

Brett Singer of Lawrence Berkeley National Laboratories at the 2016 ASHRAE Conference in Alexandria, VA. (22:57 min; 22,015 KB)

Kat Godlewski: Welcome to the US Environmental Protection Agency's Indoor airPLUS podcast series. This episode is being recorded at the 2016 ASHRAE IAQ Conference in Alexandria, Virginia. The Indoor airPLUS team has the privilege of sitting down with Brett Singer from Lawrence Berkeley National Lab to discuss indoor air quality metrics, scores, and the emerging technology that will allow us to monitor and improve the quality of the air we breathe indoors.

Nick Hurst: Brett, we're here at the 2016 ASHRAE Conference in Alexandria, Virginia and the conference is aptly called "IAQ 2016: Defining Indoor Air Quality, Policy, Standards and Best Practices." There's been a lot of discussion just in this first day surrounding IAQ metrics and scores, which seems to be the big recurring theme here. So what do you consider to be the biggest benefits of a more standardized IAQ metric that could be applied to buildings; either commercial or residential?

Brett Singer: Thanks for the question and thanks for the opportunity to talk about IAQ scoring. The work that we're doing at Lawrence Berkeley Lab is focused now more on residential, so I'll focus there if that's okay with you.

Nick Hurst: Sure.

Brett Singer: The idea of the IAQ score to me, the biggest potential benefit is it will guide or direct, signal to people, what are the features that are most likely to help them achieve good indoor air quality in their homes.

There's lots of things that people can do. Lots of products that get sold saying 'This will make your indoor air quality great'. Some of those really are great, and some of them not so much. We want to look for something that's quantitative. It will of course not be perfect, as no real scoring system is, but something that's quantitative and gives more points to features that are more valuable in actually achieving indoor air quality in practice, even though the score will be an asset rating.

Maybe I should take a minute to describe the difference.

Nick Hurst: Yes, describe what an asset rating means for a home.

Brett Singer: Right, so a lot of the indoor air quality that you have in your home results from what you do in your home. If you burn candles, if you burn trash in your home, you're going to have terrible indoor air quality; so don't burn trash. If you use a lot of chemicals and don't ventilate properly; if you don't use your kitchen range hood; if you do a lot of hobbies that involve different products that will emit chemicals into the air, that's all going to affect your indoor air quality.

If you don't take care of moisture, if you don't use your bath fan when you shower, those are things that will impact the indoor – you can grow mold; that can impact your indoor air quality. If you smoke.

We're not looking to control people's behavior. What we are looking for is homes that make it easy to manage your own indoor air quality.

So an example would be: We do a lot of work with kitchen range hoods and cooking burners (e.g. gas burners, electric burners) - produce pollutants. Cooking produces pollutants. Now, we love cooking. We want people to cook. I cook all the time. What we want though is a situation where the device in your

home that could help protect the indoor air quality while you are cooking, and we call that a venting range hood. It's a range hood that exhausts to the outdoors instead of blowing it back into your kitchen. They don't work very well. In fact, they don't really work at all. A venting range hood is something that makes it easy for you to maintain good indoor air quality. Now venting range is kind of bottom-of-the-line. If that range hood has a better design, there's certain features that make it more effective, then that makes indoor air quality even better because the venting ranges are not perfect. So when I cook and I turn my range hood on, it doesn't capture 100%, doesn't remove 100% of the pollutants. It removes maybe, the one that I have actually turns out to be pretty good, maybe 95%. But, there are some that might only remove 80% or 70% or 50%. So a range hood that only removes 50% of the pollutants when it's operated should not get as good of a score as one that removes 95%. Likewise, if that range hood is really loud, I'm probably going to use it less than if it is nice and quiet. The hood that's quiet should get a better score than the one that's loud.

Getting back, our goal with this scoring is we want to identify the features that are most likely to lead to good indoor air quality in practice, that make it easy for people to use, that are robust, that last, and that work in a range of conditions. That will hopefully signal to the marketplace, both builders, contractors, that side of the market, and then to consumers, so they know what to look for. Ultimately, there's going to be a lot of consumers who are just going to look at the bottom line. They're going to say, "I'm not buying a home that gets an 80. I want a home that gets a 90 on the IAQ score."

What it does though is they can go to the builder and say, "You know, I noticed this house has an 80. What do you need to do? What are the upgrades that can get me to a 90?" The builder says, "Sure, here are four things we can do to get you from the 80 to the 90 and this is the extra cost". Then it's in the market. That's what we want to see. Markets work well with information. So then fundamentally this is about getting information into the marketplace, so the consumers know what they're buying and the sellers can provide products that meet the consumer demand.

Nick Hurst: So ultimately builders could be incentivized to market their score and incentivize to ultimately put more of these features in their home. The same way they've done in energy efficiency.

In the energy efficiency world, we have the HERS Index, or you know, energy efficiency metrics that a number of different components that go into the home add up to some score that they can then market.

Brett Singer: ENERGY STAR, right? That's a label, that's a certification process, but you get – there are a lot of people who want to buy an ENERGY STAR home because they know ENERGY STAR is quality. They're not looking into the construction details of an ENERGY STAR home. They want something that gets that. For HERS, they're not so worried about why the home gets a good HERS score. They just, someone tells them, "This is an energy score for your home. This is the average home." They see their home is 20% better than the average. They're happy. So it's along those lines.

Nick Hurst: Sure, makes sense. Well, you've been taking a strong interest in the development of this idea of an IAQ metric. What has been done to date to start this dialogue among the research community and professionals in the building industry and what's happening next?

Brett Singer: Great question. So, this is a process that we started, I kind of lost track, at least a year ago, probably longer. Maybe a couple of years that we've been talking about it, so we've gotten a lot of

informal input from stakeholders and experts trying to get a sense of what people in the business would find useful. Are there some potential pitfalls we want to avoid? Are there some aspects or characteristics of it that might be really hard to implement or that would be undesirable? We started with that. We then developed the basic concept proposal that we reviewed with some experts. We had a group of, I think, 12 to 15 experts that we got formal input from through an expert meeting. And that was some really base scope and structure issues.

Again, I'll give an example:

One of the things we struggled with is, should we give negative scores? We're giving positive scores to things that enhance indoor air quality, but if there's some feature of the house that would degrade indoor air quality, should we give it a negative score and what are those things? How much, if at all, should we look at this as an asset rating? It's not a performance rating based on what's actually happening, but there are things that an occupant could do that would degrade the indoor air quality in their home.

So if an occupant, or not even the occupants fault - if there's a dampness or mold problem; you walk into a home to rate it and there's mold on the wall. The mold may be the result of some construction problem. It wasn't an ENERGY STAR rated home, so it didn't have good water management specifications and some water got in. It could be that the occupants didn't use their ventilation appropriately. They had a un-flued gas-heater and didn't vent away properly, so there was a lot of extra moisture and there was condensation. One of the ones, tobacco smoke, we argued a lot about this. You walk into a home and it reeks of tobacco smoke. I think most people would want us to consider that in terms of the air quality of the home because if the current occupants move out and tomorrow somebody else moves in, the tobacco contamination is part of that home now, so we struggled with some of those things.

There was some other scope things in terms of how to address issues that are interacting essentially. They were still going to have to – it's going to be an ongoing struggle because there are certain features that might provide a lot of benefit in one circumstance, but not a lot of benefit in another circumstance.

In any case, a long winded way of saying we got expert feedback on the basic structure and then we're taking that expert feedback and we're going to use that to build on the next round. We have a pretty good idea of the basic structure and form of it. Right now we're thinking of something like a 100 point scale. That may change, but it's kind of intuitive. People think in those terms. We've all been to school. Still working on what constitutes passing and failing, but that might come later as well. We're definitely going to give negative points for things that adversely impact your indoor air quality. We may make it easy for people to fix those things, so if you go in and there's tobacco contamination and someone cleans it up, then that would change the score obviously.

There's some other features that came out at the expert meeting that gets into the weeds a little bit. The next stage though is thinking ahead in terms of how this is going to play out. We need some base features that get assigned values that are clearly consensus values. We're trying to ultimately give a relative value to different features, so we need to first agree on the values, the appropriate values for some key things we kind of want to see in all homes for basic indoor air quality.

ASHREA, the Building Performance Society, has a residential ventilation standard that has certain key features: the kitchen range hood, bathroom exhaust fans, base ventilation. You're making homes really tight. We want to have some base ventilation rate, so we probably will start with those and maybe add a few others. It might be HVAC filters, so the filter of your central air handler. Some others we've talked about, and we will come up with scores or values for those basic features. Then as we look to value other things, we will be trying to assign those values in relation to those base features. If your range hood, having a basic range hood is worth 6 points let's say, then having a range hood that's quiet might be another 2, or having a range hood that is well designed might be another 3. You might say, "since I know the value in terms of reducing exposure of a range hood that gets used a lot, now I'm going to compare that to the value of having a good particle filter in my air handler system or my HVAC system." or the value of having another thing is really a big feature of this, is convenience. Of how easy it is to maintain the equipment, so if my HVAC filter is up in my attic, I am less likely to change it than if it is in my hallway. HVAC installers figured this out a long time ago, so that's why new homes always have them in a very easily accessible place.

Supply ventilation systems are a little newer to the market. They appear in lots of different places. The filter for your supply ventilation system may not be as easily accessible as the filter for your HVAC system. Hopefully it is, but if it's not, or the filter for the supply ventilation system may be a lot smaller, may need to be changed more often, especially in let's say spring when you have a lot of things growing, so you have a lot of pollen coming in, and you're collecting a lot of pollen on that. Now hopefully they're thinking of ways to take care of that, but when we're looking at design features, we're definitely looking at stuff that's giving more credit to things that are easy to maintain, easier to use, that you're more likely to use, and that they're more robust when you use them.

Nick Hurst: Right, and with the Indoor airPLUS Program currently the way it's set-up is fairly prescriptive and I'm sure that a lot of those features that are being discussed right now, the development of an IAQ score or metric, are already built into the Indoor airPLUS Program, from moisture control, radon resistant new construction, if you're radon zone 1, pest controls, pest management, materials – low emission materials that go into the home, and those sorts of things. So I'm sure builders can of course utilize Indoor airPLUS now on top of ENERGY STAR to start to make in-roads into this if they want to sell a healthier home and market those things. It will be really great to see how the IAQ metric that possibly comes out of this is able to integrate with a program like that. Sort of the same way that ENERGY STAR and the HERS Index, you know, are kind of chocolate and vanilla together. I think this presents a great opportunity for builders who are working with those programs.

What, one last question, in terms of emerging technology and new things that are in the marketplace now, how do those factor into the potential for an IAQ score in the near future? And what are the technologies in the industry that might still be lacking?

Brett Singer: Another excellent question. People are very excited about these low-cost air quality monitors that are now available. You can go out, and for \$200, buy something that is going to tell you the quality of the air in your home and there's different variants of them.

Some of them will give you advice. I'm seeing high particle levels, go open a window or turn on an exhaust fan or whatever. Then the question is, "Well, do these things have a role in helping you manage the indoor air quality in your home?" I think the answer is sort of. In principle the low cost sensors that are being used in these things offer promise of being able to track occurrences or track

physical things happening in the environment, some of which would be unknown to you, so it's hard for you to know. In fact we can't know what the PM 2.5, the fine particulate matter concentrations are in your house, unless it's really really bad. If you burn something, you know you have high PM 2.5, but we wouldn't necessarily know that there is nitrogen dioxide, unless you have a sensor monitoring that. Maybe that range hood actually has a sensor in it to monitor nitrogen dioxide, so you're cooking with gas, everything's good, you think that you don't really need it, or you have it on low and it's not sufficient, and then the nitrogen dioxide sensor says, "Hey, concentrations are getting a little high here, let's turn the range hood up to a higher speed." So that'd be great. That's the way that those low cost monitors work.

There are many other variants of that. We see some of it already; humidistat bath fans. Now we're really curious. We don't really know how well they work over time. They work pretty well when they're new, but do they work 5 years later? We don't know. I think what we're going to eventually get to is a situation where your home is more like your cars today. Where there are lots of sensors sensing important aspects of equipment performance and then eventually there's going to be sensors monitoring the sensors, so that if something is really important, you're going to know when it fails. Then you might get the message "replace your HVAC filter" because the sensor is telling you that there is a high pressure drop that shouldn't be there. Then who knows, maybe someday we'll get the message that says "Change the sensor in your HVAC system". Or when the HVAC technician comes for the annual, or semi-annual, or bi-annual inspection, they plug into the onboard diagnostics of the HVAC system and it tells them, "It's time to change the sensor" because we only rated that sensor for a 5 year lifetime. I think we're going to see a lot more sensors, a lot more intelligent controls, and a lot more sort of robustness considerations where we're thinking about how long something is supposed to last and as a regular course. We're seeing maintenance happen in a much more organized way with knowledge instead of just relying on everybody. It's hard to keep track of all of these things. I can't tell you, today, the last time I changed the HVAC filter – it was some time last winter, but I don't remember if it was the start of winter or the end of the winter and that's my fault for not being more organized, but I think I'm not that uncommon in that regard. I don't really want to have to keep track of that. I would really rather my system keep track of that and just tell me when it's time to go buy a new filter and put it in. I can do that.

Nick Hurst: Absolutely. Do you think that those technologies, those sensor technologies, could eventually lead us some day to being able to assess existing homes for their merits in terms of indoor air quality and how the homeowner is engaging with their home?

Brett Singer: Yea. Let me be clear that the IAQ score, the plan we have with an IAQ score that will be suitable, can be applied to existing as well as new homes. This is not just for new homes. I think it has great applications in new homes for all the reasons we talked about, but the score will be suitable for existing homes. It will be suitable for multifamily too. That's the plan at least. There are no doubt some other issues in multifamily that are different than single family; in detached houses.

I think what you were asking about though is the performance. Are these sensors going to be able to tell us what the actual in use performance is as opposed to just the asset?

Nick Hurst: Right.

Brett Singer: Yes, I think we are going to get there. I think that the sensors are getting better. Right now, I would say that most of the sensors we've looked at, these low-cost monitors, are not reliable enough. They're not generalizable enough, so that they measure some things well. They measure certain particles well. They don't measure other particles. Any individual sensor may not be good, so you really need 2 or 3 sensors to make sure you're getting it or you need to confirm the performance. Some of the manufacturers of these devices are checking all of the sensors that go into their devices and some of them aren't. I don't know which ones, and I've heard/ suspect that's true. I'm not sure if that's true, but clearly the quality assurance varies a lot.

Are we at the point yet? – No.

Are we going to get to the point where you can have an indoor air quality monitor on your wall that's as good as your thermostat? – Yea, I do think that we are going to get there.

For some of the pollutants that's going to be harder. I don't see us getting there in the near future for all of the contaminants that are of interest, but for some of the contaminants I think we will have, CO₂ for example, I think we're not far from the point that there will be CO₂ sensors that are kind of affordable. Less than \$100, let's say that would be reliable over a 5-year time frame or something, that if you were interested in the carbon dioxide concentration in your home, you can go look on the wall and see what it is. Right now the ones that we think are very reliable over that time frame are a little more costly than that, but they'll come down in price.

Nick Hurst: Well this is a very exciting time, obviously with those changes in technology. I'm sure that if we re-did this conversation in 6 months or a year, we'll be able to explore it even further in depth. We know you're busy at the conference this week, so thanks a lot for taking a few minute out of your schedule to meet with us, Brett.

Brett Singer: Sure, thank you for having me.

Nick Hurst: You bet.