

## Episode 54

# Building an Autonomous House

The show notes: [www.houseplanninghelp.com/54](http://www.houseplanninghelp.com/54)

**Intro:** When it comes to building a house we have control over how energy efficient it becomes, although there are other energy demands that most of our houses have in the form of mains water and drainage, and we don't really control those. So are there efficiencies to be made by bringing those services in-house?

That's what we're going to discuss with Mike Coe. He and his partner Lizzie Stoodley live in an autonomous house so we'll find out what that means.

I got the conversation underway by asking Mike how this whole project came about.

**Mike:** I suppose it started out of an increasing concern about the environment and what mankind is doing to it. A concern I've had for a very very long time but some ten years ago or so I began to take it more seriously. I read certain things in newspapers and books and so forth and with an opportunity to be made redundant from my work, which I had been happily employed for many years, the opportunity came along for voluntary redundancy. I thought well I'm in a very privileged position now that I've actually got the opportunity to do something where I think I might be able to make a difference and the idea of an ultra-low energy house came to me and seemed like the ideal thing to do.

**Ben:** Now this is more than an ultra-low energy house. Take me through your research that lead to this autonomous house.

**Mike:** Well the original idea came from during my career as a news television cameraman I actually visited a house in Southwell in Nottinghamshire which had been built by Brenda and Robert Vale who I didn't know at the time were world leading eco architects. They had built a house the aim of which was to try and tread as lightly on the surface of the earth as possible, do as little damage to the planet. I was sent there to cover this as a story for the ITV lunchtime news. I found it fascinating, I hadn't expected to see what I saw but huge orange juice containers in the basement, storing rainwater, a composting toilet system. A house that was extremely

well insulated for its time, because this was the mid-1990s, and had no heating system was intriguing.

I came away, not with the idea that one day I'm going to build a house like that, but I was really interested in what I had seen. The story unfortunately never ran on the lunchtime news the following day because some great big story, I think it was Westland Helicopter story broke and the environmental story, the autonomous house was kind of chucked out went straight out onto the cutting room floor. But the idea stayed with me and it was many years later, as I say, I became more concerned about environmental matters and the idea of building a house which treads as lightly on the planet as possible was very very appealing. The natural thing to do was to start with the principles of the house that I had seen in Southwell and work on that basis but also try to improve on it.

Ben: We've done a lot Passivhaus, and I know this is a very well insulated airtight house but we haven't really explored an autonomous house so how would you explain that?

Mike: Well the autonomy is a separate issue in a way. You can build ultra-low energy but still use conventional external services so you can have a connection to mains water and mains drainage and so forth. There is no reason you can't do that and still have a house that consumes very little energy and produces very very little waste. The autonomy was an attempt to take it a step further based on the Vale's house that I saw in Southwell in Nottinghamshire and bring in house the provision of water supply and the disposal of waste and do those with minimal energy usage.

Okay, fair enough you can build a ultra-low energy house but if you are using external services there is still a considerable amount energy used in providing you with drinking water at high pressure treated somewhere else and pumped probably a considerable distance before it gets to you and then again taking the sewage away. There are pumps involved there are long distances and there is energy involved in the treatment process so bringing all of that in house we've effectively eliminated the energy that is used in providing those services so that reduces the energy footprint of this house even further but ironically those factors are not normally considered when looking at the overall energy demand of a dwelling. Even if it's very very efficient people don't tend to take into account the provision of external services. That is another energy drain which is elsewhere and people tend not to think about it.

Ben: We'd like to think or I would like to think that there are economies of scale and that all of this is being done by electricity because it is more efficient that way, but that's not the case?

Mike: No not necessarily. I don't know whether the setting up of public utilities, certainly not many years ago, took into account the energy drain. It was more a question of well this is how we want to do it and obviously not everybody could build an autonomous house. If you lived in a very densely packed town or city centre you would probably still need to have central servicing because you wouldn't have the space to have a composting chamber to deal with the waste and you wouldn't have the garden to put the resulting waste on even though it is very very good stuff when you can make use of it. So you have to take those things into account.

And yes, if you were building a larger estate it may not be worth putting in individual waste treatment or rainwater treatment into each dwelling but you could still do it on a localised scale, a little bit like district heating systems are now being talked about as being very efficient way of providing heat on a semi-local basis.

The point is that what we have done here in the autonomous house is that we have provided the water supply and the waste treatment without using any additional energy at all and that's the key issue.

Ben: And how do you start that planning process because I am imagining, although there were the Vales, it's not that popular a choice really, is it? So who else have you been learning from and how have you got it to the stage that you could start building and knowing what you wanted?

Mike: The Vale's house in Southwell in Nottinghamshire provided the basic template on which this house was built. I'm may be fortunate. I'm quite good at, if I have any talents, I'm quite good at working out how to do things and if I can see a problem that I wish to address my mind will churn away at it for days and days on end until eventually 'ah I know how we can do this'. So I worked out a lot of the basic principles myself but then we do have the benefit of nearly 20 years since I saw the Vale's house: it was ground breaking at the time. We have obviously made significant advances in low energy building.

The Germans have done a lot, the Austrians have done a lot but we have had some progress in this country as well so where I wasn't sure of what I needed to do and didn't know how to approach certain things I tried to seek out the best experts that we currently

have available in their field. So there was a wealth of information from people who had studied specific aspects of low energy building such as David Olivier, our energy consultant, who is quite possibly a genius. We had a specialist architect who specialises in low energy buildings and various other people including the construction manager and the construction team who specialise in this kind of thing so that obviously made it all a lot easier.

Ben: Were there any issues with planning or was that straight forward?

Mike: Planning was reasonably straight forward. We didn't set out to build a house that looked very unusual. We tried to build a house, we tried to design a house which wouldn't look out of place on the edge of a rural village, which is where we are situated. So we kind of tried to make it easy for ourselves and easy for planning although there are certain details in the way that the house looks which are there because of the way that it performs and therefore the way that it had to be built. So in a sense the ultra-low energy performance sets the style.

Largely the process was fairly straightforward. There were communication difficulties inside the planning department. I'm sure that is not unusual but ultimately I have to say that they were quite accommodating and they have allowed us to build the house with a large area of glazing facing due south which is important because we need the passive solar gain from the sun.

We don't have a heating system but they allowed us to build the house facing due south which actually places it at a strange angle to the road. When I spoke to the planning officer on the day that he told me that he was passing the plans he said: "I don't fully understand what you are doing but I can understand why you are trying to do it and we have allowed you to place the house at a strange angle. Perhaps if it had been a more conventional design we might have asked you to put it parallel to the road." So I have to say in all fairness that I think that our experience with planning was pretty good.

Ben: Finding a plot. Anything to note here?

Mike: Finding a plot. It was absolutely critical that we found a plot where we could build a house that faced due south because we knew that we wanted to build ultra-low energy. I said from the very start I wasn't interested in building a house that, you know, had a little bit more glazing and a bit more insulation but was basically an extension of a conventional design. I said to Lizzie, my partner: "If

we are going to do this low energy building thing I want to really go for it." This is how we ended up building a house with no heating system whatsoever, so critical to making that work was having a house which would face due south so you could have large areas of glazing and you could collect the heat from the sun, particularly in winter when in a zero heat house you are fighting for heat in a sense.

So that was one of the key issues, I had no idea when we started looking how difficult it was going to be. The economy was in the process of crashing because we were heading up to 2008. The house that we have built is on the very, very first site we looked at which seems incredible but we looked at it and said: "Yes this is all very nice, let's go and look at some others."

And we looked at many many more over a period of months. We travelled around. We were in a slightly unusual position because the move wasn't tied to a job, it was tied to wanting to build the house because I had effectively retired early. So we looked all around an area we had chosen and we kept referring back to this site. We saw many other sites, some of them had advantages, some of them didn't, but we kept referring back to this one and eventually we said: "We keep talking about the site that we saw at Crothorne, why don't we see if it's still available?" Luckily it still was.

Ben: You mentioned heating systems there. You have no conventional heating in this house, can you explain how it stays warm?

Mike: Yes it is unusual. I don't know how many other houses there are in the UK that have no installed heating system of any kind. I don't think there are very many but this is one of them.

It works effectively like a greenhouse by having large areas of glazing facing due south but the house is also extremely high mass so all the construction of the house was based around large amounts of concrete, large amounts of high density concrete blocks. In a few cases we even salvaged bricks from old electric storage heaters and used those to build internal walls because they are specifically designed to store heat. All of that mass is surrounded by a very large amount of insulation and then the house is built airtight with a mechanical ventilation system. The thermal modelling was done using the Passive House Planning Package (PHPP).

We didn't specifically set out to build a Passivhaus but the Passive House Planning Package is already there, it's proven and it works. It's a very, very good way of modelling the performance of an ultra-low energy building. In fact the performance of this house is 3 to 4 times better than is required to achieve Passivhaus standard so you are down to 3, 4, or 5 kWh per square metre per year.

Ben: And that's because you don't actually have a heating system other than the sun? Maybe you could explain the suntrap.

Mike: In a sense it is. It works like a greenhouse, it warms up when the sun shines. The glazing is specifically designed to capture as much heat from the sun as possible but it warms up this large area of internal mass which is surrounded by a lot of insulation and the whole idea is that it warms up slowly throughout the summer and as we head into winter and the temperature outside drops, the mass begins to give the heat back.

It actually carries through December and into January before you begin to notice that the thermal mass of the building is dropping. But you have also got . . . It's so efficient in terms of its heat requirement that even though you begin to lose heat from the mass through the winter you get sufficient additional heat from cooking, computers, televisions and indeed ourselves, the occupants own heat, the so-called incidental gains that in a standard leaky wasteful building are nothing, they just disappear out of the windows. In a house like this they can contribute to keeping the house warm.

Ben: I've just had an idea here. Middle of winter, it's starting to get a little bit cool in the house, have a party! Would that work?

Mike: A house warming party, yeah that makes good scientific sense. Yes it's a very very good idea and certainly OK. I can't pretend that living with no heating system at all is the same as having a heating system. You've got to be a little bit tolerant. You've got to be prepared to wear a jumper perhaps towards the end of January if you have a lot of overcast weather but it certainly isn't unpleasant and just a little bit of adaptability is fine. Certainly during the daytime if you are busy doing housework, you are up and about, you are on the move and so forth. You don't feel cold at all because you are generating enough heat, but yeah the more people you get into the house . . . Each one of us is worth something in the region of 100 to 120 watts at rest but if you are doing a bit of moderate exercise, housework, vacuuming or something that can go up to 180 watts so it's a useful amount of heat to put into the house.

Ben: And you have a temperature differential don't you which makes your layout slightly different to most houses that we might have been in.

Mike: Well we do but physics, the laws of physics apply inside any house almost always the upstairs of a house will be warmer than the ground floor because heat rises put simply. Therefore if you have a house where you don't have a heating system it makes sense to put the living areas upstairs where it is slightly warmer and then have the bedrooms downstairs which is exactly what we've done. It actually works very well. We're very fortunate we live in a nice area so we have a nice view but the main reason for the house being upside down is because the living area is always warmer. It doesn't matter in the winter if the bedrooms are a little bit on the cool side because you just need to use a thicker duvet.

There is a second advantage in that we've found in the heat of the summer if you get a very warm spell you don't get the problem of overheated bedrooms where sometimes upstairs it gets extremely hot during the summer it's very uncomfortable and you can't sleep. Having the bedrooms downstairs minimises that problem as well so if ever I built another house, I've no idea whether I will, but if I were ever to build another house I would without question build it with the living area upstairs and the bedrooms downstairs, you win in all ways.

Ben: Have we pretty much sorted out heating? Is it worth going onto some of the other considerations because if you are not going to be connected to a water supply how is the water provided?

Mike: Well we have a basement full of tanks but they are not just any old tanks. In line with the whole philosophy of reducing waste they are recycled bulk orange juice transport containers. They are 1500 litres each they are called Rotoplas tanks...

Ben: Just stop you there, so this is something, almost an innovation? You could have bought something that would hold the water but you actually been inventive.

Mike: Yeah, you could buy a giant specialist rainwater storage tank made of polypropylene or whatever but they have to be installed in a big hole in the ground and interestingly a lot of these bespoke rainwater harvesting tanks have quite a significant carbon footprint from their manufacture. So it is some considerable time before you recoup that by the savings you make on water. I liked the idea and again this was borrowed from the Vales house in Southwell. They

did exactly the same thing they had Rotoplas tanks bulk orange juice transport containers which are used for importing orange juice from Israel but once they have been emptied and the orange juice has gone into the shops it is not economic to send them back so they are effectively a waste product. I bought mine direct from the Britvic factory in Norwich and we use ten of them to store raw untreated rainwater, the eleventh one is a slow sand filter which almost completely purifies the water and then the twelfth one is a storage vessel. So we can store 17 tons of water in our basement where we keep these tanks and the fact that we have a dry composting toilet system means that we don't use any water whatsoever for flushing the toilet. Therefore it is feasible to harvest rainwater and supply the entire needs of the house purely from that.

Ben: Is there ever a time of the year when you've got to be more careful with the water?

Mike In lots of ways you have to be more careful with everything. I think that's something I like about this house. It puts you back in touch with the seasons, with the weather, with the environment outside. Yeah we need to keep an eye on the weather forecasts and if we see that there is going to be a very long dry spell coming up we need to be sure we don't waste water. So for instance you wouldn't water the garden, you wouldn't wash the car. It doesn't mean we have to go dirty but we have to manage our water supply. It's not too difficult because it's based on the design including sufficient storage in the first place so we have actually got well over one hundred days of water so we would be fine without any rain for over 100 days. But yes that and planning ahead for the coming of the winter so changing the settings on the mechanical ventilation system and basically just being more aware of what's going on outside which I think is an excellent thing.

We moved to this from houses where you've got central servicing and when it gets cold you just turn the heating on or you are warned there is going to be a drought but you don't worry about it. You just carry on using the water because all the problems are somewhere else. They are for someone else to deal with but that doesn't mean the problems aren't there. With this house the problems, well they don't have to become problems, but you manage your own resources, you manage your own water supply, you deal with your own waste and it puts you much more in touch with the environment which I think is an extremely good way to live.

Ben: Are we lazy then intrinsically or as you've started to do all these things realising oh I do produce waste, I have got to move that

somewhere, I am using all these resources, does it boil down to the fact that your neighbour thinks why are you doing that? It could be so much easier.

Mike: I think humans are intrinsically lazy, aren't we? Basically I think we want things to be as easy as possible. I wouldn't say that living in this house is more difficult than living in a house with conventional servicing. I'd say it's different and there are certain things that you have to be aware of and certain things you have to do but then equally there are certain things we don't have to do. We don't have to have a boiler serviced because we haven't got one. So, alright, we have to look after our water supply, we have to look after our waste but overall I think it's a better life than in a centrally serviced house.

Ben: Before we move on from water I am intrigued about composting toilets. We have never talked about it before in a podcast so what is it and how come you can have it in the middle of the house?

Mike: It's quite unusual to have a composting toilet system actually integrated into a dwelling. There are lots of them in Australia and New Zealand where there are remote communities where they have got no access to mains drainage. We have also got quite a lot in this country but they are often in outdoor facilities. The National Trust have quite a lot of them in visitor centres and so forth where they are some way from main services and so they use composting toilets. It's basically a giant compost heap into which all of our human waste falls together with handfuls of wood shavings which are needed to keep the compost pile healthy. But as long as the system is properly designed and properly constructed there's absolutely no reason why you can't integrate it into the dwelling successfully, in fact it's one of the things because so many of the things of this design are experimental I would say it's one of the things that has been extremely successful.

The composting system works very very well. It completely eliminates water used for flushing which in most houses in this country still use clean drinking water and we flush it straight down the toilet. Gallons and gallons of it every day. It's immensely wasteful and when we do that we mix together two very useful substances, namely human waste and clean drinking water and we produce a problem substance called sewage. We then have to use a lot of energy transporting it away and separating out and trying to make it clean so that we can discharge it into the environment.

With our dry composting system, first of all there is no water used for flushing. Secondly the human waste which is a very useful fertiliser remains separate, composts down in the chamber to a very acceptable compost which is not unpleasant to deal with. We can then take that out and put it on the garden or just let it rot down further on the compost heap. There is also a liquid component which is very much like diluted Tomorite which you can just put straight onto the lawn or on plants or whatever. We produce our own fertiliser, high quality fertiliser. It's not horrible, it doesn't smell, it doesn't cost anything, we don't have to go to the garden centre and buy fertiliser that's probably been grown with certain environmental damage involved. So it's a very, very good way of disposing of our own waste.

Ben: Electricity next. You are connected to the grid but how do you get most of your electricity supply?

Mike: The electricity grid is our only external service connection and the telephone line as most people have these days. We do draw power from the grid in the evening when it's dark. We cook using electricity partly because there is no gas in the village and it wasn't worth going to the trouble of adding a LPG system or whatever for cooking but we have a 2.3 kW photo array which is not large but it is based on supplying a house which is already very very efficient and that covers virtually all of our energy needs throughout the year.

Our net electricity usage is close to zero but in addition we try to use the output from the photovoltaic array as efficiently as possible. So for instance although we have solar panels on the roof which produce hot water for us we also have an immersion controller which diverts excess electrical power from the photovoltaic system and puts it into an emersion heater rather than exporting it. So we use the power from the PV array to the full.

The second thing we do is that we have a completely separate 12 volt electrical system which supplies about half of the lighting in the house and the water pumps that run the rainwater harvesting system and those batteries are charged during the daytime using the power from the photovoltaic array. We use the power from those batteries throughout the whole 24-hour period so we use the PV array as efficiently as we can.

Ben: What was the biggest challenge of this whole project?

Mike: Staying sane, I think, during the construction process! We were fortunate I suppose we didn't have any massive Grand Design style cock-ups around which television programmes are based but we had a whole series of ongoing little problems which had to be sorted out as we went along, little and slightly larger problems.

It was more the challenge of the fact that there were so many aspects of this design that were experimental. It was challenging all sorts of things, it was even challenging for the building control people who were dealing with aspects of design they wouldn't normally have anything to do with.

In some cases, everything was eventually sorted out, [they] didn't quite know how to handle certain things that I was requesting and we had involvement from the Environment Agency because we have the composting toilet system that deals with the human waste. The only discharge we have from the house is grey water and that goes straight into a soak away in the garden. We had permission to do that directly from the Environment Agency yet the first Building Control Inspector that we employed wouldn't accept that we could do that so we had a certain amount of, shall we say dialogue, frenzied dialogue about dealing with our grey water but ultimately everything got sorted out.

I was somewhat nervously putting my entire life savings into something that's a prototype and experiment and I didn't know if any of it was going to work but fortunately almost everything works. Some things have had to be refined I've still got little tweaks that I'm doing to various systems and so forth, and there are things that need to be looked after but fundamentally I would say the project has been a success without question.

Ben: Do I need to ask you whether you have had any learnings from it or have you talked through most of those just now?

Mike: I was ready for the hardship that would be involved in a self-build because although I wasn't anything to do with environmental matters I lived in a big house in London for some time and I did a considerable amount of work on it, not always to do with lowering its energy consumption, sometimes to do with making it look nice. But this was all in tune with my environmental concern, which was increasing as time went on.

So I didn't enter this project wearing rose-tinted spectacles, not by any means and it was every bit as horrible as I thought it was going to be but then I took on a lot of work myself. I wanted to be very

hands-on with the project. I knew that that was going to be hard work so I did end up doing everything I hoped I could do which was all of the electrical installations including the design of the specialist 12 volt electrical system and some of the control circuitry that goes with it. All of this with the help of Lizzie, my partner, I have to say, but I also designed and installed the rainwater harvesting system with the help of the local irrigation company as we live in an agricultural area. Installed all of the mechanical ventilation system and all of the plumbing.

Ben: Well that's a lot more than I'm going to be doing, that's for sure. Just as we finish up then, is there anything else that's key to the design that you would like to pass on to people, some closing thoughts?

Mike: I would say if anybody is considering doing a self-build, just pause and have a little think about how things are likely to be going. What's going to happen to fuel prices, what's happening to the environment, how life is probably going to become more in the future and think about maybe not concentrating quite so much on style and airy interiors but just have a little think about how the world might be going and whether you would like to build in a little bit of resilience, a little bit of capability to possibly go off grid if you have to. Certainly to reduce your energy demands down to a tiny, tiny amount so that you are not affected by rising fuel prices because I think that's something that's very very important. Take advantage of the fact that if you are self-building you can do something exceptional rather than trying to duplicate a mass developer's house, I mean what's the point?

Ben: And how will that effect you here then? Have you run that future vision of what things might be like and how would you cope with this house?

Mike: The original design aim I suppose was to reduce our environmental footprint so that we could live in such a way that we did as little damage as we possibly could to the surrounding environment but also in a way that was still comfortable, where you could have a pleasant life that was perhaps slightly different to living in a house with conventional servicing. Bearing in mind how things have been going even since we built the house and building a house like this opens your eyes to so many different things. I don't know how things are going to go in my lifetime. Everything might be fine but the fact that we can survive without any kind of heating energy input I think is a very very good thing. The fact that if we need to we can go completely off grid relatively easily I think is a very good

thing. I think being independent with your own water supply and it doesn't come out of the ground it comes from the rain so it's not going to be contaminated by hydro fracking fluids for instance seems to me to be a very good way to proceed.

It does open your eyes to all sorts of things. The fact that our harvested rainwater started to dissolve our copper plumbing led me to discovering that rainwater now is extremely acidic and the reason it's extremely acidic is that there is so much carbon dioxide in the atmosphere that we are effectively raining carbonic acid. So I have actually had to pH correct the rainwater to make it less acidic so it doesn't dissolve the plumbing.

One simple thing we've got here is we've got terracotta tiles on the floor. Now these are actually necessary because where the thermal mass stabilises the temperature of the building if you were to put carpets down it would insulate the mass of the building from the environment inside so the thermal mass would not work as effectively so therefore we have put down terracotta tiles. The point about these is, as long as you look after them, they will probably last for the lifetime of the building.

Now I don't know how many people work in the carpet industry in the UK but it must be thousands of people, they rely on it for their livelihoods, the people who manufacture the carpets, the shippers, the installers, and all of these people and carpets typically replaced every 15 or 20 years. We send half a million tons of carpet to landfill in the UK every year. Now that represents a massive amount of waste but it also represents a section of the economy and it seem to me as we have built this house there have been so many instances where having a healthy functioning economy involves waste. If you eliminate the waste, so if everybody tiled their floor with terracotta floor tiles and nobody built any more carpets it would be a big problem for a lot of people who would lose their livelihoods. So think I there is an irreconcilable payoff between having a healthy, thriving, functioning economy and economising where it really matters in terms of environmental damage and consumption and so forth.

Ben: Well it has been a really interesting chat and it has been fantastic to see the house so, Mike, thank you very much.

Mike: It's a pleasure. Thank you for coming.