HOUSE PLANNING HELP

Episode 62

Does a Passivhaus Need a Heating System?

The show notes: www.houseplanninghelp.com/62

Intro: Today's topic is in response to a question from Sam Weatherill in France. We'll get to the specifics of that soon but really the whole episode is thanks to his desire to learn a little bit more about heating systems and how we select them. So I've enlisted the help of a well-respected services engineer, Alan Clarke. He's got lots of experience and particularly in relation to Passivhaus buildings.

I started by asking Alan to share a little bit on his background.

Alan: I've been involved in energy and buildings in my whole career, really, working in large consultancies on big buildings and on small and medium-sized buildings as a small partnership or sole trader.

We've been working on low energy buildings all along, really, and when Passivhaus came along that seemed to cut out some of the debate of exactly how much insulation we have. We'll just say, we have a Passivhaus and we can get on with worrying how to do it now.

And now, yeah, I look at quite a lot of heating systems for individual Passivhauses and for schools, other smaller non domestic buildings and flats and the like.

Ben: When we're considering heating systems I presume it has changed a lot since a traditional building to what you might want in a low energy building?

Alan: One of the things, yeah, we do find is that you don't really need to heat every little corner of a well-insulated house. On the one hand obviously the heat loss from each room is going to be quite a lot less and the other point is there's no cold surfaces. If we've got triple glazing and we've got rid of all the thermal bridges, you don't have to worry about putting radiators under windows and that sort of thing any more.

Ben: What factors affect the heating requirement that you're going to need for a house?

Alan: Well, in brief, that's the heat loss of all the elements of the fabric and the ventilation, so that's what affects it. The total heat load is affected by the size of the building, but then particularly we've got the wall U Value, the insulation value of the wall that is, and the windows and the ventilation system.

Working with Passivhaus specifications and including heat recovery ventilation we come down to very low levels of heat but there's no expectation that we can do without heat completely.

Ben: You say that there's no expectation that we can do without heat but is that considering occupant heat, all the incidental heat . . . Are there scenarios where we wouldn't need a heating system at all?

Alan: Not normally unless we've got our sums wrong because we do include the solar gain and the internal heat gains from occupants and the like. The snag we've got is that those gains are very variable. Obviously you could have a sunny day when it's -5ºC and with the right house no heating is needed, it's great. Then a week later it could be raining, it could be 3ºC, completely overcast and actually it would get a bit cold. Of course, you could put the oven on and make baked potatoes but if you're out there's a bit of heat needed and it is quite variable. You will get cold at times if you don't have a heating system to do that.

Ben: Talking about particularly small buildings, I've seen certain people who say they just don't put on their heating systems at all. Perhaps they find the building, even in winter, because it's so small and they've got so many people in there that they don't need it. Is this just because they haven't been tested as you say with that weather condition that will mean that they will need something?

Alan: There could be enough heat sources if people are living in the house all the time, they've got a hot water cylinder that is always giving off heat. Maybe they've always got the telly on. It depends a lot on the occupants and some terraced houses or apartments have got very low total heat losses so those gains can quite easily make up for the heat loss in most conditions.

Ben: How do you design that though, because you might think that this house will only have two people in and then actually if it's social housing or for some other reason it ends up having five people in and a couple of dogs and, as you say, all the gadgets switched on?

Alan: I think you have to pay good attention to the controls because it's not simply a case of *it's winter we need heat*, some days you need a lot and some days you might not need any at all. So good temperature control based on the temperature inside the house is important.

Generally, if you're using gas heating you're trying to throttle down a boiler which is really too big for the job. So controls that are able to lower the temperature that it runs at are the best way to go, I think. They effectively reduce the power of your radiators by reducing the temperature they run at, as well as increasing the boiler efficiency.

Ben: We have different ways that we could create this heat. If you're in a town or city, are you normally using gas or electricity?

Alan: Gas, basically. I know there's concerns about the fact that it's a fossil fuel, it's a finite resource. Our key emphasis in Passivhaus buildings has been to think about energy first and think about reducing the energy demand, and worry to some extent where that energy comes from afterwards because one source of energy is quite convertible to another quite often. Yes, the key thing is to use less, basically.

The carbon emissions from gas are not that different at the end of the day to those from using a heat pump, which is getting its electricity from the mains grid. With the current way we generate electricity, which is burning fossil fuels that's not the key thing that some people think it might be. Heat pumps do use energy. They use a higher-grade energy which is electricity and that has a higher carbon impact than gas.

This isn't to say that we don't also use heat pumps, particularly places that aren't on the gas grid. The downside at the moment is that they're new and fairly expensive bits of kit. On mains gas someone could be looking at an annual bill for heating and hot water of £200 - £300, and you could be looking for a heat pump installation upwards of £10,000. When you look at how long that's going to last, 10, 20 years, I mean it may not be that good but if it is that would still be £500 a year that you've laid out in capital on a heat pump and you could have had a gas boiler for a few hundred pounds and be only paying a few hundred pounds in gas as well.

So when you're putting your money into windows and insulation I think the heating system is no longer that important. It's not the right end of the pipe to be solving the problem.

Ben: And is there a wide range of these boilers because they're not high powered like before? We're talking a different type of boiler.

Alan: There are one or two extra small boilers but I've not used them. The problem is to have something that is readily installable by your plumber so you're not making a rod for your own back in terms of sourcing hard to find equipment, hard to find spares and instructions in foreign languages. If you just want to use a good quality boiler from one of the main suppliers in the country. We do end up with something that goes down to maybe 3kW on its lowest output, a bit more if it's a combi boiler. The heat load of our house, if it's a modest size Passivhaus would probably be 1kW at most. So that's where we have to think about how to deal with that in the design of the rest of the heating system.

Ben: And they work in exactly the same way as other boilers or are they? What you're saying is they're very similar to other boilers?

Alan: Well, they are the same as other boilers.

Ben: Fine. Yep.

Alan: We just work out what's the best way to control a normal gas boiler, the sort that would be used in a modern developer house also doesn't have a huge heat load normally and you make it fit the job.

Ben: But it will be sensing the temperature and then just kicking into gear as and when needed?

Alan: Yeah, as I said earlier, the favourite sort of controls are actually measuring the room temperature, then bringing in what you might call intelligence or might call a simple algorithm to work out that the boiler doesn't need to be running at 70º, it can be running at 55º because the room is pretty much up to temperature already. That avoids the tendency of the boiler to run flat out, overheat the space, flick out with the old click of the old thermostats and then cool down again until it's gone almost too cold. So with the smarter thermostat the boiler ticks on and off at a very low output to try and just keep the place topped up with heat.

Ben: I think this is a good point to address a question that has come in from Sam Weatherill and I'm going to read a portion of that. And that's one of the reasons that I decided this would be a good time to

chat to Alan.

Sam says: "We are building a timber frame post and beam house in the Haute Savoie department of France of around 200m^2. It will be inline with the French RT2012 norms on energy performance so requiring no more than 50kw/m^2 per annum achieved through being quite airtight, triple glazed and having good levels of insulation. Our current thinking on space and water heating is to install a condensing gas boiler rather than a heat pump. Air source heat pumps are very popular in France but we are not sure we will see the return on the additional cost versus a gas boiler," which is actually what we've just been talking about.

"We are lucky to be on mains gas in the village. The research I have suggests that the benefit of an air source heat pump versus an efficient gas boiler can be marginal, especially as the real efficiency of the heat pump drops dramatically in cold weather. Our house will be at around 700m altitude, so not too high but we can get cold winters here in the Alps so that is a factor."

Sam really wants to know some of the factors in general, which we've talked about, when choosing a heating system for a new home and I suppose more specifically as we know his situation, how do you think he's doing in what he's thinking?

Alan: Well, as you've realised, I kind of agree with him. As he does have mains gas in the village and he's probably not got an infinite budget, the condensing gas boiler would be a good choice for his house which is around the AECB Silver Standard of energy performance, which is low heating demand but not as low as a Passivhaus.

He makes a good point about air source heat pumps. In particular there's a fundamental thermodynamic characteristic of the fact that the bigger the temperature difference they are trying to raise heat from, so the colder it is outside, the more work the heat pump has to do. So effectively the less efficient it gets. It's not the way round you want it but when it's 10ºC outside and nice and warm, the heat pump is efficient and running at maximum output. When it's -10ºC its output has dropped dramatically - maybe by a factor of two in some cases - and the efficiency also drops by that sort of amount. Part of that drop of efficiency is the fact that the thing has to keep stopping every short period to defrost itself because it's trying to extract heat from air that's below the freezing temperature. They do that and they don't stop working, it just means that if it's running for

50 minutes and is then defrosting for 10 minutes you've already lost a sixth of your capacity.

What people have worried about hitherto has actually been just the capacity lost. They bought a heat pump that said 5kW on the label and then in the worst case scenario when their house heating demand is actually a little bit more than they expected because it's a cold snap, the heat pump is nowhere near the output that it said on the label running at 2ºC because now it's -5ºC or -10ºC. If you then have to switch on to direct electric heating you've really lost the efficiency benefits of the heat pump.

Interestingly air source heat pumps in some ways look more advantageous in a Passivhaus in the performance, the way they perform. When we look at the heating demand through the year we see that 60% or more of the total heat demand is for hot water and hot water demand doesn't vary much through the year, there's not an intense peak in the coldest part of the year. So the performance of the heat pump is much more consistent through the year. On that basis air source heat pumps look quite a sensible option for Passivhauses although conventionally heat pumps have been optimised for doing heating. We've looked at ground source heat pumps which generally only work at fairly low emitter temperatures and are only really suited to underfloor heating. In a Passivhaus where we're looking largely at hot water we do really want to look at heat pumps that are optimised to producing 55 degrees temperature output and the space heating side is more or less tacked on and isn't the primary use of the heat pump really.

Ben: So it seems that Sam is actually on a good track here and doing okay. Can we just change the circumstances? Maybe I'll ask a few more questions about, for example, biomass boilers. When would you think I need that? Or would that just not apply to a Passivhaus?

Alan: There's a whole lot of issues around biomass boilers here. There's the old hut in the woods approach where you're evidently coppicing or using fallen timber around you and it appears to be perfectly sustainable. You can see the wood growing and you're just harvesting some solar energy a few years later.

Then you can fast forward to now with power stations shipping whole forests of pelletised timber from Canada. This appears to be clear felled and is not in any way sustainable so a lot of modern

biomass boilers are using the same fuel sources of wood that is not being regenerated at the rate that it's being consumed and therefore is actually putting carbon dioxide into the atmosphere faster than if you were using a gas boiler.

Ben: How would you be able to check that or is this part of the problem?

Alan: Yeah, that could be part of the problem. As I say, on a small scale with your own little coppice in the back garden that's one thing but if you're having to buy your fuel on the market then it's probably not really going to be as sustainable as you like, I think.

Well basically once demand exceeds the renewable supply, even if it's your neighbour that has to buy the dodgy pellets, if you're all buying pellets then you're creating more demand than the renewable supply can provide.

Ben: Are there any other relevant renewables in this equation?

Alan: Well, for heating, in a way no, because the demand for heat itself comes at the coldest and darkest times of year and there's a simple thought, *if I have a heat pump and I have some solar PV that will do my heating, won't it?* If the sun's shining and you've got a Passivhaus with some windows facing the south you probably don't need the heat when the PVs are working. On the other hand when you come to hot water you might see that you can generate maybe 70% of your hot water by running your heat pump when PVs are generating.

Although in the past we've tended to think of photovoltaic generating electricity as really expensive and to be put into the grid and to be used in the most efficient way, what we're seeing now in Germany is that through the summer, daytime renewable generation is so high that even with their current levels of photovoltaic installation that people are now being encouraged to go down this route. You know, convert that electricity into hot water, which can be stored rather than having to draw on the power stations in the evening when they want a shower or in the morning before the sun comes up. So that is a new direction of renewable energy in this field.

Ben: Is there a final thought or just a recap when we look at heating systems in low energy buildings?

Alan: As ever we say keep things simple. People love to get carried away with thermal stores and a little wood-burning stove here and a heat pump here or maybe a gas boiler as back-up. We'll have loads of solar thermal panels feeding into this store and we'll have underfloor heating there and radiators upstairs. At the end of the day that's more complicated that you need if you've built a well-insulated box.

I mean you could have a woodburner, you could just be burning logs on the living room stove and you'll find that the bedrooms upstairs will be perfectly warm or you could have the gas boiler and a radiator or two.

It's not really the right end of the problem to be addressing, to be bolting on technology, because we're looking at how much heat the house needs, which is really how much heat it loses to outside so by focusing on the building fabric we've really solved a lot of the problems before they've arisen.

Ben: Alan, thank you very much.

Alan: Alright, thank you.