarschool.com where you will find a list of websites that monitor and report on tax credits.