**Transcript of interview with Adrian, building engineer:**

interviewer 1 0:00

We're now recording.

interviewee 0:03

Okay, cool.

interviewer 1 0:06

All right, This shouldn't take more than like, 30 minutes. Are You ready?

interviewee 0:16

Born ready.

interviewer 1 0:18

All right, um, let's start with an easy question: tell us a little bit about your background and experience with energy performance related to go there.

interviewee 0:31

So I did my masters I guess about five years ago, which is a masters of Building Science. So this degree was very heavily focused on building energy performance, as well as some other things like building facade design for energy performance, and so on. So like, insulation, windows, mechanical system. So any basically all aspects of the building. And a big component of what people care about is how much energy does it use. And then so after that, I graduated from that in I guess, like 2015. And then I was working for three years at a company called transsolar engineering, which is actually a German company from Stuttgart. But basically, we do high performance building design. So kind of like top of the top energy, high performance buildings will be hired by the architects and we'll go in early in the process, and we'll just give a lot of very high level guidance and design support for getting a building to very low levels of energy performance. Sometimes, clients will care more about this or less about it. So sometimes there's very stringent goals that will be trying to meet like that zero energy, or sometimes it'll just be kind of, you know, a little bit of window dressing, Okay, you know, just like kind of more superficial.

We work a lot for universities in the northeast, because that's kind of who's paying for this kind of thing right now. Okay. So like Princeton, Harvard, Smith, Dartmouth, like all these kind of places. And like this, the German offices do all sorts of other work, but the New York office is very focused, or just the way it's kind of worked out, it's our clients are very focused on end up being kind of universities. So energy performance is really one aspect of what we're looking at the other aspect of what we're looking at was, what it's like to be in that building for humans. So is it like a nice place to be is in, you know, is there good air quality? Is there daylight. So unlike Germany, where there's very strong rules about whether or not humans have access to daylight, like something, like every person needs to be working, like 20 feet of a window, That's not exactly the metric they use, but that's how kind of comes out there's nothing like that in the US. But some, you know, certain architects and certain buildings will care about that. And then you can help them with that sort of thing. And some of that also comes back to energy performance, like if you're using Windows for day lighting, and you're not using as much electricity for, for lighting. Okay, so that's like, kind of Crash Course of what I was doing.

interviewer 1 3:41

Okay. Sounds cool. So you mentioned, some of the customers care more, some of them care less. What do you think, in your experience is like the number one factor? Why do they want to have a net-zero building or improve in energy performance overall?

interviewee 4:07

I would say the primary factor is that they feel compelled to do something about like, climate change. Okay. That's probably the main factor. Like when, when you're talking about designing a building from scratch, that's usually the only thing that matters. And you're talking about doing a retrofit building. There are some arguments that can be made for like, I just energies, cost savings. But usually, that's just like switching out light bulbs, from whatever incandescent to or even fluorescent LED, this kit usually is much more limited kind of scope of things that people would consider maybe upgrading the mechanical system.

interviewer 1 4:51

Okay, so getting into more details about retrofit, You said there is not a lot of, or you didn't have a lot of projects that were extensive. You talked about the light bulbs. Was there any clients that wanted to invest in digitizing the system, for example, getting smart meters installed?

interviewee 5:24

Yeah, so we didn't do any retrofits. You know, we're kind of the expensive specialty people who you would call in before, like, a creative situation where you're like, starting from the ground. Um, so I don't have direct experience with doing retrofits. But like, in the case of retrofits, yeah. Typically, it's like a lighting upgrade. Sometimes it's a window upgrade. Or it can be like a mechanical system upgrade. If you have a when you're talking about like doing sub metering. Sometimes, like commercial or residential landlords will do that. Because they want to shift the utilities paying from the utilities from the central, like from being an expense for themselves to an expense for the their tenants. Okay, I'm it's like, usually when people would do like some sort of sub metering system for their tenants. developments we designed definitely had some, like submerging systems that were metering, you know, at the individual level for lighting, mechanical systems. You know, all the all the different components, plug loads, and so on. But Yeah, I think in terms of retrofits, like the reason why people would primarily be doing that is just so they can, their tenants will pay directly for their energy costs, as opposed to the landlord paying for the energy costs, and then building that into the cost of the rent.

interviewer 1 7:11

Okay, Gotcha. Alright, so Well, then let's talk a little bit more about new buildings. Think of your past experience, what is the easiest way to significantly improve energy performance? Like what has the biggest impact?

interviewee 7:32

Windows definitely have the biggest impact going to a better window performance? I mean, it depends a little bit on the building technology. But like most new buildings have pretty high window wall ratios, like 6070 80%. And in that case, is definitely windows. If the building maybe only has like 30% window overall ratio, then it's probably just the installation value of the wall. But typically, they'll feel like very high windows window already showing. So then windows are definitely the most important. window frame, like there's the glazing units, if you use insulated glazing units, And there's the window frames, and those are both pretty important.

interviewer 1 8:21

Can you explain a little more in detail what that means? Like, what can you improve? How can you improve windows that much more?

interviewee 8:35

Basically, the North American Europe are a little bit different. I'm guessing you're kind of more focused on North America.

interviewer 1 8:45

Yes exactly.

interviewee 8:50

Yes. Because basically, Europe is just a little bit more ahead of North America. Yeah. So like, in olden days, like even whatever, 50 years ago, or a bit more than 50, like 60 years ago, they'll be like single pane windows. So that's just like one sheet of glass. After like the oil crisis, and in the 70s, and people started carrying a little bit more about energy efficiency, basically, everything moved to double pane windows. So basically, you have like one pane of glass, and then a spacer, And then another pane of glass, that's the ICU. And it said, into a frame a window frame, which is like, you know, it's a window frame, it's like a piece of material that's holding the idea in place and is attached to the wall. So the glass like, Nowadays, they're moving towards triple pane ideas. So piece of glass space, or a piece of glass space or piece of glass. And even in some cases, there's quadruple plane, but that's kind of overkill. And knowing like, even in Europe, that's not common at all, triple pains, very common in Europe, is becoming more common here. But devil pains, definitely the standard here. So now there's like in terms of thermal thermal performance of Windows, there's a couple different components that are important. So there's the the new value, which is the thermal insulation value of the the window frame. So the window frame is usually like a solid piece of material. So it has what's known as a thermal bridge, basically low, like a low insulation value. So aluminum is the worst, and then you kind of fire, wood is a bit better than fiberglass is best. And there's ways of making these thermal broken, so they're very highly insulating, and probably the best. There's different types of Windows systems. So there's like a window wall or a curtain wall, The best companies that make the most highly insulating window frames are like German companies like Schueco.

So just like the installation value of the window frame, that's one property. Next one is the type of gas that's in between the panes of glass of glass. So it can be air, It can be are gone from the Crypt on

Krypton, technically better than are gone, but it's quite a bit more expensive. So people usually use are gone and are gone is a noble gas it basically, I don't exactly know why it's better. But basically, there's less heat transmitted to the gas layer. And then there's coatings on the glass. So infrared light can pass through normal windows. So like all surfaces are giving off infrared light. Like anything that's like how thermal vision cameras work, like anything. You know, like, regardless of what temperature you are, you're giving off some sort of infrared radiation. So if like the inside is hot infrared radiation can pass out of the window. Now there's you can put a coating on the inside of the window that reflects the infrared radiation back into the room. So this, these are low emissivity coatings. Now, you can also the other property that's important that properties important for heating, the other properties important for cooling, and that's called the solar heat gain coefficient.

So depending on what kind of coatings you have, you can reduce the amount of solar heat gain, which usually also affects the 10th of the window. And, like newer formulations are better and better and having like a big impact on solar, he gained coefficient, but not having a big impact on the 10th of the window. So like, if you look at a buildings from the 80s, they're usually like the glasses, almost like office buildings, Often the glasses like dark brown or something or a super weird colors because these like compounds that they're adding, Change the window, tempo. So having a low solar heat game coefficient means that a lot of heat doesn't come in from the sun. And then there's less cooling demand. And now the complicated thing is that, like the low emissivity coatings and the coatings that the solar control coatings are often the same compounds. So like one compound will do both things. And It's like, there's like, depending on which surface it is, kind of has different properties. And it gets very complicated like exactly where you want to put the coating and what coating it is how it works. And even like amongst professionals, there's a lot of confusion. But that's basically the three things you consider. Okay. Oh, I guess the spaces is the other one. So you can have us like actual pieces holding the glass apart. It can be like rubber, it can be like, essentially, aluminum spacer or so on. So you want like more insulating spacer, which improves the installation of the entire assembly? Oh, yeah, Yes. I guess there's like, sometimes there's little shading elements inside the window cavity? Like, between the glass, but that's kind of I don't know, that's kind of nice. I don't know. Yeah. Those are kind of like the main things that impact how, how Windows affect the energy performance and rebuilding.

interviewer 1 14:54

Gotcha. Okay, our project is focused on existing buildings and how we can use things from new buildings and put them into existing buildings. One of the things that we did a lot of research on is energy management systems. Can you tell us a little bit about something you did for new buildings. What kind of energy performance or management systems did you install?

interviewee 15:32

So usually, like the energy metering system is kind of rolled up in, like the building automation system, or sometimes it's called the building management system. So these these companies doing that kind of thing, or like Johnson Controls, or Siemens Electric,

or cnet's, are not Siemens Electric, just Siemens,or Honeywell.

And I don't, it's pretty rare for there to be, like, for example, in an office building, for each, like each individually, Been in the building to know how much their workstation is using like something like that doesn't really happen. It doesn't know not like, I'm sure there are individual cases. And there are companies that are trying to sell products, but it's not common. What's more common with the most common, which is the at the total building level, which is pretty much useless in terms of figuring out what is using more energy than expected or not expected. Very, it's even very rare just to have them individually metering different uses, Like lighting from plug loads from mechanical modes from, like, elevators. That's, that's in of itself, like, pretty uncommon, it's becoming more common.

In terms of like,having, like, individually metered energy used for different users, its most common in like residential and commercial buildings were which have more than one tenant.

interviewer 1 17:14

Yeah. That makes sense

interviewee 17:16

So that's like becoming standard.

interviewer 1 17:24

Okay.

interviewee 17:25

So like, I know, there are some vendors that are trying to, like sell these products where, like, each, each individual would have essentially a kind of a calculation of how much energy there you said.

interviewer 1 17:39

Yeah. Can you tell us more on how they can break metering down to different types of energy?

interviewee 18:02

So in retrofit, I think, like, one of the like, one of the problems with this, or, like, the pain points in this space for designers, is that there are, you know, like these three or four big contractors, that are basically monopolies and not very innovative, and are extremely expensive. So to add a single metering point to any of these BMS is, or BSS Yeah, costs, like 1500. dollars, okay, and all the programming is proprietary. So If you ever want to change anything, with how the whole system is set up, you have to pay like a programmer to come in and if you're, like, into your building, and pay them, like $300 an hour.

So I think that is kind of like, created a significant barrier to people doing. Okay. More, like more Finally, green nearing. But that, That being said, there are like, you know, with like, kind of raspberry pi and like, is I think it now will be like pretty cheap to actually put in these meters is just like, there isn't a good open source platform that a lot of people are using this robust for doing it. And like, the other problem is that it gets complicated if you want to wire all of these individual meters back to a central point. And The easiest way to do it is with like a Wi Fi or cell signal. But again, like the kind of just the, the players in the market just aren't quite there yet. Okay, like the ones who are trying to do like these Internet of Things, building automation systems is just like a little bit unstable. But at least from what I've heard is like, the quality of the hardware and to come, The companies doing the installation and stuff isn't, if you like, isn't quite there. And the big players, like don't really care, because they're happy with their shale business model.

interviewer 1 20:12

Yeah. Gotcha. Makes it. So if we're thinking about an old building, not the high rise ones, but lower ones. Do they even have automated systems if they were built 60 years ago?

interviewee 20:29

So like, what are we talking about a single family home?

interviewer 1 20:33

No, like, let's say like a four story apartment building.

interviewee 20:38

So 60 years ago, so like the 60s?

interviewer 1 20:41

Yes.

interviewee 20:43

No, they probably won't have any sort of system. They'll have like a utility meter. Yeah. Which meters the entire, I mean, so they'll have like a utility meter for each apartment, Then one for the entire, like one for the kind of the common areas for electricity. And then they'll probably have one like, natural gas meter for the entire building. And then the natural gas will literally, I mean, will be set to some, like some thermostatic set points. Oh, yeah. Just turn it on and off based on the temperature? Yeah.

interviewer 1 21:26

Okay. So, if you think about this kind of building, What do you think? Is there, in your opinion, an easy way to retrofit? like we talked about the windows. On a range of not too, so expensive to super expensive, how expensive is a physical retrofit, like, a windows installation?

interviewee 21:54

Um, yeah, I guess it like, it depends on what exactly. On some of the specifics, like, let's see, changing, For example, the light bulbs is obviously the easiest,

interviewer 1 22:07

Makes sense.

interviewee 22:08

switching now. switching up, the windows would probably be pretty, like windows in themselves are pretty expensive. But that's only part like materials is only part of the cost. It's also like disruptions, attendance and your rental income. So switching out the windows will be not as disruptive to tenants, but the materials are more expensive. It's like relatively easy to like pop out windows and put it into what's changing the installation is like, extremely cheap in terms of materials, but extremely expensive in terms of disruption.

what I mean, if you're doing the entire building and like possible just to put a new layer of cladding on the outside of the entire building, Sometimes that's what people do.If there's one boiler, in the basement is not so hard to switch that out. But you know, you're talking about like 1020 grand for a new boiler. Okay. I in New York, Over the last decade, they've been really aggressively trying to get landlords to switch out their fuel oil boilers enter in favor of natural gas. And so they're putting some incentives for landlords to do that. And I know, they've got like a really high acceptance rate for those programs. So that's like something that is definitely possible. But most like boilers, now, If it's even within the, like 10, or 15 years old, they're not really going to get more efficient than that, like a natural gas boilers already at like 96% efficiency. And you can't really do any better than that. And anything like change, like if you had to go into one of the units and change it from a radiator to some sort of, like radiators usually work on Steam, and a more efficient system would work on hot water. So that's like, like, I don't know, you're probably familiar with like some of these hydraulic systems in Germany, either like hydraulic floor, or some other kind of newer radiator that doesn't require as hot temperature fluid, That's like, that can be pretty challenging as well, because you have to, like go into chin like, yes, piping might not be right, like, So that's not really that easy. Um, one thing that people do sometimes is like, they use these mini split heat pumps, where they just basically each unit, All you need to do is drill a hole through the wall and have one unit on the inside and one unit on the outside. But then you have all of these like evaporator units hanging off the edge side of your building, which is cheap, but it's ugly. It's like pretty calm, if you like look at, I guess often in like Asian countries, they'll have these buildings that are just covered in these evaporator units. And that's because they just have these really TP pump systems. There are, I think there might be some companies that are doing like, like Wi Fi enabled electrical outlets, where you can have this, like home audit this residential home automation system where you can do all like sub metering for each individual outlet, which I think is it's like not super expensive. But that's like, you know, that's kind of like a game theory strategy. Like it requires the people to be paying attention. And they're kind of requires them to care a little bit and adjust their behavior in relation to what they're finding.

Like, all that being said, there's like no real silver bullet. And there are some really cheap, low hanging fruit, but you know, you They're only so effective. Like they have like likes, Like, you know, LEDs are 10 times more efficient than incandescent lights. But only about I don't know, something like 15% of your electricity is, I think residential, it's even lower, maybe residential. It's only like 10% of your electricity usage is lighting. So. Okay, so you got like 5% savings or something. Yeah, yeah, nothing. But

interviewer 1 27:16

You're probably familiar with the green new deal in New York.

interviewee 27:25

Yeah, well, there's like the new New York energy retrofit policies, which are pretty aggressive. Yeah, yeah. So ideal, which is like those guys. Yo, Cortez.

interviewer 1 27:34

Yeah. So they have like

10 years basically till 2030 to reduce 40%. of the of their emissions, right.

interviewee 27:46

Yeah. Yeah. They're very aggressive. Which is interesting. So for considering setting up like a carbon emissions market for all buildings.

interviewer 1 27:59

We're thinking about this in more detail, especially for like, you know, smaller buildings. older buildings. Those new opportunities help us because building owners have to do it.

interviewee 28:25

Yeah, that makes argument easier.

interviewer 1 28:28

A lot of energy in buildings is wasted. If we are considering a metering system that provides recommendations on how to use energy more efficiently. Do you think that this can have a substantial impact?

interviewee 29:13

Yeah, I think so. I mean, ConEd it gives out these free Wi Fi smart meters.

interviewer 1 29:19

Yeah, I actually got mine this week.

interviewee 29:22

Oh, you got yours. Nice. They obviously think that is a valuable enough use of their money to be giving each person like $100 gadget. So Yeah, I mean, like, I think that's probably pretty interesting.

I don't know, Yeah, maybe it's like a matter of interface, having the right interface that allows people to easily understand what's going on.

I don't actually have that. That kind of Wi Fi.

outlet. So I don't know what it's like to use it. I do know, it's like hooked up to their Demand Response Program, which is interesting.

interviewer 1 30:14

Yes

Yeah, I mean, let's see, like, I know, in New York apartment buildings, there's a like a lot of things you can really control. So like, sometimes your apartment is boiling in the winter, and you just open up the windows.

interviewee 30:42

Like, I think some of these old radiators can be changed, have like, retrofitted with these thermostatic valves, which actually open and close the valve based on their temperature, which is kind of cool. Um, I don't think those are very common. I think people leave their air conditioning on all day. Yes. And if they could probably, like, turn it on, or like, just have it turned on him an hour before they got home?

Like that would be pretty effective. I don't know.

interviewer 1 31:19

How do you think a landlord could influence that?

Because we're talking about, you know, tenants, right? There's only so much you can do.

interviewee 31:33

Making all your tenants pay for all their energy. That's probably the biggest thing they could do. Okay.

interviewer 1 31:39

What about heating?

Have you seen that? I know in Germany, you just pay based on what you use?

interviewee 31:55

Yeah, it's like you can't really do steam metering.

I mean, like you can't, it's very difficult to do me metering for that's like the weak point of that metering argument. It's like very hard to do metering for these old steam systems. Where you can't it's like, you can't really tell how much each individual is using. And also like the buildings near there, the units on the ground floor get, Yeah, more pressure than the ones at the top. So the like, would be unfair ones at the bottom are hotter and hotter or colder, but I'm Okay. Eating What could what could landlords do about heating?

Yeah, I don't know. This, like, definitely tricky. I guess they could replace the windows or something. Okay. Um, yeah.

I think it could be interesting. Like, if there's some sort of this carbon trading system? Like, is it possible to allowed to individual tenants to somehow take part in that? Or is it only at the building level?

interviewer 1 33:27

That's an interesting idea. Can you tell us more?

interviewee 33:30

Because , if you can create some sort of incentive structure for the tenants to care as well as the landlords?

Like maybe like, maybe if, if the building, I guess, like the building has a lot of a certain amount, then that, I guess you could pretty easily figured out like, what percentage of the energy use is reflective of components of the building envelope versus the tenant behavior. So let's say it's 5050. And then like, on, like, the, the tenants would share 50% of the carbon credits. And the landlord would get the other 50%. And the tenants would just have to share it between themselves. Something like that. I don't know. Then there'll be like social pressure to reduce it. I don't know. Just I'm just brainstorming.

interviewer 1 34:31

That's great. Go on.

interviewee 34:34

I mean, like, I think, I think New York is, you know, New York is one of the first places in the world to try this. So, Who knows.

interviewer 1 34:46

Yeah, I mean, there's definitely plenty of opportunity here. Going back to monitoring? Have you heard of verdigris? Like a small company that provides an IoT device.

interviewee 35:20

Send me a link and I'll see if I remember I

interviewer 1 35:25

What they're doing is you just connect it to your meter or something. Is there any way to measure different energy usages just based on without adding a sensor?

interviewee 35:51

So like, we're like, what kind of Where do you attach it? There's a couple times there's one you plug into the wall, and then you plug your thing into it like that? And then there's the kite. There's actually a kind where you just clamp it around a electrical conduit. Exactly. And it's, it's like a induction meter?

interviewer 1 36:12

Can you explain us what's happening there?

interviewee 36:15

So it's just like a thing, you clamp onto your electrical conduit, and then the electricity going through, it creates a magnetic field, and I can just tell how much electricity is going through it.

interviewer 1 36:24

Okay. Is there any way to tell What kind energy you used, such as heating or on AC or on lighting?

interviewee 36:38

So there's, there's our cup, I think there's some companies that are trying to do like machine learning stuff, to do signal analysis on these, These meters and to try and like disaggregate what kind of energy use is going through. I don't know how successful they are. Okay, like, it's definitely easier to just have them neater separately. Yeah. But that's, you know, that's kind of like the Holy Grail, like steam systems do you can have these flow meters for Steam systems, but they're not very accurate. And I think they kind of only work in systems that have like really high capacity like they don't have good accuracy a low levels.

interviewer 1 37:27

Okay, makes sense.

interviewee 37:31

But I didn't like yeah, metering gases, will meter gas by, you know, the, the, the boilers are in each apartment. Yeah. And you could, you could do it like German style, and have each apartment with its own boiler in the kitchen or something. But that's also a big retrofit.

interviewer 1 37:56

That sounds really interesting. Thank you. That's all the questions we had. You definitely helped us a lot. Thank you so much for your time, we really appreciate it.

interviewee 38:48

No problem. Glad I could help.

interviewer 1 37:56

Do you have any questions for us at this point?

interviewee 38:48

No, I think I’m good. Thank you.

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