What's the deal with Passive House?

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David Roberts

Hello, everybody. This is Volts for July 19, 2024, "What's the deal with Passive House?" I'm your host, David Roberts. People who have hung around energy and housing circles long enough will have heard the term "passive house." It refers to standards of construction — not just for single-family homes, but for any building — that prioritize air sealing and insulation as a way to maximize comfort and minimize energy use. I have been aware of passive house for years, mostly as a European thing — it originated in Germany — but I never really tuned in and paid close attention. Now, though, it seems like the idea is starting to catch on a bit in the US, especially in a few key Northeast markets like Massachusetts and New York.

It still represents a tiny fraction of new buildings, even in those markets, but it holds out hope that it can escape its obscure niche and start making its way into the mainstream. So, I thought I would take a closer look. To do so, I'll be chatting with Beverly Craig, who runs the building decarbonization team at the nonprofit Massachusetts Clean Energy Center. She's been heavily involved in efforts to integrate passive house principles into the state building code and create incentives for developers of multifamily housing — especially low-income housing — to adopt passive house standards. I'm going to talk to her about exactly what the passive house label entails, the benefits it brings to building occupants and to the grid, and what it would take to persuade more US builders to adopt it.

All right then, with no further ado, Beverly Craig, welcome to Volts. Thank you for coming.

Beverly Craig

Thank you, David, for having me.

David Roberts

Let's start with just a little bit of history. I know, actually, that the passive house concept has a very long, a very long history, goes way back. But let me, let's just briefly review, sort of like, where this came from.

Beverly Craig

Sure. So, let me just quickly give an overview of what we're talking about here. So, the passive house standard is a very super-efficient building standard, like LEED or WELL would be. And the concepts here really took off during the energy crisis in the 1970s. So worldwide, right, energy costs went through the roof, and we had a lot of architects, both here in the US and in Europe, focus on super-efficient and super-insulated, honestly, buildings. We, of course, in the US, lost our interest in this when prices got a little lower.

David Roberts

We really took our eye off that ball, didn't we?

Beverly Craig

We did. And then, basically, the Germans, through the Passive House Institute, perfected this building science approach of sort of five basic principles that really drastically reduce the heating and cooling associated with buildings.

David Roberts

Yeah. So, real quick, let's talk about the three performance metrics that it goes for. That aims for here. One is low thermal load, which just means it uses very little energy to heat and cool, heating and cooling being, I guess, the main bucket of consumption for buildings. The second one is low overall energy consumption. So that's like your heating and cooling plus your electricity. And then, what's the third one, I can't —

Beverly Craig

Well, there's definitely a big focus on ventilation, fresh air ventilation with heat recovery as well.

David Roberts

Right. Well, we're going to go through the principles, but anyway, that's just sort of what they're trying to achieve. Basically, it's like high comfort with low energy.

Beverly Craig

Exactly.

David Roberts

More or less. And so, the Germans sort of formalized it and made it into an official standard and have been using it for a long time. But, I think it's fair to say that in the US context at least, it's pretty nascent still. There are not a substantial number of homes in the US that have been certified as passive house, is that fair?

Beverly Craig

Well, I would say that adapting it to the US climate has taken a while. Like, Europe doesn't have the same ups and downs that our whole United States does. And so really, there are two places you can get certification. There's the German standard Passive House Institute and Phius out of Chicago. And those two both have an awareness of different climates. And so the predictions for what you would do in a building and their energy models account for that. But it took a while, I would say, to go from Europe. And Germany in particular, doesn't have a lot of highs and lows, and we are just later adopters.

Energy hasn't been as expensive, and I think that's driven a lot of it. And it's also not as critical a security issue for us as it is in Europe.

David Roberts

Right. Okay, so the core of the passive house standard comes down to five principles, five building principles. And I want to spend a good amount of time on these because one of my frustrations, reading around about passive houses, you can tell that the marketer, they consulted marketers, and the marketers are like, "Talk about the benefits. Quit boring people with technical language, talk about the benefits." And so I read and read and read and it's all about, "It's wonderful, clean buildings, and you'll be happy and your floor won't be cold when you get up." And I just kept thinking, "Yeah, but what is it? What's the mechanism?" So the introductory videos you said were really good on this. So let's walk through these five core principles and talk just a little bit about what they mean. So the first one is continuous insulation. And insulation is kind of the big thing here. So what does continuous insulation mean?

Beverly Craig

Well, I think what you want to think about is, like, in the winter, putting on a sweater, right? Keeping your warmth in is what insulation is all about. And the continuous part means we want to make sure that it doesn't have gaps in it around the building. So, that's just like the basics. And I think almost anybody who knows buildings knows that insulation is important. So, I think it's the continuous part of it that's important here is that there's a high level of detailing to make sure that you don't have gaps.

David Roberts

So, insulation with no breaks in it around the home, that's sort of what they call the envelope. And then the second principle is no thermal bridges. So, what is a thermal bridge?

Beverly Craig

On a multifamily building, sometimes there are structural things that go from the inside to the outside. So, think about a balcony, for example, might have structural steel going through it. Steel conducts heat and cold pretty well. So, in the winter, that's going to bring that cold into the building pretty easily. And so, trying to minimize, through design, thermal bridges. Also, there are many products that you can use. So, you can still have a balcony, but interrupting that transition of cold or heat through, you know, sometimes it's even like wood studs. So, just really being careful about that in the designing and then in the actual construction to make sure that it happens the way that it's drawn.

David Roberts

So, no materials that are going to conduct heat or cold from the inside to the outside or vice versa, basically.

Beverly Craig

Right.

David Roberts

And then, so that relates to the third principle, which is airtight construction. I guess I — part of me wonders, how is that different from continuous insulation?

Beverly Craig

Yeah, well, going back to the sweater analogy, if you're out in the cold in the winter and there's a huge wind blowing and you have a sweater on, you're still cold because there's lots of air coming through that sweater. So, you need a windbreaker as well on the top. That is your air barrier all the way around you. And to me, this is the key thing that is different about passive house than more conventional construction, is this really intense focus on air tightness so that you're not heating and cooling the outdoors, but you're keeping it all in the building.

David Roberts

This is the outer envelope then, this is the outside of the house. So you have an airtight shell, let's say, around the house. And then inside that, you have the continuous insulation.

Beverly Craig

Yes, it can be done in different ways, but you need both of those two layers. An architect will often talk about having a red pencil test where they go around the outside of their drawing to make sure it all connects both the air barrier and the insulation.

David Roberts

Yeah, you know, I think maybe normal people, when they think of building a new home with modern science, they probably think, "Well, of course, it's airtight. You know, why wouldn't it be?" But I think people would be surprised how not airtight most construction is. I was certainly surprised when we did an energy assessment ten years ago, my house was just absolute Swiss cheese.

Beverly Craig

Yes.

David Roberts

It was leaking air all over the place. And again, this gets to that last 5% to 10%. Right. Cause a lot of these are just tiny little details, tiny little bits that you have to cover.

Beverly Craig

Right. And when you do a blower door test, did they do one of those on your house?

David Roberts

That was it.

Beverly Craig

They're testing at a certain pressure how often the air turns over. And just for perspective, passive house, both the Passive House Institute in Germany and Phius, have an airtightness requirement that's about five to six times more tight than new construction in Massachusetts was a few years ago. So, we're talking a dramatically different level of airtightness than even new construction. So, new buildings are way better than my duplex was five times what code was when I had my blower door test. That's why we need to focus on existing buildings as well.

David Roberts

Yeah. So, you're keeping all the air out. I mean, all these first principles have to do with, basically, sealing the home. Basically, nothing comes in the home, even air that's not on purpose, basically. So, the fourth is high-performance windows and doors. That seems pretty straightforward. When we say high performance, does that mean the more expensive option at Home Depot, or is this super windows that you have to special order kind of thing?

Beverly Craig

Well, it depends on where you are in the country, first of all. And then it also depends on your energy model, where you're putting your emphasis. So, you have to get to a certain amount of thinking about it being a thermos. Right. It has to hold a certain amount of energy inside. And you can choose whether you do that on the roof or the windows. I mean, that's one of the nice things, it's not prescriptive, it's a modeled sort of option. In New England, in Massachusetts, most of our buildings do require triple-glazed windows.

And so, that's both for the amount of energy coming and going from them, but also so that you don't get condensation.

David Roberts

Right. Because of the humidity.

Beverly Craig

Yeah, yeah. But I would say, in many parts of the country, that is not necessarily true. And the cost of triple-glazed windows, though, like ten years ago, that would have been only something you could get in Europe, has come way, way down. And there are a lot more options these days.

David Roberts

So, maybe in a temperate climate, you could get away with double-glazed windows. It's when you get in more extreme climates.

Beverly Craig

Probably, and I think the other thing is, you're going to want to manage the solar heat gain with different coatings in the windows as well, depending on your climate and the way that the building — so that's sort of the passive part of when we talk about passive house is really managing that solar gain. Certain places, you're going to want that all the time. Sometimes you're going to want it only in the winter when the sun is lower in the sky. And if you're in Texas, you're going to want it all the time. Right?

David Roberts

Yeah. So, this gets to the sort of thinking a lot about context, which I think is something that doesn't, in sort of typical US mass construction, doesn't get a lot of attention, really. It's sort of like thinking about which direction the house is oriented, where does the sun come up and go down, the seasons. You really have to think a lot about the physical context. And so, the fifth principle, fresh air ventilation with heat recovery. I guess I understand what ventilation is. So, you have this sealed envelope, and this is something, I think, that came up a lot when I brought this up on Twitter, is, you know, people remember, I think, from an older version of kind of energy efficiency, this problem of sort of like people getting overenthusiastic about sealing the envelope, but then you end up with sort of stagnant air inside because there's no air exchange.

So, passive house makes a big deal out of ventilation, which I understand. But what does it mean with heat recovery?

Beverly Craig

Well, first of all, it not only just requires ventilation, but it requires ventilation to all occupied rooms. So in Massachusetts, like in a multifamily building, our old code would have only required one place where the supply was for the entire apartment.

David Roberts

Oh, interesting.

Beverly Craig

But with passive house, it's in every room.

David Roberts

So every room has like air blowing in, basically?

Beverly Craig

Fresh air that's filtered, which is really helpful, like when you have bad air quality or, like fires or things like that. Right. It's very helpful to have that. So that's the big difference. So the heat recovery part of it is that we're not wasting heat. So, like, in my home, when it's winter and I'm heating my home and I turn on the bath fan, the air goes outside with all that hot air. Right. It's just wasted. And so the concept here is that when you're getting rid of that exhaust, you capture with a heat exchanger some of the heat, usually, like 80% to 90% of it, and you transfer it into the cool air that's coming in, the cold air, and preheat it so your heating system doesn't have to work nearly as hard. So that's the heat recovery portion of it.

David Roberts

Oh, interesting. So, when you generate the heat with whatever your heat generation is, the idea is, let's make maximum use of that heat. You sort of, like, catch it as it's going out, put it back in, use it multiple times almost.

Beverly Craig

Exactly. Or, like a hybrid car or anything where you're using the waste heat. Right. To help you in general.

David Roberts

Let's talk then about the benefits. You have continuous insulation, no thermal bridges, airtight construction, high-performance windows and doors, fresh air ventilation with heat recovery. Those are the core five. I saw on the site you sent that there are other principles. Like they get up to ten, I think, in one list, like managing moisture and shading and building orientation. And so I just wondered, are the five core principles universal? Is there some universally accepted list of principles, or is it just everybody sort of has their own version of this?

Beverly Craig

I mean, I think it's how detailed you want to get into these five. Right? When we were talking about better windows and doors and the solar heat gain, the shading comes into that discussion. Right? And moisture has to do with your ventilation. You want to, with your ventilation, integrate, you know, dehumidification as an option, especially if you're in a more humid climate. So, like, I think the five cover it. It's just like how much we want to talk about each of them.

David Roberts

Right, right. How much do you want to unpack it?

Beverly Craig

Right.

David Roberts

So, the ventilation, then, when you're bringing air in, you can condition the air in a number of ways. You can clean it with a filter and you can dehumidify it with a dehumidifier. Let's talk about the benefits then. The idea is, if you do all this, you basically have a house where a) the air inside is always fresh and clean, and it's always comfortable. What do you, when you give people sort of the elevator pitch about the benefits of doing this, what do you most stress?

Beverly Craig

Well, I think at its basics, it's trying to drastically reduce how much heating and cooling is needed for a building. So in Massachusetts, we're talking 40% to 60% less energy per square foot that passive house buildings are using than a traditional code building from five years ago.

David Roberts

And this would be in the Northeast, that would be substituting for natural gas power, mostly?

Beverly Craig

Mostly, and increasingly, heat pumps for heating and cooling.

David Roberts

Right. So, your heater has to work much less hard. You save money and you're comfortable. So, what everybody wants to know, the first question everybody wants to ask is, how much does this cost? How much does this cost relative to a normal house? I'm sure that that is a very complicated answer, since, as you have said a number of times and we're going to get to later, this depends somewhat on geography, it depends on your climate. I think even within the passive house standard, there are choices you can make emphasizing different things. So, I'm sure there's no hard and fast number, but ballpark wise, if I'm a builder, I'm a home builder, and you're trying to persuade me to do this, what can you tell me about how much extra I will have to spend to achieve these goals?

Beverly Craig

Yeah, well, I can't tell you much about homes, honestly. And it's interesting because I think people immediately jump to single-family homes because of the name passive house.

David Roberts

Yes, I've been doing that in my head. Yeah, we should say this is not about individual homes. It's any building or even a complex of buildings. Multiple buildings.

Beverly Craig

Yeah. So, "house" in German tends to connote "building" in general. And so, I feel like the sweet spot is multifamily larger buildings where passive house is the least expensive add in terms of incremental cost and the biggest energy savings at the same time. So, like, I sort of specialize in that area and can talk about the costs there, but, just to be clear, I'm in Boston. There is an office building down the street from us that is a passive house building. There are schools, there are senior care facilities, there are educational schools and administrative buildings.

Like, there's even laboratories. Like, you could have anything be a passive house building. And I would say the sweet spot that we are finding and where passive house is accelerating in an extremely large way in Massachusetts is in the multifamily market. So, think about ten units or more, like an apartment building or condo building.

David Roberts

This gets at something I had a lot of questions about. One thing you hear a lot about is efficiency in bigger buildings, multifamily buildings, or office buildings. Is this problem of sort of perverse incentives or divided incentives or, you know, the idea that, like, it's frequently the case in apartment buildings that the apartment dwellers will pay the utility bills, which means that, like, the owner of the building doesn't care that much about the last 5% to 10% of air sealing or whatever. Are you running into that problem? How do you, like, who in a multifamily building, gets these benefits? Who benefits from the benefits, I guess?

Beverly Craig

Yeah, well, and I think we see the earliest adopters for multifamily in the Northeast for passive house have tended to be the affordable housing market. And that's because they're long-term owners who care about keeping those costs down. And they care a lot about what their tenants have to pay when those are given to the tenants to pay. I do think, though, there is a general interest because, you know, one of the biggest benefits here with passive house is that we have very predictable energy performance. Like so, LEED I like in a lot of ways, however, when you look at the measured performance on an energy side, it's all over the place.

And that's partially, there's not the construction verification that passive house has in the field, checking to make sure things are happening. But I think even market rate owners or condos or people who are renting apartments to market rate do like the predictability, you know. And I think your audience, right, understands that being able to shave peaks for our grid is really important. These buildings do not have the high highs and the low lows that a lot of the other buildings do that are out there. So we do see in the multifamily market a surprising number of interested parties in the market rate space.

So, our agency, the Massachusetts Clean Energy Center, did a demonstration project back in 2017, and we paid for eight affordable housing developments to upgrade to the passive house standard.

David Roberts

You paid the difference between standard and passive house?

Beverly Craig

We gave them a full grant per unit. We didn't know exactly how expensive it would be. And then, sort of part of the point was to see what changed. So, in low-income housing tax credit projects, you're at 80% drawings already by the time you're getting funding. So, this is almost like a change order. So, we could actually see, like, was it the windows, was it the ventilation? Did the mechanical systems get smaller? And so, we were able to actually track that, which is really exciting. I don't think you see that in a lot of other places.

A lot of other places, people will say, "Well, this feels more expensive." And, like, they looked at some options, you know, but they don't really have great before and after numbers. Of course, that's not the best way to design a passive house building. Like, you should start from the very beginning, because it's way cheaper to do it right the first time than it is to, like, change things along the way. But our eight, they ranged from a 1% to a 4.3% premium. And this is with no incentive or a Mass Save incentive or any tax credits. I think most people had thought before this that it would be more like 10% or 15%.

David Roberts

Yeah, that would have been. I guess that would have been my guess.

Beverly Craig

Yeah. And so, like, I think that was really helpful. And then here in Massachusetts, our Mass Save utility-run program, which provides incentives for new construction, sort of took the lead that we had set here at MassCEC with those demonstration projects and provided three grants per unit for any new construction multifamily. They've been running that for five years. And we have 120 buildings, probably 9000 units by 2026. They're going to get built to the standard. So that carrot, maybe it's not everything that needed to be put in to make it cost neutral, but it's enough to really change the tide in the adoption of Massachusetts.

David Roberts

Interesting. So, under 5%, generally, for multifamily buildings, you think that's sort of generalizable? Like, do you feel comfortable, sort of like promising builders, it'll be under 5% of a cost premium?

Beverly Craig

Well, what I would say from the folks from our eight, there are some lessons. One is, the more educated the team is and the more experienced, the cheaper it was. So, I think in some ways, it's going to be like LEED, which was, everybody said it was a 2% premium 20 years ago. Now it's sort of paperwork. I mean, I do think there's real differences in the construction that are going to go to zero right, over time, but I think it's hard to do the first time. And contractors, when they don't have a known quantity, tend to throw a high number at things for risk. Right. So —

David Roberts

Yeah, right.

Beverly Craig

But I think you'll see the Massachusetts market, especially if we can successfully, like, we're a public agency, we are trying to get the lessons learned on these earliest projects transmitted to the folks who are now going to have to do it as part of code here in Massachusetts so that they can skip past the hard steps and do it the least expensive way possible. Right. That's really the goal.

David Roberts

Right. So, these costs are not fixed. They can be brought down over time, the cost differential. A slightly different question than additional money is additional, I guess you'd say, hassle. I don't know how you'd measure that exactly. But, like, one of the things I run into on this pod again and again, when you're innovating in an industry that is, let's say, small c conservative, which I think a lot of these big trade industries tend to be, and this is what I've heard basically about the building industry, is that they're quite grumpy, don't want to be messed with, don't want to be given additional things to do or additional money to spend, that there's quite a bit of resistance to this.

And I'm wondering what is the, for a contractor, is it difficult to do this not just in money terms, but in, you know, finding the materials, finding the trades people who know how to do it, you know, finding the right kind of windows, is it a big extra hassle?

Beverly Craig

So, I think the first time you do anything, it's a hassle. Right? And I don't know, in your newsletter you were talking about, there is no conservative position anymore. Right? You have to be somewhat aggressive.

David Roberts

Change is coming.

Beverly Craig

Right. The contrast is, if we don't build buildings the right way now, when they're new, it's a whole lot more expensive to retrofit them at 15 years. And that's why you see it taking off in like, New York City. Passive house is like taking off through the roof in New York City because of Local Law 97. Right. And so, folks realize that if they build it to the passive house standard, they're not going to have to retrofit it in 15 years.

David Roberts

Right. But is it pretty — I mean, from what you've heard back, like, I'm curious, sort of the qualitative feedback that you've gotten from builders.

Beverly Craig

Yeah. So, a lot of them like it because they feel like it's higher quality construction. There's so much construction verification. You're making sure all the way through that what the architect is drawing is actually getting built. And so, you're not going to get callbacks as much on things failing because you've tested it as part of the whole process. That isn't to say that it's not hard to find subcontractors who — even an electrician needs to be aware that if they cut a big hole for the outlet and they don't tell someone, that's a big hole in the air barrier that's going to be a problem for someone.

So, there's a basic level of understanding that you have to do things slightly differently. But we're talking about, like, an evolution in construction practice as opposed to, like, a transformation and all these, like, you know, wacky-doodle new technologies we haven't really dealt with before. It's stuff that anybody who's worked in a high-performance kind of world for larger buildings is getting very familiar with. But that's not to say we don't

need to train people. We absolutely do. There's a real crisis in the labor market around workforce training for high-performance buildings right now.

David Roberts

Yeah, I mean, it mostly just seems like slowing down and being more careful and detail-focused. Right. Which I guess if you're a craftsman, intuitively, I want to think that, like, you would appreciate, you know, like, maybe that's why you went into the field in the first place, because you wanted to do good work. You know, it's like, sort of like an excuse to do good work, almost.

Beverly Craig

Yeah, and it's durable, right? So an owner is interested in this because, like, I don't know, I worked in affordable housing ten years ago, and we would come back every 15 or 20 years to refresh baths and kitchens and get financing for that. And then we would open up walls and realize that there was rotting sheathing and, like, mold and insulation. So the nice thing about this is, like, there are so many people's eyes on the building science, you're not going to get that nearly as much, I think. So these are going to be more durable, higher quality buildings in the long term. Of course, it's a little hard to know since we don't have a huge sample size that has ten years under its belt in the US here. But it just makes sense, just like this higher level of ventilation. We don't have great health data yet on it, but it's got to make sense that it's better.

David Roberts

Yes, I wanted to mention when we did the ventilation point that indoor air quality has really gotten quite important lately. Quite a bit of attention for very obvious reasons, you know, from COVID to wildfire smoke, et cetera. And, you know, when I talk to people about this, about indoor air quality, people are just horrified. We have no, you know, like, relative to outdoor air regulations. We have almost no regulations of indoor air. There's like, construction codes are terrible. There's just like, it's just a terrible situation in the US. Our indoor air quality.

So, the fact that every passive house building has sort of like rock-solid fresh air inside it is a big deal. I think that's one of its sort of flagship things to brag about.

Beverly Craig

Agreed. And honestly, my allergies have gotten worse over the last few years. I put in heat recovery ventilation at my house just for the filtered air, for my allergies. There's a lot of reasons on the health side. And the other thing that I like about passive house is a lot of the things folks tend to not like about multifamily buildings are drastically reduced with passive house.

David Roberts

Right. They're drafty, they got thin walls, you can hear your neighbors, etc.

Beverly Craig

Yeah, they're a lot quieter. I don't think a lot of people recognize that. And within the Phius standard, you're compartmentalizing. So you're not getting the cooking or moisture or who knows what they're smoking next door, right, coming into your unit. And also pests from both the outside. This airtightness, it keeps the critters out. And also between units, it really protects that way. So those are like some of the things I don't think people immediately think of, but I think quality of life wise are why I would want to live in one.

David Roberts

Yeah, that's so important. I mean, not to go off on a little rant here, but I'm always saying like, if you're advocating for density, for urban density and infill and building up, you know, walkability, all these kind of things that I'm constantly talking about in this pod, you really need to go the extra mile to make sure that it's pleasant to live in those places. Do you know what I mean? And for a lot of people, I think their experience in the US, the quality of life is not great. So that's really interesting. One other point I wanted to make about the costs, we were talking about the upfront costs, but as you say, we don't really have enough data yet to measure costs over time.

But if you think about the costs of a building over its lifetime, I bet passive house comparison comes out looking much better because you avoid some of those retrofit costs, et cetera.

Beverly Craig

Yeah, I would definitely think so. We just don't have the data on it yet. I mean, what we do know is these buildings use predictably a whole lot less energy. So, any community that has an energy disclosure ordinance, like Boston, New York, Philadelphia, you can look at buildings that are passive house certified and compare them against other similar ones, and you find 50% less energy use per square foot. Sometimes higher, sometimes slightly lower. But that's pretty dramatic, right?

David Roberts

Yeah, that's not incremental.

Beverly Craig

No.

David Roberts

I wonder if you can get dramatically better performance. Like 50% better energy performance and all these dramatic improvements for 1% to 5% extra costs. That seems like a great deal. And yet, these standards have been around, as we said, for decades, and US builders still aren't doing it. So, what's the disconnect? What do they not know? What are they wrong about? Why hasn't this taken off more, I guess, is my question?

Beverly Craig

Well, I don't think this is a niche thing in New York, and especially not in Massachusetts. But five years ago, people wouldn't know what you were talking about when we said passive house. So, I think there's some learning that needs to happen. I do agree that doing anything new is hard, right? Like, it's just change is hard. It's really hard. Even if it's the right choice to change, we gotta be there to help people make transitions in terms of the way they're thinking and the way they're building, where they're even operating these once they're built. You know, our agency at the Massachusetts Clean Energy Center really has a big focus on workforce development.

And we are trying to upskill existing workers who are operating buildings like this, as well as getting new entrants to the construction industry and getting upskilling of construction workers within Massachusetts. So, there's really a lot that needs to be done around that. But, yeah, change is hard. That's what I think is the biggest issue.

David Roberts

Yes, pushing a boulder uphill. One thing that comes up when you talk about passive house is getting these performance gains involves, I think it's fair to say, more materials upfront. Like, you have thicker walls in these things and you have more massing to absorb heat, etc., which raises the question of embodied carbon. So, these building materials, as listeners know, were generally made with fossil fuel-based processes. So, they represent some emissions, what are called embodied emissions. And so, if passive house buildings are using more materials upfront, it follows that they have greater embodied carbon in them.

And I just wonder how we think about that embodied carbon relative to the carbon savings you get in operation. Like, what is the sort of scale of that?

Beverly Craig

Well, we are definitely, as a nation, not paying enough attention to this upfront carbon associated with the building material.

David Roberts

Hardly any.

Beverly Craig

You can't say enough about that. We definitely have initiatives here in MassCEC, trying to raise awareness and design techniques and high-impact, low-cost things you can do to reduce embodied carbon. But I don't see the passive house as in conflict, and I don't necessarily think that it's additional material. You need to be wiser in material. So again, in those larger buildings, so multifamily buildings in Massachusetts, the big changes around that air tightness number, we're not seeing changes in insulation in a substantial way. So if that's one of the places you think that there's additional material when you get to a building of this size, that's not really the case.

So, single-family homes definitely need thicker walls for sure, and a lot more insulation. But, like, that thicker wall could be, you know, wood-based fiber products or a hemp-based product. It's about, like, what you choose to use and, like, avoiding the very worst. Like, so it's great that on some of the foams that are used in high-performance buildings, the worst blowing agents have been banned now in the US. It took us a while to sign on to that. But, like, there are similar things that we need to think more carefully about. So, concrete is another great example.

Right. That's one of those really high embodied carbon building materials. And we can both design with less of it and start using switch outs for that Portland cement, which is the really problematic part of it with glass

pozzolans. And there's even like here in Massachusetts, there's a company, Sublime, which MassCEC has—

David Roberts

Yes, they've been a guest on this very podcast.

Beverly Craig

Yeah. And so, like —

David Roberts

We love Sublime.

Beverly Craig

You know, that's potentially extremely low, possibly even nearing zero carbon concrete. We need a revolution in the sort of materials that we're using, and we need to design more carefully. We just had done an embodied carbon challenge where we gave prizes to larger buildings that incorporated changes. And it was really interesting. Both the grand prize winners, the biggest focus actually was on the owner. So one was a UMass Amherst laboratory. They had defined certain needs. So like, a lot of the savings were actually in reducing the amount of square footage that they built. So they did some more dual-use spaces and they stacked offices in the lab portion where they needed really high ceilings.

And the same thing: The retrofit winner was a historic library that they're going to do in addition to. So they saved the building itself, but they also reduced by quite a lot the amount of space by doing more dual-use rooms.

David Roberts

Ah, interesting. Yeah, I bet once you get thinking about that, there's a million different ways to come at that problem of embodied carbon. I should say, I did read one post from a woman who's a passive house designer, has a passive home that she lives in, who did the math on embodied carbon versus operational carbon. And her first conclusion was that her passive house actually had lower embodied carbon than a standard house, which is somewhat counterintuitive. But also, I think the more important point is just that that difference is dwarfed by the difference in operational carbon.

"You know what I mean? Like, eliminating a fossil fuel boiler is just like a huge over time in a way that ends up dwarfing embodied carbon. So, but anyway, so speaking of retrofitting that library, one of the things I wanted to ask about is all of this seems like I can completely envision how all this works when you're building a new building, right? You're just sitting down with a blank sheet of paper. You can design your perfect envelope and your continuous insulation and all this. But when it comes to retrofits, how on earth — I mean, like, I understand how to retrofit a building just to make it more energy efficient, right."

There's just lots of obvious, familiar things. But retrofitting a building to the point that it passes passive house certification, that is somewhat mysterious to me. Like, how would you take a big, old, drafty library and completely seal the envelope and eliminate all thermal bridges? The mind boggles. Is it possible? Are people retrofitting big buildings to passive house standards?

Beverly Craig

I mean, if you're going to completely gut a building, you can. But both the Phius and PHI have a retrofit standard that is —

David Roberts

Oh, a separate standard.

Beverly Craig

— not asking for the same level of performance as a new construction building. And like, I give credit to both of those organizations because it is very hard with the variety of existing buildings and their existing level, which is like all different, you know, 100-year-old building versus a '70s building. Like different needs different options for what you can do. So, like, I give them both credit for working on this.

I think both of them sort of recognize that if you do this all at once, it's very expensive. We couldn't, at scale, like here in Massachusetts, we know that like 80% of the buildings that are here today in Massachusetts are still going to be here in 2050 when we need to be at net zero, right? So we need to make them all a whole lot more efficient, maybe like 30, 35%, and get the fossil fuels out of them. But, like, they recognize instead of trying to do those all at once, necessarily — and like, to me, this is the biggest promise for the way we need to learn how to retrofit buildings — is we need to make sure to capture any natural replacement that would happen.

So, like a hot water heater only is going to last eight years, right? So, you want to get set up to the electrical so you can put in a heat pump when that dies. And you want to, every time a roof is redone, or you're replacing windows or you're replacing the heating system, or you're residing, or, you know, you can think of these major things that happen in the life of a building and capturing all of those, going a little bit extra. It's a reasonable amount to think about doing that. It's just, it's very hard to do that because that's not the way ownership often is.

A lot of times, buildings turn over, right? So that's like, I think, our biggest challenge is having, you know, the roadmap for how to get these buildings

to net zero. And I do think there will be a lot to learn from buildings in the next five years that try the EnerPHit, which is the PHI retrofit standard, or the CORE REVIVE of Phius, because I think we're going to learn, you know, how are people staging this? How many years does it take? Like, what are the major things? Like, are certain things like you can imagine, like roofs are super important, right?

Just like in people, you put on a hat, right? A lot of heat goes at the top or at the bottom. Especially on a larger building, there's a stack effect. So, there may be these places that are just super important to focus on early, no matter what. And the rest, we can just sort of make sure that people don't just replace with like —

David Roberts

Well, when you say, "Make sure."

Beverly Craig

Yeah, I don't know that there is a way to make sure.

David Roberts

I mean, it seems to me like if you want Massachusetts buildings to be zero carbon by 2050, at the very least, you need all building upgrades from now on to do this, right? To strive for passive house-ish standards. You need that to start immediately. How do you do that? Is there a law? Are there codes? What is the mechanism by which you stop a building owner from just sort of slapping on, you know, just getting it over with? Like putting whatever the previous roof was on, just a new version of that. How do you intervene in those decisions?

Beverly Craig

Yeah, well, we have building emission standards for larger buildings in Boston and Cambridge, just like New York has its Local Law 97, where, you know, for a number of years in those communities, larger buildings have had to report their energy use and their climate impact, and then they have to ratchet down their energy use over time or get fines. That is in place for those larger buildings. How do we do it across the state? A little more challenging, right. And maybe we should be only focusing on the largest because there's a lot to learn here and that's where the biggest impact would be.

Right. It's in the bigger buildings.

David Roberts

Right. And I guess maybe you could, I mean, tell me if this sounds crazy, but maybe you could hope that, like if you get the big builders comfortable with these techniques, that they'll just sort of filter down through the industry naturally. Or is that naive to hope?

Beverly Craig

I hope it's not naive.

David Roberts

So, one other question is about geography. You have this extra upfront cost. I'm just imagining that there are certain geographies, certain climates where eliminating energy for heating is a huge deal. You save a lot of money, and it's an obvious decision to make to do this upfront. But I'm thinking about other climates that are like more temperate climates where there aren't these extremes, or maybe not as much humidity where you're just maybe not getting as much out of this. You're maybe not getting as much benefit out of this as you would in the more extreme climate.

And maybe it's not — doesn't add up to be worth it. I'm just sort of wondering how geography contingent is all this stuff. Or do you feel confident saying that, like, everyone everywhere could benefit from this?

Beverly Craig

I'm not an expert, honestly, besides in the Northeast climate, however, I like what Massachusetts has done with its energy code. It has made an optional stretch code. So we have this specialized opt-in stretch code that's harder across Massachusetts, and communities can choose to raise their hand and say, "We want all new construction over 12,000 sq feet to meet this harder code and to have to be a passive house." And so we've had, I think it is 32 communities, which represent, like, 27% of the population in Massachusetts, raise their hand and say that.

David Roberts

Oh, interesting. Just for, like, public-spirited, you know, like, purposes. Like, what do they, what do they get out of it? Just, they feel good about themselves.

Beverly Craig

I mean, I just think this climate is a very big issue in Massachusetts. And, you know, this is in town hall — Massachusetts, except for the largest cities, this is a town hall state. And so, like, there's like 300 residents having this conversation. So there can't be a lot of super big critics or I just don't think you would have seen that. But, like, maybe that's a way nationwide. Like, I think New York's thinking about doing something similar and, like, in Chicago, similar things, right? That communities can choose to do this if it makes sense for them.

I mean, I'm not optimistic that, like, Mississippi builders are going to be really interested in this, but maybe they are because of the humidity. I don't know. Like, I do think the other thing that I would love to see is right

now on the national stage, the Department of Energy has this Zero Energy Ready Homes, which I think is a fantastic name: Zero Energy Ready.

David Roberts

What does that mean? What does that mean, ready for?

Beverly Craig

It basically means the Energy Star. Are you familiar with Energy Star? Which is like the EPA, it's Energy Star plus making it solar ready. So, having enough roof when you build it and a conduit to the basement and room, it's not really that hard above Energy Star. And what I would say is, like, Energy Star is a little behind the times. We'd love to see that updated, too. But basically, it's a prerequisite to get Zero Energy Ready. And a lot of the IRA monies and tax credits are tied to that Zero Energy Ready. I would much rather see, because it's a voluntary standard, that it be a little bit more. Like, it would be great to see what is all in the Phius standard replaced with the Department of Energy's Zero Energy Ready because it's really not a hard stretch, the Zero Energy Ready.

And if people are going to do it on a voluntary basis, I would like to see so. That's a little harder.

David Roberts

Well, let's just look at Massachusetts. You have this stretch code that cities can adopt if they want to. Are there incentives for doing so? Like, are there other policies where you can get extra, you know, rebates or, or whatever, some sort of financial boost for adopting this as a builder? Like, are there other policy incentives?

Beverly Craig

Yes, so there's a $3,000 per unit incentive for multifamily in Massachusetts through the Mass Save utility program. So, the utilities recognize that this is a game changer in terms of energy use. They have done that for five years, and I think they're even thinking of upping it honestly in the next series.

David Roberts

Oh, interesting. So, the utilities are into this then? Just because, I guess, big buildings being predictable just makes it more manageable, makes the grid more manageable, I guess. So, utilities are jazzed about this.

Beverly Craig

Yeah. At least the energy efficiency side of utilities is not always, but —

David Roberts

Yeah, I was going to say, the gas utility is probably not as much.

Beverly Craig

I mean, it doesn't necessarily require, like, you don't have to be fossil fuel free to be a passive house. By the way, a lot of projects still have hot water. You know, in a multi-family situation, there's not a lot of technology options yet. There are in other countries, they're coming our way, but they aren't really there yet across the board here, they're just starting to emerge. So, passive house is really about driving those heating and cooling loads down. It does not necessarily prescribe what they would be. But I see very few new construction buildings in Massachusetts, at least, that are going to have both heating and cooling that don't go with a heat pump system of some kind.

It just sort of makes sense because it's less expensive than two separate systems. So, the heating and cooling is going to be electric, at least in

Massachusetts, with heat pumps. But we're still working on the hot water question.

David Roberts

Right. Interesting.

Beverly Craig

Yeah.

David Roberts

And isn't it Massachusetts where they're experimenting with these thermal networks, too, like, you know, replacing the gas network with hot water?

Beverly Craig

Yeah.

David Roberts

Geothermal hot water. They're experimenting with that, too. It seems like that would integrate very nicely with a passive house.

Beverly Craig

Exactly.

David Roberts

You could get a lot more out of that if all the buildings were extremely low load.

Beverly Craig

Yes, and like geothermal, instead of air-source heat pumps, also work great with this. Right. So, you see increasing numbers of those, too.

David Roberts

Trey, one other question about the grid thing. One of the points that was made in one of the articles you sent to me is that it said even the most up-to-date energy codes cannot, and I quote, "crush wintertime heating loads." And this is put forward as a sort of special benefit of passive house. What does that mean exactly? What is the significance in particular of suppressing wintertime heating loads?

Beverly Craig

Well, as we increasingly are electrifying heating with heat pumps, whether it's air source heat pumps or ground source heat pumps, we're not just going to have problems with summer peaking problems, we're going to have winter peaking. Right.

David Roberts

Arguably much, much larger than summer peaks. It gets very cold up there.

Beverly Craig

Yeah, yeah. And so, if the heating demand on a building is half because its envelope outside of it is really like a thermos, right, and it's not letting out the heat, then it's going to require less of a stress on the transmission lines and the whole electric system.

David Roberts

Yes.

Beverly Craig

So, it's like a thermal battery in some ways. You could sort of think of it like Lisa White at Phius talks about this, and I think it's an underappreciated value of passive house in general, especially our bigger buildings.

David Roberts

That's fascinating. That's fascinating. Yeah. And I think it's a — I just want to stop and emphasize this point because it's a huge deal. As we talk about electrifying everything, this is arguably, you know, people point to, like, sectors that are going to be difficult to electrify, like aviation or whatever. But in my mind, the most difficult challenge in electrifying everything is precisely this: heating and cooling in extremely cold climates in the winter. Like, that's just a lot of energy right now that we're getting mostly out of natural gas. Moving all of that onto the grid is just going to be an enormous challenge for grids.

So, insofar as you could slash their heating and cooling needs by 50%, that seems like more than an extra. That seems like a necessary complement to electrifying heating and cooling. Like, you're just not going to be able to do that on a mass scale unless you cut the energy demand of buildings. It seems to me, anyway.

Beverly Craig

Yep. And when we retrofit, we can't just replace with heat pumps. We have to focus on the envelope in our colder climates; we just have to.

David Roberts

So, yeah, you mentioned this earlier, but I just wanted to sort of clarify the kind of relationship to passive house to building codes. How easy is it to just adopt passive house as your building code? I'm sort of like, building codes are kind of like minimums, right? I think that's what they're designed to be, is like a minimum, whereas, like, passive house is like not minimum, it's like maximum. So it just feels like — it seems like a kind of an uneasy fit. Do you think it's better to keep those separate, or is the way you see passive house spreading via codes?

Via working their way into codes? I guess I'm not totally clear on the relationship between passive house and codes.

Beverly Craig

Yeah. So, I would say in Massachusetts, we made passive house an alternative compliance path for meeting any energy code in Massachusetts. Back in 2015, I believe New York, Washington State, and then some cities like Boulder and Denver have done that as well. So, I would say that's like step one, right? Like, make it an alternative compliance path. It means a whole lot less energy modeling and HERS rating and things like that. That would be like normal things you would have to do.

David Roberts

And to do that, you're just taking it off the shelf. Like, literally just taking the Phius standard and sticking it into building codes. Is it that straightforward?

Beverly Craig

Exactly. The community is going to need to see at the time of design that either PHI or Phius has said, "If you design it this way and build it this way, it should be a passive house." That's an important thing before they let them start construction, for example. And then at the end, they want to make sure that they've actually done all the stuff that they need to during construction. So that's an alternative compliance path. Now, because we have this option in Massachusetts for communities to choose the higher energy code that mandates the passive house, then it's different.

It's like brought up the floor in those areas, which is sure a different discussion. I'll tell you. It's all suddenly about, "How do I do this?" Instead of, "I don't want to do this." So, it does change things.

David Roberts

Always a better discussion.

Beverly Craig

Yeah, but I don't think everybody's ready for that. So, I think policy generally works better when there are both carrots and sticks. So, the fact that we have a number of years of carrots that we've learned from made it a lot easier for those communities to opt into that harder standard.

David Roberts

Is anyone making it required? Like, is it baseline required? Any in any jurisdiction that you're aware of?

Beverly Craig

So, it is only, I believe, in these communities in Massachusetts that have opted in. So, it is mandatory for 12,000 sqft or above.

David Roberts

Oh, I see. So often it becomes mandatory.

Beverly Craig

Right. But it's not really, I don't think it's anywhere else. There's definitely a lot of incentives. And so in affordable housing, there's a bunch of states, probably like ten or 15, that give you extra points for low-income housing tax credits. So, you're more likely to get chosen for financing. So, there are these indirect things I've even heard of, like loans where the loan amount in New York would be lower. The other thing is they find in market rate that tenancy doesn't turn over nearly as much. So, banks love that because turnover cost in apartments is very high.

And so when people are really happy.

David Roberts

Yeah, if you got one of these, you'd really want to hang on to it.

Beverly Craig

Yeah.

David Roberts

I'm guessing the contrast between one of these apartments, I bet, and most available low income housing is, I'm guessing, quite stark.

Beverly Craig

But I'm talking about even in market rate developments that are passive house, people like staying in the apartment so long they don't move out. Right. Even when they up the rent. And so, banks like that because of the loan value. And so, like you see some financing agencies in New York sort of like giving you a better rate if you go with a passive house. So, like there's these indirect carrots. Right. But nothing standard across the board.

David Roberts

Right. Well, my final question would just be like, it seems like Massachusetts has, to some extent, figured out how to get this going. Like, passive house is expanding rapidly in Massachusetts in a way that does not appear to be happening really anywhere else in the US. So, what is the, insofar as you're talking to advocates and state legislators and state officials in other states and conveying what Massachusetts did to cause this sort of little mini renaissance of passive house, what's the formula? What do you tell those states? What is the first, second, and third thing to do to replicate Massachusetts' success?

Beverly Craig

Yes, well, I definitely think starting with demonstrations, then incentives, and then this opt-in stretch code is the right formula. It's encouraging because the incentives part of it, NYSERDA is offering them now, ComEd in Illinois, National Grid in Rhode Island, and Austin just appropriated money to do a demonstration program.

David Roberts

Oh, interesting.

Beverly Craig

So, like, we're seeing people move into this space. Hopefully, we're breaking new ground here in Massachusetts and we can give a lot of lessons to people about what's working best.

David Roberts

Awesome. Well, thank you so much for coming on and talking through this. It's really cool. It seems like this, as I said, sort of like the yin to the yang of cleaner energy generation is using less and I think it doesn't get as much attention always as the other side, but this seems like, as I said, a necessary complement to all that stuff. So, thanks so much for coming on and talking through it.

Beverly Craig

Thanks so much for having me.

David Roberts

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