HOUSE PLANNING HELP

Episode 202

Designing the ventilation, heating, and hot and cold water systems for Ben's house – with Alan Clarke

The show notes: www.houseplanninghelp.com/202

Ben: Maybe you could just explain, first of all, what your role is and what that entails.

Alan: If you think that's an easy question to start with. I don't think it is.

I've got one easy role which is the building services designer, which is a fairly straightforward engineering role of producing designs for the heating, plumbing and ventilation, possibly for the electrical layouts as well, depending on whether the architect covers that or not. And then also some energy analysis role, particularly for a passivhaus.

Some of the boundaries tend to split with different design teams. Some architects' practices keep the energy analysis in house, which makes sense if they're energy literate and using PHPP, because the first stage of PHPP is working with the building fabric, the windows, the form of the building, the insulation and so on. So, that is a fairly architectural side of the design, though I still do that with other architects who aren't particularly interested in getting into the spreadsheet side of things.

Ben: At that point when we've hired you, what are the first things that you want to do, to be able to begin your work?

Alan: Probably the first things, practically speaking, are making physical space for the particular services we want in the passivhaus, and to make them work well. The ventilation side is what people aren't normally familiar with. Obviously, architects like Parsons and Whittley are experienced and familiar with what they're doing.

Ben: Take us through some of the things that you're doing, what programmes you're using to come up with all these drawings, how you're specifying the MVHR – give us some detail.

Alan: Alright then. For a passivhaus, which is the main business here, I actually work from the PHPP Energy Analysis Program or within it, quite a bit to start with, because there's an interplay between the services I design and the useful information about the building that's in PHPP.

So, I would start developing the ventilation scheme in terms of the numbers, the airflow to each room, how that all balances out. That's got to work on the plan so, you can see which room is a supply type of room, which are the bedrooms and living spaces, and which rooms need extract from them. So, you look at that on the plan and identify those, maybe identify if, for instance, a toilet off a cloakroom or something, there might be no need to extract air from both of them, and then schedule that out in the ventilation worksheet that we use for passivhaus and feed that back into PHPP so that from an early stage we're modelling with the airflow system that we expect to design to.

The other thing I've started to pull out from PHPP is the heat loss information. For instance, the window areas and the U-values of the fabric and the windows. And then when we come to look at the heating system design in more detail, I can use that information to work out the heat loads for each room.

Ben: If I understand this correctly, firstly it's very much about ducting, looking at PHPP to see that what you're about to specify is going to be right, but the heating comes further down the line, what physical equipment you're going to have. Does that come before the MVHR unit or do you work with the same MVHR units?

Alan: Sticking with ventilation, I think the ventilation is probably a bit more important to get right. It's a bit less swappable. It's got to be there from the start.

I work with a few different ventilation systems, all Passivhaus certified, and all easy to get hold of in this country. But the certification for the Passivhaus MVHRs first of all tests the efficiency under the methodology that fits in with the energy calculation in PHPP. Also, typically, with a Passivhaus approach, it's not an optimistic methodology. It really looks at how much heat your MVHR is losing out of the house and other ways of looking at the efficiency tend to attribute heat loss from the room where the MVHR is into the system as being a gain to the heat supply to the room that the air's supplying to.

These are quite subtle differences but in order to encourage you to use the certified units, the PHPP Passivhaus Certification dock

several percentage points from any claimed efficiencies from a non-certified unit. So, in the grand scheme of things, it's cost effective to use a certified unit. It also ensures we've got things that you need in a passivhaus which is frost protection for the MVHR, which means when the air is sub-zero, the system won't shut down the supply air, which is what some non-Passivhaus Certified systems do, which doesn't really make sense in an airtight house where you need it for your ventilation. So, that's one of the things about that.

The other thing is that they've always got the commissioning controls to let you set them up in a properly balanced way so that we're not wasting heat through unbalanced supply and extract, where say you supply too much air, some of it is actually leaking out through windows and cracks and so on. So, the commissioning side of the MVHR is important. You need a piece of equipment that is designed to be commissioned properly.

Ben: And that's not part of the process you do, the commissioning? You just give the equipment that you know can be commissioned, correct?

Alan: Yes, that's right. I have commissioned a few units, for instance in my own house, of course, I had to do everything myself.

Ben: What did you learn through that process? What does it mean in practice when you're commissioning something?

Alan: That it's quite hard to measure airflow accurately. Also, you pick up on the fact that it could be quite hard to get a high airflow rate on a distant terminal, the one that's furthest away from the ventilation unit.

Ben: I noticed that on a lot of the duct runs that you have in our sketch, that they actually almost just get into the room that's furthest away from the MVHR. Are you trying to keep those runs short?

Alan: I'm trying to remember exactly what it is like.

Ben: We can put this into the show notes, but do you want to have a quick look at it?

Alan: Okay, yes.

Ben: What I've got in front of me, which we'll give you a chance to look at in the show notes, is the floor plan. And you just overlay your design over the top? Is that pretty much how it's happening?

Alan: Yes. Not fully BIM stage anything here, I'm afraid. Most of the architects working on individual houses are generally doing their working drawings as two-dimensional CAD drawings. I take their drawings and hide all the various notes that aren't particularly relevant and just do my own drawing overlaid on top, so that we should see everything matching up physically in the building.

Ben: It seems to be the upstairs where there's not much ducting.

Alan: Yes. Maybe winding back a little bit, there are almost two philosophies of where to go. We're the purists in terms of airflow. The other way is to think there's hardly any ceiling space. If we make the ducts really flat, we can squeeze them in and no-one will know. The downside is that you need more fan pressure to push the air through these smaller ducts. More fan power needs more energy in the fan, it means more noise generated at the unit, it means more electricity consumed in the fan. And also, that tends to be a system which doesn't come with well-sealed junctions in the ductwork.

We've got another approach which has always borne fruit in terms of quiet and efficient systems, which is to use slightly bigger, round ducts which are inherently easier to make airtight junctions, and then try and think a bit more cleverly about how to make space for all of them. This has kind of evolved over the years with some feedback from the builders that we've worked with as well, on what's a good way to go.

So, you see the ducts are spread around quite happily on the lower floor because we're using open web floor joists which are engineered joists with a metal zig-zag giving plenty of space to fit services through. That gives us plenty of scope there. But upstairs, you've probably found that a truss rafter roof is a sensible and economic way to make a roof, but in the passivhaus, we make the air barrier the base of the trusses. Loads of insulation goes on top and there's no way I want to be putting lots of ducts through that air barrier and into that cold loft space. We want to keep them inside the warm, airtight envelope. But it means we're going to have to drop the ceiling somewhere to run those ducts. So, we're using the simple philosophy that the landing tends to connect all the rooms together so, we'll run the ducts in the landing. It doesn't have any windows so, you won't lose any window head height if we lower the ceiling a bit and you won't really mind having a lower ceiling there.

And that's why the ducts stop at the bedrooms because they'll step up to a higher ceiling, and we use a sort of side throw air terminal that's designed to be mounted on a wall and designed to jet the air into the room, so it mixes up.

Ben: So, it doesn't need to be in the middle of the room. The novice that I am, knowing nothing about it, I'd say, 'does that not need to go into the middle?' But I trust you. It's alright, Alan.

Alan: It's okay. It's not just the novices and it's not intuitive, I don't think. I have been the [inaudible]. We have had the CO_2 monitor setup for consecutive nights in our bedroom which has an MVHR vent supply just over the door, trying to see if there's a discernible difference in carbon dioxide concentrations around the room with such an asymmetric air supply. We really didn't find any. It's not actually just down to the air terminal throwing the air physically across the room, it's just that air does circulate in rooms quite well.

Ben: Interesting. And the ducting system, I remember from one of our early podcasts – and probably I've got the details wrong – I think it might've been Andrew Farr suggesting a rigid system. Will this be rigid, or have we moved on from there now?

Alan: We're using rigid here, yes.

Ben: I think the one's that I've seen from Green Building Store that I know were using have all been metal as well. Is there an advantage to that?

Alan: I think there are some advantages, yes. Some of it isn't inherent to the metal but it happens to come as a very well-engineered system with smooth bends so, it becomes a low pressure loss system. It comes with sealed junctions with little rubber gaskets. So, you can build a ductwork system that doesn't leak without having to lash lots of sealant or sticky tape all over it.

Ben: The particular unit that we've selected, what is it and why have you chosen it for this project?

Alan: It's a relatively new Zehnder Passivhaus-certified MVHR, fairly large capacity so, it's suited to family houses, and it's been designed with integral airflow measuring inside the unit which means that you can set it up and choose your ventilation rate. Say it's a hundred-and-fifty metres cubed per hour, dial that in on the controls and it will maintain that, even as filters get dirty or other conditions impose themselves on the system.

It makes it quite easy to setup and it also means that you won't start losing ventilation performance as time goes on, as you don't go around changing the filters and they quietly increase their resistance.

That's one of the issues maybe with a low resistance efficient duct system. A blocked filter will make quite a difference. I think that's probably the case with most ventilation systems, to be honest.

Ben: Are we using any sound attenuation? Is that the right terminology? Or is it just not necessary because this machine's so quiet?

Alan: No, we are using sound attenuation. I think that because it's a new generation of these ventilation units, because it's got this flow measuring, the fans don't have to have any integral consistency in flow rate. The speed can be adjusted in response to the measurements. So, the fans have been designed from the ground up to be efficient and quiet. But we're still designing to the Passivhaus acoustic requirements which are 25dB(A) in bedrooms and the living room. And for that, we need some attenuation in the ductwork which is a cylindrical silencer, which is a straight through tube with an absorbent material around the outside with a perforated baffle. So, that doesn't impose any air resistance but it's quite good at taking out a lot of the noise.

Ben: One of the issues that we had on this project – I think it probably comes back to your terrible clients that you had – was the fact that we changed the size of our kitchen and reduced our utility area, which meant that the MVHR system did not have enough room. And then we looked at the possibility of having it upstairs. Eventually, we settled for it being outside the thermal envelope.

You didn't seem too fazed by that. I know that Chris and the team certainly, everything they do they like inside the thermal envelope. Can you explain a little bit about why you suggested this and some of the issues that perhaps we were worried about that maybe we shouldn't be worried about?

Alan: It's not outside, outside. It is in the garage, so it is in a protected space. I think it would be pretty unlikely to be sub-zero in the garage. And the duct heat loss side of it is catered by having insulated ducts from the MVHR to within the house. I put in the unit just inside the garage on the wall of the house. Those ducts are very short. So, the heat loss from there is pretty small.

Interestingly, the average temperature inside the MVHR unit, when you think that it's a mix of outside air and inside air in the same unit, is halfway between outside and inside. So, it's not obvious that it belongs inside or outside. So, it's not an extra heat loss from the MVHR to put it in the garage. It might even be slightly more efficient, basically.

As an aside, there's an interesting project of trying to build the MVHR actually within the wall itself, which is the ultimate logical place to put it, so that it's half inside, half outside itself. It's got some practical problems of dealing with condensate and connecting ductwork not into the living space, but that's …

Ben: Will the MVHR unit be in a protected box, or is it just going to be there in the garage? I think you might have mentioned before, the ducting all goes to the outside as well for the fresh air. I remember my wife was saying, 'won't you just get all the fumes from the cars?'

Alan: Yes, we're certainly running intake and exhaust ducts out through the garage wall to outside. It's up to you whether you put a box around it, to be honest.

Ben: I don't know. I follow your lead, Alan. I don't question you.

Alan: It's not a problem. It doesn't need it.

Ben: It won't be in a box then, in that case.

Looking at a couple of other aspects then, the boiler system – did I imagine this in the early days: did you suggest underfloor heating for us? If so, why? Because I thought underfloor heating was the devil.

Alan: I don't know about the devil. I think it must've been your project architect, actually. Dan, I suspect. Because it wasn't me.

Ben: Okay, but why do you steer clear of underfloor heating?

Alan: The issues we've got are that it's inherently quite a high output system. It's got the whole floor available to heat the space. That also means it's expensive. You've gone and cut your heating demand down by a factor of ten in a passivhaus, but you've still got to pay the full rate because you're still covering the whole floor with underfloor heating, which doesn't make a lot of sense to me. And then you've got something that's too powerful, so you have to then put more effort into the controls and the design to try and throttle it back to a point where it will work.

Ben: Will we be using our heating system, a lot of the time, just very low settings?

Alan: I think my experience of detached houses, that's probably right, yes. And obviously as you were discussing earlier, for the size of the plot, you're effectively encouraged to build a fairly decent sized

house so that you've got the same occupant density as social housing projects.

I've worked with Parsons and Whittley where they would have at least two four- or five-bedroom houses with the same floor area. So, it would be more people, more internal gains. So, I expect you'll be using the heating a bit.

Ben: Tell us about the boiler, the Vaillant ecoTEC Plus 615.

Alan: It's actually very ordinary, which is the point basically.

Ben: It's gas as well, isn't it? I suppose that's something we should talk about. You did ask me – would you have just gone, if I had said I wanted a ground source heat pump? But again, this is the podcast things washing over me. I'm sure, if you have access to gas, you always suggest – or not necessarily you, but someone has told me in the past, to use it.

Alan: I'm seeing more projects with air source heat pumps, generally off the gas grid. In the past, we've done them with LPG, but I think it's becoming more common to go to air source heat pumps, although there's a high capital cost, they've got lower running costs.

Ben: But what happens when they break? I've had this question from people before who've said, 'Ben, I'm having this taken out because there's no-one to fix it, whereas if we had a normal gas boiler, there are thousands of people who know how to fix it.'

Alan: It depends. That's why we're using a mainstream brand. There are some people who have thought, 'oh, Passivhaus. We'll have to find the gas boiler that has the lowest possible output. It's a special import from Germany.' But then, as you say, if something goes wrong, your plumber from Berkhamsted isn't necessarily going to know what to do with it. But if you've got one of the mainstream ones with spares and technical support, that's all going to make your life easier.

So, the heat pump market was a very small, individual supplier business. We're now seeing quite a few housing associations working with, for instance, Mitsubishi and other manufacturers as well, who have got quite a bit more support in the country than they used to. So, that's probably where we'd go otherwise.

Ben: I know that we've jumped about a fair bit and I probably haven't done your processes any favours. Are there any other key parts that we should mention in what you do?

Alan: In terms of the house design?

Ben: And this particular case study.

Alan: Looking at hot water distribution, which is something we've done research on and have, as ever, a slightly individual approach to, which is aimed at getting your hot water to your taps nice and quickly, but without any circulating hot water that's continually losing heat into the rest of the house. We do that with smaller bore pipework which has become possible with mains pressure on vented hot water systems.

So, there's a little bit of a design exercise in looking at the plan of the house, drawing on where the pipes have to go, seeing how long they are. And as ever, I've got a spreadsheet now tacked into the PHPP where I check the pipe sizes are going to match up with the flow rates and the available pressure. That then sums up the numbers to pop into the hot water sheet in PHPP, to work out the heat loss as well.

Ben: I know you recommended a flow restriction as well, which I'm all happy for. However, there's one concern which is if my wife turns on her shower and says, 'I knew we shouldn't have had this' on day one. So, it's very difficult to gauge what that means and whether we need it or not. Can you isolate it and just say, well, her shower, let's make that go a bit faster?

Alan: We can design for a higher flow rate shower if you want. I think it is possible to have a low flow rate that's a bit disappointing, to be honest. But there are diminishing returns. As you go for more and more water, the extra pleasure and enjoyment becomes less and less.

Ben: Where's that sweet spot?

Alan: I think it's probably around ten litres per minutes, although maybe I'm being very stingy. Someone else will say it's more than that.

Ben: I'm going to hope that she just doesn't notice. We'll continue on as normal and I'll say, 'it's too difficult to retrofit.'

Alan: I don't know what your showers are like at the moment. That would be useful to know.

Ben: Well, there are no worries there. Our showers have been dribbles all of our times. So, hopefully it will seem like a big improvement. And does the actual equipment – and this is something we're specifying at the moment, the bathrooms – should we be trying to

make the shower head something in particular to maximise what you've done?

Alan: Yes, I think so, in that a lot of manufacturers have a range that is designed to work with some level of flow restriction. Some of them might be designed for six litres per minute, as a very eco, low water use, but they also recognise that there are people who want a bit more luxury and go up to twelve litres per minute, but they still fix at that so they're not going to run their hot water tank empty and it will still be relatively energy efficient and water efficient.

There are quite a few options, but it's still better to have something designed like that, rather than a showerhead that maybe is expecting twice as much water and then you put a little restrictor in it upstream and it's quite disappointing. You've got to have a showerhead that's designed to work in conjunction with some sort of flow regulation.

Ben: As we get towards the close, a couple of things are still in my mind. One is that I was surprised that there was a radiator in each room. This may come back to what we were saying earlier about this is not necessarily a small house anymore, and keeping that even temperature with a low amount of heat in each room.

Alan: By some people's standards, there isn't actually a radiator in each room. I can't remember exactly, but I think we put in fewer than might be standard.

Ben: Yes, definitely. I'm just saying, this is probably a tiny radiator as well.

Alan: But for instance, I remember you've got at one end of the house, a bedroom which has effectively got three external walls and balcony doors perhaps. I've got some clients who sleep with the windows open in their passivhaus and have no heating. Obviously, they are very happy with that because that's what they want it to do and it's great. And then other people actually want to have their room warmer.

Particularly when we looked at, for instance, the room at the other end, which is a bedroom, but I happen to know is a study or a workroom as well. It's one thing to snuggle under a duvet at eighteen degrees in the cold weather and that's what the British Standard says, to design a bedroom to eighteen degrees. I can do the calculations and say we don't really need to put a radiator in there. But if you turn it into an office, that's going to be a bit chilly for

the typing and you want twenty degrees. So, we put a radiator in there.

Again, if you've got a room downstairs that is for elderly parents, I don't know what they'll want but you might as well be able to keep it warm if you need to.

Ben: Good thinking. Like it. When you get to the end of this process, we've hired you as a consultant, what is the final documentation that you're passing back for the tender process or the next stage of the project?

Alan: So, what I'm doing for this type of project, which is quite a small scale project compared to what a lot of engineers do, is not handing over a five-hundred page standard specification, but instead writing something fairly easy to follow and as short as possible, to on the one hand provide a shopping list for the contractor to work out what he's got to price for, and also provide basic instructions on particular things we want to be installed in particular ways, the pipe size, the thickness of insulation and a list of the types of terminals for the ventilation unit, the ventilation unit itself. So, all of the kit has got to go in there, plus the instructions on how to get it commissioned and what flow rates to commission the ventilation system to.

I try and keep that into a short a specification as possible.

Ben: Finally, are we likely to be needing you again in this process? Do you come back at the end, or is that pretty much you've been the consultant, job done?

Alan: It varies depending on the builders, to be honest.

I haven't been introduced to your contractor. I quite often have a small amount of involvement which is particularly if they're not used to what we're doing in particular ways and talking through that. Sometimes it involves going to site, particularly to see how things fit together at the first fix, and maybe again towards the end.

Obviously, as clients, you can see it will be expensive to ship me over to your house for a monthly site meeting so, I'm not planning to do that. And you're working with Parsons and Whittley who we've worked with before and they know what's going on. So, I don't think that's going to be such an issue.

Ben: Alan, don't worry. I'm sure we'll catch up again at some point.

Alan: Okay. Nice to talk to you.

Ben: Thank you, Alan. Cheers.

Alan: Bye.