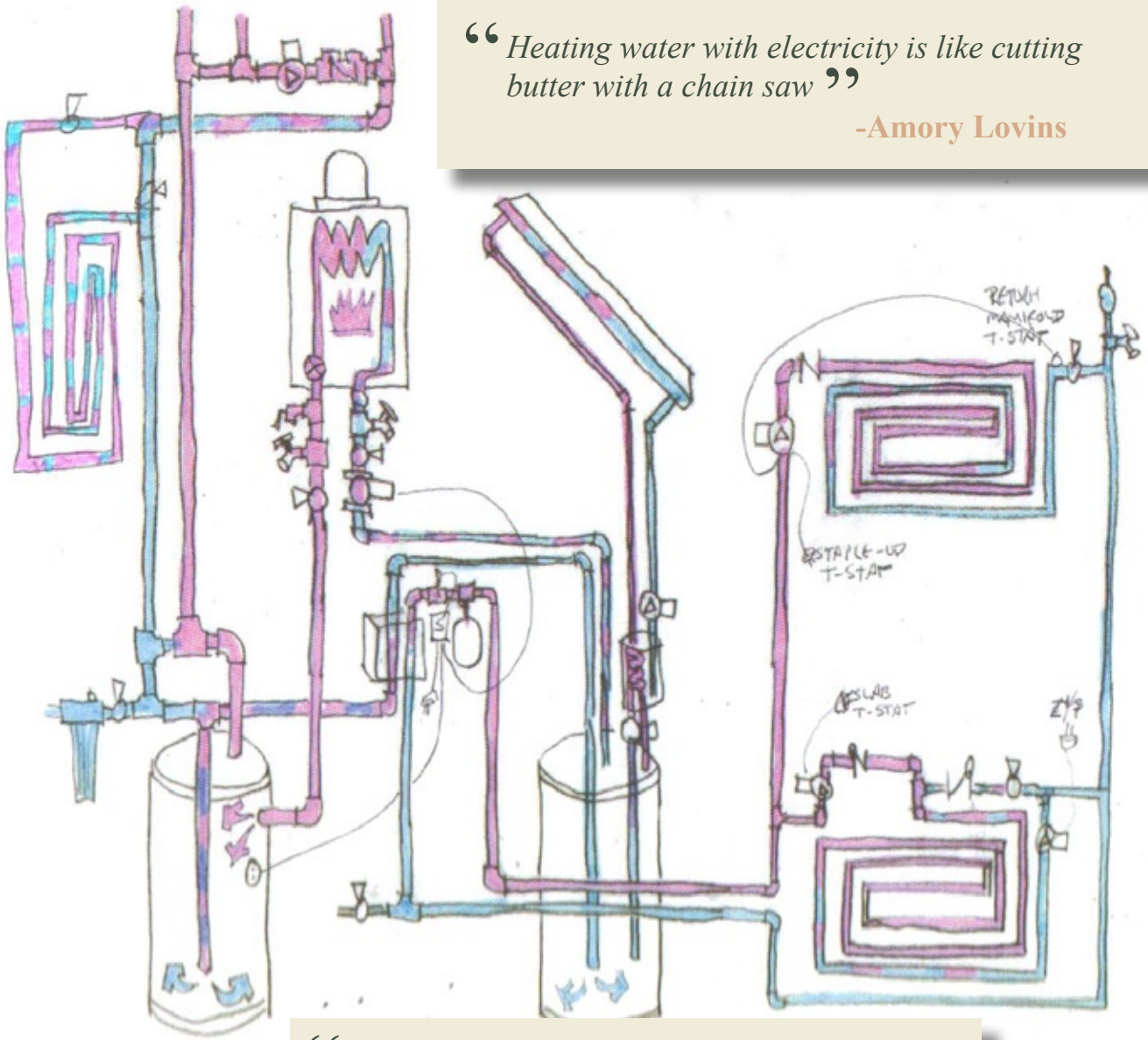
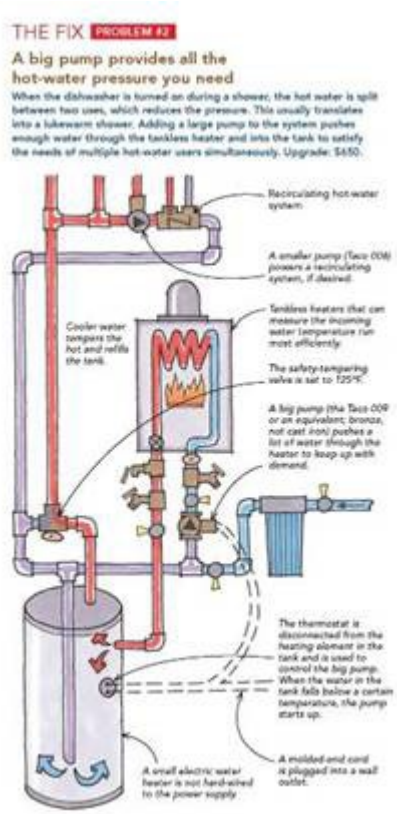
Synergy of demand water heaters with solar and radiant floor heating

> *"Heating water with electricity is like cutting butter with a chain saw"*
>
> **-Amory Lovins**



> *"Everybody likes a hot shower, but that doesn't mean I want a nuclear powered shower"*
>
> **-Larry Bohs**

We've been using tankless propane water heaters for years now and they have improved the designs to the point that it's all we install these days but there are a few misconceptions about them and some limitations as well as some opportunities that need to be considered.



First is the assumption that you can just take out a tank water heater and install a demand water heater and all will be well. Demand water heaters suffer from maximum through put issues that can lead to variable hot water pressure and they can send out slugs of un-heated water (the "cold water sandwich" effect.) which require tempering tanks to resolve. These issues are discussed in my essay in Fine Homebuilding Magazine.

Second is the energy efficiency issue. While tankless gas water heaters do use less energy to heat a given quantity of water per year, the fact that they can provide as much as 5-8 gallons per minute of hot water all day long may mean that you may end up using so much more hot water that your energy bill will actually go up. (I think that if you have lots of teenagers the most energy efficient water heater may be a 20 gallon electric tank that runs out of hot water quickly so they have to keep their showers short.) I think of you a demand water heater as more of a luxury item than an energy efficiency item for this reason. For this reason it is best to use a solar water heater to pre-heat water for the demand water heater to mitigate the tendency to use more hot water when faced with an inexhaustible supply.

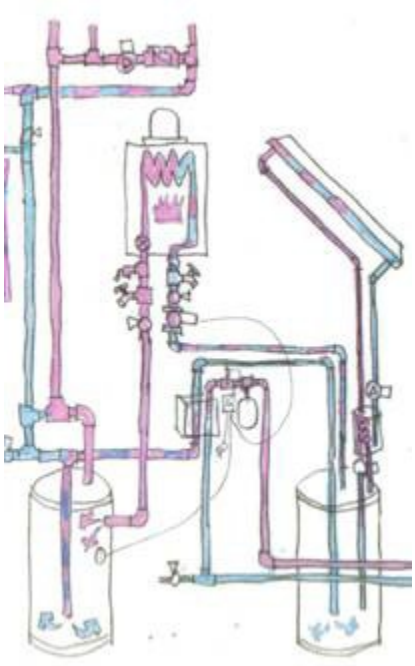
Due to the fact that solar water heaters sized to provide sufficient hot water in the winter can provide far more than necessary in the warmer months a combination of solar and demand water heating can be ideal to provide heat for a radiant floor system that would then be able to use excess heat collected from the sun to warm the floors of the home

Adding a solar water heater to pre-heat the water going into the system.

Once we have solved the cold water sandwich and the variable pressure problems by linking the demand water heater system with the 12 gallon tempering we still may not see the promised savings due to the energy efficiency of the demand water heater simply because we never run out of hot water so we tend to use more of it.

With all these new tax credits it sure would be tempting to hook it up to a solar water heater. As it turns out it's a piece of cake, just plumb the solar water heater into the line running from the hot water heater to the cold water inlet of the demand water heater.

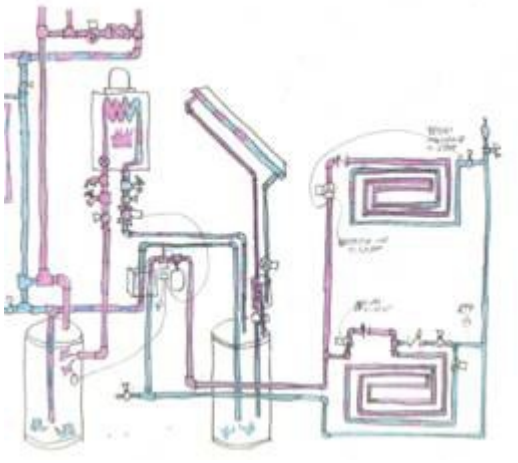
Up until now everything I said about demand water heaters could apply to any brand, but once you hook up a solar heated water tank you really need a unit that can measure the temperature of the incoming water and modulate the flame to only heat it as much as needed to meet the desired output temp. To the best of my knowledge the Rinnai, Tagaki, and Rheem/Ruud are the only brands that can do this.



Set the output temp on the solar tank to about 170 degrees or so and when the pump cycles it won't cycle for long and the heated water will just flow straight through the DWH to the tempering tank and then out to the house through the tempering valve at 120 degrees.

Use a radiant floor to turbo charge your solar panels.

Finally, we've noticed that in our homes with solar hot water sized to provide sufficient hot water in the winter months frequently will have much more water heating capacity than many families have a use for in the spring and fall when their heating systems are burning fuel to heat the homes. Many days will start out with pretty hot water in the solar storage tank from the day before even if it's cold enough outside that the furnace is fired up and heating the house. By linking the solar hot water to a section of radiant floor we can dump that excess heat into the house. Every BTU from the sun that we can use to heat the home is a BTU we don't have to buy from a utility company. By dumping the heat from the sun into the floor when appropriate we can keep the solar tank cool so that when the sun comes out we will have someplace to put the heat. (Everybody asks me if the house won't get too hot in the summer, if the thermostat doesn't call for heat it will just accumulate in the solar storage tanks) because the demand water heater is a very capable back up we can use all our solar BTU's for space heating and still not have to worry about not having enough heat to take a shower, or ten showers in a row if the need should arise.



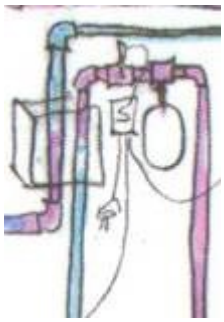
We use these systems to supplement the heating needs of the house. To use one of these systems as the sole heat source for the house would necessitate hiring an engineer to do the sizing. Our homes generally have heat pumps and woodstoves so if the radiant system should prove inadequate to the needs of the

home on a very cold day there are multiple back-up options. Without the solar assist our experience has been that radiant floor heat is actually less energy efficient than a well designed and installed 15 SEER heat pump or a 90+ gas furnace.

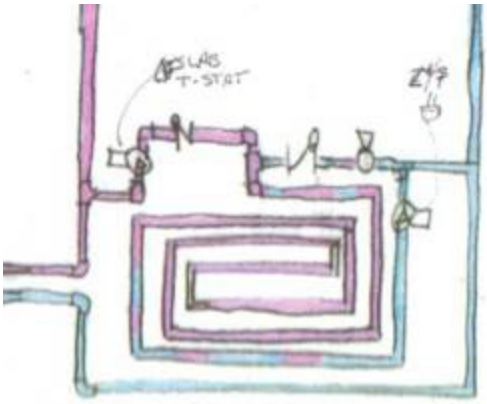
Lessons learned from designing and installing combined demand/solar/radiant heating systems

People have been using potable water in radiant floor applications for years but there is some evidence indicating that there may be negative health implications to breathing steam in a shower while bathing in water that has been heated and cooled repeatedly especially in staple-up (non-slab) radiant floor applications. Isolating this water is therefore considered a best practice. The system shown uses a flat plate heat exchanger to isolate the radiant water from the potable water. Since radiant floor systems are often "creatively" zoned the design shows slab zone as well as a staple up zone such as would be used with a plywood subfloor or "warm-board."

Slabs generally utilize two pumps, one circulates the water continuously through the floor to minimize hot spots and over heating the other adds heat to the floor as required by the thermostat. Staple up systems generally are insertion only as they operate at much higher temperatures in order to push the heat across the radiant barrier of the finished flooring.



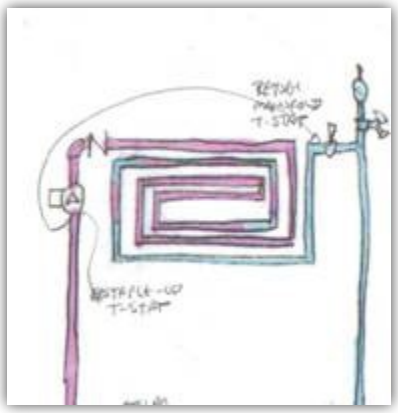
Linking a solar collector to a slab radiant floor is generally much more effective than linking it to staple up due to the fact that the water displaced out of a slab by the incoming water will generally be less than 75 degrees but the water returning from a staple up radiant floor can easily be 120 degrees. (Assuming it can flow into a small zone at 135 degrees and only lose 15 degrees to the floor before leaving to return to the heat exchanger.) In this situation the water leaving the heat exchanger and flowing into the solar storage tank would be 120 degrees and the ability of the solar storage tank to gain BTUs from the sun would be compromised.



A solution to this problem is to install a thermostat on the pipe leaving from the staple up floor manifold that would break the circuit to the staple-up circulation pump if the floor was returning water hotter than 110 degrees to the heat exchanger. Since this would only affect the staple up loop it would leave the slab loop and tempering tank thermostat fully functional while the staple up floor is resting.

Many of our homes have very small staple up zone dedicated to the floor of the master bathroom only. These zones are so small that there is no practical way to run them off the heat exchanger. In lieu of this we run them off the re-circulating hot water system using the same time delay occupancy sensor that controls the bath fan in that bathroom circulates the hot water returning from the master bath to the water heater through a small staple up loop in the bath room floor on the way back to the water heater as

demanded by occupancy in the master bathroom. A bypass valve in the master bath vanity or similar discrete location allows the recirculation to bring hot water to the bath in the summer time with out heating the bathroom floor.



Because these systems can have numerous zones the pump that circulates water through the heat exchanger must respond to numerous different thermostats to control the flow of water through the heat exchanger on the radiant side and to use a reed type low voltage flow switch to sense that flow of water and activate the pump on the water heater side. To accomplish this in the simplest way possible we link the Sika VS 20M low flow reed switch (.59 gpm sensitivity) with a Honeywell RA89A unified transformer controller per the side bar.

Working out all the details and nuances involved in making these systems operate efficiently has been the work of years of research, plagiarism, and all too much trial and error. I want to take this opportunity to publicly apologize to all my very patient and tolerant clients who have welcomed me into their homes over and over again as I worked the bugs out of these experimental systems. I hope to atone for this by sharing these lessons learned in hopes that future builders may profit from my mistakes.