HOW TO BUILD A HOME LIKE A CAR THAT GETS OVER 100MPG - PART I

Energy efficiency is, and has always been, one of the key reasons for building a radiant floor heated home. Given the rapidly escalating cost of energy, the efficiency of radiant heat has never been more important.

What about radiant heat makes it so energy efficient?

• Parasitic losses.

Parasitic loss refers to energy lost due to inherent inefficiencies of a system.

For example, duct work is relatively large in diameter, difficult to permanently seal and insulate, and is often located in unheated crawl spaces or basements. As hot air is blown down these ducts, heat is lost through the walls of the ducts and potentially wherever there may be leaks at joints.

When hot air is blown into a room with a door closed, there may not be a good return path for that hot air. This causes a slight increase in the pressure of that room. This can often cause the pressure to be released by leaking outside around the weather stripping on windows. The blowers used in forced air systems typically require 9 times as much electricity as the pumps in radiant system. All of these parasitic losses add up in forced air systems, decreasing their efficiency by up to 30% compared to radiant floor heating.

• Lower ceiling temperatures.

When air comes out of a forced air heating system duct, it is typically between 120 and 140 degrees. This hot air rapidly rises causing a heated air layer near the ceiling. This can often be 10 or more degrees warmer than the air temperature at the floor. This stratification effect becomes greater as the ceiling height becomes greater. When ceilings are hot and they are just below a cold roof, heat loss can be quite high. It is precisely because of this effect that we insulate ceilings and attics so much. Radiant heat floors stratify much less, first, because 50% or more of their heat transfer is from infra red which is a form of invisible light. Like all lighting, its effect is greater the closer you get to the source. In other words, it concentrates much of its output near the floor, where you and your children live instead of near the ceiling where only the spiders live. Second, because the temperature of a radiant floor is quite mild (typically 75-80 degrees), to the extent that it does warm the air that comes into contact with it, it only warms it to the mid seventies which means that it does not stratify to nearly the extent of 120-140 degree air. It is not unusual for the ceilings in a radiant heated home to be 10-20 degrees cooler than a forced air home.

• Zoning reduces energy usage.

Most forced air heated homes have a single thermostat, in other words, they are single zone systems. This is because forced air systems are inherently difficult and therefore, expensive to zone. Most radiant heat homes have numerous zones because it is relatively easy and inexpensive to add zones to a home. It makes sense to heat bedrooms perhaps to 65 degrees while maintaining 70 degrees in a family room or even turning off the heat in a guest bedroom until it is needed. Directing the right amount of heat to the right rooms based on their usage can be a big energy saver.

• Lower air temperatures for the same comfort.

If we are outside on a spring day when the sun is shining, we may be comfortable without sleeves when the air is only 60 degrees because the radiant warmth of the sun allows us to be comfortable at a lower air temperature. The same is true in a radiant heat home. With the warmth of the infrared shining on us from the floor, studies have shown that the same comfort is achieved in a radiant home when the thermostat is set a couple of degrees lower as compared to a forced air home at the higher setting.

• Blowing hot air paradoxically can cool us.

When we are outside on a mild spring day we may be comfortable until the wind picks up. Even though the air temperature has not changed, the mere fact that there is air movement across our skins causes evaporative cooling. Paradoxically, the blowing hot air from a duct can cause you to set the thermostat to a slightly higher temperature to maintain the same comfort achieved in a radiant heated home at a lower set point.

• KSU study.

It is difficult to precisely quantify the savings from these last three effects because actual savings can vary quite a bit depending on the design of a particular home, the climate zone it is located in, the fuel used to heat the home and many other factors. Nonetheless, a thoughtful study of all of these effects was done at Kansas State University in conjunction with the American Society of Heating Refrigeration and Air-conditioning Engineers (ASHRAE) that established that a more or less typical radiant heated home in the US can expect 25% savings over a conventional forced air home.

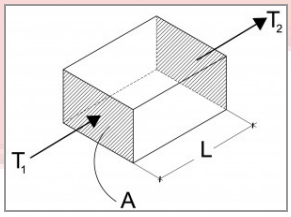
Warmboard drives these energy savings numbers higher for several reasons:

• Warmboard is the most conductive radiant panel assembly.

It has a thick top surface (0.025") made of high conductivity aluminum alloy (1100-0). The modular pattern of channels are fully lined by this continuous aluminum plate to maximize the contact area with the hydronic tubing. The aluminum plate covers the entire floor and is everywhere in direct contact with the finish floor materials. This makes for a highly conductive assembly.

The basic equation for heat flow is: heat flow (F) equals delta T (ΔT) times Coefficient of Conductivity (K) times cross sectional area (A) divided by the length (L) over which heat must flow.

$$F = \frac{\Delta T \, K \, A}{L}$$



It is a principle of thermodynamics, established by this formula that as conductivity goes up, water temperature can go down. It is always less expensive to heat water to a low temperature than a high one. It is well accepted in the boiler industry that for every three degrees that you lower the water temperature, you save 1% of the cost to heat that water. This means that compared to the least conductive radiant floor systems (staple up), Warmboard uses as much as 60 degrees lower water temperatures for the same heat output. Comparing Warmboard to thin-slab systems Warmboard uses as much as 30 degree lower water temperatures; an additional 10-20% savings over these more antiquated radiant panel assemblies.

• Warmboard maximizes the efficiency of condensing boilers.

Most modern ultra high efficiency boilers are termed condensing boilers because when they are operated below 140° F , the water vapor in the flue gases condense into water droplets on the heat exchanger thereby extracting the maximum amount of energy from every gallon of fuel oil or cubic foot natural gas. Because Warmboard systems typically operate well below 140° they can increase the efficiency of these boilers by up to 8% when compared to radiant systems that require higher water temperatures.

• Warmboard's low mass allows the efficiency of temporary temperature set back.

Many state energy codes require that programmable (set back) thermostats be installed to allow energy savings at night when occupants are sleeping. High mass systems never make use of this feature because it takes so many hours for them to change their output. Fast responding Warmboard radiant heat works quite well with night time set back, saving additional energy in the process. Vacation setback is another important means for saving energy. If you're going to be away from your primary home on vacation during the winter, it makes sense to set your thermostat back to perhaps 50 degrees which will save considerable energy while you are gone. Or if you have a vacation home perhaps on the ski slopes you would similarly want to set the home back when not occupied, but with a high mass system it may not be worth your while to save that energy if you're going to wait a day or so for your home to get warm. But with Warmboard radiant heat, you can be comfortable in an hour or two after returning home which will encourage many homeowners to save all the energy possible with vacation set back.

• Warmboard's low mass prevents overshoot.

High mass systems have been known for producing less than the desired amount of heat all morning and more than the desired heat in the afternoon. The afternoon overshoot problem is often resolved in a high mass system by simply opening windows to dump the excess heat. While it is difficult to exactly quantify the savings that come from Warmboard being able to accurately and quickly adjust its heat output to match changing loads, it makes simple sense to have a heating system that does not require opening windows in the winter to provide the desired temperature.

• Warmboard's low water temperature requirements are ideal for alternative heat sources.

There are a number of innovative means of heating water, such as ground source heat pumps, solar, fuel cell cogeneration, etc., that are highly efficient but only work best with moderate (under 120 degree) water temperature requirements. While most radiant heat systems require warmer water than these technologies can supply, Warmboard's high conductivity make it a perfect match for these technologies. This helps explain why five universities at the recent Solar Decathlon, including MIT and the University of Maryland, the top US entry, chose Warmboard as an integral part of their ultra efficient entries.

• Save thousands on fuel costs each year

Modern homes are well insulated, have excellent glazing, low energy usage lighting and many energy efficient solutions that make them seem more like the 40 mpg gallon economy cars we see on the road today than the gas guzzlers of the past. But if you add a radiant heat system to that otherwise efficient home and combine it with a fast response, low mass, highly conductive Warmboard radiant subfloor, in effect, you can start approaching the ownership of a home that behaves, by comparison, more like a car that gets 100MPG. We say this not only because of the theoretical savings detailed above, but because we have many homeowners living with the comfort of Warmboard heat in their homes who report heating bills as much as 60% lower than similar sized homes in the same community. If you might normally expect to pay $5,000 to heat your home through the cold months, bills in the $2,000 range are what many Warmboard homeowners are experiencing. But remember, your mileage may vary.