

Hannah Debelius: Hello, everyone. We'll be started in just another 30 seconds or so. Thanks for joining.

All right. Hello, everyone, and good afternoon, at least if you're on East Coast time. We're so excited to have you today. You're in the right place if you are here to learn about GHG Emissions Reduction Audits: Taking Audits to the Next Level. I have a couple of housekeeping items to go through before we get into the content today.

The first is that you'll notice all of our participants are muted. We are recording this webinar, and it'll be posted on the Better Buildings Solution Center in case you'd like to reference it again or send it to a colleague or that sort of thing. If you are having any technical issues, if you use the chat button, which will be at the bottom of your screen, you can drop down to Tech Assistance Anna, and Anna will be happy to help troubleshoot any of those issues you might be having. And finally, I just want to say that we are really glad to have partners and organizations from the whole large Better Buildings Network and beyond join us today, however, we are going to be referencing the Better Climate Challenge a lot, so we'll talk about this more, but if you are interested in the Better Climate Challenge and are not yet involved, you can always reach out to a contact you have in Better Buildings or my email will be at the end of this, you can reach out to me directly.

My name is Hannah Debelius, and I am very honored to be working with the whole commercial sector for the Better Buildings Initiative. And I am joined by a wonderful panel of experts today who are going to be diving into our subject. Hannah Kramer, who is the LBNL BCC – that's Better Climate Challenge – Technical Lead, as well as Dan Luddy and Tom Abram, who both serve as Technical Account Managers for the Better Climate Challenge.

Today we're going to really digging into GHG emissions reduction audits, the benefits to owners but also the scope of those audits, how you can be – how you can access those or arrange those within your organization, and then also, once you do that, what do you actually do with the results, how do you evaluate them and how do you report and make decisions working toward hopefully your portfolio-wide emissions reduction.

Today we'll be using a tool called Slido, which should be familiar to many of you who have joined our Better Buildings webinars before. So right now, if you go to [slido.com](https://www.slido.com) and enter the event code BCC, you can do this either in another browser on your

computer or also on your mobile device. Again, it's slido.com and enter the event code BCC. We are going to be utilizing this throughout the whole presentation to do some interactive pieces and also to submit questions. You can submit questions anytime in this, and if you have it open, you can also upvote other people's questions with a little thumbs up, and as they get upvoted, they actually move up our list and so we're more likely to be able to get to them at the end when we take Q&A. So I hope you all again enter slido.com using code BCC, and Anna has also dropped that into the chat for you all to access.

I would like to thank all of our many Better Climate Challenge partners for getting onboard with us to work toward establishing and then sharing workable pathways to decarbonization. All of these organizations have committed to at least a 50 percent reduction in operational emissions over ten years. If you are on the line and your logo is in front of you, thank you very much, and I'm so glad to have you onboard. And if you are not on this slide, again, please reach out to either your regular Better Buildings contact or you can reach out to me directly. My email will be at the end of the slide because we'd love to talk to you more about this and share access to other technical assistance opportunities such as working groups or one-on-one technical assistance you can get through the program. So with that, we will start digging into the actual content for the day, and I will turn it over to Hannah Kramer.

Hannah Kramer:

Thanks, Hannah. All right, so we're going to talk a lot about this shift today from energy efficiency to greenhouse gas emissions. Many of you are familiar with energy efficiency audits through – for your buildings. Maybe you do those audits yourself. And there's a lot of focus on reducing emissions. And the differences in that and how we can sort of build upon our long history on energy audits to leverage that for emission reduction.

This slide here is really to focus on energy efficiency first. So there's lots involved in an emission reduction audit: electrification, renewables, low-carbon fuels, but first and foremost, we want to avoid or use less. That makes everything easier in the end. So this is kind of one of the tenets of our program.

I want to just up front – I'll also give this to you at the end – tell you about an emission reduction audit working group that's just kicking off next month on July 10. If you are a Better Climate Challenge partner or ally, or if you aren't now, if you join, then you can be a part of this working group. It'll be a lot of peer exchange around what are your experiences doing emission reduction audits

and transitioning into that world of asking your auditor to do more. So we're going to be talking about scope. We're going to be sharing example RFPs, sharing example audit reports, and likely coming out of that with some templates and tools that will be informed by all your experience.

So the QR code on the left is for signing up if you are a partner or ally to the emission reduction working group – audit working group. And then the QR code on the right is to our resource that this webinar is based on. This was published in February, and we just issued yesterday actually a revised version that's just slightly revised. So if you've downloaded it before, you could download it again today with that QR code. It's really kind of the how-to guide for owners. We call it the audit checklist because at the end it has a real – a short checklist per task to summarize what's been discussed in this guidance document. So it's the owner's lens. We've been coordinating with ASHRAE, who is also really focused on this issue, and they are developing guidelines from the auditor's lens, so the more how-to of the details of what's included. We're a big higher level, but have what are the questions that owners need to ask? What do they need to do to make sure they're getting the type of audit they need for emission reduction? So download that, and this whole webinar is going to give you the summary of what's included in that resource.

I also wanted to put this new resource in context with our other work in emissions reduction. So why transition from audits to emission reduction audits? We've talked a little bit about that. The other connection is do your climate action plans and your sustainability plans have the highest-level goals and targets. They're creating organizational change and inspiring that change. We need to build up the how to get to those targets. So if we start at the building level emission reductions, we know what we're going to do, how to at the building, what retrofits and improvements need to be made, and all those building level audits can roll up to your greenhouse gas emission reduction plan. We have another guidance document that just focuses on that portfolio level plan, which is this middle piece here, and there's a different webinar that we'll send out that we've done in the past for that piece. But for now, we're just talking about the audit itself, which there's a lot of pressure these days to meet local regulations and mandates, and then these volunteer programs that are focusing on this. So we hope that this guidance document can help you get to where you need to be from the emission reduction audit perspective.

And now I'm going to transition over to Dan. Dan was the primary author on the audit checklist, and he's going to describe how it all works and do a little back-and-forth with Tom, who has also done a lot of auditing in his career.

Dan Luddy:

Great. Thank you, Hannah. I appreciate that. That was a great introduction to the why for the audit, and so now I'm going to jump into the what. The what is a greenhouse gas emissions audit. As Hannah mentioned, it is similar to what you may already be familiar with an energy audit but sort of takes it to another level with some other pieces that we'll discuss in greater detail. It's basically an assessment of the greenhouse gas emissions associated with a specific existing building. Part of it is to calculate the Scope 1 and 2 emissions for the building. As a sort of reminder if you're not as familiar with the different scopes of emissions, Scope 1 is the direct emissions that come from your building form fossil fuel combustion equipment, so this could be furnaces, boilers, appliances, things of that nature. Scope 2 emissions are the emissions associated with your electrical usage for the building as well. So together we typically call those the sort of operational energy-related emissions for the building.

And the purpose of the audit is to assess where those emissions are and to provide recommendations to reduce those emissions over time, either by replacing equipment at end of life, providing recommendations for new equipment that could be done – installed, or by adjusting operations or controls to better optimize the systems in place. If you are familiar with your energy audits and different flavors of energy audits, the guidance that we've developed here is comparable to an ASHRAE Level 2 audit, which is a sort of middle tier of the audits methodology that ASHRAE has released, or on the ISO standard, ISO Tier 2 energy audit.

As Hannah mentioned, energy efficiency is still the sort of central first step that we always advocate for when it comes to looking at emissions reductions, and if you have done an energy audit before, you're probably familiar with the term energy conservation measures, or ECMs. These are the recommendations that the auditor – energy auditor typically has for how to reduce the energy use in your building. So an emissions reduction audit takes – includes that scope of looking at energy efficiency reductions but expands it to include what we're calling emission reduction measures, ERMs. And those measures are recommendations for emissions reductions that does encompass energy efficiency and potential for load reduction in your building, but additional items here that we've listed. So looking at means of electrifying the

systems in your building or to implement EV charging to assist with fleet vehicle electrification. It also looks at refrigerant usage in your building, whether it's in-between the existing refrigerants that you do have with equipment in your building currently and looking at potential opportunities for low or no global warming potential refrigerants to be used in place of it. And also assessing the potential for onsite renewable energy from photovoltaics, solar thermal, renewable energy systems that you can implement onsite and potentially bring down the overall emissions profile of your site itself.

And so with that, I want to bring Tom in here too to kind of talk to these. Tom, what do you see as the benefit of approaching these items together in a sort of a holistic audit package?

Tom Abram:

It's really important to be incorporating all of these items cohesively. There's a lot of interactivity between them. There's a lot of opportunity to kind of leverage efficiency to be able to right-size your electrification elements, your heat pumps that you may be moving toward to make sure that you're able to leverage as much solar or onsite renewable capacity as you can. So there really are a lot of advantages to being able to look at this cohesively as well as avoiding rework. You'd hate to have a situation where you have to do some sort of an electrical upgrade to be able to address one element of this and then a few years later somebody's asking about EV charging capabilities or other elements. It really gives you an opportunity to look at it in a cohesive way.

Dan Luddy:

Well said. That's absolutely true. We're going to definitely dive into – or discuss opportunities to implement things over time and combine measures together, so that'll be certainly a point of discussion for us. To dive into the specifics of the audit, we've identified sort of four main tasks through the lifespan of the audit scope itself, which you can see here: sort of initial data collection and target setting; the actual Step 2, which is the onsite inspections themselves; Step 3 being the sort of analysis that the auditor does; and then Step 4 is the review by the owner, selection of measure to implement, and actually getting the work done.

We're going to dive into each of these topics in more detail in the upcoming slides, and I also want to just mention that the key stakeholders for this audit process, certainly we have the auditor themselves, building owner should be involved throughout all these tasks and the process and be part of the communication, and the building engineer or operator or operations team should also be a key stakeholder as well to be able to provide information to the

auditor about how the building is currently operated and also to help influence the recommendations that will be made for future operations so that they can help to prime the building for future success. That is sort of at a minimum the stakeholders. There's certainly opportunity to bring other parties into it as well.

Tom Abram: Yeah, definitely agree, and I'd say it's a really good opportunity to be able to engage staff at this point and really provide some education in terms of what are your overall emissions reduction objectives. Especially helpful to understand context into why or why not certain strategies are being considered. They might wonder, well, we recently put in a condensing boiler and building elsewhere in our portfolio. Why are we changing streams here? And so that's really important to provide that context, engage, and also to identify champions within those stakeholders.

Dan Luddy: Absolutely. All right, so let's dive into the specific tasks starting with Task Number 1, which is sort of all the information that we need to collect first before we get too far into the audit. So there's the data collection piece and then establishing your goals and targets for the audit itself. So first off, the owner should work for the auditor to compile records that you have for the building: metered energy data, as-built drawings, if you have a billing automation system that provides sort of metered data or other sorts of submeters or other sorts of information about the specific systems in your building, providing that to the auditor as well to delve into, or any sort of equipment submittals. All that information could be relevant and, as an auditor, it may not seem like it, but sometimes it's a fun task to be able to sort through everything and kind of see where everything is in a building and understand how it works.

The Scope 1 and 2 emissions need to be calculated based on the historical data, so based on what's metered for electrical usage, natural gas usage, any other sort of fuel oil or steam or other sorts of energy sources, that would be compiled by the auditor, and the emissions profile would be calculated based on that data and applicable greenhouse gas emissions factors. Which leads us to discussing those factors.

We did want to stop and sort of highlight this because this is a key part of the emissions - greenhouse gas emissions reduction audit is working with your auditor to decide on what are appropriate emissions factors to use for your different sources of energy to be able to calculate your Scope 1 and Scope 2 emissions. There are a number of different methodologies out there for calculating

emissions factors, whether it's looking at sort of your region or your local utility. It can also depend on whether it's historical data, so if the emissions are calculated based on the emissions profile the past five or ten years, that's going to give you a look at what the emissions might look like today, but it may not necessarily look like what the emissions will be in ten years, particularly with the greening of the grid and more penetration of renewables into a lot of our local grids themselves.

So when you're looking at these audit results, it's important to work with the auditor to decide on what are the appropriate emissions factors to use for this analysis, whether it's using the historical factors for your region or for your locality, or if you want to use a future projection of where the emissions are going to go, particular if you think you're in a region that may have a higher-than-average penetration of renewables or something else that means that your – some other reason why your local conditions may diverge from larger regional factors. Tom, would you agree with that? Have you seen how emissions factors impact building design or building operations?

Tom Abram:

Yeah, definitely. And I'd say this is a case we really want to make sure that the folks that you're working with are kind of kept abreast of current developments, that they're really aware, they have an amount of carbon literacy in addition to kind of the technical capabilities and understanding of building systems. I saw one situation where an organization was assessing looking at moving away from natural gas for one of their systems, and it showed that there really wasn't much of an emissions reduction benefit. When we dove into it in a little bit more detail, there were a few issues. One was they were using kind of somewhat outdated average national grid emissions factors, and this was in California, so there were some regional considerations. And the option that they were looking at was more of kind of a standard sort of an approach. And when you are able to use equipment technologies like heat pumps rather than kind of the electric resistance and less efficient equipment, you really can see some significant savings from emissions reductions, even in areas with relatively dirty grids because you're able to leverage a heat pump, you're moving heat around, and your need for energy is reduced dramatically, and that can really reduce those emissions. So definitely important to consider your local factors and make sure that you're looking at it in a sophisticated way.

Dan Luddy:

Definitely, and I think we're going to talk about this more when we talk about renewable energy too and onsite and how that impacts it. Let's move on to the next slide.

Setting targets. This is another piece that is important to do right off the bat at the initial stage working with your auditor to decide on what are appropriate targets for emissions reductions that you are looking to get to for your building. Many of you have signed up for the Better Climate Challenge, and by doing that, you've committed to 50 percent emissions reduction over the next ten years on a portfolio level. At some point, if you have that or some other sort of aggressive emissions mandate for your organization or for your jurisdiction, those mandates will have to trickle down to your specific buildings and you'll have to have – it's a good opportunity to define a specific target for your building, whether it's 50 percent or more or less. Giving that idea to the auditor up front helps them focus on their – focus their look at your building and their recommendations to be able to come up with pathways to get to those aggressive targets instead of just looking for the easiest and lowest-hanging fruit. So that is an opportunity to work together with the auditor to do that.

And I should also mention that the targets should be focused on site-specific greenhouse gas emissions reductions. Some of these mandates out there would include the opportunity to use renewable energy credits or green power purchase agreements to kind of provide offsets for your building emissions. The purpose of the audit is to really just reduce the emissions profile of your building as much as possible so that you can mitigate or eliminate the need to do these additional offsets to get to your targets.

All right, let's dive into Task 2, and this is where we go out to the actual building and we start walking around and we go all over the building. As an emissions reduction audit, we're going to focus on the same things that we'd investigate for an energy audit, so we're doing to look at HVAC equipment, how it's currently functioning, the condition of it, if there's an opportunity for replacements. We'll also look at lighting systems, lighting controls, plug load systems and controls as well, and then some additional pieces to kind of match with that additional scope that we're focused on for a more holistic look at emissions. Building envelope should be evaluated for potential for remediation and opportunities to improve thermal performance and reduce heating and cooling loads.

And the auditor should also spend a bunch of time in the basement or in the mechanical and electrical rooms that are in the bowels of

the building to be able to assess the electrical service that currently runs to the building, what sort of capacity is there, and room for additional loads. And also just assessing all combustion equipment in the building and just making an inventory of all the equipment so that we can come up with recommendations or alternatives to be able to replace that equipment over time. The auditor should also go up on the roof and be able to assess the opportunity for onsite renewable energy, whether it's rooftop-based solar photovoltaics, solar thermal, or a deed on the rest of the site too, whether it's parking structures. There's a number of options out there, and so the auditor should be aware of and assessing that as well. So it's walking all around the building.

The inspections themselves, if you're familiar with what's typically analyzed during an energy audit, the first three bullets are things that auditors would do for an ASHRAE Level 2 audit: identify operational deficiencies, opportunities to reduce energy usage, and reduce emissions; recommend equipment replacement opportunities that they see, whether it's current or in a short to medium time frame; and identify any sort of immediate needs for improvements, operational fixes, if there's equipment that clearly is broken or malfunctioning or has a need for maintenance or repair, flagging that so that billing service team can address that more immediately. The bottom three bullets there that are in the green circle are what we're additionally adding for an emissions reduction audit, so this is evaluating the electrical service and panel locations so that we're aware of where there might be capacity to add additional loads, whether it's EV chargers or tie-in for onsite renewables or heat pumps or other sort of electric-based heating systems. It includes an inventory of refrigerants in a building and refrigerant-containing equipment and what those refrigerants are, and also an investigation of the solar readiness and space for renewables on the site itself.

So at the end of this Task 2, the sort of physical onsite portion of the audit, we recommend that the auditor provide to the owner what we're calling an initial assessment report, and this would be an interim communication between the auditor and the owner for an opportunity for the auditor to communicate what they found onsite, sort of condition of everything that they looked at, any sort of insights that they want to share with the owner about how their building's currently functioning, specific needs for improvement, and then also outline where the auditor is going to focus on for recommendations and to do their actual analysis of potential greenhouse gas emissions reductions. This is a good check-in with the owners so that you can help to course-correct the scope of the

audit and so the owner's aware of what the auditor's going to be looking at and there's agreement there, and it's just a great window for the owner to see in a more telling manner what's going on with their building and to address any issues. I know this is sometimes done with audits, depending on the methodology. Tom, have you seen this and do you think this – do you see the value of communicating this to the owner at this stage?

Tom Abram:

Yeah, absolutely. I think because you mentioned it's really important to get that alignment. It's important to understand whether the mix of measures that are under consideration have a chance of achieving the emissions reduction targets. Obviously there needs to be more in-depth assessment as part of the further steps, but it is really good to check in and understand are there other areas of consideration, are there ideas that staff might have that they want to make sure are being explored and considered at this stage? So it's a really good time for engagement, not just with whoever is leading the audit on the other side, but also engaging the facility staff to make sure their ideas and concerns are being addressed as well.

Dan Luddy:

Absolutely, that's a great point in getting the facility staff involved with it. I've also mentioned that the guidance document we have has an outline for what we'd recommend to be included in this initial assessment report as well.

So we've calculated the greenhouse gas emissions, we've gone onsite, looked at everything. Now the auditor's gone back to the office and they have all this data, and it's time to start analyzing and developing recommendations, energy emissions reductions, measures that they can recommend to the owner and to develop those targets to be able to meet the emissions reduction goals for the project. As you recall from the beginning slides, we're adding newer types of emissions reduction measures, so in addition to energy efficiency, we're also looking at electrification, fugitive refrigerant emissions, and renewable energy onsite. And so with each of these ERMs, the auditor will be developing certain analysis results. It'll be operational costs savings, operational energy usage savings, the cost to install and calculate a simple payback based on that initial cost and the utility cost savings over time. All those pieces should be familiar for a typical energy audit. The new piece that we have here for an emissions reduction audit is to take that and also show the emissions reduction savings – or sorry, the emissions savings for each of those measures as well so that we can evaluate not only the things that might save the most energy or have the lowest cost but also would reduce greenhouse gas

emissions the most too. And those pieces don't necessarily all line up on each measure, as we'll talk about in a little bit more detail. But let's start by jumping into each of these four types of measures on top, the energy efficiency, electrification, fugitive emissions, and renewable energy.

So energy efficiency ERMs, this is what most people who have experience with an energy audit would be familiar with. These are measures that directly reduce energy consumption for the building, and audits should include a scope that covers basically all these systems of the building itself, so including the building envelope, lighting, HVAC, service hot water, process loads, any other significant energy user in the building itself, and so those recommendations could be new equipment, it could be improved controls for some of those equipment, or things that can be phased in over time. As part of these measures too, the auditor should assess how energy is tracked with the building, if there's an energy management and information system. And if there isn't, that should be part of the audit is to assess how energy usage can be tracked and monitored over time moving forward so that the owner can have insight into how their building is performing and be able to identify issues from the data if and when they occur. Tom, do you have insights to discuss about the energy tracking and emissions performance?

Tom Abram:

Yeah, definitely. It's being able to track your energy and your emissions on a regular basis, which I think people at times get a bit overwhelmed at how might I be able to track emissions at my specific building over time, and really once you've got those emissions factors, you apply it to your energy usage in the buildings and you're able to track that fairly easily on an ongoing basis. I would say it's really critical to be looking at energy management information systems as whether they exist or whether that's an opportunity to incorporate in the future. It's really a great opportunity to be able to optimize their operations if you leverage – especially if you're leveraging fault detection diagnostics, you can identify performance failures and issues, energy opportunities on the fly. I'd say all of this data is really good at being able to inform emissions reduction auditors in identifying which measures might be most effective as well as being able to identify the electrification readiness in many cases, being able to look at the data and understand what are the actual loads that are happening in your facility rather than what the design loads are. So I think it's all really critical to be tracking this information and it's probably a reminder for folks to make sure that their systems, if they've been enabled, are they continuing to track performance. And if trends

have stopped, now is always a good time to start those trends going again so that when your auditor comes they're able to take a peek.

Dan Luddy:

Absolutely, yeah. And it's – you can provide a lot more insight than your monthly utility bills, which is sort of one data point a month. Can be really helpful for the audit, future audits, or retro commissioning agents as well, which we'll talk a little bit more later.

The next category of emissions reduction measures to discuss is electrification, and so this would be providing alternatives for all combustion equipment – fossil fuel combustion equipment on your building site. Not that you necessarily would be able to implement them in a short timeframe, but just providing pathways for electrification for all systems for the owner to consider as they plan out their future phasing. So as I mentioned, the auditor should provide at least one all-electric replacement for each type of combustion equipment, and you can not only just space heating and service hot water heating, but any sort of process-related uses in the space itself, so it relates to cooking, fireplaces, appliances, all this equipment which is typically not looked at with an energy audit. They're not usually looking at replacing kitchen equipment or appliances, but it's important to assess what is the emissions profile of that type of equipment and how can we provide alternatives for that in the future. So that should all be assessed.

And if you're familiar with heat pumps, you're familiar that there's a lot of different types of heat pumps, whether it's air source, water source, ground source. They could have different backup types of heating systems, whether it's a fossil fuel backup, electric resistance backup. The auditor should have experience in assessing different types of electric – heat pump based electric systems so they can provide the recommendations for the best type of systems for your specific building. That's a whole subject that we can spend a lot of time on. In fact, there's another webinar that we did last year on heat pumps in existing buildings, which I'd recommend. So it should be something that should be assessed, and the auditor may have recommendations to either use heat pumps to augment the existing heating systems that are there or to provide a completely new system that could be phased in over time.

We also mention here thermal energy storage because we feel that – and thermal energy storage is a technology that could really boost the benefits of heat pumps in a way that a lot of folks are not thinking about currently. Thermal energy storage is storing additional hot water energy for times of peak usage, which can

really downsize the overall capacities needed to meet those more extreme loads. So that can really optimize your overall heating system, and if you're putting in a new heat pump-based system, it may be a great opportunity to use thermal energy storage to reduce the overall equipment size. So we love to talk about those synergies of different technologies together. Tom, do you have any other considerations around electrification?

Tom Abram: Yeah, the only thing I'd note is that electrification really starts with efficiency. The more you could incorporate efficiency, improve your envelope, you're going to be able to put in smaller heat pump systems and reduce the cost of those systems, so definitely, again, encourage, just like thermal energy storage, passive approaches to envelope can also facilitate electrification.

Dan Luddy: Absolutely. The third category of emissions reduction measures to evaluate would be fugitive emissions reductions. So this is mitigating any sort of – identifying and mitigating any sort of leaks from equipment that contains refrigerants. A lot of those refrigerants have very, very high global warming potentials, so not only can mitigating those leaks help your equipment run better and reduce the need to recharge that equipment in the future, but it also just reduces the overall emissions profile and sometimes significantly, particularly if you're losing a lot of refrigerant from certain systems. It's also an opportunity to investigate the use of low-GWP refrigerants for future equipment. Some of these refrigerants that have high GWPs are actually being phased out. R22 has already been phased out. R410A is currently being phased out. So if you have older equipment, it may be more difficult to service in the future, and so that may impact your decisions of when to replace certain chillers or air conditioning systems or refrigeration systems and what you would shift to.

Finally, the last category of ERMs would be renewable energy and making sure to assess the opportunities for onsite renewable energy as part of the audit. This could include – will likely include solar photovoltaics in most cases but could also include solar hot water, solar thermal, or potentially in some cases wind microturbines or other sorts of small distributed renewal energy systems. This scope sometimes is provided by separate consultants for the owner. For example, solar contractors may come out and do an assessment for a future photovoltaic array on the roof. That is certainly doable. If you've already had an assessment done, that's great too. That information and that assessment should be communicated to the auditor so they can include it in their analysis and view it at the same time as you're viewing all these other

possible emissions reduction measures. And it's an opportunity to then phase in any sort of retrofits that you're doing to incorporate that renewable energy system. If you have to upgrade your electrical service to tie in this PV on the roof, it's also a great time to make sure you have enough capacity for future heat pumps or future EV chargers and just do that electrical service upgrade one time and do it right. It's also an opportunity to combine with energy storage such as a battery energy system for additional resiliency for your building.

So the auditors looked at all these different ERMs, they've come up with a whole list of potential ERMs to provide to the owner. This is a sample – example of some recommendations that you may see in an audit. Usually the audit would include a table like this where your – they've laid out all the different recommendations that the auditor would have, including the energy savings, the energy cost savings, the first cost, the simple payback, all the things you would see in an energy audit, but I'll draw your attention to the green column, which is the emissions reduction as well, and so that's really the difference here that we wanted to show and to highlight and show that that magnitude of emissions savings may correspond to the magnitude of energy savings, but it might be different. So it's important to look at all these measures and compare and contrast them in that way.

The different color scheme you see here and the key that we've identified is basically the different types of emissions reduction measures; orange being energy efficiency measures similar to what you'd see in an energy audit; the blue being electrification options or replacing fossil fuel-based equipment with different heat pump alternatives; and the yellow is an onsite renewable array as well. So the report that you'd get from the auditor would have this sort of summary and also institute what would be – they would consider to be changes that you could make in the short term, medium, or long term, and from there you can start to evaluate the measures and look at it. So Tom, when you look at this example, what are the first things that strike your eye?

Tom Abram:

I'd say one of the things to keep in mind as part of this is understanding kind of the framing and the intent of the audit. This is typically going to be conducted when an organization has some sort of an emissions reduction goal, either at the portfolio level or the building level, and making sure that you're able to look at a set of these measures – and talk about packages in a minute – but making sure that you have a good selection of measures that can achieve some deep emissions reductions. Also note it's important

in many cases to be looking at the incremental cost. And so there are cases if you have a boiler replacement that's upcoming or chiller replacement or other equipment, the businesses, as usual, kind of alternative is going to have its own cost too. So making sure that when you're looking at that first cost, in some cases, you want to be looking at that incremental cost because you're already going to have to invest. So I think it's really good to take advantage of those natural opportunities to decarbonize during renovations, during end of life to kind of reduce that comparative first cost. Other interesting thing is look for opportunities to be able to reduce the operational cost of electrification in many ways by increasing the amount of onsite solar that can serve those loads. You can really drive down some of those overall costs and improve the payback.

Dan Luddy:

Definitely. And I don't know about you, but some of the owners that I've worked with in the past, understandably their eyes go straight to the simple payback, and that is the metric that is the most important. And to your point there, Tom, the first cost that the auditor puts together will include certain things, but it may not include certain things too, and it's important to discuss that with the auditor as they're developing the report and even when they deliver it to you, does that first cost include any sort of incentives or tax credits that are available for your local utilities or state or federal programs. And then, like you're saying, Tom, what's the opportunity or what's the cost of not doing this? Is there going to be a cost of replacement down the line of a business-as-usual item, and how does that compare? And maybe it's just a portion or a fraction of this overall first cost that they're quoting here for the full installation at the beginning. So all very important things to consider as you're looking at it.

And as Tom mentioned too, the next piece or what the auditor should be doing is to take these recommendations and apply them to that target that you've agreed upon at the beginning. So for example, when we're looking earlier, we had thought about having a 50 percent emissions reduction that we'd want to get to ten years from now, so the auditor should be able to assess how your building can get to that point based on the recommendations that they have here.

So a portion of the analysis should be taking those ERMs and then packaging them together into ideally several scenarios for the owner to consider to be able to meet their targets. What you see here is different packages of the measures that we had on the previous slide to be able to meet the emissions reductions that the

owner is looking for or needs to meet based on certain mandates. You can see Scenario 1 is what we're calling the low simple payback upgrades, just the lowest-hanging fruit, anything that's a simple payback of less than five years, that's the easiest to implement. If we do that sort of only those upgrades, you can see we only get about a 10 percent emissions reduction. So even though we're saving energy, we're saving cost, it's not the full targets that we would need to get to to help contribute to our overall portfolio level emissions reductions. So then we need to start looking at combining some of the other measures together to be able to get to that 50 percent target that we initially identified in the outset. So in this case, there's two scenarios identified that could get to that 50 percent, Scenario 2 and Scenario 3. And you can see that they kind of take different pathways to get to that 50 percent target.

Scenario 2 is a combination of a lot of the energy efficiency upgrades plus some electrification. In this case, replacing or augmenting an existing gas boiler with an air source heat pump and then including the onsite renewable energy system as well to be able to get to that 50 percent threshold. So that is one potential pathway. The other pathway, Scenario 3, is to invest more heavily in an electrified system for the building, ground source heat pump system for space heating, and domestic hot water heat pumps as well, combining that with onsite renewables is another pathway to getting to 50 percent reduction, and that might be more favorable in some cases if there's a need to do a more rigorous and enhanced upgrade of the HVAC system based on end of life and things like that.

And then finally, Scenario 4 that we have in this case is a look at what would be the high-performance stretch goal if we included everything, and so you can see that we can get further beyond that. So some different ways of slicing and dicing the measures and looking at it.

These results, the auditors delivered it to you, now it all goes back into the owner's court. How do we select items, how do we identify them and implement them and make this happen over the timeframe that we need? So there are a number of things to consider. As we mentioned before, first cost, simple payback, those are two things to consider, but also emissions reductions that are mandated or part of your corporate goals, regulatory considerations to think about, financial incentives from tax credits, rebates could be factored into it, and also your capital planning. When are you going to be replacing your equipment, when are you

going to making risk building, how can we integrate best with that to reduce costs and mitigate any sort of costs associated with this. So the owner should evaluate the strategies and make sure to integrate into your long-term capital plans. Based on this, you can develop scope and solicit bids for specific projects, specific upgrades, and you can work with your auditor to do that and can also develop future commissioning plans for this equipment and then carry out those projects.

This is another example, taking the previous example that we had and just showing how it could be implemented over time and phased in. So in this example, some of the easiest, lowest-hanging fruit is done up front, so installing VFDs and LEDs and the sorts of things that are sort of easier to swap out and low-cost implementation could be done in the early stages. The bigger changes like moving to a ground source heat pump system, replacing boilers, that could be done at the end of life for those boilers, which may be years out, but there's important things to do – important things that can be phased in earlier such as upgrading the electrical infrastructure at the same time that you're installing EV chargers. But if you upgrade that infrastructure to also handle future PV loads or ground source heat pumps, then you've sort of set a solid foundation and could potentially reduce costs as you implement things over time. So this is an important step too once you have the results from the auditor is looking at how can you best phase in these things, what order works best to be able to get to your emissions reduction target, and how does that tie into your capital planning structure.

We're a little short on time so I'm just going to jump ahead to the next slide. Just a few more. There's additional options that you could include in an audit scope. We listed them in the guidance document, and it includes these things there. These we identified as optional because they're not necessary for each and every building, but things that you may want to consider having your auditor look at, whether it's a more in-depth study of your electrical service and panel loads, whether it's including commissioning as part of your service. Audits are – there's certain synergies between commissioning or retro-commissioning for an existing building and making sure that your equipment is running at optimal levels and the audit which is sort of investigating potential upgrades in the future. It could also include a look at energy storage and assessment or demand management and load flexibility, so another term for the demand management is grid interactive efficient buildings maybe for that term, so that is responding to grid loads. It's going to be more important on the grid moving forward, so

things that you can consider for your building going forward. Tom, do you have anything you want to add on these additional services?

Tom Abram: Yeah, the only thing I'd say is definitely you could, as you're developing your RFP for these, include some of them as optional scopes to be able to get some pricing and understand what that might cost, and then you could consider whether it could take those scope items in or not.

Dan Luddy: Definitely. Definitely a way to do that. Finally, just to recap on the guidance document that we have issued already, if you've heard this presentation, you think, Dan, that sounds great, I love all those things that you're saying. Do you have a short, concise two- or three-page summary of everything that we talked about in this webinar? We've got you covered. It's part of the guidance document. There is a specific checklist for owners which you can use to develop scopes of work, develop an RFP that you can send out to make sure you get the right auditors and the right scope that you're asking for, and it also provides some considerations or things to – prompts for you to be able to use to provide questions for your auditor and make sure that they are providing the right sorts of – asking the right sorts of questions to fully look at all the different options to reduce emissions for your building. And it also provides some more feedback on how to use the results and think about those results. So that should be that with the checklist, and I think the next slide is questions.

Hannah Kramer: Thanks, Dan. We have a few minutes for questions here. I know there's a lot of questions. I'm going to just jump into it. I like this one. Can you talk about the best way – maybe this one would be for Tom – the best way to discuss measures that are greenhouse gas emission reduction measures that don't have a payback due to increased operating costs, at least in the near term? And this is not uncommon in markets where electricity is expensive.

Tom Abram: Sure. I'd say a lot of it comes down to framing, and there's different ways that an organization can achieve their emissions reduction goals. And the way I like to think about it is if you've committed to an emissions reduction goal which is aligned with the science and is really needed in this time for us to take urgent action, if you've made that commitment, at that point try and align with what is the most effective way for us to achieve those goals. A lot of times organizations might look at purchasing REC's or offsets, and they don't really think about what is the payback on those, which in many cases there isn't. It's an added cost. So understanding how

you could look at the full picture and compare the different pathways that can allow you to achieve your emission reduction goals, and then identify ways that you might be able to get other benefits. If you're improving the HVAC, you could also improve thermal comfort. You could potentially improve work productivity, et cetera, so really understanding are there some other co-benefits that you could incorporate as part of these upgrades.

Hannah Kramer: Great. Those are good perspectives, Tom. Thanks. Next question for Dan. If a building is already energy audit completed, what can be done to align it with the emission reduction audit guidance? Do I need to start over?

Dan Luddy: Typically, if there's an audit done recently, we can leverage those results. There's not a need necessarily to start over, but there could be additional scope to lay those additional energy reduction measures on top of it. So if you've gotten a good audit that provides a lot of the recommendations for energy efficiency upgrades, perhaps there's a smaller piece of scope to have an auditor just assess opportunities for electrification to look at refrigerants and renewable energy. And you can kind of combine that with what you already have without having to redo that work.

Hannah Kramer: Okay. Although we did talk about, obviously, the benefits of doing it together, but if you're in the position of not being able to take advantage of that, there's still a way out, right.

Dan Luddy: Analyzing the results together, so that second piece, that smaller piece, should be able – that sort of secondary audit should be able to take the results of the first audit and piece those energy efficiency pieces together with the other components that they're working on.

Hannah Kramer: Great. Here's a question for Tom. How would I identify which buildings in my portfolio would benefit from an emission reduction audit?

Tom Abram: I'm a bit biased, and I would encourage you to look at the emissions reduction planning framework, which is also available on the DOE hub for emissions reduction planning. But really it's – if you've got a portfolio, trying to identify buildings that are representative of different categories. If you have some buildings that have different types of HVAC systems, some that are more reliant on natural case versus others. It's important to take – be able to look at some of those buildings and select the ones that might represent – that you might be able to use to scale to some of your

other buildings. It's also always good to talk to your facilities manager to understand which buildings concern them, and there might be buildings that have upcoming renovations. Those are really good ones to try and get an audit on to be able to make sure that you're taking advantage of that natural opportunity to decarbonize and not put in equipment that you're going to want to replace again in five or ten years.

Hannah Kramer: Great. And we will send the link to the portfolio level emission reduction planning framework. There's another question in here about is it better to do the easiest ERMs across a whole portfolio versus tackling all potential ERMs at the few biggest emitters? We talk about those kinds of things in the framework, so I'll just say check out the framework and reach out to us if you want to talk about that more.

All right, well we're running out of time, unfortunately. This is a great topic. I'm going to turn it back over to Hannah Debelius to close us out. I personally wanted to thank Dan and Tom for a great job.

Hannah Debelius: You took those words out of my mouth, Hannah. I was going to say thank you so much to Dan and Tom. That was really great, and also I just appreciated the back-and-forth on that. And our partners get the additional benefit of being able to talk to them and other technical account managers more.

You're going to hear me pitch this one more time, but for the Better Climate Challenge, we are so fortunate to have over 150 organizations already committed to at least 50 percent reduction, and we hope that you'll join us if you've not already. So you can follow that QR code or the link Anna sent out and get connected with us.

You also have the opportunity to join other webinars. This is a list from our summer series that's happening right now, so you can visit the Better Buildings Solution Center to sign up for these individually or go ahead and sign up for our whole summer series webinars. There's some really great content coming up, and I'll say I'm particularly excited about highlighting the Better Project and Better Practice Award winners because we had – it was tough to choose awards this year. We had some great stories to share.

With that, thank you all so much. As Hannah Kramer mentioned, we will be sending out the slides, the recording, as well as the links to the emissions reduction plan and the audit checklist resources.

So all those will hit your inbox or they'll be available additionally on the solution center. So thank you so much again to Hannah and Dan and Tom and you all for joining us. Happy auditing.

[End of Audio]