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Pam Cole: Hello, everyone. I'm Pam Cole with Pacific Northwest National Laboratory, and I'd like to welcome all of you to today’s energy codes commentator webinar. And it is on, Are We Saving Energy from Code Control Requirements in Real Buildings. We hold a webinar the second Thursday of every other month at the same time. So, keep a watch out on the building energy codes programs training page, and topics get added.

So, a course description of today's webinar, again, this is going to be a study on reviewing the energy savings resulting from implementation of code control requirements in real buildings. And it will give an overview of this project and what's been going on with the studies and so forth.

So, the learning objectives for today's webinar are, you're going to understand the importance of building controls in the commercial energy codes. Identify 14 most impactful building control measures in the commercial energy code.

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And basically understanding a relationship of commissioning activities and commercial code control requirements. And then a degree to which the building controls are being designed, installed, configured according to the code requirements.

Before we begin into the main presentation, I do want to introduce you to David Cohan, and he is the manager of the Building Energy Codes program. And he's going to give a broader overview of the actual program and some of the projects of the Building Energy Codes program. David, go ahead.

David Cohan: Okay. Thank you, Pam. And thank you, everybody, for participating in this webinar. I just want to give a little context. DOE works in the development, adoption and implementation of energy codes. And all of those phases are important, but we all know that energy only gets saved when the buildings are actually constructed to meet the code requirements.

So, because of this DOE has focused a large portion of its energy codes resources on research –

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that can identify code requirements where the compliance is low and the potential savings is high. Because that's where you get your most bang for the buck. And if we get this sort of data that lets building officials, states, utilities, state energy offices target their education, outreach and regulatory resources more effectively so that we get the savings, which is what we're always looking for in energy codes.

So, I'm sure many of you have heard about the residential field study that's been underway for a few years. It was single family homes started in eight states. More than a dozen states have now used the DOE methodology, and there is data and more information about the project available on energycodes.gov.

And we're also in the early stages of field studies for retail and office buildings, and a separate study for low-rise multi-family.

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So, we'll keep you informed of results of all those as they progress. But, again, I just want to emphasize that we're actually trying to collect this data in a broad range of building types. The study that you're going to hear about today was more narrowly targeted. Controls are an extremely important component of recent codes. I believe in the last couple cycles it's accounted for almost a third of all the new code changes.

But, we actually don't know much about how they're designed, installed, and operated in new buildings. So, what you're going to hear about was a relatively small effort to start to better understand the status of controls and to see if savings opportunities exist. So, before I turn it over to the main presenter you'll see on your screen a little blurb for the 2017 National Energy Codes Conference.

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And I just want to encourage you all to sign up for that. The link is there on the page, energycodes.gov, so please take a look. It's in July in Pittsburgh, and they're always very well-received and attended. So, please sign up. We want lots of people there from lots of different areas.

Okay. All that being said I'm now going to turn this over to Mike Rosenberg from Pacific Northwest National Lab. Mike is a chief scientist there. He's an ASHRAE fellow, and he was the principle investigator for this project. So, Mike, take it away.

Mike Rosenberg: Okay. Thank you very much, David. First I want to give you a little background. Building control automatically adjusts building's lighting, service water heating, HVAC, and sometimes even envelope components in response to environmental conditions like temperature and humidity, time schedules or occupancy status.

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They include sensors, controllers, control devices.

They're often under the management of a building automation system, especially for large buildings, not necessarily for small buildings. This is a screenshot from a building automation system. The computer workstation. It shows the status of an air handler, a VAV air handler and all the different control points, input of control, energy recovery wheel, fans, dampers, just kind of an example of what that would look like.

And then some of the controls components that you may be used to seeing out in buildings. This first one here is a daylight sensor connected to a light fixture. It senses daylight in day lit spaces like this big atrium here. This is an interesting one. Are you guys seeing my pointer? Can somebody tell me that?

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Everybody's on mute. So, maybe not. This one – the third –

David Cohan: I cannot see your pointer. No.

Mike Rosenberg: Okay. So, I won't take it for granted, thank you. The third one from the top right is a occupancy sensor on a fixture in a parking garage. It's a pretty interesting one. When there's nobody under that fixture there's actually a green light that lights up to show that the parking spot is open.

On the bottom left is a wall-mounted occupancy sensor that you're probably all very, very familiar with and most enclosed offices have those these days. They detect when somebody comes into a room. They may or may not turn the lights on automatically when somebody comes in. But, they definitely shut the lights off when people leave.

This next one is a little bit of a – it looks like a funky aftermarket occupancy sensor attached to a single light fixture. And the bottom right one is a parking garage, and there's a light fixture with a photocell on it, and you can see that light fixture is far away from the openings, and the light is not on –

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the ones for the back by those openings. The ones for the back by those openings are on.

Some more control components. This is a large lighting controller. Next to it in the middle upper picture is a variable frequency drive to control the fan speed of variable air volume fans. To the right of that is a temperature and humidity sensor that's in a computer room. And on the bottom right is a valve actuator that controls the hot water going to a heating coil to provide temperature control in the space.

A little more background. David mentioned, we did a little survey of all the changes to the commercial energy codes since 2004, and about 30 percent of those were related to building controls. So, about a third of them having something to do with building controls.

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Control requirements are difficult to implement. Verification is really beyond the expertise of most code officials. They're not trained mechanical engineers, for the most part. Maybe in some large jurisdictions they are. And it's very complicated to verify controls.

And this slide is just kind of to show you the level of complication. This is the submittal from the mechanical engineer from an air handler. In some ways a little bit similar to the screenshot you saw before, but showing many more points of control; temperature sensors, coils, filters, fan. And this is just for one single air handler in a building. In a large building there could be 20, 30 or more of these.

There are similar control schematics for pumps, fans, chillers, boilers. So, there's a lot of complexity involved in building controls. So, the project that we did, our goal was to evaluate the degree to which high-impact control requirements are properly designed and implemented in new buildings.

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And we took a three-step approach to do this. The first thing we did was to identify the most impactful requirements, and we drew the line at 14. That was about what we thought we could handle in this study is take the top 14. We did a survey of commissioning agents to understand the relationship between commissioning and code required controls.

And then we did a field study where we assessed the design and implementation of those code required controls in 24 new buildings. So, really, the very first step was we did a survey of the two modeled building energy codes for commercial buildings, ASHRAE standard 90.1-2013 and the 2015 IECC. And we identified all the requirements, individual requirements in those codes related to building controls.

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We ended up with 90 requirements. Most of those overlap between the two, there are subtle differences but not many requirements that are strictly for one and not the other, although there were a few. And then we took those 90 requirements, and we grouped them into what we call measures, which are just simply groups of related requirements.

So, for example, we have a thermostat setback control metric. That includes three requirements. There's a requirement that says when people – when a building is unoccupied the temperatures need to be set back, and it actually says in one of those two codes, I can't remember, 55 degrees for heating and 85 degrees for cooling. So, 30 degree offset between heating and cooling when people are not in the building.

There's also a requirement that says you have to have programmable controls with start/stop functions with at least seven different available schedules for each day of the week. And then finally there has to be a manual override so if somebody comes in at night they don't have to turn the whole system on in the whole building and maybe forget about it and leave it on all the time.

Then it has to have a manual override, like a push button, that sets the building to occupied status for no more than two hours.

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So, that it automatically goes back to unoccupied status after that. So, those three requirements became the thermostat setback control requirement.

Once we grouped those 90 requirements into measures we had 51 measures. And we ranked those measures. We got together a group of six experts, and we asked them to rank those 51 measures in 3 different ways: applicability in buildings, how likely are you going to find it in a building; the energy impact of non-compliance, if they don't comply is it a big deal from an energy standpoint or not; and then the likelihood of non-compliance, is it something that's so easy to get that you're almost never going to see it not comply.

So, they ranked in each of those three ways, and from that we took the top 14, and that's what this list is here. I'm going to very briefly discuss these just so that you have a flavor of what they're all about.

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The first one is five degree thermostat deadband and setpoint overlap prevention. That's a requirement that says that the heating and cooling setpoints on a thermostat has to be at least five degrees apart, so it's not fighting itself in heating and cooling. Economizer integration is the next one. That's a requirement where you need to have an economizer for free cooling when the conditions are right outside. It has to be integrated with the mechanical cooling system. It can't just be one or the other. You have to use both when there's a capability of saving energy to do that.

And then there's some high limit control requirements that say you can't shut off the economizer until it reaches certain high limits, which are different in different climate zones. Sometimes it's dry-bulb temperature, other times it's humidity levels. Thermostat setback. That's one that we talked about previously with the automatic temperature setback, 55/85 and the manual override and the seven schedules.

Demand controlled ventilation. This was a requirement that applies to densely occupied spaces like conference rooms or gymnasiums.

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What this does is outdoor air needs to be brought into spaces to ventilate for people. And when you design a system, for example, conference room, you have to make sure you have enough outside air for all the people that might be in there. You might have a conference room that holds 50 people, but very rarely are those 50 people all going to be in there. So, demand control ventilation says when there's fewer occupants you control the amount of outside air and reduce it, so that you don't bring in as much and waste energy. That's typically controlled by a CO2 sensor.

The next one, automatic outdoor air damper control. There's an automatic air damper on air handlers that opens to allow ventilation in there when people – when a space is occupied, closes when the space is not occupied. This requirement is such that when a system goes on to meet a night setback, there's no people in it, but it just gets too cold or too hot at night. That damper has to remain shut. And also during morning warm-up, when you're warming a building up before occupants are there that automatic damper should be shut as well.

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Optimum start controls. Imagine you have a building that's occupancy begins at 8:00 in the morning. You've been set back to 55 degrees at night. Obviously, you don't want to just turn that system on at 8:00 in the morning. People will come into a 55 degree cold building. So, one way of doing it is to just start the building at 6:00 every morning and start getting it up to speed.

Well, that's not allowed by the code. Optimum start says that the building control system has to have some smarts in it, some logic that looks at the temperature of the building indoors, looks at the temperature outdoors and makes a decision about how long before occupancy it has to start up.

Zone isolation. This one is a requirement for if you have an HVAC system that serves lots of different spaces. There has to be the ability to isolate individual zones, so that if some zones have different schedules than the others you close those dampers automatically, and you're not providing conditioned air to those zones that are not occupied.

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The next several are about – have to do with typically variable air volume reheat systems. The first one is the limit on simultaneous heating and cooling. Those of you who might not know the way a VAV reheat system works is that you have an air handler that provides cool air out of the air handler, very typical value is 55 degrees. It's sent out to different zones, and depending on what the demand for heating or cooling is in those zones, if the zone needs cooling it just supplies 55-degree air, and it varies the amount of 55-degree air.

If a zone is in heating it reheats that 55-degree air. So, obviously, that could be a wasteful strategy. So, this requirement says that before you reheat any of that air to zones that need heating, you have to reduce the air flow as low as possible and still meet the load. That's what this requirement is about.

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Static pressure reset, another one for those same systems. The fan speed on those variable air volume reheat systems are controlled by a static pressure sensor in the duct work. There's ways of adjusting that static pressure setpoint so that you can reduce fan energy automatically by the position of the dampers, what zones are in heating and cooling and how much air flow is needed overall. With some smart logic the pressure setpoint can be reduced and fan power can be reduced as well.

Supply air temperature setpoint. I mentioned that the air is coming out of the air handler at some cold temperature, typically 55 degrees, and that may be reheated up to 90 or 95 degrees in zones that need heating. This requirement includes logic that looks at the conditions of all the zones. So, if no zones require cooling, why supply 55-degree air and heat it again. It doesn't do that. It will raise that supply air temperature higher, as high as possible to still meet the loads in the buildings.

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So, one zone may be in cooling but not full demand cooling. So, maybe you get away with 60 or 62 degree air. That means that the zones that are heating have to heat that air up less. On to lighting, occupant sensor control, I'm sure you're all familiar with. We looked at one, people come into a room and the lights turn on or maybe they're manual on in some code requirements. They can't turn on automatically, but the key is that when people leave a room they shut off.

Daylighting controls. If you have spaces that have ambient light introduced between – from windows or skylights, and there's enough light that you don't need the electric lighting, these controls include a photo sensor and a controller that dim the automatic lighting or the electric lighting so that you only get what you need and save some energy there.

Exterior lighting controls. This is mostly about requirements that say you have to turn the exterior lighting off when it's light outside. So, parking lot lighting and building façade lighting and walkway lighting needs to turn off if it's light enough.

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And then the last one, occupant-based interior lighting controls. It sounds a little like the occupancy sensor, but it is a different requirement. Occupancy sensors are only required in some spaces, but almost all buildings require what we sometimes refer to as sleep control. That is a lighting system that turns all the lights off in a building by schedule. So, that's the last of the 14 requirements.

Okay. Onto the actual study. Part 1, the commissioning agent survey. We recruited ten experienced commissioning agents. They represented seven states and one Canadian province. And they had each commissioned an average of 215 buildings. So, very experienced commissioning agents here.

We surveyed them on a number of things. The extent of their services regarding code required controls, their knowledge of those controls, their findings about whether those controls are actually working, designed and working correctly in buildings, and their thoughts on what the greatest impediments were to making that happen.

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So, here this compares to the field work in that this is, okay, what are they remembering? What do they think is going on out there? And then the field work is actually looking and seeing what's going on out there. So, a few of the questions, the first one we asked them if they thought that code compliance verification was included in commissioning scope of work.

And interestingly, only four out of the ten thought that it was even part of the scope of their work. The other six said that, no, they are not responsible for their code compliance. They're responsible for the owner's design intent and what's written on the design documents.

So, a follow-up question to that is whether or not those that feel that they are responsible, whether they actually do testing or trend lobbying or some kind of functional testing to make sure that they're in compliance.

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And only three of the four of those that said it was their responsibility to verify compliance actually do testing. Seven of them didn't. And then we asked if they thought construction documents provided sufficient information for successful implementation of codes. Very interesting on this one, not one of the ten said yes. Four of them said sometimes and six of them said no. So, they obviously think that the designers need to do a better job here.

And we asked them – the final question in this set is if control contractors generally meet all the sequences and requirements specified on the plan. Only two of them thought they did. Six said sometimes. Two said no. In this slide we asked them questions about or a question about each of the 14 requirements or measures.

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I'm not going to go through the details in each of these, but it's just to really give you a flavor. So, the first question is, do they do design review and testing for code compliance to see if there were some that got more than others. And the answers all range between three and five. So, not a big variation. It looks like exterior lighting controls got a little bit of a review.

So, apparently if only four of them say they look at code requirements, they look at exterior lighting controls for whatever reason. They're in the design more often, or it's just something that they do. But, it just kind of gives the same flavor as that previous slide.

The next one is an interesting one. We asked them if they thought that the control requirements met code at final testing. And this one was interesting because, if you remember, only three of them said that they actually did final testing. But, in all cases more than three said it met code after final testing. I'm not sure how they know that if they didn't look. But, these are the answers, for what they're worth.

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And then, our last question to commissioning agents is, we asked them to identify what they thought the biggest impediments were to successful implementation of code control requirements. The most popular answer was a need for better training of design engineers. Six of the ten commissioning agents thought there needed to be better training of the design engineers.

The next most popular answer was that the code is too complicated and changed too often. Three of the commissioning agents responded there, and then two said there was a lack of well-defined control sequences. I would've thought this would've been a little higher based on some of their previous answers.

And then one each for the following impediments: owner's desire for a simple building, lack of clear design intent, improper training of HJs, lack of clear delineation of responsibilities. So, sometimes some finger pointing about whose responsibility it is to get it right.

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Lack of team coordination meetings and lack of testing and training and certification for installers.

Okay. Onto the field study. So, in this study we looked at 24 buildings, all new buildings, newly constructed buildings as close as possible to their certificate of occupancy. Some a little after, some a little before. Four office buildings, one fitness center, two dormitories, two retail buildings, three medical office buildings, two hospitals, nine education buildings, both higher ed and K through 12, and one multi-purpose building that was kind of an odd mix, café office and a hot yoga studio. So, probably a one-off building for sure.

These were fairly large buildings. They ranged in size from 10,000 square feet to 240,000 square feet where the median size was 70,000 square feet.

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And the buildings came from six states and three climate zones. We had one building from Colorado, in climate zone 5B; three from Idaho, in 5B also; four from Oregon, in 4C; six from Utah, in 5B. We had six from Washington, two in 4C and four in 5B. And then four from Wyoming in climate zone 6B.

So, what we did in the field work is we evaluated these 14 measures from 3 perspectives. The first perspective is how well the requirement is included in the design documents. We call that the design perspective. The second perspective was the capability of the installed components to achieve the described control sequences. That's capability. Could it function the way that the code wants it to? And finally, how the building controls are actually implemented in those buildings. How are they actually working? We call that the configuration perspective.

And obviously, you could have the first two be fine if the configuration perspective isn't very good, and you're not going to get the energy savings.

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For each measure and each perspective we scored them from zero to ten. Zero meant that was completely non-compliant, absent from the building or the design altogether. Ten indicated that it was fully compliant or exceeded compliance, for exceeding compliance you got a ten as well. And then scores between zero and ten were based on the condition that was observed out in the field and scoring system that we developed for each of the measures.

So, just a little example of a scoring system for one measure, the thermostat setback control we've already talked about, the heating setpoint's supposed to be at 55 degrees, cooling at 85 degrees, so that's a full 30-degree offset. If that was encountered in the field or the design, it got eight points. If there was only 15 degrees, if they went up to 60 and 75 it got 8 points.

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No offset – excuse me, it got four points. No offset at all, zero points. And then the other two requirements, the manual override, if there was a manual override with a two-hour limit got one point. If it had the seven-day programming that was required it got one point. So that was the scoring example for that measure.

So, now onto some results. This is for the design perspective for each of the 14 requirements. And you can see there's a really broad range. For demand control ventilation in all the buildings where this control requirement was triggered and not every requirement was triggered in every building. For example, the ones that deal with VAV reheat systems are only triggered in buildings that have VAV reheat systems, obviously.

But, demand control ventilation, which was triggered in a lot buildings, was always included in the design. Zone isolation. This one's a little misleading. It says it was never included in the design.

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But, this one, there was only one observation, only one of the 24 buildings required zone isolation, and it wasn't in there. So, there's not much of a takeaway, I think, from this with an n equal one here. The other's a little bit of a range. It ranged from about 50 percent, or from a score of 5 up to 90 and just sort of a range so you can see that.

So, a lot more detail in the report including a bunch of statistical analysis that – and there's one to report at the end, so you guys can dig in deeper there. Next I added the capability perspective, and this is interesting because it's quite a bit higher than the design perspective. In a lot of cases full compliance on the capabilities.

So, even though it wasn't in the design, building systems becoming equipped to achieve the capability – they had the capability to achieve the control requirement. Not in all cases, but pretty good for most of them. I think the lowest here is about 8.5 score.

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So, then if we now look at configured perspective we can see, of course, it's quite a bit lower. So, even though they had the capability they were not configured to operate according to the control requirements. We also found that buildings that had the requirement in the design were more likely to have it configured that way as well.

So, you can see in all cases lower than the capability score has to be, in most cases, the configured score was lower than the design score, but not always. And we're going to look at some of the same data in a few different ways that can give you some different perspectives on it.

This next chart, these bar charts, we split up the 14 requirements into HVAC, lighting, and then the sum of all the requirements.

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And this green portion shows us if we look at the design of the HVAC systems we see that 45 percent of our observations got a perfect score of 10 for the design. Looking at the orange, 20 percent had a score of 0, it was not included at all; 34 percent came in somewhere in between; and the average score was about 6.7 for the design on the HVAC systems for all the measures.

On lighting, very similar results here on the design side. 45 percent had full compliance for design; 13 percent 0, it wasn't included at all; 32 percent fell somewhere in between; with an average just under 8.0. And then just this sums up the overall or it falls somewhere in between the two.

Now, if we add capability, similar patterns to what we've seen before, on the HVAC side 90 percent of all the observations had perfect compliance.

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Two percent, no compliance, they were not capable at all. Eight percent, somewhere in between. The average capability score for HVAC, very high, about 97. For lighting we see not quite as high as HVAC, about 86 percent – excuse me 76 percent were fully compliant and scored 10. Five percent not compliant at all for capability, they had no capability. 18 percent somewhere in between. And average score over 90.

And then looking at putting them both together, HVAC and lighting started getting a number in between the two. And finally, we have the configuration perspective, and as we've seen before this is quite a bit lower, HVAC only 44 percent of those requirements were set up to operate the way the code is asking that they are.

Eighteen percent, not at all, and 38 percent scored somewhere in between with an average score of 7.0.

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Lighting, a little bit better. Sixty-one percent fully compliant, perfectly compliant. Eight percent non-compliant totally. And 31 percent somewhere in between with an average score here somewhere in the upper 80s. And once again, the overall is just combining the lighting and HVAC.

And we're going to look at this data one more final way. This represents all the data points that we collected. So, if we look at 14 measures, it's not 14 measures times 24 buildings. It's somewhat less than that, because as I mentioned, not every measure is triggered in every building.

But, it turns out there were 741 data points for all three perspectives, and this is just a distribution of those data points. And you can see the positive from looking at this is the highest distribution was with a perfect ten. Anything to the right of this dotted line got a full score.

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So, out of those 741 data points, 60 percent, 446, so 60 percent scored a perfect 10. So, if you wanted to give this a compliance score, you know, pass/fail for all these measures, you would say that this group of buildings scored a 60 percent. So, that is interesting data. But, maybe something that's more important is to ask the question, what's the energy impact from the non-compliance with those code requirements?

And really the energy impact is based on the configuration score because that's really what is about. That really has to do with how those things are working. It doesn't matter if the design is good, if it's not configured you're not getting the energy savings or the capability.

So, we've done some of this work in the past.

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Those of you that were on the webinar a couple months ago, we talked about a different study that was more broader in scope where we covered all energy code requirements, and we assigned lost energy cost savings to different commissions, different conditions of measures that we encountered in the field. And we did this based on prototype building energy simulations. So, we were able to simulate the different conditions and assign a lost energy cost due to those different conditions.

For this study we did not specifically do any additional simulation. We relied on a couple of other studies. That one and another one that was done at PNNL that provided us with some information and was able to give us a pretty good estimate on the lost energy cost savings from this sample of building and these measures.

So, it is an approximation. We did not always use climate zone specific data because we didn't have it. In some cases we used national data. And we didn't always match the building type exactly. We didn't have a hot yoga studio with offices and something else, and I don't remember what it was.

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But, I think it really gives a good flavor, order of magnitude of what the lost energy cost savings could be. And down at the bottom here are the two reference studies if you want to get some more information on those, you can look those up. And here's the results for that. So, looking at the entire 24-building sample, for HVAC lost energy savings it was about $288,000.00 per year for all 24 buildings. Or on average about $12,000.00 per building or $160.00 per 1000 square feet. These are all annual numbers, so pretty significant.

Lighting a little bit lower than that. $14,000.00 per year for the entire sample. $570.00 per building, and about $8.00 per 1000 square feet. So, really the takeaway here is ifcode required controls when correctly configured in this sample, a total of about $302,000.00 in energy costs could've been saved.

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Or 12 percent of the total building energy use, so pretty substantial.

So, conclusions. The question we started out to ask was, are we saving energy from code control requirements in real buildings? Well, the answer is yes. We are. We are getting controls in there that are asked for, they are designed, they are capable, they are configured in many cases. But, of course we could be doing a better job.

Some of the big takeaways here, I think on the commissioning agent's survey it's clear that verifying code requirements is not considered to be in a commissioning agent's scope for the majority of commissioning agents. Poor documentation of control requirements from designers is one of the things that leads to problems. But, commissioning agents feel that the controls are being successfully implemented in most cases, which is a little more – 60 percent, more than half of cases.

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They feel that control requirements, code control requirements are being successfully implemented. And now the field study, requirements that are adequately specified in the design documents are more likely to be implemented successfully. We did some fiscal analysis here that's included in the report. There's a link to the report on one of the last pages. So, if you're interested in seeing more material about that and some of the other statistical correlations you can do that.

We found that control requirements were capable of compliance in 85 percent of the observations but successfully configured in only 50 percent. So, that tells us with very little investment we could close this gap. These controls, since they're capable of providing these energy savings sequences, these energy saving strategies, we could move this up closer to the 85 percent with very, very little investment.

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And then finally, substantial energy cost savings could be recovered if there was better implementation of the code requirements. Approximately $168.00 per 1000 square feet per year or 12 percent of the total energy cost.

Okay. Now, I'm going to turn it back over to Pam. She's going to talk about a few things and then we'll go to a few questions as well.

Pam Cole: All right. Thanks, Mike. Just a little overview of the building energy codes program resources that we have out on the website. So, we do have software tools. COMcheck is a commercial energy code compliance software tool that's available. There's a desktop and a Web version. The screenshots are the Web tools that we have.

And then there's the residential energy code compliance tool called REScheck. We do offer technical support. We have a helpdesk that answers questions on the national energy codes for compliance and on the software tools.

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We have some code notes on specific code items and code requirements that have been issues that we have received questions on that we knew needed a little bit further explanation that are out there and available. There's several, several publications that are available, many, many different types of publications that the economist to the research engineers that they do and scientists. You might want to go take a look at the vast majority of those.

And some resource guides. There's a code official guide, an architect guide, a policymaker guide, and those are available on the different stakeholder groups that you might want to take a look at.

And then we also have training materials. We developed slide decks for the main IECC and 90.1 when they come out. And they're basically – the intent of those is for trainers, but we have others that take them and use them. We want you to use them. Take them. Customize them. Use them for your training that you have in your area or your chapter or whatever it might be.

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So, those slide decks are available for you to use at will.

And there's the helpdesk. You can go out to the helpdesk and out to the website. And also a link to the actual PDF of the report that Mike has been going over on the study that he was talking about today. So, I think we're going to – we'll leave this page up for a little bit. And we did receive a few questions. Not a lot, so Mike, you did an awesome job.

And I'm going to address the question, and we'll have Mike answer some of these. So, Mike, are you ready to answer some questions?

Mike Rosenberg: Sure. Go ahead, Pam.

Pam Cole: So, was the study – some of those studies, were any of them done in the southeast? Were any of the commissioning –

Mike Rosenberg: No. They were not.

Pam Cole: The commissioning samples, excuse me. Were any of the commissioning samples done in the southeast?

Mike Rosenberg: That is a good question, and I don't recall that offhand. You could find that out in the report.

[0:40:00]

Or I could get back with you by e-mail. I just don't have that in memory.

Pam Cole: Okay. This is in reference to Slide 18. How did the respondents know that they were meeting the design code requirements despite the majority of them saying, quote, no, when asked if they were aiming for code compliance?

Mike Rosenberg: Great question. That was one of the takeaways that we got. We asked questions and recorded answers, right. So, maybe it needs a little more probing, but how they know it meets the design if they're not looking at it and how they know that they're configured correctly if they're not testing it. Those are two questions that we came out of that.

One possibility is even though it's not in their scope and they're not specifically doing it, they become aware of what's going on in the building because they're getting very involved in the building and the building control system. So, they get a feel for it.

[0:41:00]

But, I think it – their statement about not – it was really sort of a – it almost felt like, this is not our responsibility. We are not the ones that are doing code compliance. If somebody tells us to look for a control requirement that's required by the code and puts it in their design, we will do it. But, de facto we are not the code enforcement. I think that was kind of a takeaway that we got from them.

Pam Cole: Okay. Then another one came in, it was on reference to Slide 21. And it is, wouldn't the scoring system be skewed for the different kinds of buildings? For example, the thermostat controls may be more rigorously automated in hospitals then in, say, schools.

[0:42:00]

Mike Rosenberg: Yes. And we tried to adjust the scoring somewhat for that. Yes, it would be. That's the answer. It would be different for different building types. Buildings that – a hospital that doesn't have any set back wouldn't get a poor score on that because it's not required to.

So, in a hospital that measure would never get penalized. It would always be a ten because there's no setback requirement because the space is unoccupied. Maybe that's what the question is getting at. So, if that was the case then it either really didn't comply or it didn't have it.

Something like demand control ventilation, we said it always complies, but that didn't always mean there was demand control ventilation in the space. It meant that the code triggered demand control ventilation, sometimes they complied by having – by meeting an exception. For example, I think heat recovery is an exception to demand control ventilation.

[0:43:00]

It doesn't mean that they always got demand control ventilation right, but they had heat recovery, which was an exception, so they scored a ten on it. And once again, there's a lot more data for information on the scoring system in the report as well.

Pam Cole: Okay. Were the buildings selected new or existing?

Mike Rosenberg: These were all new buildings. I think we went – we might've had a couple that were up to a year post-occupancy, something like that. We tried to get them – the best time would be if we could go in there the day after they received their certificate of occupancy. That would be the sweet spot.

Some of them we went in there a little before, and in some of those buildings the controls weren't set up, some of them, so we were not able to look at that, so we didn't ping them for configuration if the controls were in place but they were not set up yet. In other buildings you always wonder, have they maybe been – the further away from occupancy you get, the more likely that things have changed. So, we try to stay as close as possible.

[0:44:00]

We actually did a little statistical analysis to see how far out past occupancy you could go and expect to get the same answer that you got when you were very close to occupancy. And I think it showed that within about a year you're pretty likely to get the same answer you would get if you went in there just post certificate of occupancy. And there's, once again, a little discussion of that in the report. That said, our sample numbers were pretty small, so while the statistics prove out I take them with a little bit of a grain of salt. So, a bigger study would be nice.

Pam Cole: Okay. Does quote, configured, mean someone who's verified that the implements actual work as designed or as required by code? I think –

[0:45:00]

Mike Rosenberg: As required by code.

Pam Cole: Okay.

Mike Rosenberg: As required by code. We saw many cases where things were not in the design at all, but yet they were capable and configured even though it was not in the design. So, that tells us that vendors, equipment vendors and contractors are providing equipment that meets the code in many cases even if it's not called for in a design. That is another takeaway.

Pam Cole: Would retro-commissioning close the gap?

Mike Rosenberg: Absolutely. The difference that we showed, 85 percent capable and 50 percent configured. That's exactly what retro-commissioning or building retuning or anything like that is really useful for, right. Low investment, high potential payback.

Pam Cole: Okay. This is two questions in one. Was the field study conducted on buildings that had commissionings done, and were different buildings studied at different points of post construction? For example, one year post construction.

[0:46:00]

Mike Rosenberg: I think I answered the second question already. It varied. We tried to make it as close to post construction. Some of the buildings were commissioned and some weren't, and we actually collected that data, and we tried to do some statistical correlations there as well.

In most cases there just wasn't enough data to come up with some really meaningful – we were hoping we could say, "Hey, commissioning really helps these controls out." And in some cases we were able to show a relationship that it was better. We did it on a measure by measure basis. We looked at it by HVAC and lighting. And there is some details on that in the report as well.

Pam Cole: Okay. What was the total square footage of the 24 buildings surveyed?

Mike Rosenberg: Well, we could do the math. I think it was 70,000 – no, that 70,000 was the median, so I can't do that math.

[0:47:00]

Pam Cole: Is it in the report?

Mike Rosenberg: It's definitely in the report. We have all the sizes of the individual buildings. They were large. I mean, so if the median was 70 and we had 24 you can sort of hazard a guess it's not going to be the correct answer 'cause the median was different than the mean. But, I could get that for you if you want to know, or you could look it up in the report and send a e-mail with that information.

Pam Cole: Okay. It's encouraging that the commissioning agents had a pretty good idea of the implementation of controls, even though they didn't have empirical data. What two or three things would you recommend be done to increase configuration of controls?

Mike Rosenberg: I think that – a couple things. I think it would be good if engineers and building owners build code compliance into the commissioning scope of work.

[0:48:00]

So, that they actually check the controls for those codes required sequences. If they did that the commissioning agents would check it. There's no doubt about that, and they were clear about that. The other thing in codes is the issue of capable versus configured is a little bit tricky. In some instances the code says things should be capable of doing something. In other instances it should be configured.

We took it to mean that while the codes do not require long-term operational parameters of the building, we took it to mean – we interpreted it as to this study that the controls should be configured according to the code as it's turned over to the AHJ and the building gets a certificate of occupancy.

So, that's an interpretation that we made that we think is correct.

[0:49:00]

And also to note that both the two model codes have gone through a change. No longer does it say, "Controls need to be capable of," anywhere. It actually says, "Capable and configured to," both 90.1, 2016, and I don't remember if it's in the 2015 IECC or it was approved for the 2018. But it really makes it much clearer now that its configuration, at least at the time of the building being turned over to the owner and getting a certificate of occupancy. That's important. If it doesn't start out its life being able to achieve these control requirements it become much more expensive and difficult to have it happen later on.

Pam Cole: Has a study been done to compare the cost of installation of lighting controls versus energy savings payback analysis?

[0:50:00]

Mike Rosenberg: Oh, there's been many studies that do that. They're done all the time. Engineers do that on a regular basis for individual projects. I work with the standard 90.1 community and have inputted to proposals in the IECC and we always do a cost benefit analysis to those lighting control requirements and pretty much any requirements that we're pushing into the code or recommending for the code. So, there are lots of studies out there. Some of which PNNL has publicly available.

Pam Cole: Is there a general consensus about who's responsible for enforcing the controls code requirements? For example, is it the AHJ authority having jurisdiction, the one enforcing it? Or is it the commissioning agent?

Mike Rosenberg: I think it's clearly the AHJ. The commissioning agent is not responsible for code compliance.

[0:51:00]

That's not their job. You would think that it's in the due diligence of a building designer to specify code compliant buildings. But, the buck stops with the AHJ really, and that's what's problematic here because AHJs for the most part are not going to have the technical capability and the time to do some of this verification. So, in my mind expanding the commissioning agent's scope of work is a really good idea if we want to achieve better controls in buildings. They're the experts.

Pam Cole: What factor did the plans check process impact the design compliance? I'm not sure I understand that question.

Mike Rosenberg: I'm not sure I really – yeah.

[0:52:00]

Pam Cole: We might need more detail on that one. We can –

Mike Rosenberg: Maybe they mean the plans check impact the capability to what gets installed. If that's the question, if you remember that bar chart, the capability was always much, much higher than the design. So, it's hard to say what impact the design has on the capability. But, we did show impact of the design on the configuration.

Pam Cole: Okay. How do you know that the HVAC issue is low cost? Meaning in quote, low cost commissioning rather than duct leakage or installation issues. How do you know –

[0:53:00]

Mike Rosenberg: I was speaking specifically to these control requirements. So, the point that I was making is that if these specific controls, whether it's thermostat deadband, simultaneous heating and cooling limitations, occupancy sensor control. If those are not configured correctly but they're capable, in other words, all the equipment's there and they've got the setpoint and settings that just need to be adjusted to configure them, while it's not always as simple as changing a number somewhere, sometime it takes some expertise. It is much, much lower cost than if these controls were not capable at all in the first place and you had to buy material or equipment in order to get that done. So, that's why I say it's low or no cost.

Pam Cole: Can an AHJ refer to this report to help with verifying compliance?

Mike Rosenberg: This report is publicly available.

[0:54:00]

If it's of use to them, they certainly can.

Pam Cole: Okay. Well, we only have a few minutes left, and that sums up the majority of the questions. There's some specific ones that we might need to reach out to individually if Mike has the time to do so. If not and you have a question or you didn't get a question answered you can submit those through our helpdesk, and we've left this screen up that has the helpdesk URL there.

And we do thank everyone for participating in today's webinar. Keep a look out on the energy code's training page as topics get put out there. Again, we hold a webinar the second Thursday of every other month. And if you have a topic of interest that you would like to see us to review and see if it's possible that we could use that topic and present on it we would like to hear from you.

[0:55:00]

So, you can submit your topics through the URL that is through the helpdesk or you can through the webinar reminder that you received today. Either way you can get them into us for any great topic ideas. And so, I'd like to thank everyone and all of you now can disconnect.

[0:55:14]

[End of Audio]