

Episode 40

Is the Passivhaus Standard a World Standard?

The show notes: www.houseplanninghelp.com/40

Intro: Martin Holladay is a senior editor at Green Building Advisor and he's a man that I've wanted to get onto the podcast for some time. He was keen to talk about some of the pros and cons of the Passivhaus standard, which opens up actually into a discussion about whether it's the best approach for all climates. I started by asking Martin how he got to work at Green Building Advisor.

Martin: Well, for years I worked as a builder and remodeler, building single family homes, additions and renovations in Northern Vermont in the north east part of the US. Then about, I guess, 15 years ago I got a job as an editor at the Journal of Light Construction, which is a monthly magazine in the US. From there I switched to Energy Design Update, a monthly newsletter that was founded in the mid 1980s to focus on super insulation and I was there for 7 years, and then moved on to work for a new website called Green Building Advisor where I've been ever since.

Ben: I know as well that you were involved in those early passive solar homes over in the States, so I'm very interested in this whole movement because we've touched on it once before in a podcast but only in passing. So what was your involvement, what house did you build and how did it go on from there?

Martin: Well I can't claim to have been part of the early, pioneer group of those building passive solar houses but I was well aware of what was going on. I was relatively young when I built my first house, which was in the early 1970s. I followed passive solar principles which at that point were fairly well known, which was to orient the main axis of the house in an east-west direction, to put most of your windows on the south side of the house and few if any windows on the north and so on and so forth.

The house was a classic hippy house in the sense that it was thrown together with found materials and inexpensive stuff picked up at the dump and thrown away by others. And it leaked like a sieve. Like most houses of the era we didn't know much about airtightness in those days and especially poor hippies without any money had few recourses for building really tight houses. So that

was a learning house but it was an example of those early principles and there was quite a movement of builders, far more sophisticated than I was when I was 18 years old, who built houses based on research mostly done in Colorado, New Mexico and Arizona which have climates quite suited to passive solar design. Those early so-called solar houses were seen as one response to the energy crisis.

Ben: Maybe you can explain what passive solar is? Or does it just go along those same concepts that you've just gone over?

Martin: Well the early solar years, dating back to MIT researchers in the 1940s, looked at different ways to collect solar energy and they were usually divided categorically into active solar systems, which had pumps and blowers, and some mechanism for storing solar heat. If it was a solar air system the heat was usually stored in a rock bin, usually in the basement which was literally a large bin of rocks through which heated air would be blown. Then the air would later be blown through the rocks on a cold night and some of the heat would be gathered up that way or more commonly in large tanks of water. And solar collectors on the roof, water collectors or air collectors would with means of pumps or blowers transfer this heat to the storage system.

In a passive solar house the idea was no pumps, no blowers and you simply used the design of the house to maximise solar gain. So by putting most of the windows on the south side of the house and fewer on the north these houses would heat up quite nicely on a clear sunny day. They had a lot of drawbacks because they also lost a tremendous amount of heat on cold winter nights because of the large amounts of south facing glazing. So they had the reputation of being very uncomfortably hot on sunny days and uncomfortably cold at night and this reputation was fairly well deserved for the early passive solar houses.

Ben: How did it move on from there? This was obviously a good idea of using the energy from the sun and perhaps storing it in some thermal mass but you were talking about the 1970s and we're 2014 now, so what's in the gap in between?

Martin: Well, I think what most people look at as a kind of pioneering house was the Saskatchewan conservation house. What it really tried to do instead of simply gather solar energy, although it did that as well, was to experiment with super insulation. It was a house that

was built on airtight principles, was tested at about 0.6 air changes per hour at 50 pascals, which by coincidence turns out to have been the same level of airtightness advocated by Dr Wolfgang Feist in his Passivhaus standard.

It had R40 walls and R60 ceilings. Again this is using the R value as it's expressed in North America – these aren't metric values. And it had triple-glazed windows and these types of specifications have been recommended ever since in cold northern climates for super insulated houses. And the house performed extraordinarily well and the principles were widely copied by a very enthusiastic band of builders and this idea of super insulation was taken up by Ned Nisson, who founded the newsletter that I later edited, Energy Design Update.

Through Ned Nisson's efforts as well as the efforts of these Canadian researchers, these ideas were promulgated widely. A book was written in 1985 called The Superinsulated Home Book and a whole movement advocating super insulated houses took up. What you had at that point were two somewhat contradictory or certainly opposing views of the best way to build a low energy house. The traditional passive solar people thought that you could get there by collecting lots of energy and the super insulation people thought that collection of energy was not really the issue. The issue was building a tight enough envelope that you didn't lose energy and on balance I think the super insulated group has been proven correct and a lot of the early ideas of so-called solar house design have long since been abandoned or modified.

Ben: I know that you were keen to talk about the strengths and weaknesses of Passivhaus so after what you've just mentioned there, does that take us up to the Passivhaus standard? What is different between what you were talking about there and the Passivhaus standard?

Martin: Well, I think advocates of super insulation in the late 1980s and throughout the 90s in the US didn't have rigid targets. They certainly used blower doors to check their airtightness and many of them competed for the lowest air leakage numbers they could come up with and bragged about how low they had gotten.

They generally understood that in a cold climate you want triple-glazed windows with a high solar gain coefficient on the south side and a low U factor on the other side, and they generally understood

that you wanted thick insulation everywhere. There were no magic numbers that you have to aim for. When Dr Wolfgang Feist in Darmstadt, Germany, decided to develop a standard that he chose to call the Passivhaus standard, in the mid to late 90s, he decided some what I think are fairly arbitrary goals for annual energy use, the most famous of which is 15 kWh per m² per year.

By pegging an energy budget on the standard he required cold climate builders to invest an extraordinary amount of money in insulation that will never foreseeably be recovered in any possible energy savings. When true believers in the US started copying the Germans using the Central European standard in our climates they were ending up with 14 inches of rigid foam under their concrete slabs, they were ending up with R100 insulation in their attics and they were sometimes paying \$6,000 or \$10,000 for reducing tiny amounts of annual energy use that could easily have been supplied by a \$400 solar panel producing electricity. It was this kind of absurdity that created a backlash in North America.

Somewhat surprisingly the backlash was so well argued that Katrin Klingenberg has come around. She was the one who founded the Passive House Institute US and she has now organised a committee to try to come up with a new Passivhaus standard that works for North American climates, which I think is a recognition that the Darmstadt, Germany, standard has no global validity.

Ben: This is quite interesting. Obviously you know that my knowledge is fairly limited but if I understand you correctly what you are saying here is it does change according to the climate that you're in, you feel the effectiveness, it doesn't work quite so well where you are in North America.

Martin: Well, super insulation principals work everywhere with the possible exception of a mild climate where no space heating or cooling is required. It obviously is silly to have highly insulated walls in Hawaii where the most pleasant climate is simply to open the windows and to enjoy the breezes coming off the Pacific Ocean but in most climates where you need air conditioning or heating, insulation makes sense. The question is, do we want to be spending tens of thousands of dollars for very thick insulation when the amount of money we invest is far more than will ever be saved in 100 years of operation?

That's the absurd situation we're now seeing in America by architects promoting the German Passivhaus standard, so common sense says you don't insulate infinitely. You want to insulate to a point where you achieve some cost effectiveness. If you double the thickness of your insulation you cut your heat loss in half but each time you double it you're spending more and saving less. So the traditional way to determine when to stop insulating is determined by cost effectiveness. You guess at the lifespan of the building, you guess future energy costs, you put a dollar figure on the amount of energy you will pay over the lifetime of the building and you try not to spend more on insulation than will ever be saved in energy.

Recently with global warming concerns there are additional questions, which is our moral responsibility not to foul up the planet but we also need to engage in global warming mitigation efforts that are also cost effective. It can be argued that very thick insulation saves the planet but if we are focussed on houses for the wealthy that are extraordinarily expensive we may not be investing our dollars where we could do the most good to reduce CO₂ levels.

So all of these issues require a sharp pencil and careful thought. It's easier to do this in central Germany, where Dr Wolfgang Feist developed his standard, than it is in northern Vermont where I live or northern Minnesota because our winters are colder than his. That's why his target cannot be cost effectively attained. We need to use less insulation than the Passivhaus standard would require in our climate. That may be exactly as much insulation as he uses in Darmstadt but we will end up perhaps spending 10 or 15 more dollars a year than Dr Feist would like and that will allow us to save \$6000 in insulation.

Ben: Should we be looking at anything else? Comfort, for example? Or again is it something that is just not relevant in certain climates where it's actually the climate that provides the comfort?

Martin: Well Dr Feist makes a good point and he picked it up from super insulation pioneers in the US that the advantage of a good thermal envelope is it's more comfortable. You want your interior surfaces to be close enough to the interior air temperature that your skin is not radiating heat to the cold outdoors during the winter. The classic example is a single or double pane window on a very cold night. The interior surface of that glass is so cold that if I sit beside the window my skin will feel cold even if the air temperature is at what we would consider normal interior air temperature of perhaps 72°F

and that's because our skin radiates heat to cold surfaces so by changing that double glazed window to a triple glazed window we become more comfortable. After this basic goal is achieved and the interior surfaces are within, let's say 15°F, of the interior air temperature, perhaps 10°F depending, you become comfortable enough that further insulation isn't in any way detectable by the human body. So if I have 4 inches of rigid foam under my floor I will have a comfortable floor. If I change that to 14 inches of rigid foam under my floor, as the Passivhaus standard requires in a cold climate my feet will not feel the difference.

Ben: Very interesting, what you're saying here. So, what does that mean going forwards then? What should we be thinking about if climate change is our goal and we want to be the most effective – is it using renewables?

Martin: Well, first of all, I'm very much in favour of super insulation principles, especially improving the airtightness of ordinary constructions, so I think the Passivhaus movement deserves our credit for focussing on the right things. Moving forward, we certainly need to remember that Passivhaus is not a religion, it shouldn't be blindly followed and I very much hope that it doesn't become enshrined in our building codes because it takes away flexibility from builders. That's number one.

In terms of renewable energy, we absolutely have to go forward to a fossil fuel free future if we're going to save the planet and preserve it for our kids and that generally means a massive investment in photovoltaic arrays and wind turbines, to some extent tidal energy and perhaps even new forms of geothermal using earth heat. There may be a few other types of energy we can depend on.

I think one of the priorities now that we need to emphasise is that we should resist the unfortunate tendency – well, I see this in our country, I don't know if you have it in the UK – where local interests oppose wind turbines or local interests oppose, in some cases, PV installations because they are afraid that it will be an aesthetic detriment to their neighbourhood. As a result we're finding it harder and harder to site renewable energy installations in the US when we really have to move forward at a faster pace, not a slower pace, so I find that a little dismaying.

Ben: Are there any other drawbacks – just going back to Passivhaus for a moment – that we should highlight before we move on?

Martin: Well, right now the problem is cost and I think the other thing to say is that the Passivhaus movement in the US is focussed very strongly on new construction and it doesn't take much simple maths on the back of an envelope to point out that the timetable for building new homes is an entirely different timetable from the one required by our climate crisis. I mean we really have got to get a handle on this crisis within the next 10 or 15 years, or we are very much in trouble. Building new homes for, frankly, mostly wealthy people to very high super insulation standards does not address this issue. We need a massive focus on what's referred to as weatherization in America, which is the improvement in the energy performance of existing homes and we also need all kinds of other measures which have nothing to do with construction.

So I think to some extent a focus on Passivhaus is a little bit of a red herring when it comes to addressing the climate crisis. We need to eliminate and close down all our coal plants, we need to actually reduce the amount of energy each family uses, we need to change our transportation system and we need to weatherize our existing buildings. Those, I think, are far more urgent than focussing on new construction.

Ben: Well, let's have a couple of questions then, that have come in. One from Twitter first of all and this is Juraj Mikurcik and he says: "What's the biggest barrier in the uptake of large-scale, multi family Passivhaus in the US?"

Martin: Well probably the existing building codes and the fact that energy is so cheap. We have had a few multi family Passivhaus projects in the US and we've reported on them on Green Building Advisor but right now the building code allows much lower levels of insulation and with energy so cheap right now they're almost giving natural gas away in the US! It hardly pays for a commercial developer to even think about these issues.

Ben: There's one from David Cummings from Bolton Landing in New York who wanted to know: "What are your thoughts on the marriage between natural building and Passivhaus and embodied energy?"

Martin: Well, I assume by natural building he means using materials like straw bales, mud, adobe and so on. I think that there's a lot of potential to using some of those materials for energy efficient construction. Others, frankly, don't really perform that well from the

perspective of having a high R value assembly. I think straw bale is the most promising of the natural building materials because a straw bale wall has a fairly decent R value and once it's plastered on both sides – as they almost always are – it's quite airtight. So I see a lot of promise for straw bale construction if an owner/builder has a lot of spare time and lives somewhere where straw bales are inexpensive. That's one approach.

These methods aren't ever going to be adopted on a wide scale because the labour involved costs too much and if you have to pay someone to build according to these natural principles you're going to have a very expensive house that only the very wealthy can afford.

Ben: But you can have a small house? You don't have to go crazy. And is that not one of the lessons that we're probably going to learn?

Martin: Absolutely. And we try to emphasise that on the Green Building Advisor website as much as possible. It's the most important thing you can do in planning a new house is to build small. I agree completely.

Ben: Thomas Langley has a question via email, slightly longer so let me read you some of this: "For me a question that has come up from speaking with a range of green house-builders is whether to pay the extra to go all the way to Passivhaus standard or do as they all recommend and compromise on airtightness to save money. It's a matter of value for money in finding every last leak and getting the certificate. When does it become uneconomic to continue? Every house-builder I've spoken to dies not to recommend bothering going to Passivhaus certification but to stop with an earlier compromise whilst still valuing the envelope fabric first approach."

Is this more or less what we've been talking about, the core of what you've said today?

Martin: Well I think the cost effectiveness of airtightening measures – that are necessary for achieving the Passivhaus standard – are far more justified than the insulation levels. Most builders who care and get excited about the concept of airtight construction learn very quickly. They may have one house, which is a kind of learning house where they realise the effects of sloppy construction, but once they get it, once they integrate the use of gaskets, foam and

caulk into their everyday lives it happens on its own. I think it could be argued that . . .

And the 0.6 air changes per hour at 50 pascals that is required by Passivhaus, I don't think it's set in stone. A lot of people are quite happy with 1.5, but that's different from saying: "Let's just give up and use ordinary building practices."

Ordinary building practices in the US often result in 8 air changes per hour or 6 air changes per hour at 50 pascals. We can do much, much better than that with hardly any investment and if we just pay attention it's not hard to get to 1 air change per hour. So I don't think we have to berate ourselves if we don't quite meet 0.6 but we should get as close to that as we can.

Ben: Are you saying that airtightness is the most important factor when we talk about not losing heat and saving energy, just because of what we've mentioned about insulation varying according to climate?

Martin: Yes.

Ben: Okay. [Ben laughs.] That sums that one up nice and neatly. [Martin laughs.] Very good, Martin. Well, you've had some fantastic information for us today so I thank you for that but I just wondered, are there any closing thoughts or is there a question I should have asked you to get a bit more information today? What shall we finish on?

Martin: I don't know about closing thoughts but the advice I've given is focussed for . . . has a US perspective and I could well be contradicted by a British builder because what you do in your country is likely very different from what we do in the US and in some cases probably better or more advanced, so that's a kind of general caveat to everything I've said.

Ben: Martin, thank you very much.

Martin: Thank you, Ben. It's been a pleasure.