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Male: Hello, and welcome to our Building Energy Code seminar series. The series is based on our National Energy Codes conference, which is hosted annually by the US Department of Energy. We're here to present you with the latest in building energy codes, from developments in the model codes, to updates on what's happening across states and local governments, to highlighting tools and resources that you can take advantage of in your day to day practice.

We'll be hearing from a number of leading experts about the challenges they're facing, ways they're working to solve them, and how their efforts are building the energy efficiency, comfort, quality, and affordability of America's homes and businesses. Join us virtually every week for important topics and interactive discussions and help us continue the conversation. To learn more, visit energycodes.gov.

Richard Fowler: Welcome, everyone. I'm Richard Fowler with the Pacific Northwest National Laboratory. I'd like to welcome you to the –

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US DOE and ECC seminar series. Today's seminar will cover what's in store for ASHRAE Standard 90.1. Looking ahead, this series will cover other timely topics, such as what's new in the residential provisions of the 2021 IECC, advanced technologies, energy policies and resilience, and more. We hope you'll join us Thursdays at 1:00 PM Eastern Time and keep the conversation going. Lastly, I would like to launch two quick polls so our speakers can get a better understanding of our audience today.

Poll number one asks in what region are you located? Okay, I'll go ahead and display what the answers are. It looks like we're fairly represented all across the US. Thank you for doing that. Let's go ahead and launch the second one, which asks what most closely –

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aligns with your profession. Okay, I'll go ahead and close that and see what we have. We have a lot of architects and engineers, and some code officials, and others. Thank you very much for participating in that quick poll, and now, without further ado, I will turn things over to our moderator, Michael Tillou, from PNNL, to introduce our speakers. Mike, take it away.

Michael Tillou: Thank you, Richard. Welcome everyone. I'm Michael Tillou. I'm a senior researcher in the Building Energy Code program at PNNL, and I'm gonna be moderating the question and answer portion of the webinar today. We have a fantastic panel of speakers who are gonna share with you some of the changes we can expect to see in future versions of ASRAE Standard 90.1. First up, we're gonna hear from Len Sciarra. He's an architect with over 20 years of experience –

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and a strong background in sustainable design. Len is the current chairman of the ASHRAE 90.1 Envelope Subcommittee and was a part of the core team that developed the AIA 2030 reporting tool. Following Len, we'll hear from Dr. Thomas Culp, who's the owner of Birch Point Consulting, and who specializes in the areas of energy efficient glazing, window performance, Low E glass coatings, and building code development. He is co-vice chair of the ASHRAE 90.1 project committee and is also an active participant with the International Code Council.

He currently represents the National Glass Association and the Aluminum Extruders Council. And then finally, we'll hear from Richard Lord. Richard's an ASHRAE fellow and a senior fellow at the Carrier Corporation with over 45 years of experience in the design and application of all aspects of commercial air conditioning systems. Along with Dr. Culp –

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he is co-vice chair of the ASHRAE Standard 90.1 Project Committee. He is currently working on refrigerants and commercial system innovations with the innovations group at Carrier. So, with that, I will like to hand it over to Len to get us started today.

Leonard Sciarra: Hi. I thank you guys for coming here. We realize that after we scheduled this, this is during green build, so hopefully you'll learn something here, and you can take it to, you know, your firms. Okay, so as Mike said, I'm chairman of the envelope subcommittee, and I'm gonna go over a couple changes, next slide, on the envelope, that are coming full in the envelope, and one is a backstop, one is thermal bridging, and the other is air leakage. Okay, so next slide. So, the envelope backstop, this is a current addendum.

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It's passed public review, so it's already in the queue. It was to the 2016 code, but they carry over to 2019, and it's a concept that came through sort of New York and Washington, and it's really about the trade off, the way that Section 11 and G, the trade off sections of the code work. Next slide. So, why do it?

One of the things that we've – as we've thought about buildings is that doing renovations for our envelopes are pretty expensive, doing retrofits. It's easier to change out light fixtures. It's a little bit easier to change out mechanical systems, but usually envelopes are around for a long, long time. And we were trying to figure out a way to sort of limit the way you can trade off something very, very durable like a building envelope, or a window, or a wall with something like a light fixture.

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Next slide. So, how does it work? Basically, with 11 and G, you have a trade off mechanism, and as it stands now, you can trade off amongst systems. 11 and G are a little bit different, but conceptually you can trade off really, really efficient mechanical systems with a sort of very inefficient envelope, and it just puts a little bit of a limit on the way that that works, and it uses what we call a COMcheck, which you guys are probably all familiar with – next slide – on how that works.

And so what you do is you enter all your information into COMcheck, and then there's a limit of 15 percent of 7 seven percent for residential occupancies or non-residential, you know, occupancies. And then if you hit that limit, you're safe. The next slide has an example of it. So, you know, here's the typical COMcheck, and you can see the – it's kind of a little small in the lower right –

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but there's an allowable – it sort of has that allowable margin, seven percent, and then the current envelope is four percent worse than code. So, this building then could proceed to the next step of trading off amongst all the mechanical systems or lighting systems. It's another step for designers, but it's something that we think is gonna help mitigate and invest in high quality, durable envelopes for some short-term gains. Next slide.

So, the other thing that's coming on is called thermal bridging, and this has been out for public review. It hasn't been voted for the full committee yet. It's still in the middle of the process. We're in a second public review, and the content is basically that when we think about buildings and we think about –

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simple insulation strategies, we assume that everything meets perfectly. Your wall insulation perfectly meets your roof insulation. Your windows are perfectly aligned with your insulation. We sort of idealize all of these things. Now, we know in real life that that's not the way buildings are built.

There's lots of things that poke through the insulation. There's junctions. There's different geometry, and so we looked at this, and we tried to sort of say, "Okay, we're gonna start to quantify what this is in all these thermal bridges," and so next slide.

And you know, we started this maybe ten years ago. There was a research project where we started to look at the impact of, you know, unmitigated thermal bridging on our prototype models to see if it's a really big deal, and it turned out that it was kind of a surprisingly big deal, bigger than we all thought. And so we said, "Okay, let's see how we can get this into the code so –

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we can start to, you know, get our build, our code more aligned with the way the buildings are actually built. Next slide. So, it's an envelope revision, so it would be Section 5, and then what we have is it's tradeable, so it's enough. Even though Section 5 has mandatory provisions and tradeable provisions, it has a prescriptive path, so it's sort of, "Do this and you're good to go."

It's sort of a little bit kind of like a guideline, but it's more like, "Do this strategy and you're okay." And then there's a trade off for those conditions where it may not – you maybe can't do the prescriptive path, or you have some odd geometry, or there's some sort of an all other type of situation. Next slide. So, the first thing we did on this is we sort of broke thermal bridges into three big chunks: clear field, linear, and point. Next slide. It's gonna go super quick to the last slide.

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And then an example of a clear field is sort of in a – for example, if you think of a metal stud wall, in the middle of the wall, although there's, like – maybe if it's a brick veneer wall with metal studs, all those little brick ties were part of the clear field thermal bridge. A linear thermal bridge would be as shown in the picture here, like a lintel, like a shelf angle, something long that goes across that could be quantified. It could be a roof edge. It could be some other type of slab edge that comes through, but something, a linear element.

And then we have what we call point thermal bridges, which are basically big pieces of steel, big pieces of concrete, big pieces of wood that are poking through the insulation. So, we sort of put those into three big boxes. Next slide, and then we started to set criteria for all of those different types, and within those, we sort of have – most of those –

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you can see are linear, roof and wall. Walls and floors are sort of linear elements. Fenestration in walls are linear. Cladding supports is sort of a combination between linear and point, and then big steel elements, other elements. Now, we've stayed away from clear field, so this addendum is really addressing linear and point and not addressing clear field.

That is gonna be another strategy within the way that people calculate overall U-factor for sort of overall assemblies. Next slide. Whether that's a roof, and it's all the screws that hold the roof down, whether it's a masonry veneer and all the brick ties, or whether it's some type of lightweight cladding with a rail system, those are all gonna be sort of clear field thermal bridges, because they're sort of part of the wall. So, this is an example of the prescriptive text. We sort of have the category, roof edges, so this is where roofs meet walls, and then we have a series of descriptions based on where the insulation is.

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In many cases, building insulation is on the outside. In some cases, it's on the inside. In some cases, it's inside the wall or a cavity, so we have a lot of sort of different solutions for where the insulation is located in your particular wall assembly, and we have some little diagrams to sort of help explain some of this. Next. The trade off is, as you can expect, you sort of basically add up all your thermal bridges, whether it's linear or whether it's a point thermal bridge, it'd be just a point – would be to the cross-sectional area.

You sort of look at your building, and you know, buildings have all types of geometry. There's different corners. There's different intersections. You start doing area take offs and then within COMcheck, we're building the instruction modules so people can sort of say, "Okay. I have 100 linear feet of exposed slab," or, "I have, you know, 50 feet of wall to window intersections," and you either comply –

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or you don't comply based on the prescriptive, and then next slide. There's default factors – it'll be on the next slide – within COMcheck. Yeah, here's the default factor, so if, for example, you have a wall to window transition and you comply, you put the default factor in. It takes into account in the model, and you're good to go. If you don't comply, then you put in an unmitigated factor, and then you run your model, and depending on what else you're doing on the trade off, you would comply or not comply.

So, we have default values for a prescriptive solution that complies, and we have default values for an unmitigated or prescriptive for a solution that doesn't comply because say you can't do it based on the geometry of your building or the design of your building, you know? You would then make up that thermal bridge, you know, in another way, so this is all in the appendix. It's a pretty long addendum. There's stuff in chapter five as well as stuff in the appendix. Next slide.

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So, the big question is, you're asking me to put in all these numbers, you know? I'm calculating. I can calculate the length of my roof, because I'm an architect or an engineer. I sort of know how much roof edge I have. I know how much window I have, but I have no idea what a thermal bridge or what a quantity, what the factor is for this thermal bridge, so within Appendix A, we have, like I said, default factors and mitigated for mitigated and unmitigated details.

Next slide. There's an online thermal bridging guide. This was an offshoot from the research project that we did that has a lot of sort of typical details, and they have these what we call CHI and PSI factors. These are these linear and point thermal bridge strategies. Next. Manufacturers have them –

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so some manufacturers have a thermal bridge. You can see this one here. That highlighted in black is the CHI factor for this linear thermal break. Next slide. ISO 14 is the international standard.

They have default factors. You can see their little graphics are very similar to ours, but they have sort of default factors for different geometries that you may encounter as part of your building. So, there's a lot of places out there. So, with that information, the CHI and PSI factors and the geometry of your building, it's just simple math. You do the math and then you enter it into COMcheck to do a trade off.

Next slide. Okay, so I'm sure there's some questions on that. We'll get to them in the end. The last big changes coming forward is air leakage, and this is sort of working its way through the process. It's not as far along as the backstop, but it's further along than thermal bridging, and basically it's just increasing the stringency –

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for what was already in the code for air leakage. Many, many years ago we started this path on air leakage and air infiltration. It started with just some sort of descriptions of what to do, and then as testing became more widespread, we started to establish targets. It's a mandatory requirement, so it's not trade off-able, and it's already in the IECC, so I should mention that thermal bridging is also.

A version of thermal bridging is in the IECC as well. It's just a little bit – formatted a little bit different than in 90.1. So, next slide on air leakage. So, the reason for this is that we know that uncontrolled air leakage is an energy loser in most climates. Next slide, and how does it work? The same exact way. We haven't really changed any of the mechanics, except for one. There's one piece we'll get to. Next –

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so these are the big things that have changed. So, the Air Leakage Target changed. It was .4 before for whole buildings, and now it's .3, and then there was sort of what they call a safety valve. If you can't hit the .4, you could've hit .6, so now it's changed to .45.

So, it was .4 to .6. Now it's .3 to .45. Now, this hasn't gone through full public review, so it may change, but that's sort of the way we're headed. It applies to new buildings, and what we did is for new, small buildings – so new, small buildings, less than 25,000 square feet, they must test. That's kind of the big change for this, whereas large buildings can still do inspections or verification. The big piece to this was we added a new multizone test, ASTM 3158, to allow for these small buildings to be tested –

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and then air infiltration is changed to air leakage. And I kept saying, "Infiltration," but really the term we should all be using, and you should all be using with your colleagues, is air leakage, and it could be either infiltration or exfiltration. So, air leakage is the word of the day. Next. I think that's the last slide. Yep. Onto you, Mr. Lord.

Richard Lord: Welcome, everybody. What I'm gonna try to do is go over a lot of the things that are happening with the mechanical efficiencies, primarily in chapter six, so if we can go the next slide? Yeah, just a quick overview. A lot of the things I'm gonna talk about is unique to kind of mechanical efficiencies. A lot of times we'll put stuff in the Standard, but it's in the Standard, but it's not in effect until a couple years out. So, I'm gonna get some of those things that you're gonna see. There's major changes coming in the industry in the year 2023, so a lot of those are –

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in the 2019 Standard. And then I'm gonna cover some of the things that will happen in the 2022 or farther out Standards. These may or may not happen, so just keep that in mind. I just wanna give you a view of what's coming. Next slide. So, a little bit of history on mechanical efficiencies.

You know, they started back in the 1970's, and we tend to treat mechanical equipment like air conditioners and chillers and things like that as an appliance, so they tend to have a standard efficiency metric, and then they also have some prescriptive requirements that cover things like economizers and things like that. These metrics were kind of based on industry standards like the AHRI standards, Department of Energy, AMCA, ANSI, AHAM, various organizations write grading standards. They're always typically at standard rating conditions, so it kind of represents an average US condition, like 95 degree ambient, maybe 67-degree return air, and it may or may not be the conditions you're gonna see in your building.

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There's typically separate metrics for cooling and heating. They're typically based on simple products, a product without a lot of features on it. No economizers, no energy recovery, no reheat, things like that. They're also very product specific, so you know, for example, you can look at an air-cooled chiller and a water-cooled chiller. They both have an efficiency metric like an EER or kW per ton, and it'll have an IPLV.

You really can't compare those two products because it's only the product. It's not the full system, and for example, they're water-cooled because a cooling top, so that's not in the metric. They're typically always done at full load. Now we're starting to change on that. I'll talk about that more as we get into it, and they're not intended to predict energy of a building.

A lot of people try and do that, but they're really just to compare two products. It's like highway and city miles per gallon. That's not the fuel economy you're gonna get, but they allow you to compare a product and say, "Is this one more efficient –

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than the other one?" The definitions and updates to these also vary. Some of the products are directly controlled by the Department of Energy under the NECA Act. Others are also controlled by ASHRAE and then approved by DOE, so typically residential products are directly controlled by the Department of Energy, and then commercial products are usually controlled by ASHRAE. Some are then ratified by the Department of Energy, and then there's a unique clause that a lot of people do not understand, which is called preemption.

So, if it's a federally controlled product and the state elects to say, "Well, we wanna be more efficient," federal law preempts states from going to a higher efficiency. This has caused a lot of emotion in the industry, and you know, a lot of ways people try and get around it, but that's for, you know, most of the products, like residential, like commercial. They're preempted by federal requirements, and then there's a lot of prescriptive requirements in chapter six that define things, and these are defined in Standards like 90.1 –

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IECC, 189, and some of the state requirements like Title 24. Next slide. So, a little bit of history. This just shows, and this is some of the work that PNNL's done. So, over time, we track efficiency in 90.1, and we try and see how well we do.

This shows the history of 90.1, starting back with the initial Standard, which is 90.75, and you can see how we've improved. In 2000, we got some dramatic improvements in the efficiency, and you see we've been progressively on a fairly aggressive path. And then there's some projections that get out to 2030, 2035, you know, where we could theoretically be at net zero. Just be careful on this, that, you know, it gets tougher and tougher to get to those metrics, and there are certain things that I'll talk about in a minute that kind of prohibit mechanical efficiencies from getting to that point. If you just click it again to show on top of this.

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So, what's gonna come up next – if these go forward – yeah. What I've superimposed on here is what's happened with mechanical efficiency. So, these are typical – sorry go back one slide please – so yeah, shown on here, as I've shown a couple, you know, typical products. So, there's 150-ton air cooled chiller shown in the green, the 10-ton rooftop shown in the purple, and then a 500-ton water cooled chiller.

And you see these actually have improved faster than what 90.1 has improved, and you can typically see the large chiller has improved significantly faster because people tend to focus on very large equipment, and they focus on it. You also can see some dotted lines in there. We've changed metrics in there, and I'll talk about those in a minute, but you can see equipment has improved pretty dramatically. Let's go to the next slide. So, this chart tries to show kind of what we're running into.

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There's a term that we often use in the equipment efficiency, which is called Max Tech, and you start to reach points where you can only add so much surface to a unit, and you really get very little benefit, so a lot of chillers are running to what we call a one degree approach. So, your evaporated temperature in your heat exchanger is at 43 degrees and your water temperature is at 44. You can add some more surface. You can get a little bit more, but these are on exponential curves, so it gets very, very expensive.

So, if you look at the top part of that curve, that's kind of the full load efficiencies, and we're pretty much on some products starting to approach the technical limit. So, we started *[audio cuts out]* a look at an annualized metric, part load metrics, and that's the bottom part of the green curve, and we have some more runway there that we can play with, but we're starting to run out of that in some products. So, you're gonna see more and more annualized and part load metrics, and then we're gonna see different approaches on how we can get efficiency, and I'll talk about those. Let's go to the next slide.

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So, you know, kind of the issues with the current metrics – I've hit on these a little bit. Most are full load based, which is not the best approach, because buildings never run at full load. Most are based on a common national metric, so you know, an efficiency metric for Florida can mean one thing. It means a different thing in Alaska, but we use the same metric. They're not always based on real buildings, you know?

They don't use typical conditions in a building like, you know, a lot of residential, like commercial, is rated with 80-degree return on temperature. You typically don't see that in buildings these days. They're based on a basic unit, so they don't include things like they look at a rooftop and it says it's got an IEER of 12. Well, it doesn't include the economizer.

And the economizer adds a lot of efficiency improvements to it, but they're there just to compare mechanical equipment efficiencies. They're typically component based, so they look at a chiller, it doesn't include the cooling tower. It doesn't include the pumps, and they're very prescriptive test procedures, you know? A good deal of the industry spends a significant amount of their time –

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meeting these test procedures that are backed up by certification programs. The bad part about them is they really are not a metric that you can take and put into a building modeling simulation tool. They really were never intended for that, so we're working on ways to improve that, and then they also don't allow you to compare systems, so you can look. A rooftop has an IEER or VRF has an IEER.

They're really not comparable. They're different test procedures, and then some products don't yet have metrics, so there's a lot of new products coming out, especially with electrification. Next slide. So, a little bit on building a little profile. One of the things we've tried to do in the 90.1 committee is really look at buildings and trying to understand how they run, so this is some work that came out of some of the reference buildings that we have, and it's a typical large office building.

I think it's in climate zone five, if I remember right. You can see the dark blues are the occupied cooling. The light blues are unoccupied cooling. The reds are heating –

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and you can see a lot of problems with this chart when you first look at it. First of all, the design cooling point is that green dot up on the right-hand corner. Nothing runs there, but we spent a lot of time optimizing equipment for that point, and the same thing with heating. It's even further oversized by 25 percent, and then you see in this, it shows a lot of these, just that we have with mechanical cooling is this building has simultaneous cooling and heating. You might have a boiler running.

You might have the chiller running at the same time. There are ways you can transfer energy, and these are things you're gonna start seeing as we come forward, so we're trying to reflect this in some of the new approaches we're taking in 90.1. Next slide. Looks like we have a little bit of slow internet.

So, ASHRAE 169 divides the world into climate zones. So, some recent work, we used to have 17 climate zones. Now we have 19, and you can see the color codes there, so you know, you go from the south to the north. It gets from warmer climate zones to colder climate zones, you know?

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The south or the lower numbered climate zones, zero, one, two, three, four, and then seven, eight, and nine are the cold climate zones. And then we divide them into moist climate zones, which are the A zones. The B zones are the dry climate zones, and C are the marine. A lot of work's been done to look at this internationally, but taking a piece of equipment, you know, designed for Florida doesn't mean it's really the best piece of equipment for climate zone eight in Alaska.

So, you know, we're starting to look at that and say, "Do we have regional requirements?" Next slide, please. So, the other thing we look at is, especially on commercial buildings, the commercial buildings, the low profiles are significantly different. You take a small office building, you compare it to a hospital, or you compare it to a laboratory, the low profiles are significantly different. So, one of the things we've tried to do, and these are available from PNNL, we've come up with these reference buildings, and we do a lot of work analyzing these.

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We're looking at do we have different metrics for them, different ways to approach efficiency in these buildings, and then we've also picked reference cities that we used, and I just put these in here. These are great tools, if you ever wanna compare equipment at various regions, so we tend to use these reference cities. Next slide, please? So, the reason I'm showing you guys a lot of this is this is important in terms of how we look at efficiency metrics.

The other approach we do – *[coughs]* excuse me – is we tend to focus on components. We tend to treat everything like it's a residential window unit, so we have a lot of metrics on chillers, so we'll look at that little green box around the chiller, and we analyze the heck out of it. We look at the cooling tower. Unfortunately, that cooling tower, we only look at the fan part as the function of GPM. There really is no requirements in 90.1 about approach for the cooling tower, so you can put it in a very efficient chiller, and then put in a large approach, and you really don't get very good benefits. So, you can kinda see this. We do it for fans.

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We do it for coils, but not everything in the system is really defined. Next slide? So, some of the work that's started to happen, and you'll see this in 90.1. It actually went into effect in 2010. For the residential products, after a long, agonizing discussion with the Department of Energy, they've decided to divide the United States into three regions.

So, there's an eastern zone. You can see it down there in the white area. There's a northern zone and then there's the west coast zone, and there's different efficiency metrics now for those. So, when you look at SEER, you'll see a 13 SEER in the cold climate zones and a 14 SEER in the hot climate zones, and then the same thing with the heating HPF. There's a major change coming in 2023.

They've totally redone these metrics now, so in the metric they factored in things like, well the static pressures are really too low. They factored in the load lines are different, so come 2023 –

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you're gonna see a new metric that'll be called SEER2 and HSPF2. The numbers will go up, but then they'll be readjusted for the higher statics, the different load lines, so you know, we go into a 15 SEER, but it's really a 14.3 SEER2 is what it'll be. And then really, there actually will be probably a fourth climate zone for Canada, because Canada wants a different metric for their colder climate zones. Next slide. So, the other thing we've started to do, and this gives you an example of a typical park metric, so you know, on rooftops in 2020, we came up with a metric called IEER, and it's very similar to the chiller metric. It's a weighted average of four different rating points: the A point, which would be at 100 percent; the B point at 75 percent –

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C and the D at 50 and 25 percent. As these points are changing, we also are changing it out, and you kinda look at the weighting factors, you know? There's two percent of the time is at full load, 61 percent at the B point, and so on down the road. This *[audio cuts out]* assumes at the end is really properly sized at 100 percent, so really in reality, it's even less at point A, but these actually, dramatically change the way units are designed.

So, you'll look at a lot of the rooftops now coming out, they have things like two-speed fan motors, more stages of capacity, a lot of things that really optimize the part load in annualized performance, and you're gonna see more of that as we move to some of the new metrics. Next slide. So, some of our recent metric changes. The other thing that's happened is on chillers. Chillers are very much looked at very closely, and one of the things that came about is technology development. We have a lot of chillers now that are variable speed –

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or have lots of stages of capacity, and we started thinking about it, that you know, you look at a chiller, and especially in a large building, they never run at full load. So, we came up with two paths, and you look on the Standard, you'll see a path A and a path B. Path A is intended for full load optimized. That's if you're in a place that they have a lot of multiple chillers and you sequence them so they stay a lot at full load, or path B, which is more part load intensive.

And most of the effort in the industry now is focused on path B, where you'll see some significant improvements in the metric called IPLV. If you look in the Standard, you'll see both ratings in there depending on what people wanna use, so it makes it a little more complex, but a lot of things have happened. The other thing with chillers is we added a new table in the 2019 Standard, which is a heating chiller, and when you look at a lot of the buildings, and you if you think back to that chart that I showed you, we have simultaneous heat and cooling. One thing that's unique about a chiller is it can heat and cool at the same time.

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So, you take the cooling load that might be on the core of the building, you boost the temperature up through the condenser, you reject that heat to the perimeter of the building, and now you have energy recovery in the building instead of having a COP on the order of five, now you have a COP in the order of eight. So, you get significant energy improvements, so there's a brand-new table in the 90.1 Standard and then 2019, there's a new addendum that'll be coming out in a few weeks on that. Next slide, please? So, recent metric changes.

So, there's some other things that you'll see in the Standard, so DOAS Units are now filled out in the Standard. They have a new metric called ISMRE. That's a moisture removal efficiency metric. More and more people are starting to use DOAS equipment. There's some benefits you can get from a system aspect where you just condition the outdoor air. Also, so your VRF's have an EER and a SEER. Data centers, they have an SCOP, which is for the CRAC units, so those are the standalone units.

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And the data center's also a PUE, and there's a new standard out, I don't know if you guys have all seen this, called 90.4. It has a metric called MLC, which looks at the overall system efficiency of the data center cooling in a sense, you know? PUE was basically a ratio of the total energy to the IIT energy, so if you got the PUE at one, that means you had no mechanical cooling. And then we have a new fan efficiency metric in there also, a FEI, that you'll wanna look at.

Next slide, please? So, the other thing. We're starting to look at different metrics, and the chart on the right kind of shows you a hierarchy, so you know, originally we'd started out with very simple metrics, EER, COP. Then we came up with metrics like there's a guideline I'll call guideline B that compares the efficiency of a rooftop with an energy recovery, and then we just keep working our way up to IPLV's and IEER's, things like PUE's, getting up to regional combined metrics –

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and then all the way up to full building modeling. As we start to move up this thing, about the time you reach the PUE, we need to have new tools, so one of the things the industry's working on are new modeling tools, both in 90.1 and in other ASHRAE standards, and I'll talk about this in a minute. Next slide, please? So, one of the things we're starting to think about is a systems approach. Instead of just looking at the chiller by itself, let's start looking at the complete systems: the pumps, the towers, things like that.

So, you're starting to see some of these approaches come out in water cooled chillers and rooftops. Supermarkets is a big opportunity. Let's go right to the next slide, please? So, this gives you an example. You remember this chart I had before so we could look at the chiller by itself, and just hit the slide again, please? So, one of the things we can start doing is drawing control –

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diagrams around these components. So, one of the things we're starting to look at is do we have a new metric that really looks at the chiller plus the cooling tower plus the pumps? Now, you start to factor in, say, hey, do we have high pressured up piping? I start to look and say, "Is it better off to put a better chiller in, or to put in an oversized cooling tower, considering the cooling tower can also be doing free cooling?"

So, there's a lot of work in the industry and some new metrics being developed, some tools being developed, you know? You may actually see the first of these on the 2022 version of the ASHRAE 90.1. Next slide, please? And similar thing. Same thing on a rooftop, you know?

Typically on a rooftop, the IEER, it reaches a cooling efficiency of the mechanical cooling of the coils and the fan at a static that's really not used in the building. So, we're starting to look and say, "Hey, do we pick up – do we include the energy recovery? Do we include the economizer? Do we include the terminal units with reheat and things like that? So, another way we're starting to look at it.

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Next slide, please? And then the last slide I'll show you is a typical supermarket. You know, supermarkets are an interesting thing, you know? So, we have some metrics in 90.1 on refrigerated racks and walk in coolers and things like that, but you look at a lot of supermarkets, they may have standalone cases in there. A lot of them reject their heat to the space and then you put in cooling to cool them down, so there's a lot of work in the industry in, say, do we look at the whole supermarket as a system, you know?

And the same thing can be on a retail UMC. You take a look at a McDonald's that has 40 tons of cooling on the roof. 20 tons of that cooling is to pick up the heater rejection from the refrigeration system that are rejecting heat into the space. Next slide, please? So, some of the new metrics they're starting to work on, so I mentioned SEER2 and HSPF2. There's an interesting work under way at Purdue called load-based testing. It's really being pushed a lot by Canada where we stick –

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a unit in a room and we have a low profile that we feed into the data system that's a real building, and then we track the residential unit from zero load to full load, and look at cycling, and all those sorts of things. We're also working on a new chiller metric that'll factor in regional requirements and multiple chillers, working on an IEER2 that'll probably include the economizer, the ventilation. It may actually go the load-based testing approach. Interesting tool developed by – it started with the work in PNNL to develop what they call a total system performance ratio. That would look at the whole mechanical system together, so that's that full diagram, includes the pumps, the cooling tower, and everything.

Similar thing in Canada. It's called BEEM, which is based on some work that was done in Europe on what they call a Second European Directive. You'll see on water source heat pumps; they really haven't had a metric change in a long time. They're now coming out with an annualized metric very similar to the IER, and then underneath AHRI –

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they have a little systems steering committee looking at new approaches to do this stuff. Similar committee in Canada called 424 that's looking at the total billing. They're probably taking it a step further. They're not only looking at the design of the building, but the sustained performance, and you may start to hear things like outcome-based standard. 90.1 hasn't talked about that yet, but that's something that's probably coming, and then I mentioned the Second European Directive, and then the last thing in the next to last slide is ASHRAE 205. This is a new approach on how we can model equipment much better.

It's really tough for you guys to model HVAC equipment because we're focused on the simple metrics, and what you need a full map performance. Next slide, please? So, this is the last slide. So, this is ASHRAE 205. This is been out for two public reviews. We just finished it up. It's about ready to come out for its third IOC and then should be released, but this is a way to develop models –

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such that you could get an electronic rendition of the equipment, port it into your simulation tool, and then model it. One of the things we've learned is a lot of the modeling approaches that are used in Energy Plus and tools like that were developed 20, 25 years ago. They really don't do a good job on pro-intensive machines, variable speed machines, so this new approach will basically give a much better approach that then can be ported into these programs, backed up by certification programs. So, there's a lot of work on this. This has been in a long development, but we're getting close to getting it released. Next slide, and that's the last one, so I'll turn it back over to Richard.

Thomas Culp: All right, Tom Culp here, and I'm taking over for the next part where I'll be talking, changing subjects a little bit from –

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envelope and mechanical to now renewable energy in ASHRAE 90.1. Next slide, please. So, currently in previous versions of ASHRAE 90.1, as well as other energy codes around the country, there's no requirement in the base energy codes for renewable energy, but you can take credit for the use of it in the performance path, so in ASHRAE 90.1, that's side better chapter 11, the energy cost budget method, or appendix G, which is the performance rating method. Now, one caveat to that is the credit when you use the performance path, and it's limited to only five percent of the building budget, the budget building energy cost, when using renewable energy. That's still a sizable amount when you look at the overall building use versus the renewable energy system, but there is that limit. Next slide, please –

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but what we wanted to talk about today here is what's new and what's coming in ASHRAE 90.1, so this is new. There are three addenda all related to on-site renewable energy that are done. They are now published. BY, CK, and CP are the letters they go by, and this is a new prescriptive requirement for a minimum amount of on-site renewable energy on all new buildings and additions, and we'll talk about the specifics here in a minute, but I did wanna highlight that this is the first time that renewable energy is being required as part of a base national model energy code.

It's not just about code programs, things like LEED, or so forth, or other green building programs. This is to apply nationwide in a national model energy code. We've also seen some regional activity. I think New York City and then also the biggest one is probably California state, although that's only for single family homes and again, it's local.

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So, this is kind of a big deal that this is at a national level. We're now trying to bring renewable energy into the base energy codes. Now, it is a prescriptive requirement, so that means that you could also trade it off and make up for it in the performance path if it's not applicable to your building or your design, or you just don't wanna do it, but it's a prescriptive requirement. So, this, because of the timing, it is published.

It's finished. It's complete. It's not in the book version of 90.1-2019. It was published shortly after that, but it is available for jurisdictions to adopt and use if they so choose, and the link is there. You can find it on the ASHRAE website, and then because it's now published and done, it will be incorporated into the 2022 full edition of the 90.1. Next slide, please. So, what is required?

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Essentially, it's what's up there on the top, that the building or the building site must provide an on-site renewable energy system with a capacity of 0.25 W/square foot multiplied by the sum of the condition floor area of up to the three largest floors. So, we'll dissect that a little bit, about what does that mean. Where do these numbers come from? But first, before we get into that, I wanna start off – what type of renewable energy?

Now, as you might guess from the unit's W/square foot that the requirement and the cost effectiveness that the committee went through was developed around solar PV generation, because that's the most ubiquitous and cost effective renewable energy resource in use today, but it's not limited to that. You can use other types of renewable energy or if you don't wanna do that at all, you can make up for it in the performance path. So, as part of the addenda, we also clarified the definitions for on-site renewable energy and renewable energy resources. So, basically what it boils down to is –

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it can be energy from a wide range of sources: solar, wind, biomass, hydro, or extracted from hot fluid or steam heated within the Earth, which means geothermal, but not a geothermal heat pump. It has to be really geothermal, which you know, superheated steam and things like that from the ground – very rare. Now, the key part though is it's harvested at the building site.

That's partly because 90.1's current scope is limited to the building and the building site, and so even though it lists things like biomass or superheated steam, it has to be at the building site, so that means you can use all sorts of renewable sources, but you have to get it there. You can't be trucking in loads of biomass to burn onsite. That doesn't count. It has to actually be from the site, so for that reason, most likely it's gonna be solar –

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some microturbine wind and so forth, but if you happen to have that on your site, like we were told there's a county in Idaho where they might be able to take advantage of some of this, some of these other sources. You can do that, but it has to be onsite. You cannot take off credit for offsite renewable energy at this time because we're limited by our scope. We will be looking at it in the future, and some of the green codes do allow you to take credit for things like community-owned solar and PPA's and things like that.

That's not in 90.1 at this time, but it might be in the future. Next slide. So, what does this mean, going back to the actual requirement, you know? What's this thing about up to the three largest floors and where did this 0.25 W/m2 capacity come from? So, the three floor thing, where you have this capacity number of 0.25 W/m2. Oops, that's supposed to be watts per square foot, not meter.

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You multiply that by the conditioned floor area of the three largest floors, and that was chosen because this allows the requirement to apply to both short and tall buildings. So, if you have the one-story warehouse with a lot of roof space, it's very easy. You just take the square footage of that one story and multiply it by 0.25 to figure out how many – well, you know, what size capacity system you need to install, but it also works for tall, urban, infill site, which is always an issue, you know?

Or if you have a 40-story building, relatively speaking, the roof area available there is much more limited relative to the size of the building versus a low-rise building. However, by using this up to the three largest floors, it still works, because in that case, you just take the three largest floors, not all 40 stories. Multiply it by the capacity limit. The committee went through a number of scenarios to kind of prove out that yes, this works, and I'll talk about what –

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this means in terms of roof space in a second. But as far as the number, the 0.25 W/ – I'm gonna have to go back and fix these slides. That should be square feet – was shown to be cost effective in all solar zones under ASHRAE's scalar analysis, and that's the way that the ASHRAE committee looks at lifecycle costing to prove cost effectiveness. And the key point I wanna make is we're always asked about this.

Well, did this include the tax incentives, or tax credits, or subsidies either from utility incentives or the federal tax credit? No. We were very careful to do the cost-effective analysis without taking account of anything, that this is the pure pricing and value of the energy use. Now, we used PNNL prototype buildings, a couple different prototypes, and then we were able to show that if you have an installed cost of $2.65/W or lower –

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that will pass ASHRAE's scalar of 17.2, and again, this is just the way that we look at lifecycle costing and lifecycle cost effectiveness over the life of the product. So, then what is the current pricing out there? Well, what we used was we looked at other sources as well, but probably the best resource out there is NREL's National Renewable Energy Labs' 2018 cost benchmark report, and there is a very big difference between the small residential systems and larger commercial sized systems. So, for smaller residential type systems, less than six kilowatts, the average pricing was $2.54/W, so that passes this scalar requirement. And I use the word, "Was," because we also looked at the trend, and the trend is it's already dropping. Every year it's dropping, so it's already below that, and we'll price out and be cost effective. On the commercial size systems, that's floor systems –

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between 6 and 200 kilowatts per the way NREL did the pricing, and then there's even lower pricing if you get into an industrial level larger than that, but those systems are a step lower, at about $1.83/W. So, again, that proves out cost effective, and that's how we were able to justify the requirement. Richard, can you click one time? Thank you. So, we looked at this number, you know, not just in terms of pure cost effectiveness, but also what are some of the other issues, and one of the big ones is roof space competition.

You have a lot of stuff up there. You may have skylights. You have rooftop equipment. You may have decks and walkways. You may have gardens. All sorts of stuff are going on roofs these days, so we looked at that in terms of roof competition, so for a number of prototype buildings, it looks like this level that was selected –

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requires less than four percent of the roof area. So, that allows a lot of – that's a relatively small system. It allows a lot of room for all that other stuff. We also looked at the capacity and size of this number in terms of what's it do for power production on every hour of the day or every hour of the year, you know? Not just your cloudy days, but what about on a peak sunny afternoon where it's at max capacity?

Where is that energy, and the key aspect here is we are not making any assumptions about net-metering. Net-metering rules vary across the country quite a bit, so this is sized so that even on that peak sunny day, the energy is being used at the building site, so it's minimizing net generation on an annualized basis and the hourly basis. You're not reliant on being tied into the grid. Yes, these will often be tied into the grid –

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but your – the energy from this requirement will be going into the building and there's no assumption about net-metering, and PNNL took a preliminary look at this. It's not part of their official progress indicator yet, but they're taking a preliminary look. It's estimated that the energy reduction from this requirement's about 4.5 percent, which is quite significant in overall building energy use. Next slide.

So, any time you set a requirement, it's equally important to look at what are the exceptions. Where does it not make sense? There are a number of exceptions. Number one, there are exceptions for buildings that are excessively shaded or have insufficient solar radiation, so that's – and how that's calculated and determined as specified in the actual code text. So, if you happen to be on a site that you just don't have any sunshine because of –

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surrounding infrastructure or geographical features, then there's an out. Second is alterations and smaller buildings, so this only applies to new buildings and additions where the three largest floors are over 10,000 square feet. Looking at the cost effectiveness, it was actually cost justified down to about 5,000 or 6,000 square feet, but we chose 10,000 as a nice, round number. We wanna be a little careful when sending sort of abouts on these smaller buildings and smaller businesses.

And then alterations, there's language in there to make sure it's clear that those are accepted, that if you are doing a lighting upgrade, that that would not accidentally trigger this requirement. So, this is really intended for new buildings and new additions where the three largest floors are over 10,000 square feet. And then finally, there is an exception related to the roof area if your roof is already covered, 80 percent of your roof area is already covered by equipment, planters, vegetative space, roof gardens –

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skylights, or occupied roof deck, then that's an out. And as I mentioned, we looked at this. We believe this requirement will typically require less than four percent of your roof area, so it's really not an issue, but we just wanted to be cautious as this is the first time this would be an on-site renewable energy requirement in a base energy code, and last slide, please. So, now for some pretty pictures. As I mentioned, you can take advantage of other types of renewable energy, as long as it's on-site, but to be honest, the most common will be photovoltaics, which can be rooftop PV, it can be ground-mounted PV, it can be building integrated PV, or BIPV, which is becoming more popular, and then also perhaps micro wind turbines. So, I just threw up a smattering of pictures just to kind of, you know, give you a little flavor that things don't have to be your traditional rooftop panel anymore. Starting from the upper left there, that is a traditional –

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rooftop panel system. I believe that's a Walmart store. You can see skylights there for daylighting as well. The next picture to the right, those are PV cells embedded in a laminated glass so that it's an overhead glazing, and that's being used to provide both power production as well as daylighting. I believe that's an airport; I think in France.

The next one over, you can incorporate PV into opaque rainscreen and opaque spandrel area, so that doesn't even look like PV, but it is, and there have also been some studies we get questions about. "Well, what about using nonvertical surfaces?" Some studies show that you can still get about 70 to 75 percent of the production out of vertical surfaces, south-facing vertical surfaces, as an optimized rooftop system, so don't ignore your vertical surfaces. Next picture, that upper row, far right, that's a micro wind turbine that is –

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suitable for use on building sites or on tops of buildings, so that's an option. Bottom row, far left, bottom left, that's in Salt Lake City where they've incorporated PV cells into the overhead glazing in the canopy of a walkway, and so we see more people doing that in walkways, covers over parking areas, so forth. Next slide. The second bottom row, second from the left, that's incorporating PV on the top of sunshades.

So, there you're getting a double bonus where you're providing shading for the buildings, but you're also using that space for renewable energy. The next one, bottom row, second from the right, that's actually at NREL in Colorado where they've incorporated what looks like just normal tinted glass. It's not. That's a thin film PV in the vision area, so you can actually see through it from the inside, so that's incorporating PV not just in opaque areas –

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but into vision areas as well. And then finally, the bottom right side, that's a traditional ground pole based. There's different ground-mounted systems, but pole-based works quite well, and as long as that's on your building site, connected to your building, then you're good to go. So, I just wanted to kind of give a flavor of some of the opportunities out there and that this is coming. You won't see it in your official book till the next version, the 2022 version, but it is published and available there as a published addenda for jurisdictions to adopt and use if they see fit. And with that, I think we'll hand it back to Mike, I believe.

Michael Tillou: We've got a number of questions from the audience, and we'll get those answered, and then I'll be asking our panelists some follow up questions and hopefully get some discussions started for the remainder of our time. So, I think the first question is for you, Len, and –

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the question is asking – it relates to the air leakage work that the envelope subcommittee's working on, and the question is, is ASHRAE considering including separate apartment or dwelling unit air leakage targets similar to the new requirements that are gonna be in the IECC 2021.

Leonard Sciarra: So, no. We have just one air leakage target for both residential and nonresidential buildings of a .30 CFM per square foot.

Michael Tillou: Okay, so I think the new requirement that they're asking about is sort of the compartmentalization testing of dwelling units. Is that something that the envelope subcommittee has on their radar to discuss and consider?

Leonard Sciarra: Yeah, I'll have to see. I'm not intimately familiar with –

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the AFTM 3158. I think that that that allows compart – I mean one of the reasons we wanted that in there was that allows compartmentalization of spaces. Now already in 90.1, there is compartmentalization language, so you can test buildings by – you can test parts of buildings to parts of buildings, but there's nothing in there specifically that says, "You need to test one unit at a time in a multifamily housing situation."

Michael Tillou: Okay, and then there's one more question related to air leakage. Do you wanna comment on the .3 CFM per square foot target? The question is that seems pretty high if you compare it to, say, the passive house –

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US air leakage target, which his substantially less at .06. Any thoughts on whether 90.1 is gonna continue to sort of ratchet down that air leakage, or are we sort of *[crosstalk]* not there?

Leonard Sciarra: So, as I think was illustrated by what Richard had and what Tom has is, you know, we're a national code. We're adopted for lots of jurisdictions, from the East Coast to the West Coast and everywhere in between, and I think that it's just an incremental improvement, right? I think the 90.1 committee in general believes in incremental improvement slowly over time, and I think it might be slow for some people, but we want to continue. We want the codes to continue to be adopted by jurisdictions across the country.

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I believe in appendix G, you can trade off air – you can trade off somewhat tighter envelopes, I think. Let me get back to that, because I believe – I think you would know this, Mike, though, right? You can trade off?

Michael Tillou: I do. If you're using appendix G, and for example, if you're designing a passive house building, you can claim credit for building your building envelope tighter than what's required by the Standard. So, you could get credit for that and use it as a tradeoff against some other feature, you know, more glass or something like that, so that is an option that is available.

Leonard Sciarra: Right, but it's not available within COMcheck, so people would have to sort of go that way to a full model –

Michael Tillou: Correct.

Leonard Sciarra: – as opposed to just an envelope model.

[1:03:00]

Michael Tillou: Correct. Okay, I think that there's a few questions here about renewable energy that I'll sort of direct to Tom. So, I think the first one you touched on a little bit, but I'll maybe let you chime in some more about it. Is the renewable energy requirement strictly on site, or does community renewable count? I think you answered this a little bit, but I'm gonna sort of expand the question a little bit and sorta say, "Is the group that's working on renewables within 90.1 working on changing the on site requirements to sort of expand the scope to include some of the innovative ways that groups are trying to develop renewable projects like community solar?"

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Thomas Culp: Yeah, and I guess I'll answer for two parts of ASHRAE. So, first for ASHRAE 90.1, we are currently limited by the current scope of 90.1, so it has to be harvested. "On site" is the wording and harvested means sunlight or if it's biomass, it has to be literally harvested on site and things like that. So, a community solar, PPA's, things like that – or VPA's – would not count, but I will point that ASHRAE 189.1, which is a green building standard, and they write the technical content that becomes part of the international green construction code. They have expanded that. They have a little more freedom in their scope, so they prefer – the first choice is to have it on site, because then you don't have any transmission losses, so you get full credit for that, but you get particular credit if you –

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use a community solar project, for instance, or you know, like my hospital system here in La Crosse, Wisconsin, they are energy independent, and they're using landfill gas from across the road. That would not count, unfortunately, under 90.1. It would count under some of these green building programs. Now, Mike's question as far as the future, yeah, we're looking at that. There's a workgroup looking at do we need to expand the title, purpose, and scope of 90.1 to account for some of these other energy uses that were not, you know, both in terms of like, renewable energy, and you know, and greater interaction, and things like that, but also for even things like just lighting, you know?

There might be lighting in parking lots. That's not necessarily connected to the building. Is that covered or not? So, we're looking at these issues. That will require some tweaking of the scope. If that happens, then yes –

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the workgroup within 90.1 would like to look at this, because then that gives more flexibility for building owners and projects to try and do it on site when you can, but maybe in the future also give credit for others, other renewable sources as well, so…

Michael Tillou: Great. Thanks, and there's one more sort of renewables related question. This one is sort of related to the recent IECC appeals hearings, and the question is, the recent appeal to the 2021 IECC resulted in the IECC recognizing its scope does not encompass requiring electric vehicle charging or an electric outlet for stoves. How do you anticipate this result affecting the requirements to install renewable energy?

Thomas Culp: Yeah, so first off, IECC and ASHRAE 90.1 follow different processes. The commercial IECC does reference –

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ASHRAE 90.1, but in general, they follow different processes, and yeah, there was a proposal for buildings to be EV ready. They didn't have to put in the EV charging systems for cars, but they had to be – the wiring and the ducting, you know, it had to be EV ready. It had to be ready so that a future owner could install that. That was taken out, so it will not be in the IECC.

Now, of course, the building owner can still choose to do that voluntarily, but that is not part of the energy code. I would say it only has a tangential relationship to this renewable energy requirement. Now, that's obviously ideal if you design a very high performance, future-looking building, where you have renewable energy generation, and storage, and use, all on the site, but it doesn't have to be that way, and just the pure renewable energy requirement was just justified –

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on its own merits. Basically, here's the cost of it. Here's the energy and value of that energy produced on it over the lifetime until it was – the requirement was justified on its own basis, not accounting for the fact that it would be nice to have battery, or other storage systems on site, or things like EV usage on site, but that will come in the future, hopefully. And I will point out that there is a group in 90.1 looking at energy storage of all forms, not just electrical, but thermal and other systems as well.

Michael Tillou: Okay, thanks, and I've got a question here for Dick. As part of your discussion, you mentioned TSPR as one of the things that might be coming along in 90.1, and for those that don't know, TSPR is the total system performance ratio, and it's a systems approach for looking at –

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HVAC system performance, and it has been most recently adopted by Washington state for HVAC system compliance, but I understand ASHRAE 90.1 has a group that's looking at this approach. Can you maybe tell us a little bit more about what's being discussed?

Richard Lord: Yeah, sure, sure. Yeah, this approach is kind of along the line of what I was trying to explain in that you would have a baseline building, and there's a tool that PNNL has developed that will help use this approach where you'd model a baseline building, and the baseline building would have a reference system in it. Let's say, for example, it's a small office, so it's got a rooftop on it, and then you would model your proposed building mechanical system and compare it against the baseline building, so it's very much like appendix G –

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but on just the mechanical system. So, you know, for example, if you had a rooftop that the code requires an economizer, and for some reason, you say you don't want an economizer. You can go in and you could model it and prove that I'm better than that system, and then you would be approved to use it. And it's gonna be an optional path to start with, but it's kind of setting the groundwork for down the road where do we just look at the whole system and not just the components? So, it's kind of an exciting approach, and we'll see how it works out. And like Mike said, it first was implemented in Washington, but we're trying to carry it over to 90.1.

Michael Tillou: So, is a systems approach like this, is this really an approach that's sort of a replacement for the prescriptive path?

Richard Lord: Yeah. I mean the way 90.1 works; you still have to meet the prescriptive requirements. Now, down the road, maybe that'll go away, you know, for example –

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where you wouldn't have to meet all the tables in there. Ideally, my approach would be somewhere down the road, we kind of get rid of all these tables, because they're a pain to maintain, and we look at a systems approach, but right now it's gonna be an optional path.

Michael Tillou: Yeah.

Richard Lord: But down the road, it could become the primary path.

Michael Tillou: Okay, and I know another if you look at the IECC, and this is sort of a question, I think, for all three of you. You know, the IECC, for several cycles now, has had these additional efficiency credits that projects are required to meet, and there's a list of six or seven, and they have to pick, you know, one or two to comply with. Is this idea of additional energy credits that goes beyond prescriptive requirements something that 90.1 is looking at? And maybe tell us a little bit about –

[1:12:00]

what's being discussed.

Richard Lord: Yeah. Maybe I can start, and I don't know if Tom and Len wanted to join in, but there is an overall working group underneath 90.1 looking at the energy credits approach. So, we've been working at that quite a while, getting close to having a proposal that will go out for public review probably in the spring of next year. So, similar to what was done in the IECC, but maybe version 2.0 with a lot of new features and a lot of discussion, so it'll be interesting see how that goes, yep.

Leonard Sciarra: Yeah, and I'll just add that – so for those who aren't familiar with the 2021 version of IECC, and you know, weren't part of the hearings, you know, what Mike was talking about, the prior versions of the IECC had these additional efficiency measures where you picked one, so it might be high efficiency lighting, or it might be higher efficient mechanical equipment. It was like you just picked one off the list.

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For the 2021 IECC, there was a proposal that turned that into a point system, recognizing that, you know, a U-factor. It is more important in where I live, in Wisconsin, than it is in Florida, but cooling is very important in Florida, so you know, it gives relative points based on what feature you're doing, and you have to earn a certain number of points. So, that will be part of the 2021 IECC, and that's what Dick's talking about, that 90.1's looking at as well. Pacific Northwest National Lab has done a lot of the technical analysis for both the proposal at IECC, as well as what's being proposed for 90.1, and like Dick said, there will be some nuances, different committees, different groups, so everything's being tweaked a little bit different, but the same general concept.

Thomas Culp: And I think what both of these are pointing to is that as we get more sophisticated –

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with our energy codes, we realize that not all buildings are alike, right? As Dick pointed out, you use the same energy code for a McDonald's that you do for a hospital and for a 40-story high-rise, and they're very different buildings. They operate very differently, and so for the longest time, the code was just very simple, and as you get to different buildings, we're gonna have to have different strategies. And so the codes are struggling with this idea of very simple requirements that are very simple, versus something that is more applicable to the actual project, and both codes, I think, are dealing with this, and this optional point system is sort of the first generation of maybe getting into this differentiation within building codes for different buildings, you know? There's a little bit of it in the Life Safety Code, but in general, the Life Safety Code buildings are a little bit more similar.

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But you know, even within just the structure of the building codes, there is a differentiation between a low-rise building and a high-rise building. For example, in the building codes, there's a whole high-rise section, right, that are requirements that are very specific to a high-rise building, but if you're building a low-rise building, you don't need to worry about it, because it's basically they're different. They're totally different buildings.

Michael Tillou: Okay. Thank you, guys. I've got another question here. I think its sort of for each of you to maybe chime in, if you want. What is ASHRAE doing to get these updated codes recognized in states? There's a lot of states that are still working off of a version of 90.1 that may be three or four generations old. Any thoughts on how we can accelerate the adoption of the most recent versions of our codes –

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that we're working on?

Thomas Culp: Well, I mean I'll throw in my thought. My personal philosophy and thought on this is anything we put into the codes and standards, we need to be careful to make sure it's cost effective and practical. And when you do that, and if you do your homework, I'm showing, yes, it's cost effective and practical, it's hard for people to oppose that, and it makes it easier for jurisdictions to adopt the Standard. And part of the whole process is after the Standard is published, PNNL and DOE do a determination on does it save more energy, but they're also trying to look at is it cost effective? And then that will hopefully allow states to then more easily jump to the next version, you know? There's always gonna be politics and some places are gonna be more proactive than other places, but versus, you know, sometimes –

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it's, you know, to pick on the low-rise residential guys. There's been a lot more contention around the states and different places because of maybe one provision in there, whether it's sprinklers, you know, not even energy related or something like that, can cause a lot of contention and then that can slow adoption or speed it up in some places too. So, in my view, 90.1 does a good job of making sure that provisions are cost effective and buildable and practical and then that hopefully will help make it easier to adopt.

Leonard Sciarra: And training, you know? One of the –

Richard Lord: *[Crosstalk]* ______ _____ _______ _______.

Leonard Sciarra: So, you know, these things are complicated. The building codes are getting – these energy codes are getting more and more complicated, and one of the discussions I had with the building department recently was they don't have time to study two codes, so the more that ASHRAE as an organization can provide –

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training for jurisdictions that want to adopt it to kind of lessen that burden, because yes, they're complicated, and so that would be something that they can do to help adoption within different jurisdictions, provide some resources on that end.

Richard Lord: Just to add to what these guys have said, one of the challenges we face is it's even getting more complex because we now have cities that wanna be very aggressive on energy codes. So, you look at New York City, you look at Seattle, you look at Vancouver, a lot of them are reaching out and saying, "We're gonna go past where the state is." So, you know, it's a lot of education. This is why we do these webinars. It's why we do training, but these codes are complex, and so whatever we can do to try and educate these people, make it so they can understand it, because regulators don't have the time to understand this stuff. Big cities do, but small communities don't, so…

Michael Tillou: Okay. Someone's got a follow up question on this discussion.

[1:19:00]

They're curious. As these energy codes get more complicated, has ASHRAE considered coordinating at scope with the IECC?

Richard Lord: Mike, I can maybe start there, and Tom's been involved in this too. I mean we tried an experiment with ASHRAE *[audio cuts out]* 199, where we actually joined forces, so when you look at 189, that's a combined IECC and ASHRAE 199 committee, and we haven't killed each other yet, right, Tom? We're still friends on the committee, so it's a nice effort to try and do that. I mean I think it would make all of our lives easier if we had one national building code for energy, so we're trying.

Thomas Culp: Yeah, and I would say the question was about scope, and the scope is pretty well aligned in terms of what types of buildings it covers, but they are two separate codes, and they're developed different ways, and so you end up with different results. A lot of people, including myself –

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I work in both forums, so for my clients, and in my part of the world, which happens to be like fenestration, I work very hard with people to try to get them aligned, because it's easier for my industry, the manufacturers and then also the architects and specifiers too, if it's the same in both. There are people, and I know other people trying to do this same thing in other parts of the energy code, so people are trying to make them similar, but I don't know. I'm skeptical whether they'll ever be the same, but you know, that did happen with the green code, so we'll see how that works.

Richard Lord: And maybe one thing to add to it, just to make, you know. We're looking just at the US, but I do a lot of work on international, and there are 400 international energy codes, so we've been trying to work through the United Nations to try and come up with a common approach, and it's a challenge.

Michael Tillou: Yeah.

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Well, we're quickly coming up on the end of our webinar here, so I'll just sort of throw out one last question for everyone. Are there any things that we didn't cover yet that 90.1 is looking at or considering that you wanna share with our audience? Maybe we'll start with you, Tom *[laughs]*. ______ _____ _______.

Thomas Culp: Well, as I mentioned – I mean Len's gonna talk about the envelope stuff, and he already did quite a bit, but outside of that, you know, I know people are gonna be looking at energy storage, and demand shifting, and things like that. Can that be part of the energy code, because you know, as we start to move towards a lot of locations having these climate goals, and you know, may need to look at the impact and the interrelationship between the grid and the building. And that's a real challenge, but –

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that's something, at least as a starting step, you know, the energy storage, and peak shaving, and demand shift, and things like that. I know that's one thing that's gonna be looked at, and then on the renewables, you know, we'll be looking at this new requirement that's just out there now, but you know, are there next steps like we already talked about? But I'm also involved on the envelope side, but I'll let Len talk about that, what's coming next on envelope.

Leonard Sciarra: Right, so the other things we're thinking about are a simplified approach to kind of make a very simple version of 90.1 for very simple buildings, because again, there are some buildings that are very, very simple, but look like a house, you know? Your dentist's office may look like a house in some jurisdictions, and in some cases your building may look like a hospital. Like I said, we're looking at thermal bridging for overall assemblies, so that would be, you know –

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ties and girths and rail systems to get a more sophisticated view of an insulation in sort of a regular wall system. And then, you know, we've also been sort of looking at orientation, and we've been looking at siding, and fenestration, and sort of overall wall assembly. Every couple years we look at the overall insulation values to see if they're right, because as mechanical systems get more efficient, the economics for building insulation change. So, it's all interactive, you know? It's all sort of we work with the lighting and the mechanical together to sort of come up with an optimal building that of course then represents all buildings across, you know, North America.

Richard Lord: And maybe just to add a little bit to what the guys have said is that one of the things we're trying to look at is the Standard in general, and how do we make it more user friendly –

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yet it's a lot more complex Standard. But you know, if you notice, you look at the older Standards, they used to be a two-column format, which is really not conducive to look at it on electronic screens. So, we're trying to look at can we simplify the Standard? Can we make it more electronic-friendly? Can we make more tools to make it easy to use?

So, I know Mike and the ECB are looking are looking on ways to improve ECB in terms of how you can make it easier to model, and then I think down the road, we're gonna have to start looking at, you know. We did a little bit of work on commission, you know? Typically 90.1 is a design standard, but maintaining buildings is very important, so we're gonna have to look at that, and this is just more me. I think once we finally get out of COVID-19, I think we're gonna be looking at healthy buildings too. I think that's gonna become an important part of how can you make a healthy building, but how can you make it energy efficient? So…

Michael Tillou: Fantastic. Well, I wanna thank all of you for taking the time to come –

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and talk with us today, and I think I'll hand it back to Richard in case there are any last-minute housekeeping things that we need to take care of here, so thank you all.

Richard Fowler: Sure. I'm just extending another thank you myself to all the speakers and thanks to all of you for tuning in today. As a reminder, we have a great lineup of topics to cover during future seminars. We hope you join us on Thursdays at 1:00 PM to help keep the conversation going. Thanks again.

Male: This has been the National Energy Codes Conference seminar series hosted by the US Department of Energy. Join us each week for a number of other important topics and building energy codes just like todays. We're here every Thursday afternoon –

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at 1:00 PM Eastern. Participate live in our upcoming events or listen to past events on demand through our energycodes.gov training portal. There you'll find other helpful tools and resources from education and training materials, to compliance tools like our RESCheck and COMcheck software, to the latest on state code updates, to analysis of energy code impacts from energy savings, to cost effectiveness and more. Check out energycodes.gov for those and a number of other technical assistance resources from DOE, Pacific Northwest National Lab, and others. From the DOE Building Energy Codes program, we hope you learned something new about energy codes and enjoyed today's session. Thanks for being part of the conversation and we'll see you next time.

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