Episode 14

Low Energy Barn Conversions

The show notes: www.houseplanninghelp.com/14

Ben: I'm with Bill Butcher from the Green Building Store. Hello.

Bill: Hello.

Ben: And today you're going to take us through your approach to low energy barn conversions. Before we start into that subject I think we want a bit of background on you, how you got into building, how you founded the Green Building Store and your story.

Bill: Crikey! That's a long one. I actually started off at 16 at the tech college in Exeter doing an HNC in building and went doing the quantity surveying route for the first few years, decided office life wasn't for me. I suppose I wanted to change the world a bit, which is . . . Anyway I ended up learning to plaster and picked up the tools.

So the combination of my practical experience and the management quantity surveying side came together really with my, I suppose, radical leanings which is the environmentalism. Green Building Store with two other colleagues was founded in 1995 and we've sort of moved into supplying components and the services around low energy and sustainable construction.

So, of our turnover now construction is only 10%, albeit the same size as it was years ago. The rest is windows and door systems, heat recovery ventilation, training consultancy and that sort of thing.

Ben: Before we introduce the Stirley Farm project I think it's very much worth our while looking at Denby Dale because that's been a big project, it's something that's finished, you've got data back from it, so how did you get involved in that one?

Bill: Well Passivhaus is a central European methodology, as you know Ben, based around a software program put together by physicists Wolfgang Feist and [Bo] Adamson, where you use this system to design the building not to need the energy in the first place.

In 2007 my business partner Chris had been over to Bregenz, I think, at the Passivhaus International Conference and had come back and said to me: “I think we’ve got to go this way, Bill. I think we ought to take the business this way.”

It just so happened that Geoff and Kate Tunstall walked through our door a month later and said that they wanted a house building for their retirement in their garden in Denby Dale, just south of Huddersfield, a ‘green house’ as they called it which in their eyes was going to be a dormer bungalow with a low of renewables.

We said: “Well, actually, we think you ought to go down the Passivhaus route. We’re sort of discovering this at the moment.” And luckily for us they did. That’s simplifying the story because there were many crooks and crannies along the way but in 2009 we started building.

So, they had a very small budget, relatively small, which actually was good because it made the build very relevant. We were going to get the building to perform to these levels. In other words, it’s quite prescriptive. You have to prove that it’s only going to need, in this case, 15kWh per m^2 per annum to heat as opposed to a normal house which might be 150 [kWh per m^2 per annum], for example. So what avenues were open to us to get this three bedroom detached house to perform to those levels?

We had planning implications. West Yorkshire folk will not allow anything unless it’s West Yorkshire stone, so the walling system, where were we going to go? To keep the price reasonable a builder will stay within his own comfort zone. For example, we at the Green Building Store are used to building with masonry, cavity wall, as a lot of other builders are.

We could get the materials over the road at the builders’ merchant, literally 300 metres away, apart from three items, really: triple-glazed windows with insulated frames – which in fact we at Green Building Store import ourselves anyway – mechanical vent heat recovery, which again we provide and design at Green Building Store and the tapes and membranes, which are actually more available now, even three years later.

Other than that everything, blocks, stone, insulation, roof trusses, everything else came down the normal procurement route. That’s what made Denby Dale very different from every other Passivhaus project because to be fair they were using their own vernacular methods. There was two projects in Wales by John Williamson,

brilliant, timber frame or the Camden house by Justin Bere, imported Austrian kit house.

That's another thing about fabric first, you can build in any style you want. It's about the performance. And it's not just about saving energy, it's about comfort because these places are, well I might say tranquil. There's no surfaces internally less than 17°C when it's -10°C outside. That has drastic effects on cutting out convection. Most buildings that we live in, well I use the analogy of the bonfire night. You're stood in front of a bonfire on November 5th burning on the front side, freezing on your back.

Now in fact we have that in a lesser form in all our buildings so we have to whack the thermostat up to 23°C to counteract that feeling. In a Passivhaus where you don't have that convection of cold air falling you can keep the thermostat down to 18°C.

Ben: Can I rewind a little bit to when you were talking about cavity wall? Is that what the majority of buildings are still constructed in that way at the moment in the UK?

Bill: Well, the simple answer is yes. Timber frame companies will try to tell you otherwise because it may be easier to do it, to build better in timber frame. Really what we're talking about is better building.

Ben: And if we have a timber frame, then we don't need any of the other . . . You can use very green components because you'll just be cladding it in timber. Is that how it works? I'm still a bit confused in this area.

Bill: Well, it's a bit more complicated than that. Timber frame is, in my view . . . You can either have pre-formed panels where it's built in a factory or you can have what we call stick construction, which is basically a load of 4" x 2" timber arrives from your local timber merchant and you build the frame there.

There are advantages and disadvantages of all methods. Timber frame would be, particularly the pre-formed, pre-fabricated units, you can get up very quickly, so you've got a building that can be worked on inside while the weather is bad and the actual rain screen, if you like, which can be anything – renders, brickwork, stonework, timber cladding – can be done in better weather.

Because of that comfort zone, I mentioned earlier, builders will price more tightly when they know what they're going to do. So if, in certain areas of the country the majority of houses . . . Put it this

way, 65% of all new housing in 2010 was cavity wall construction, masonry, traditional masonry. Probably 25% was timber frame.

Ben: Let's move on to the Stirley Farm project. Can you set the scene first of all?

Bill: Well, the scene is on the hill above Huddersfield, really exposed. These were three bankrupt farms that were owned by Kirklees Council, dairy farms actually, right on the edge of Huddersfield and it was given to the Yorkshire Wildlife Trust. This was quite a departure for them, taking these farms over. It was recognising that wildlife and farming is intertwined, so they are running this farm quite traditionally with a herd of cattle, beef cattle. The grasslands are kept in the way that they would've been over hundreds of years but being very but being very – I think the term they're using is – low carbon, no fertilisers and all the rest of it or minimal.

So they have got derelict buildings with these farms and part of their remit is food growing and what food can be grown in that climate, at that height, and how to prepare and cook that food. They came to us with this derelict barn and said: "What can we do with this to make it into an education centre?"

After a couple of years that's where we're at. We're converting it in such a way to get down to Passivhaus levels or be certified.

Ben: I know that you've got a very good blog on this that's live at the moment and you're updating all the time as you progress through. So let's talk about some of the challenges, first of all. It's a derelict building, how do you make it a low energy barn conversion?

Bill: Basically it was very structurally unsound. It wasn't apparent when Yorkshire Wildlife Trust took it over, although I was suspicious when I first saw the building. The original plans were, as most people would think, stick a bit of insulation on the walls inside, a wood burning stove and maybe some PVs if we could get a grant, and there we are. Of course, it was costed in such a way to reflect that thinking.

I thought at the time, crikey, no, this building is in a worse state than they're thinking. We've got to get the structural engineers in. Sure enough, we found that it was pretty unstable. So a lot of the costs, literally had to go into making the building stand up, which was underpinning the foundations, which were very minimal. Because we were putting in a new floor with a lot of insulation underneath we were undermining the existing foundations.

Ben: So you're putting a new floor underneath the building?

Bill: No, not underneath, within the building. The actual floor level will end up at the same level as it was, well just about anyway. In fact it was sloping inside originally but we have to be level now. In so doing we have to excavate, which is quite normal in a retrofit but of course we do it even more with this level of performance because we're looking at 200mm of polyurethane underneath a 6-inch concrete slab with the hard core. Well, of course, if you add all that up you are digging down – particularly at the top end of the barn – well underneath the existing foundations because in the past they would have dug down and found, *oh well this soil looks alright*, and laid a big stone and started off that.

So we have to put in big concrete pads. You have to dig under the existing walls and put in alternate 1m by 1m concrete pads underneath the existing wall to stabilise it. So that was the first problem.

The second problem was that the walls were actually falling outwards. What alternatives did they have, did we have? Well, one was obviously to pull it down, which some might say was the easiest thing to do. [Bill laughs.] It was decided not. Politically it would've been, I think, disastrous because the trustees of the Yorkshire Wildlife Trust had gone out on a limb to do this project and they'd paid money for these actual buildings.

Ben: It's an interesting concept though, when we have all of these derelict buildings and this new methodology is in complete contrast with the old buildings?

Bill: Well, in 2050, when we're supposedly using 90% less carbon than we're using at the moment, 80% of the buildings that are standing now are still going to be here, so we've got to find methods of cutting down our CO_2 emissions. This is just what happened on this particular project at this point in history.

So what we came up with – it was my partner Chris' term actually – was a box within a box, relatively easy in a barn because you've just got a big open space, not so easy in a terraced house where you've got all your floors and internal walls already.

That's what we did. We are building a timber frame building, if you like, within the existing masonry and stabilising the existing

masonry walls with the timber frame as well as insulating and creating the air tight envelope.

Ben: Are they touching?

Bill: No, no, no. We have a nominal cavity of 2 inches, 50mm, but the walls are so all over the place that that will probably go to 300mm in places. So, what we're doing is we've set in concrete pads in the existing masonry, blocks of about 450mm by 450mm into the internal . . . We've taken out 450mm by 450mm area of stonework in 30 different places or 40 different places within the building and then we've resin fixed into the outer skin of the stonework, if you like, in a hedgehog type way 4 threaded stainless steel bars. We've then set concrete around those bars and we are then connecting that block, that concrete – I don't know what it should be called really – connector – nobody's ever done this before [Ben laughs] – to the timber frame. We're using the teplo tie, which is the basalt and resin ties, which are an insulator in their own right but extremely strong.

So these rods are going to be resin cast into the concrete blocks in the masonry and then held within our timber frame so we haven't got the thermal bridge. And this is another aspect of fabric first philosophy – you've got to minimise the heat transference through thermal bridges. It's all very well having a lot of insulation but if you've got a lot of breaks in that insulation, you're potentially causing a lot of problems.

Ben: Is there a good definition of a thermal bridge? Is it that simple that you're trying to avoid that area where it's all going to conduct or do we need to know anything more about it?

Bill: It would be wonderful if we didn't have gravity. Right! [Bill laughs.] You're going to have thermal bridges because of holding things up. You've got to hold a roof up, you've got to hold a building up, haven't you? It would be wonderful if people didn't want windows because you could just have very well insulated walls everywhere and then selfishly they want doors as well. [Ben laughs.]

Now we have to have buildings with all this, well those three aspects really, and they are going to be thermal breaks in their own right, so we can build a wall to a U value of 0.1 quite easily. That's what the Denby Dale one is and that's what it's going to be at Stirley Farm. I might say three times better than existing building regs at the moment, but our doors and windows, albeit they're the best that we can do are 0.8 U value, so in fact they're 8 times

worse than the wall next to it. Now how that's installed in the wall is very, very crucial. You have to try and wrap the frame with insulation from the walls or continue the insulation around the frames but they are a thermal bridge in their own right.

You don't want, for example, steel balconies sticking out of your buildings, cantilevered out because as we know steel is one of the worst conductors of heat. We just have to look at the concept right from the beginning in a different manner where thermal performance is as important as keeping the rain out, when you think of a building right at the beginning.

Ben: In the middle of that, I was suddenly thinking to myself that I'm sure all of these ideas are catching on and growing but I also feel lots of things are going to go wrong, with perhaps when the cowboy builders come in. Is this just something that has to happen?

Bill: Well, that is . . . I don't know. I'm just one person in this world. [Bill laughs.] All we can do is . . . I think it's a massive opportunity for the construction industry to up its game, where the industry is not seen as this last bastion if you like of a school leaver, *oh well he might as well go into building*.

Why can't building be – well, it is, to get buildings to perform to this level – an engineering project? Look at the British car industry at the moment, how well that's held where actually we have far better training. I mean, it's holistic, it's a win win situation. We need buildings to perform. We therefore need a well-educated workforce, not only the workforce but the professionals that design and an educated client base, in other words why people are paying for what they're doing.

Again, none of this will happen until we've got better teamwork. I must say that the usual procurement method that we have for building which is putting out tenders to 6, 7, 8, 9, 10 builders will never lead to high performance because the builder hasn't any ownership over the building. It's far better to get a builder in partnership during the design stages so they can input into that design. They can actually work out . . . I don't know anybody that doesn't like doing a good job.

Does that answer your question? I mean, it's too big for me to answer in one go, really.

Ben: Perhaps it was just a thought in my mind and retrofitting, there's plenty more I could ask you but I want to get back to Stirley Farm

as that's our main thing that we're discussing today. So, thinking about the moisture, I know that this is where things could go wrong. We could get rotting. I'm sure I read in one of your blogs that you'd mentioned a project in Europe that had gone wrong, so how are you going to avoid this?

Bill: The problem with moisture in buildings can come from several different angles. One is groundwater, so that is what most people know of being dealt with with damp proof courses and so forth, and tanking when we're below ground. We've got moisture from wind driven rain through a wall, through masonry because stone brick is porous so we have to deal with it in one way or another.

The third one here is not understood very well, it's solar driven moisture. This can happen in the summertime and this is a danger where you've got, again, a radical construction. In effect, what you're doing with the external masonry wall when you've extremely well insulated internally is make it colder. It becomes in effect like a garden wall because you aren't losing heat from your building through the masonry, which is what we have in all other buildings. For example, a 9-inch brick wall in a London terrace with lime plaster inside originally, lime mortars, can breathe. It can get wet but then it breathes out in either direction. When you've put internal insulation in with a complete air tightness layer, what can happen is in the summer you can have a heavy rainstorm, the wall gets very wet, the sun comes out and actually the heat from the sun drives the moisture inwards. That can then drive that if you haven't got a well ventilated cavity it can actually then soak the timber frame inside. That's the case in Belgium that you're talking about. It wasn't built with the care to attention that was needed.

Now we think through software programs that, well, we know that as long as we ventilate well enough that moisture will actually be taken away in water vapour. How much we ventilate, no one knows. So that's the question around Stirley Barn which has been an interesting debate.

There is a software program called WUFI from Germany which we've used and that shows that if we can get an air change rate of between 10 and 100 – crikey, how do we measure that, how do we know, it comes down to wind speed and everything, doesn't it? – we'll be okay. If we go below 8 air changes per hour within that cavity there is a danger, so the software program tells us, that moisture will start building up in our timber frame.

Ben: I know that you can monitor moisture in the buildings. Do you think that this is something that more and more people will do as they build a new house? I don't know expensive it is to install. Or is it really only one or two research projects?

Bill: I would say you only need to do one or two. It becomes impractical to do it on every building but we do plan to do it on Stirley barn, where hopefully Leeds Metropolitan University, who we work with quite a bit, will monitor it on that moisture level. I must say, because I've been around for a long time building in Yorkshire, I'm pretty sure that we're going to be okay.

Ben: Well, that's a good point to leave it. In the show notes we'll put the links to both Denby Dale and also Stirley Farm and we can watch the progress of that latter project, maybe catch up another time? That would be great. There are plenty more things that I could ask you.

Bill: I could go on forever. [Bill and Ben laugh.]

Ben: Bill, thank you very much.

Bill: Great, thanks.