

Episode 98

An Off-Grid, Earth-Sheltered Passivhaus

The show notes: www.houseplanninghelp.com/98

Intro: Today's podcast is with Christina Snyder from Equilibrium Energy Spaces in Michigan, USA, and it's particularly relevant if you're doing a self-build, a project where you'll actually be undertaking a lot of the work yourself. What's that going to mean? How might timescales change and if, like Christina, you want to be experimental too, how's that going to affect things?

I started by asking Christina to tell me a little bit about herself and her interest in green building.

Christina: Well as a young person I was helping my father to make solar renovations on our home and I also started in high school even, designing. I won a design competition for a solar house in high school. And then off to college and I kept trying to pursue those interests through college. And then after I graduated, I lost one job just before 9/11, the terrorist attack, and so there were no more jobs in architecture offices. So I started teaching students how to design zero-energy homes. There was a State competition that allowed students to enter and compete against each other to design a zero-energy house for Michigan. We ended up, the students of the school that I was working for, winning the competition twice in a row. So that was getting too boring so they discontinued the competition after we wrapped up all three prizes the second year. And then we entered a solar decathlon and about that time I learned about Passivhaus. I think I remember it was because the University of Darmstadt won that competition, beat the pants off us with the Passivhaus. So I figured if you can't beat them, you've got to join them. So then I started taking my Passivhaus training and became a certified Passivhaus consultant. I should also mention I had married a fellow who was a renewable energy systems installer.

Ben: So that's where all this solar comes from, the solar interest?

Christina: Yes. Solar and wind.

Ben: I hear that you are building your own house and this is a project that's live at the moment but there are a number of different facets to it. Have you ever build a house before?

Christina: I grew up working construction from the time that I was big enough to – well, my earliest toys were blocks that were cut-offs from a construction site and I would be daddy's right-hand girl and hand him the tools he asked for. So I was on construction sites from the time I was old enough to get in trouble.

Ben: In terms of your own home, have you lived in one that you've built before?

Christina: No but I did a lot of renovating on other people's homes growing up and even some new construction work as well. I should say that my father built the house that we were living in but that was before I was born. But it was an ongoing project finishing it. We moved into it before it got its first coat of paint. So that was something like twenty years later.

Ben: How have the types of houses that you've lived in changed?

Christina: The houses that I have lived in, I guess it was about high school that my dad renovated the house that he had originally built to make it more of a solar home. It didn't really have the best orientation to be a solar home but we enclosed a south-facing greenhouse space and added more insulation to the walls and roof and stuff. And then while in college, I actually worked my way through school partly by helping my landlord to do renovations on an old historic home. So that was pretty fun. And I currently live in a very old, hundred year old farm house that has very little insulation at all. So it makes me appreciate the Passivhaus that's under construction because already with the heating systems set down at fifty five degrees, it's warmer than the house that has the furnace set at sixty-some degrees.

Ben: As someone who knows a lot about construction, when it comes to your own project, you want to push the boundaries a bit. So tell me what is different about this project and what do you set out to achieve by the end of it?

Christina: What's different about this project is that it's doing a lot of things that haven't really been brought together before into a single project, at least not in Michigan. So I've got the Passivhaus stuff, we're going to try to go all the way to zero energy and be able to power the house with nickel-iron battery system like Thomas

Edison's first batteries. They're less toxic. So we'll have solar hot water, wind and we're actually going to try to do some seasonal space heating where we'll take the surplus energy from the solar hot water system in the summer time, put it into a season heat storage tank, whatever we don't need for the domestic hot water loads and then in the winter time we should still have enough solar hot water for our domestic hot water but we can take the surplus heat that's still in that tank from the fall and be able to heat most of the way through the winter by putting it into radiant floors in the house. We also have a composting toilet and will be looking at doing grey water treatment and rainwater storage and a whole bunch of other things like that, that are rather experimental in terms of what most code officials would see. But they haven't given us any trouble about it because I am basically owner-builder-architect. So if anything goes wrong, it's my fault. I can't point at the code official. It was all my idea.

Ben: Clearly you're taking on a lot with this project from financing it to finding the location to designing it. Does that ever cause you concern that you're doing too much of it?

Christina: My husband says we're on the bleeding edge of technology. And that's certainly true but there's a long history of architects experimenting on their own homes. This is not the sort of thing you want to do your learning curve on a client's house. So we only have money to build one house. We're going to throw all these experiments into one big pile and it's probably going to be a couple of decades' project by the time we get everything – I don't know if it'll ever be house beautiful but that wasn't really one of the goals for us.

Ben: That's quite something to say. A couple of decades' project. And you're totally unfazed by that or it has to be this way?

Christina: Well as I said, the childhood home that I grew up in, I never realised it growing up but the first coat of paint went on twenty years later. So it's not that the construction may be continuous that whole time, it's just that we'll do it in phases and we'll constantly be tweaking the results that we get. I have some friends that have a house that's been under construction for thirty-some years. [Ben laughs.]

Ben: I think that's a record. I'm not sure.

Christina: Some people just enjoy – it's kind of like the nesting instinct. You enjoy tinkering with your house if you're that kind of mentality.

Ben: Let's start out with the beginning of this project. How did you find land? Was it just an open patch of land or is this a rebuild?

Christina: We did some searching. It's actually rather difficult to find good solar exposure. By that I mean I want to have sunshine year round from at least nine a.m. to three p.m. is my ideal. That's not entirely necessary for a certified Passivhaus but the better you can get, the easier it's going to be to hit the mark. We didn't want to just have a Passivhaus but also to go all the way to zero energy where all of our energy needs would be met from current sunshine and wind.

Ben: And this is a rural area?

Christina: It's a rural area. We ended up settling near some neighbours of ours who run a certified CSA sustainable agriculture – it's a certified organic farm but it's subscription-type farming where people buy shares of the organic food. So they're good friends of ours and it's nice to be within walking distance of them. But we searched pretty much through the whole city and you can't just go on a real estate website and type in 'I want a good solar exposure.' So we did a lot of looking at the satellite photos, we visited a lot of sites with our solar pathfinder to take measurements before we actually decided where we wanted to be.

Ben: How soon after acquiring that plot did you then move on to designing and building? I get the feeling that this ongoing process might be different to what a lot of people are doing but tell me about that.

Christina: The farmer that previously owned the land was a bachelor farmer and he needed to sell because of the economic downturn. So in some ways that economic downturn played into our favour because not only did the land take a drop in price and we were able to afford it better when he decided to put it on auction but we also didn't have to fight to get labour assistance or materials. Those sorts of issues were much better in the downturn.

Ben: How much of this house is in to the earth and how much is above ground?

Christina: The house has three storeys of windows on the south. It's got two levels on the north but the lowest storey on the north has no windows at all. And the windows on the second level on the north, the ground is coming just in below those windows. They're as high as they can be and still serve as egress windows. The windows on

the first floor on the south have the same kind of relationship to the ground. So there's a full another storey on the north side than the south side.

When you look at the pictures, you'll see a little structure on the north side of the building that was kind of our practice structure but it's for storing rainwater and that will pretty much be completely below the ground level.

Ben: Take us through the process then of how you're progressing.

Christina: We broke ground in 2011 and it was a very deep hole. The ground floor of the house is going to be, like, fourteen feet below ground on the north side of the house and about three feet, four feet on the south side. We had a hard time keeping that hole open that year because it was a record wet year. We pretty much got the foundations in the first year of foam on that year. And I haven't mentioned yet the construction of the house, the basement level, everything that's buried below ground is sixteen inch thick slabs of the white EPS beadboard, like Styrofoam cups but it's a little bit denser. We set those up and glued them together and then coated both sides with glass fibre reinforced concrete, about half an inch on the inside and the outside of the foam. That makes it into a structural insulated panel that's incredibly strong. It's also the weather barrier and on the inside of the house it serves as the air barrier that keeps moist air from inside the house from leaking into the walls.

Ben: That's the foundations that we're talking about there?

Christina: Yes.

Ben: On top of that what structure have you got?

Christina: When we started the project we actually thought we were going to build the entire house that way. It would've been like an ice chest house. It took us a lot longer than we thought it would because we had a pretty steep learning curve. The people that first turned us on to the building system wanted seventy thousand dollars to train us, not including the equipment. We said 'we can't do that.' [Christina laughs.] So we found out who their suppliers were from a fellow that makes the equipment that they use and so between the equipment manufacturer and the suppliers, we were able to piece together a recipe and start experimenting. But in a large extent we were pretty self-taught with our method and that's probably why we still don't have it perfected enough to do it for somebody else. We ended up

at one point hiring a fellow who's been doing it professionally for more than ten years and he's got his own specially developed chemical recipe for the concrete that he won't disclose to anybody. But it probably takes a good ten years to get really good at doing this method of building. And that's why it took us so long owner-building to make that happen.

Ben: So was that the right choice then in your mind? If it's something that's quite complex to get a good grip on, you didn't consider other ways of doing this. Why were you so keen?

Christina: Well it wouldn't have been good for a client but we wanted to build in the south side of a hill, earth sheltering, and we needed to meet the Passivhaus standard. We needed, like, an R60 wall. So if we had done insulated concrete forms where you've got about six to eight inches of concrete in the middle then the entire wall assembly would've been close to two feet thick. It still wouldn't have been easy to do. So this seemed like a logical way to get the amount of insulation that we needed and it would be very strong and it would have much less CO₂ emissions because you can't make cement without making an equal amount of carbon dioxide emissions. It's just part of the chemical reaction.

Ben: Let me just almost paint the picture a bit and you can tell me if I'm wrong here. So who is working on site as you're doing this? Have you done this with your hands, this whole ...?

Christina: Mostly my husband and I were working on this site. We would setup the foam and when we got a certain amount of it done, we would have a spray day. When we did a spray day with the large equipment, it's a really gruelling process because once you get started with that equipment, you pretty much can't take a break because the concrete would set up in the hoses. So we would do about eight, maybe nine hours of non-stop spraying the concrete on the wall and then it'd be another hour of clean up afterwards. We needed at least six people to help us but they weren't especially skilled labour. We kind of taught them as we learned.

Ben: And when do you need that concrete layer through the different elements? I'm just trying to get it clear in my mind.

Christina: The fellow who does it professionally, I believe he sets up the entire Styrofoam walls from ground all the way up to the roof level, builds those up before he puts any concrete on it at all. And then he just goes like crazy for a week spraying it. But when we first started, we weren't sure how strong this system was, never having done it

before. So we were trying to do each tier of foam as we went up to attach them together. Now I have a lot more confidence that that's not necessary so when we made the jump from finishing the first floor level to getting ready to put the second floor level on with wood walls on the south and east side of the building where they weren't going to be below grade, we had the carpenters coming in the week before, I was erecting all this foam that was going to hold the roof up on the north side. And rather than trying to coat it all with concrete, I just sort of taped the seams and plastered the seams with some concrete and the rest of the foam was bare. It carried the roof loads for over a year through the winter and into the next season with bare foam.

Ben: Every so often when I'm doing this podcast, I realise the audio is not good and we need diagrams and pictures which is why we have on our website things to backup this particular interview.

Christina: I have some pictures I can ...

Ben: Definitely. I think that will help clarify what's going on here in case – I think I've asked enough questions about it but I want to see it.

So does this take us up to date then of where you are on the build? Because you're still in the middle of this.

Christina: The carpenters were able to help us get the wood walls which are made out of I-joists instead of dimensional lumber and the roof trusses on before last winter. So it's been a little over a year that those have been up in place. Last summer we got the roof on and all the insulation in the walls, the cellulose insulation in the walls. So that's about where we're at. We got the windows in except for two.

Ben: Is there a danger that these components might be deteriorating in the time that it takes to get it weather tight?

Christina: You can actually notice with the foam that it gets yellow when it's exposed to the sunlight. I did try to keep the foam tarped when it was in storage on the site and much of the time that it was erected. But it's not a big problem when it's yellowed because you can take a rasp and just rasp off the part that's yellowed and get down to the pure white foam again. Then you can still get a good bond with the concrete.

Ben: How long has this project been going on now?

Christina: It'll be a little bit under five years now.

Ben: When do you hope to move in?

Christina: Well that answer hasn't changed much. I keep saying it'll be about a year from now but that's pushing the horizon out further and further. So we'll probably go ahead and try to move in as soon as we get the Certificate of Occupancy. It may be a little bit over a year but not much more now.

Ben: Maybe we should schedule the next podcast then, the follow-up of what actually happened. Are there any other aspects that we haven't looked at that are worth mentioning or that are unusual?

Christina: Well we have root cellars. My husband was living for the better part of twenty-some years as a vegetarian on locally grown food. So he's very much into having the proper climate for each type of food. So we have three different rooms that will each have different combinations of temperature and humidity. Mostly passively. And I have actually stored apples for over a year in the first half of the year without any refrigeration and they're still edible and good. So the apples moved in before we did. [Christina laughs.]

Ben: I think I remember seeing one house here in the UK where they had a section – it was outside the thermal envelope but there as a larder. Because our temperature in the UK is often quite cold, it worked perfectly. It was just outside. You wouldn't necessarily notice it unless you knew how it was designed but I thought that was a clever addition.

Christina: Yeah. In this case, the larder or the food storage rooms are actually below the frost line. So they should stay cool like a cave year-round.

Ben: That sounds like a cellar. Get some wine down there.

Christina: Yeah. It is. If we were into wine, that's where it would be.

Ben: What has been the biggest challenge so far?

Christina: Well they say that if you really want to test your marriage, try building a house. So there were some rocky times and I don't think they're over yet but we're still together and I'm very much pleased and hope that we will be for the next fourteen, fifteen years. That's about how far we're into it now.

Ben: Okay. I think then we have more or less covered most of the aspects. In the show notes we'll have some pictures and different bits and pieces. Christina, thank you very much.

Christina: Thank you. It's been a pleasure.