Episode 308

Testing the thermal performance of a house – with Tom Fenton of Veritherm

The show notes: www.houseplanninghelp.com/308

Intro 00:00

Tom Fenton 02:10
My background started in design actually. So together with my parents, we ran a bespoke design consultancy that focused on building envelopes, so facades for industrial units and commercial properties, and ultimately specialised in how those facades went together from a construction perspective, but as well as performance and other things. So, that experience in design led us to come up with the idea of Veritherm. We sat in quite a unique vantage point actually where we could see all of the pitfalls in the design and construction process that would kind of impact the performance of the building fabric, but quite often sat at the bottom of the supply chain, and couldn't really do much about it. So yeah, that's my background, worked from school in the construction industry, started off as an apprentice looking at engineering, both mechanical and electrical engineering. And then once that apprenticeship had concluded, I then joined the family firm.

Ben Adam-Smith 03:17
Thermal performance then, what is a good starting point for this?

Tom Fenton 03:21
I think thermal performance is very little understood actually, in our industry. It's something that's quite notional. We use theoretical design assumptions to understand thermal performance. But actually, true building performance or true thermal performance in buildings is rarely measured, which means that we don't really have a benchmark to understand where we are, where we're going, or where we need to be really. So I think that that's where our ethos comes in, in terms of, we're promoting measurement of thermal performance in favour of desktop modelling exercises, which seems to be the status quo at the moment.

Ben Adam-Smith 04:01

Why does it not get measured? It would seem an obvious thing, doesn't it? End of the process, you've built a building? Now let's see how it did. Is it just the test wasn't there or why?

Tom Fenton 04:13
Yeah, I think until recently there hasn't really been a commercial facing solution that will allow us to do it. So, there's academic approaches, but they tend to be very complex, expensive, very much implemented at a research level, meaning that it's not really suitable for mainstream construction projects. So that's where we come in really. We're trying to kind of make thermal performance measurement simple, affordable, and ultimately scalable, so people can integrate it into their projects without it costing them an arm and a leg. And yeah, until the last two or three years there haven't been many tools to do that.

Ben Adam-Smith 04:53
Affordable is quite an interesting point, isn't it? Because the amount of money you spend on a building, actually you're willing to invest quite a lot in knowing that it's doing what it's supposed to. But that's not always the case is it? So what becomes affordable?

Tom Fenton 05:06
Yeah, it's bizarre really, because we use this analogy all the time. You know, your appliances in your home go through more of a robust testing and verification process for performance and energy efficiency, than a £200,000 newly constructed home, which seems really bizarre. So yeah, I mean, coming back to that point, the affordability element. So existing research level tests for thermal performance might cost you somewhere in excess of £10,000 per property, which obviously is not a palatable price point in terms of mass rollout. But in terms of our system, you're looking at somewhere around about £500 per home. But obviously understanding that that could give you fantastic data that allows you to make informed decisions, as well as a really good quality control tool. The value far outweighs the investment at this stage. So we're starting to see quite a lot of appetite, now that price point is starting to come down.

Ben Adam-Smith 06:08
Now, for me, the obvious one is at the end, but are there other uses of this in buildings that perhaps might need retrofitting? Or is that not the primary use of it?

Tom Fenton 06:19

Everybody says the end, but it's probably the least valuable time to test in my opinion. You know, it's needed, and we do do a lot of pre handover testing, but about 50% of our work is actually in the retrofit market. So, we might take a baseline measurement of the existing home to understand how it's performing, then feed that data back to the design team so that they can look at fabric upgrades that are actually suitable for that property. And then we can actually introduce testing throughout the retrofit process. So as you install a new element to the building, so whether that's double glazing, loft top up, external wall insulation. You can actually quantify as you go to ensure that those benefits are being realised, and then obviously post completion as well.

Tom Fenton 07:04
We're also working with self builders, certainly in the Passivhaus market, where we will actually do two tests. So one once the insulation is in, but the external linings aren't installed. So if there's a howling error, you can actually identify it with further diagnostics and possibly remedy those issues with the external envelope before sealing it up.

Ben Adam-Smith 07:26
Do you find having tested a number of passive houses that actually there is a variation in the consistency according to the build method?

Tom Fenton 07:36
Yes, I think certain build or archetypes or structures tend to perform better than others. We've tested a lot of buildings with steel and metal in them. And obviously, in terms of thermal conductance, it's not as good as something like timber or block work or masonry, like you suggest, so you can start to see those trends. What I would also say is that we talk about trends, but a lot of it is down to the build quality and the detailing, actually. So you might have a fantastic property with high performing products and specifications. But if you haven't got the detailing quite right, between junctions around windows, etc, etc, it can really be the downfall of the property. You know, heat's like water, it will find your weakest point. And that's where you're going to be losing energy from.

Tom Fenton 08:24
So, you know, we've tested lots of Passivhaus dwellings that are fantastically insulated bar one really howling error. And you know, ultimately that means that that property is substandard in comparison to its design predictions. We also have others that exceed their thermal specifications. So yeah, it's a really interesting

one. But ultimately, if you can catch it at the right time, you can pinpoint these errors and, and like I say, rectify them before the building becomes operational.

Ben Adam-Smith 08:51
Can you take us through the actual test and what it entails?

Tom Fenton 08:56
Okay, it generally goes in three phases. So there's a setup phase. So that includes retrieving the thermal specifications for the property, entering in some basic dimensional information for the building, and then actually deploying the kit inside the property. So that includes environmental sensors. So mainly recording temperature readings, they're typically deployed one per room in the property so that we can actually label each sensor per room so that if, possibly, a room isn't getting warmer or cooler than others, you can start to pinpoint errors in the building.

Tom Fenton 09:33
And then we apply a controlled and measured heat load to the property, so we actually deploy space heaters inside the property, and then we circulate air with fans. Once that's done, we then create a heating curve. So we turn on the heaters, all remotely via our platform, and we heat the building for 50% of the evening. We then cut off the heating and allow the building to cool passively. And then all of that data along with the power data is sent up to our cloud-based software, run through the algorithms and you can actually then generate a result. So Veritherm encompasses all energy loss from a building in units of watts per kelvin. So the easiest way that I can explain that is Veritherm quantifies the rate of energy loss in your building per degree of temperature difference. So that can be useful for understanding whether it complies to the design. But it can be fantastic as well to understand actual heat losses for the purposes of sizing or specifying a heat pump, for example.

Tom Fenton 10:39
So yeah, it's quite a simple process. It's a 12 hour overnight test, so it's very quick, and results are instantaneous. So once you've gathered the data, through the click of a button, you will retrieve a full report, which will break down those losses into various areas. So we quite often carry out an air leakage test, so that you can understand what losses are attributable to air infiltration, so gaps and holes, and what losses are attributable to fabric, so insulation performance. And obviously, that gives you a lot of clarity on how your building is performing as built rather than relying on say PHPP

calculations, or the standard SAP process that is used to generate a building's EPC.

Ben Adam-Smith 11:27
So you talked about PHPP there? I mean, is there the opportunity almost to export that data, you have a lot of data in PHPP, which makes it such a great modelling tool. But then when you get your report, how are let's say for example, there's a thermal bridge, how do you identify that specific point where it's happening?

Tom Fenton 11:46
So Veritherm doesn't identify the specific points. It can identify possibly areas or zones of a building that look questionable. So at that point, you may decide to do some further diagnostics. So whether that's a thermal imaging survey or other things, but the real kind of useful element with Veritherm is, we can pull the data from a PHPP calculation or a SAP assessment, for example, but you can actually then push the data back, which will allow you to model in the real world performance and communicate to your clients actually what impact that has long term, whether that's on emissions, or fuel bills, or heating demand. So you can actually use those figures and start to model scenarios based on what you've got.

Tom Fenton 12:29
In terms of diagnostics it's quite an unusual one, really, because it's the chicken and egg scenario. If you do a thermal imaging survey, and you see thermal bridges and different bits and pieces that look questionable. You have no real tangible evidence, whether that's significantly impacting the performance of your envelope or not, you know. Ultimately, windows will still show cooler than the external fabric, for example, but actually, what do those images mean with regards to performance? So that's where thermal performance measurement comes in, is it can give you a quantification that can then be used alongside other diagnostic tools.

Ben Adam-Smith 13:09
So these sensors that you've got in the rooms, is there a standard placement for them, because that could be in some buildings where you place it in the room could be a different temperature? Or is that really not the case, it's always going to be a sort of ballpark figure?

Tom Fenton 13:24
It's basically, the more data points in the property, the better the outcome, I would say. Typically, it's one per room, but on each sensor, you have a high and low level temperature probe. So you're

actually taking two measurements at different heights within a room, which gives you a better overview of the average temperature in that space. To be honest, with the type of measurement that we produce, adding additional sensors in a room probably wouldn't enhance the quality of the results. I think it's actually more about the application of heat and the air mixing inside the property that is the important thing. So that's why we introduce fans inside the property, so that ultimately we can get uniform temperature rise in the property. So you don't want to have a specific room in the property that isn't getting heat, for example. In terms of the sensors themselves, normally they're just central to the room.

Ben Adam-Smith 14:21
Can you explain the difference between thermal imaging and the process that you're undertaking?

Tom Fenton 14:27
So thermal imaging is a visual inspection of heat loss in a property. It will give you an image that a person then has to interpret and possibly identify what that means with regards to energy loss in the building. With Veritherm we take a drastically different approach in that we quantify the rate of heat transfer. So we actually give you a physical number at the end. This is what the building was designed to achieve with regards to the rate of energy loss, and this is what it's actually achieving. With that number, you can then break it down into different things. So, how is this property performing thermally on a scale of very good to very poor for example? What's the average U value across the building envelope? What's the gap in performance between designed and as built?

Tom Fenton 15:22
So it's a quantification. It's physical evidence and data and numbers that can be utilised to inform decision making. So you can feed that information back to an architect to help them actually improve the design led process, you could feed that information back to a self-builder. So for example, if you've got a 400% gap in performance, it may be that that self-builder needs to look considerably at improving the envelope. If there's a 5% gap, then actually, that's not going to make a huge difference on their fuel bills and their emissions. So I think it's that tangible data and evidence, which can be paired with thermal imaging, but thermal imaging is quite constrained in that, if you're not trained very well, the images can actually not show you what you need to see, as well as only being useful at night time. So you've got to go out and actually gather those images at the right time in the right place. So that's how they

differ. But what I would say is they complement each other quite well.

Ben Adam-Smith 16:27
Yes. Is this really about the U value? You're sort of verifying that and coming up with a number?

Tom Fenton 16:33
Yeah, basically. You know, whole building U value that then can be split down into different kinds of outputs. But ultimately, yeah, we are verifying that number, quickly and efficiently.

Ben Adam-Smith 16:46
Now, when we get the report, how is that laid out? Or, you know, how are we going to use that?

Tom Fenton 16:53
So we will break down your energy loss into things like air tightness, fabric and ventilation. We will also give your building a thermal efficiency rating a bit like what you see on an EPC certificate, so that kind of traffic light system. We divide the rate of energy loss by the usable floor space inside the property, which allows you to say compare a five bedroom dwelling to a one bedroom bungalow on the same scale. We also quantify the performance gap as a percentage. So if there's a gap in performance, whether that's a positive or a negative gap, we can actually translate that to the customer, as well as giving an average U value across the building envelope, which can then be used to influence design and decision making.

Tom Fenton 17:41
The other thing that we're using it for quite frequently is for the purposes of sizing heat pumps. So we will actually use those values to influence sizing and balancing of heating systems. So for example, a new build property might underperform, which means that the heat pump won't be able to kind of run efficiently. And quite a lot of existing buildings may be oversized to compensate for the unknown, which means it's a lot more expensive. And again, if you oversize a heat pump for a building, it's not going to run how it needs to. So we've had a few scenarios where we've done that and there's cost savings, so capital savings on equipment as well as operational savings as well, using those real world values.

Ben Adam-Smith 18:28
You mentioned positive and negative numbers when it refers to the performance gap. Is it most of the time negative?

Tom Fenton 18:37
Yes, if I'm honest! Yeah, I mean, certainly kind of newly constructed home. So you've got to imagine that every energy calculation that is done for a home is based on an idealised build. So we take standard U values from data sheets provided by manufacturers, and we assume that that value will be achieved in situ, without considering all of the other things that goes on. So things like workmanship, replacement of materials, thermal bridging, even design errors, you know, it can go right back to the design. And all of those things added up can deliver a home that's underperforming considerably against its design.

Tom Fenton 19:19
However, there are occasions where performance is right at the top of the agenda on a particular project and we see homes exceeding their thermal specification. Quite a lot of existing homes as well tend to exceed their thermal specifications. So say it's a 1920s home where we don't have any U values from product manufacturers and the fabric specification isn't understood. If we're going to retrofit a heat pump or specify fabric upgrades, then quite often we see those homes performing better than those assumptions, which means actually, there's a cost saving for the client. So, do you actually need to specify that thickness of insulation? Do you need to go bigger with the heat pump, for example? So there's a lot of value in measuring both new and existing homes. And to be honest, it can, it can go either way.

Ben Adam-Smith 20:15
A few minutes ago, you mentioned EPC. When you look at a property that's already been given an EPC rating, how do you find that the thermal performance, does it sort of marry up in order as you might expect, or is that all over the place?

Tom Fenton 20:32
Tends to be all over the place. What we would say is most properties that we test, the design and the measured values almost never tie up whichever way it goes, because we're almost always getting it wrong, whichever way that may be.

Tom Fenton 20:44
In terms of existing properties and EPCs. The process is something called RdSAP, which is reduced data standard assessment procedure. So we will pluck thermal values from standardised tables based on the building's construction type, and what year it was constructed in, and we will come up with a basic thermal

specification for that property. The issue is, now that we're looking to upgrade however many million homes across the UK, those thermal specifications are being used to then make decisions on fabric upgrades and what needs to happen. But as we know, that's a stab in the dark, and quite often, it's not representative of what is there. So what we find with existing properties in that reduced data approach is that we measure them and sometimes you know that the building is actually better than thought. And it means that, you know, ultimately the client can have a cost saving, the retrofit strategy can be reviewed before it's rolled out across 80,000 homes. And there's serious value and savings in taking that measured approach to retrofit to be honest.

Ben Adam-Smith 21:49
And that's another point really, that even if homes are part of one development, presumably, your test can uncover different problems in different buildings. It's not just one development has all the same results.

Tom Fenton 22:03
Yeah, exactly. So you know, you might do a sample on a development, you might get two identical homes that perform very differently. And ultimately, the homeowner is then burdened with that underperformance and probably none the wiser. So this is what we're trying to do is kind of identify those pitfalls in that construction process. A bit like airtesting when it was introduced, you know, everybody at the moment prides themselves on their airtightness results, certainly in the Passivhaus sector. So what we're trying to do is get people priding themselves on the thermal performance, the overall performance of their property, rather than just that one element, which is important, but is far from the whole package.

Ben Adam-Smith 22:46
Airtightness and insulation together, they almost go hand in hand. Are there any other factors that should be considered as we look at this overall picture?

Tom Fenton 22:54
Yeah, so there's the ventilation element, ultimately. So because we test the property, before it's occupied, we don't measure the ventilation element. Because quite often, it's lots of different things, whether it's natural ventilation, ie people opening windows, or mechanical ventilation, like MVHR systems. So it's fantastic to get a thermally and airtight property, but actually, when you do that you need to make sure that the ventilation element is correct as well. That can be monitored long term. So we're looking at a monitoring

solution that can then look at the property in use to ensure that kind of internal environmental conditions are as they should be. But really, there's three elements to fabric performance, its ventilation, insulation, and airtightness. And you've got to get all three of those right to achieve a high performing property.

Ben Adam-Smith 23:47

When we're building Passivhaus we have an airtightness test. And well actually, you probably have more than one airtightness test, but one of those interesting points is that you're trying to get it as good as you can. And so you have that snapshot at a certain point. Is it exactly the same point that you would test the insulation and how that thermal performance is going?

Tom Fenton 24:08

Yeah, so we have engineers that will come and do airtightness and Veritherm in one visit. So we test at the same time, normally as the air leakage assessment, which makes it a seamless approach. You know, you get one engineer, he turns up, he does the range of services, and then comes back to you with all the numbers in the reports the following morning so that the project delivery isn't affected by that test being implemented during the project, which is quite useful and beneficial and means that everybody is getting clarity on where things stand with regards to performance before the building's signed off, which is ultimately where the value lies.

Ben Adam-Smith 24:45

So where would you like to take this then, or is it just trying to get more people to see the benefit of doing these tests?

Tom Fenton 24:52

I think the end goal is to get this incorporated into legislation and things like part L of building regulations. You know, we've got the introduction of the Future Homes Standards coming in, which gives a requirement for photographic evidence of insulation performance. But that's quite tricky and time consuming. So what we're trying to do is saying, look, implementing measurement techniques is actually probably a better way of doing it. Until that happens, yeah, it's all about growing demand and proving the different value to all of the different stakeholders that we work with. So whether you're an architect that wants to kind of understand how properties are performing and use, and then implement that into your future projects, right down to product manufacturers who want to understand how their products are performing in situ, we work with a wide range of clients. And between now, and later iterations of Future Home Standards, we're looking to just scale the service and

evidence what value it brings to all of the different people that are involved in the construction supply chain.

Ben Adam-Smith 25:56
Are there any other aspects that are important that I haven't touched upon? Or perhaps don't grasp?

Tom Fenton 26:02
Not particularly, I mean, the only thing with thermal performance measurement is it seasonal. So obviously, we've got to achieve some kind of temperature difference between inside and outside. July and August tend to be the most difficult months to test. But other than that, it's quite a robust and dynamic system at this stage that can be you know, you dump the kit in, you leave it overnight, you come back, and it gives you a result. You know, once people start to get their eyes on the data and the information that comes back, we tend to find that they roll this out on other projects, because it's very useful and interesting data to have.

Ben Adam-Smith 26:38
Well, Tom, thank you very much for your time. Really appreciate it. Cheers.

Tom Fenton 26:42
Yeah, thank you, Ben.