

Hayley McLeod:

Okay. Good morning, everyone. I hope that most of you have made your way into the waiting room, and then have been funneled into this session, so welcome to the 2020 Better Buildings, Better Plant Summit, which is a virtual leadership symposium this year. Next slide. Thank you all for being with us today for the launch of the Building Envelope Campaign. We have a wonderful session prepared, but before we dive in, there are a few housekeeping items that I need to cover.

Please note that today's session will be recorded and archived on the Better Buildings Solutions Center, and we will follow up when today's recording and slides are made available. Next, attendees, you have the option to share your video as well as unmute yourself. That being said, we ask that you keep yourself muted when you are not speaking, to avoid any background noise, and if you experience any audio or visual issues any time throughout today's session, please send the Moderator a message in the Chat Window that's located at the bottom of your Zoom panel. Next slide.

My name is Hayley McLeod. I'm the Building Envelope Campaign LEED and Project Manager, and in addition to speaking, I'll be moderating the rest of the session. I'm gonna go ahead and give you my background. I have a bachelor's in biology from the University of South Carolina and a master's in public policy, focused on environmental policies, from Georgia Tech. I'm relatively new to Oak Ridge National Lab, been there for about six months now.

Prior to that, I spent the last five years in industry as a LEED Specialist and Sustainability Consultant for a small commercial architecture firm which specialized in high-performing buildings. Now that I'm at ORNL, I'm a Technical Professional and Project Manager, and I'm working on several projects across both commercial and residential building. Next slide. If you've been to other sessions this week, you'll know that we'll be using an interactive platform called Slido for the Q&A and polling, and if this is your first session of the week, fret not, it's pretty simple.

If you could take a moment now to go to [Slido.com](https://www.slido.com) on either your mobile device or by opening a new window in your web browser, once you get there, you'll see the option to enter an Event Code, and today's code is BBSummit. It's not case-sensitive – just BBSummit – and then once you've done that, you can select today's session in the dropdown menu, and we're Unsealed: The Building Envelope Campaign. If at any time you would like to ask

myself or our panelists any questions, please submit them any time throughout the presentation.

And then Slido has a really nice functionality in that you, the participant, can actually vote on questions that you definitely want answered. So I hope we have time to answer all your questions at the end, but if we don't, using that Upvote function, we can make sure that we answer the questions that most of you want to know the answer to. Also note that you can go back and forth between the polls and the speaker questions at any time by clicking the Polls and Q&A tab at the top of your Slido screen.

Hopefully you guys have all made your way over to Slido.com and entered the event code BBSummit and selected our session. Next slide. We do have a social media presence for the Better Buildings Summit this year, and so here is the Twitter and LinkedIn information, and we hope that you'll join the conversation on one of those two platforms. Next slide. So we are actually cuing up our first word cloud in Slido, so if you could go over and enter in one to three words what do you think of when you hear the term "building envelope"?

And that should start populating that, you guys; give us your answer. Okay. Shell is getting a lot. Yes, results are starting to come in. See some concerns about leaks. I see windows, walls, doors, roof, cladding, façade, needs a huge stamp, mailing something. Yeah, insulation – I was waiting for insulation to pop up. Okay, it looks like the results are slowing down – well, some results are slowing. I'll give you guys another few seconds to tell us what you think about the building envelope while I get a drink of water.

Okay, sustainability – ooh, a one-time investment – we hope to maybe change your mind about that today. Okay. Yeah, it looks like most of us are on the same page here, so excellent. So Andrea, you can probably go ahead and close this word cloud. Thanks for playing, everyone; trying to keep you guys engaged. Okay, so just to run through our agenda for the day very quickly, you'll hear a little bit more from myself, and I'll introduce the program to you. We have Doctor Simon Pallin who as the Technical Lead will walk us through the building envelope performance metric and our building assessment tool.

And then Jessica Abralind from Arlington County will walk you guys through the tools from sort of the user's perspective, and then at the end we will have a Q&A session. Next slide. And here are the smiling faces of our speakers today. We are sad that we don't

get to be with you in person, but we are excited to still be able to interact with you on this virtual summit. Next slide. Okay, so let's see here – okay. Thank you again for joining us. This is the formal launch of the Building Envelope Campaign. Next slide. And we have a little video here to introduce you guys to the campaign.

[Video playing, music 0:07:08 to 0:08:33]

Okay, so now that you guys have learned a little about us, we have another poll for you on Slido, so if you could move back over to that, we wanna know what type of organization you represent that brings you here today. Give everybody a minute or two to answer this. All right. Okay, lots of Other. For the Others, if you wanted to go back over to the Q&A section on Slido and let us know what industry you represent, that would be great. I'm always curious to know who I missed in my list of organization types.

We have so very many Others – yeah, I'm very curious to know who you are, so please enter that in the Q&A for me. Thank you. But otherwise, we have lots of research and academia, building owners and managers, engineers – a pretty even split it looks like – oh, engineers pulling ahead. But some manufacturing and industry folks, some ESCOs, architects, so I'll give you guys another few minutes to let us know where you're from. Looks like I missed government being an option in my poll; we'll have to remember that in the future. That would have cost them a few.

Okay, great. We can jump back over to the presentation and close this poll out. Thank you. Okay, so like I said, I'm from ORNL. We are one of DOE's National Laboratories, located in Oak Ridge, Tennessee, which is in East Tennessee just outside of Knoxville. We have over 5,000 employees, the nation's most diverse energy portfolio, and the national's largest materials research portfolio. Next slide. ORNL is also home of the Building Technologies Research & Integration Center; that acronym we say as BTRIC.

It was established in 1993, so coming up on 30 years here. It is one of nine national user facilities, and it is the only designated user facility focused on building technologies. So what that means is that our doors are open for collaborative research, and that there are funding mechanisms in place to facilitate those collaborations in our over 38,000 square feet of research space. So if you wanna learn more about BTRIC, search for BTRIC at ORNL.com. Next slide.

So what is the relationship between ORNL and Better Buildings? Well, the Better Buildings Alliance has seven technology or tech

teams, and the Building Envelope tech team is at Oak Ridge National Lab. Next slide please. So I know that we're at the Better Buildings Summit, and so a lot of you have probably seen these numbers before, but I did leave this slide in to provide some context for our campaign. When you're trying to push a new technology forward, having access to a network of more than 230 organizations who manage 11 billion square feet is a great launching point.

And like the previous technology campaigns, we are aiming to accelerate the adoption of efficient building technologies – in this case, the building envelope – by providing technical assistance, resources and guidance on implementation best practices. Next slide please. We do have some very large shoes to fill. The previous campaigns have resulted in a combined almost \$66 million in electricity cost savings through energy use savings, so we are excited to be one of the latest in this line of campaigns. Next slide.

So why envelope technologies, specifically? And that is because envelope technologies account for approximately 30 percent of the primary energy consumer in commercial buildings, and that means that they play a key role in determining levels of comfort, natural lighting, ventilation and how much energy is required to heat and cool a building. So this is certainly not a comprehensive list of the envelope tech team, but there is myself and Doctor Pallin, who you'll hear speak later.

And we could not have gotten this campaign off the ground without the additional assistance from Doctors Bhandari and DeGraw, who are also on our tech team, and our full stack developer, the wonderful Kita Cranfill. Next slide. Okay, so I've been setting this up for almost 15 minutes now; I've given you a lot of background information, but let's really start to drill down on our campaign, specifically. So what are our campaign goals? So we have three primary goals.

The first is to motivate action and increase awareness of the value of investing in high performance envelope technologies for both new and existing commercial buildings. We hope to recognize leaders adopting and achieving high performing building envelope systems, and we want to demonstrate and document energy and cost savings with integrated design, construction, commissioning and maintenance from implementation of high performing building envelope systems. So basically, those three things are we wanna motivate you, we want to recognize you, and then we want to document what you did well. Next slide.

So those may sound like some pretty lofty goals, so my next couple of slides are gonna lay out how we plan to achieve them. The first thing you have to do is gather a wonderful Technical Advisory Group, or TAG, that represents perspectives from across the industry, and then ask them lots of questions and have them ask you lots of questions, and really benefit from their experience. So thanks, TAG, we couldn't have done it without you. Next slide.

The next step is to inspire really broad industry engagement. We are trying to motivate two main membership categories in the campaign, but I do wanna note that both of these categories are free and obligation-free, so we encourage you to contact us and explore what the campaign can do for you. And it's not a good fit, you aren't under any obligations to do anything else, but we really, really wanna engage you, so the supporters will have access to technical expertise regarding envelope technologies.

They will partner with the tech team to spread the word about the campaign, and they'll be listed and recognized on the Building Envelope Campaign's website. So we picture this category as being mostly manufacturers, researchers, ESCOs, industry organizations, groups like this, that do not directly own or operate buildings, but are invested in the outcome. So that's the first category, supporters. The second category is participants, so participants will have access to campaign resources, including the building assessment tool, and technical expertise in evaluating envelope options.

They will be able to stay informed on envelope technologies and resources produce through the campaign, and they will be recognized on the Building Envelope Campaign website, be eligible to achieve annual awards, and to possibly partner in developing case studies. So we're imagining here that participants will be the building owners and managers themselves, or professionals who are directly contracted by them, so architects, GCs, consultants, that kind of thing.

One final note is that we know construction projects take a long time, particularly ones that include retrofits that might include building envelopes, so buildings completed since January 2019 are eligible to be submitted for recognition from the campaign. So think back to some fun buildings you've worked on over the last 18 months, and if construction is complete, we encourage you to join as a participant and see if that building could be recognized by the campaign. Next slide.

We are so incredibly grateful to have brought on board three organizers who I know are going to contribute so much to this

campaign, so I'd like to take a moment to introduce and thank The American Institute of Architects, the International Institute of Building Enclosure Consultants, and the International Facility Management Association. We have big plans to incorporate our campaign into efforts of theirs and vice versa, and I think that we're just really excited to have these organizers on board. So thank you again, AIA, IBEC, and IFMA.

I also wanted to take a moment here to say thank you to our early participants and supporters. These are groups that have seen a webinar we've already given – we had some sneak peek and coming soon kind of webinars – and who got excited about it when they saw it and went ahead and signed up. So we are very grateful for that faith. Next slide. So I've mentioned this building assessment tool a couple of times, and I wanted to introduce it very briefly here.

Our other speakers will address it in much greater detail, and this is also our beta version, but I just wanted to show you if you were getting a little scared that like this is really manageable. We really focused on this tool being simple and broadly accessible. Next slide. So you enter, you know, that very basic building information into the building assessment tool, and then you are taken to a results page. If it's one of these buildings that's been completed in the last 18 months, and it's done and you're satisfied with the results, then it's time to submit to us.

But the great thing about this tool is that it really can be used to make design decisions, and so you can save your building to the account. You can look at the building characteristics that have been identified for you that has the most room for improvement, and then you can go back and change design decisions. You may decide that you wanna spend the money on the extra windows, and so you can edit the building and use this tool to make decisions right up until you submit to us. Or maybe you don't submit to us, and that would be sad, but that's okay, too. Next slide.

This Results will also funnel you to our resource library that we compiled for you. We have sorted these sort of broadly into three categories: commercially available technologies, case studies, and additional resources, and you are able to sort according to the building characteristics. So if you think that your windows could be better performing, but you aren't necessarily sure, we have a whole library about windows for you. Next slide.

We are planning on several recognition tiers and categories, so the first category is for existing buildings. So this would be for a

remodel or an envelope retrofit, and these are Retro 30 and 50, which represent a 30 or 50 percent improvement in building envelope performance between the existing building and the retrofit. Next slide. We do have a category for new construction as well. This will be Novel 20 or Novel 40, and these are for either a 20 or 40 percent improvement over the relevant code. Next slide.

And then we also wanted to have some flexible categories, so we have Role Models and Honorable Mentions. Role Models will be available to those buildings which meet a campaign recognition tier, and also incorporate an additional advanced strategy or technology and truly serve as role models within the industry. And then we also wanted to have an Honorable Mention category. This category is reserved for buildings that have not met a campaign recognition tier but are still making a noteworthy impact on the campaign. Next slide.

So to summarize, I wanted to give you a bird's eye view of this process. So the first step is that you will sign up as a participant or supporter, and if you sign up as a participant and have actual building information that you wanna enter into the assessment, you do that, and you say your building, and you interact with the website and the tool. That allows you to determine your building envelope performance and review energy efficient solution options, and if you're content with our result, that's great.

You can go and submit them, or you can go back and change your mind as many times as you want before you do finally submit it to us. But then once you submit your final results that will kick off an email exchange between you and our tech team. We'll request a little bit of verification documentation to validate the values that you have entered into the assessment tool, and then once we have verified those results, you are eligible to be recognized by DOE at an as yet undecided industry conference. Next slide.

So thank you very much. That wraps up my primary speaking portion, although like I said, I will be moderating the rest of the sessions. So that's my email address and the Envelope Campaign email address, and if you have any questions, feel free to reach out to us there or visit ec.ornl.gov. Next slide. Okay, so next up we have Doctor Simon Pallin, who works with me at Oak Ridge National Lab. He has been in the building industry since 2005 and spent several years conducting research in Europe.

He holds a master's degree in structural engineering and a Ph.D. in building technologies from Chalmers University in Sweden, and in 2013 he joined the Building Envelope System research team at

Oak Ridge National Lab. He's an expert on everything that involves the thermal and moisture durability performance of the building envelope. He has conducted research on a probabilistic risk assessment of WISE building performance and works with both existing and developing new simulation tools to estimate hygrothermal (heat and moisture) performance of building components such as walls and roofs.

Thanks to his profound knowledge in heat, air and moisture transfer and building, Doctor Pallin has developed methods and metrics to assess the overall thermal performance of buildings. He is currently the Technical Lead for the Commercial Building Integration team at ORNL and is also greatly involved in the Residential Building Integration research team. Under the DOE Building America program here, he is responsible for the development of the Building Science Advisor, or BSA, which is an online school to guide the building industry to design moisture durable and energy efficient wall assemblies. So take it away, Doctor Pallin.

Simon Pallin:

Thank you, Hayley, and thank you for the introduction. Yes, so I'm gonna talk about two things. One is the metric that we use for the campaign and will use for the campaign to validate the building envelope performance. Like Hayley presented to you here, we have these criteria and awards that a participant can receive, and we needed a way to evaluate and validate the building envelope performance. So we started looking into existing metrics out there, and we also looked into other industries to see what metrics are available and could be used for the campaign.

We ended up using one of our own, or at least one that we have defined the way we think a building envelope metric should look like. So the first part of this presentation will be to just sort of briefly explain what that metric is, which we refer to as the BEP metric. Can I have next slide, please? So like I mentioned, we looked into other industries as well, and for the car industry, when we wanna compare cars – and you can please click twice here – we may wanna compare one car with another.

And similarly to buildings, there are all these variables that will affect the actual performance of the car and of the building, so it's sort of a similar world. For the cars, we have a really good metric; we have the miles per gallon, and it really helps us to compare one vehicle with another, so that was a good comparison or some other industry that we used to figure out what metric would be best for this purpose and this campaign. Next slide, please. So we have a

building, and another click, and we also have all these variables, all right?

We have R-values of many components – walls, roof, foundation, fenestration. We also have thermal bridges and installation quality, airtightness, building type, and many, many other characteristics that will have an impact of the actual performance of the building. Some of these variables here that we typically use when talking about the performance of the building envelope, such as R-value or airtightness and so forth. They're good, but they're not giving us the whole picture.

So we need to have something that gives us the whole picture in order to be able to evaluate the building envelope performance of a building, and also to be able to look at the performance prior to, let's say, a retrofit and after a retrofit. Next. Yeah. So we do have EUI, right? I can have another click. And that's a great indicator – and another click, please. The problem with EUI is it's typically mostly applicable to existing buildings, and it says here one-way connection. What do we mean?

Well, it's pretty easy for us to calculate EUI based on overall consumption or demand, but we really don't know what's inside, so it's really a black box and we don't necessarily know what's inside of the box. So it's hard if we're gonna try to do a retrofit of the building envelope, then how can we figure out what will actually be the impact if I do this, or do something else? So that's what we mean with a one-way connection; we needed something else, and EUI is highly influenced by building usage.

And I know that there are many of you thinking now, well, how about this metric, how about this rating? And yeah, there are many rating systems and other metrics out there, but we haven't found one that we think will suit this campaign. Next. And predicted EUI, so simulation work – and another click please – it could be complicated, and it's time consuming. Obviously, we need to simulate something when we validate, but we didn't wanna look into something that is too comprehensive.

We wanted to have a metric that is easy to understand and easy to understand what it represents. Next. Yes, yes, yes – EUI is not equivalent to miles per gallon, and what we mean with that, is that EUI is heavily influenced by the usage of the building. For miles per gallon, yes, when you determine the miles per gallon for a vehicle, you have agreed on a driving pattern but you apply that to all the cars, so everyone's on the same level, while EUI is not. Next. Okay, so here's how we see it.

Very basic fundamentals of things when it comes to the HVAC cooling and heating demand, and this is generalization, but it's basically how you could see things is that the demand that the HVAC cooling and heating system will see is a sum of the loads that the building envelope contributes to and all the internal loads, such as plug loads and people, lighting and so forth. We wanted to lift out the building envelope part of this, right, because this is a building envelope campaign, so our metric needs to comprehend the building envelope part of this, what we see in green here.

So second row here is we see the building envelope energy load that contributes to the HVAC cooling and heating demand is equal to the BEP value distributed over the building envelope area. So the BEP value is a load distributed over the area of the envelope. That seemed most reasonable to us for this campaign. Next. Yes, sort of emphasizing what it is, and we see the unit here of the BEP value, which happens to be the same as for EUI, but it represents everything that has to do with the envelope. Next.

And what do I mean with that? Well, here, if we gonna dive deeper into the fundamentals here, the thermal heat transfer mechanisms that are relevant for buildings mainly are the solar radiation we see from the outside from the sun, and how that affects the opaque envelope surface temperature, but also the thermal load that is transmitted through the windows and almost immediately acts as a load on the interior side. Then we have thermal conductance.

Which is, compared to solar, a relatively slow heat transfer mechanism but very relevant, in which is transferred heat from the outside to the inside or inside to the outside. And then we have a pretty quick one we talk about, which is air leakage, which can many times result in an energy penalty, significant one, because it allows conditioned air to be removed and replaced by unconditioned outdoor air. So obviously if you're gonna have a metric that represents the building and the building envelope thermal performance, then all of these mechanisms must be accounted for.

So this slide is just sort of trying to nail down the mechanisms and presenting it as a thermal persistence R here, but then BEP is a function of R. But what you just need to see here, what we wanna present, is what we have the BEP is designed to account for. There you go, yep. So just a small comparison of what the BEP represents, and we also wanted to make sure that it's working well with more comprehensive simulation tools, because you can calculate BEP any way you want.

But we wanted to make sure it matches well or generates a result that is reasonable for some of the most common energy performance simulation tools. So we looked at the cooling demand and the heating demand for a building, and see how the BEP metric, or the generated estimated energy in heating and cooling demand using the metric, how that relates to tools like Energy Plus and WUFI Plus and RSC1, and we see that it's a good fit. It seems to be working there well. Next one.

This is just quickly showing how when you introduce something new, it's hard to understand what does it represent; is 40 a good value, or is it a bad value? What does it represent? The way we do it for the campaign is that you always have the base case that you compare against, and I will talk more about that when I move into presenting the actual tool that we have developed for the campaign. You will always compare it to something else, and Retro 30 means that your new building will perform 30 percent better in terms of the envelope than prior to the retrofit.

And for, let's say, novel 20, then you're comparing to the most recent energy code, and then your design proves that the building will perform 20 percent better than code. But still, it's good to have some sort of appreciation of what the BEP value is and represents, and here's a map that was created from simulating the BEP value of a building all over the U.S. I think this is probably 816 climates that was put into a map and generated a map like this to somehow get an appreciation.

We can see that obviously it increases the value of the BEP, but the BEP value is also significant even in the *[break in audio]* and you can see that because the BEP value takes into account the solar loads and where the building is actually located. So if you're talking about the R value, the R value is 15; it's gonna be 15 in Minnesota, and it's gonna be 15 in Florida. But the BEP value actually counts for the external loads and the outer climate, how it's located, everything, and therefore it's gonna vary, depending on where you put it.

I think it's reasonable, we think it's reasonable, because you're not gonna move a building. It's gonna sit there, and the performance needs to be evaluated based on the conditions and the loads it's exposed to. We think that the BEP metric does. Next slide. So this is actually our website, and this is where I'm gonna head over now and present the tool. Okay, welcome to the Building Envelope Campaign website. This is the home screen and front page. From here you can request to join the campaign either as a participant or as a supporter by clicking on the Learn More button.

From here, you can click on either of the two options. Once you do that, your Outlook will open a prewritten email with the information we request from you to become a campaign supporter or participant. When we receive your request, we will send back an email with details on how to access the campaign tool and resources. Now let's go back and assume that you have received your login information. Click on Access Campaign using the orange button or at the top right corner of the screen.

Once a dialogue box appears, type in your username and password and confirm. So this is what the actual tool looks like. Here you will enter your building characteristics and the information needed to calculate the BEP value of your building. From here, you can also access Save the Building and Resources, but I will revisit that in a bit. Let's start by entering information about your building, and let's see where that takes us. This information that the tool asks for is the name of your building.

This will be helpful if you enter more than one building and wanna go back and make changes or review your previous entries. Now I'm gonna name my building My Building in Chicago. Now I need to define whether I am working on an existing building or if this is a new construction. In my case, I will assume that my building is an existing building, and it was built in 1998. Next, I will have to inform the tool where the building is constructed, because it doesn't know that it's in Chicago.

I select the climate zone, which is 5A, and the state is obviously Illinois. The tool uses this information to estimate what energy code was adopted during the time of construction. For this example, the tool informs us that, on average, Chicago has one year delay in adopting the most recent energy code, and why is that important? Well, the goal of the campaign is to encourage building elements to improve the building envelope thermal performance. In order to do that, the building needs to be compared against something.

For new construction, your building will be compared against the most recent energy code. But for retrofits like this example, your building will be compared against a code at the time of construction. Further down this website, we will see where these entries come in play. Next, we need to select the built environment surrounding your building. This information determines the exposure to wind loads and thus estimates air leakage rate. Since this is Chicago, we will select Urban or Dense Urban, which is a realistic built environment for that location.

Now we will move over to the geometry of the building; there are 16 prototype buildings to choose from using the dropdown menu. I will select Large Office Building. The 16 buildings in the dropdown, many are DOE prototype buildings with established geometries. As you probably noticed, once I made my selection, the default values changed and appeared in the boxes below. Obviously, you will have to change these values to match the geometry of your building.

The tool asks for conditioned floor area, building height, number of floors, and surface areas of your walls and windows. As you may have spotted, this data is collected in feet or square footage. In case you wish to switch to SI units, you are able to do that using the toggle up here. Now let's move on. Next, the tool will ask you for your building materials and other building characteristics. You will need to enter information about your existing building, pre-retrofit and post-retrofit.

The information about your building characteristics before you retrofit goes on the left side, and the information on your retrofit design goes on the right, so let's start with the left side. Here is where the code assumption that I previously mentioned becomes relevant. Based on the type of building, climate zone and adopted code, the tool estimates R-values of your walls, your roof, your window U-factor and window solar heat gain coefficient. In case these entries don't match your actual building, you can make any changes you wish.

The tool actually has this built-in R-value calculator, so in case your R-value doesn't match what you expect your existing building to look like, the tool will allow you to select materials and estimate an R-value of your assembly. You can even add or delete materials as you wish and define their thickness, then click on Submit, and an updated R-value will appear for your assembly. You can also select your façade materials and roof materials, and if you know the U-factor and solar heat gain coefficient for your windows, that information goes here, too.

Before we move over to the retrofit design, you are asked if you have conducted a blower door test. If Yes, you will enter the result of the test in this box. If No, the tool still wants to know if you've taken any additional steps, or any steps, to improve the airtightness of your building as part of your retrofit. If you clicked Yes here, you will be given a 10 percent reduction credit, meaning your planned or actual retrofit will be assumed to have an airtightness level that is 10 percent better than pre-retrofit.

So let's move over to the right side of your entries, the retrofit design. Basically, everything looks the same here, and you can make your entries to match that of your planned or executed retrofit project. For the sake of this example, I will assume that I have added more insulation to my walls, and I have replaced my windows. My new R-value is gonna be 19, and the U-factor for the windows is gonna be .28, and this likely change in the solar heat gain coefficient to .30.

Before I leave the building components and material properties entries, I would like to notify you what this would have looked like if this was a new construction. In that case, you will not be able to make any changes to the left side entries, thus the base case for which your building will be compared against. Instead, for new construction, the left side represents most recent energy code requirements, but for retrofits, like for this example, we do have to enter.

We are almost finished here, but first, we are asked if we wish to enter advanced settings, and if we decide to do so, we will be able to define our thermostat points and setback temperature. This information is very relevant for an accurate BEP value; therefore, we encourage you to enter this information. If you don't visit the advanced options, the calculations will assume settings corresponding to the prototype building selected. Here you're also given the option to define internal loads for lighting, plug loads and people.

Let's move on. Before we can review the assessment of our building, you will have to indicate that you have reviewed the security and privacy notice and acknowledge that the information entered will only be accessible to the campaign team. Good. One last thing before we click on Check Result. Here we also find a Save button. At any time during the process of entering this information, you may save your entries and come back and finish at a later time, so let's do that.

Let's go back and look at our list of saved projects by clicking on Saved Buildings. Here we find our large office building in Chicago, and we may view it, edit it, clone it, or even delete it. Let's edit it and go back to where we have entered all the building information. We click on Check Results and wait the assessment of your building; 32 percent improvement, great. That means that this building is qualified for the Retro 30 award. Let's take a look at some of the numbers displayed on this page.

At the top, we see the two different BEP values, pre- and post-retrofit. We also see a summary of some of the entries, such as wall, roof and window properties. On the table values, we see Update Inputs. Clicking here will allow us to go back and change our entries if we so wish. Below the summary table, the tool provides information that can be very valuable. Here we see four different charts representing four different building envelope components and features: walls, windows, roof, and building airtightness.

So what is neat about this is that the tool runs multiple simulations to figure out how an improvement in performance for these categories may affect the BEP value, so let's look at the Window charts more closely to better view what information is given here. The Y axis displays the BEP value, and the X axis on the improvement factor. What this means is that the tool changes the window U-factor and solar heat gain coefficient separately and calculates the change in BEP value that such improvement involves.

There are two straight lines in the chart representing the award levels of Retro 30 and Retro 50. The two curves depict the change in BEP value when improving the U-factor and solar heat gain coefficient for the windows, respectively. For this example, we see that reducing the U-factor will significantly improve the BEP value; however, the reverse is true for solar heat gain coefficient. For this building, and specifically, this climate, a lower solar heat gain coefficient will instead slightly increase the BEP value.

And the reason for that is that Chicago has a noteworthy heating demand, and thus will benefit from solar radiation during the heating season. This analysis is also completed for walls, roof, and airtightness. Then what the tool does is identify which of these four categories, when their performance is improved, will result in the largest reduction in BEP value, which in this case happens to be airtightness. That is also why a solution package is presented below the charts in this category.

Actually, it's a short description and a link that will direct us to where the complete solution package is available. But before we go there, I just wanna show you how you submit your building as ready to be reviewed by the campaign team. For this example, the building reached Retro 30 level, and we may consider this as our final design. Then we move up to the right corner of the summary page and click on Submit, which will send an automatic email to the campaign team.

Okay, great. Let's go back and have a look at that solution package for airtightness. We click on Airtightness Resources, and a new window will appear. Now we're at the resource page for the campaign, and specifically the package with information related to airtightness. Here, we find various technologies available to improve airtightness. We find case studies and additional resources related to this category. Since this is the main site for resources, we can enable or disable any category we want, and the information provided will change.

The resource page also allows you to alternate between retrofit projects and new constructions. This completes my introduction for the campaign website. If you have any questions, please don't hesitate to reach out to us. The website also provides our contact information at the top right corner of the page. We hope that you are interested in joining this campaign, and we are looking forward to working with you. Next please. Next slide, please.

Hayley McLeod:

Okay, thank you very much, Simon. So now you guys have gotten the broad overview from me, you've gotten the nitty gritty from Simon, and now we are going to hear from Jessica Abralind, who is going to give you the user's perspective on this tool and campaign. So I would like to take a moment here to introduce her. She is a LEED AP with 15 years of experience in sustainability. For the last 10 years, she has served as a Green Building Planner for Arlington County, Virginia, facilitating the development of green buildings in Arlington through the county's Green Buildings Density Incentive Policy.

She coordinates with a variety of stakeholders including business leaders, environmental experts and advocates, residents, and political leaders to develop, assess, and implement the green building program. The program has led to the development of over 50 LEED certified commercial apartment and hotel developments in Arlington and is saving millions of kilowatt hours of energy and millions of gallons of water each year. Jessica is also responsible for the development and implementation of Arlington County's Facility Sustainability Policy that targets net zero energy ready for all of Arlington's new public facilities.

Jessica is a co-founder and co-coordinator of the DMV Net Zero Energy Coalition promoting net zero energy building development in Washington, D.C., Maryland, and Virginia. Take it away, Jessica.

Jessica Abralind:

All right. Hi, everyone; thanks to Hayley and Simon for inviting me to be on the panel with them today. Again, my name is Jessica

Abralind. I work as a Green Building Planner in Arlington, Virginia, and the main part of my job is to implement our Green Buildings Energy Incentive Program. That program encourages the developers of new office, multifamily, and hotel buildings to incorporate energy efficiency and green building best practices into these new buildings.

I also wear another hat for the County, supporting the sustainable development of our new municipal buildings, so fire stations, libraries, community centers, for example. When I'm wearing that hat – and that's the perspective I'm bringing today – I have more of an owner's role, so working to ensure that we apply Arlington's facility sustainability policy, which sets net zero energy ready as the target for all of our new municipal buildings. Next slide.

For today, I'll be talking a little bit about Arlington, Arlington's history of participation in the DOE Better Buildings programming, and then go through my experience using the Building Envelope tool on one of our new construction projects, the Lubber Run Community Center. Next slide. So a little bit about Arlington, for context. Arlington, Virginia, is located right next to Washington, D.C. It's pretty small, 26 square miles, with a dense population.

Arlington's development strategy over the last 40 years has followed smart growth urban planning principles where development is concentrated around metro rail subways, the subway stations, and we develop walkable urban areas around the subway stations. Arlington has 11 Metrorail stations, and then surrounding these more urban areas are large pockets of single family and low-rise residential areas.

Arlington has more commercial office space than downtown Los Angeles, Boston, Dallas, Denver, or Atlanta; the Pentagon is in Arlington, and Amazon is building their second headquarters here. And, very exciting but a bit daunting: last fall, due to lots of public input and political support, we updated Arlington's community energy plan with a new goal to achieve carbon neutrality by 2050. We're really excited to be working on that. Next slide. Arlington's been participating with the DOE for many years.

Since 2012, Arlington's been a Better Buildings Challenge Participant, and has reduced building energy use intensity in our portfolio by 18 percent, so my colleague John Morrill leads that effort and is doing a really great job there on our municipal building. Arlington has a page on the Better Building Solution Center that holds a number of case studies and videos of some of

the work that our energy team has done over the years, and in this slide you can see there's a screen shot of some of those.

So details on the energy retrofit on our central library, for example, that reduced electricity use by 40 percent. There's a video of Discovery Elementary School, our first net zero energy building, that is saving about \$100,000.00 annually in energy costs. And there's info about our very innovative energy lending library, where residents can check out energy saving tools from the library like a thermal camera that they can take home, identify air leaks and missing insulation, so that they can save energy at home.

I've been a part of the Building Envelope Technology Research Team since 2018, and most recently helped beta test this Building Envelope Campaign Tool. For the rest of my presentation, I'll share with you my experience using that tool. Next slide. Before getting into the demo of the tool, I'll first describe the building that I used as the test case. Lubber Run Community Center is nearly done with construction now. It's located in one of our more suburban areas, surrounded by single family homes.

The design and construction team: VMDO was the architect, CMTA is the mechanical engineer, MCA is the general contractor. The building is about 56,000 square feet of new construction; it says 53,000, that's a typo. And the building is targeting net zero energy ready status, with an energy use intensity of 24 kbtu per square foot per year. It's also pursuing LEED Silver certification, and recently performed a building enclosure test. I think it's worth defining net zero energy ready.

In Arlington, we describe that as a high-performance building that is so energy efficient that a renewable energy system on site can offset all or most of its annual energy consumption. The building envelope is a critical component of achieving a high-performance building. There is typically very little space or limited space for the solar that you can locate on your site, and so that makes energy efficiency of the building really important.

So this building also has a dedicated outdoor air system and geothermal for heating and cooling, but the engineers will tell you that you just cannot achieve net zero cost-effectively without first focusing on the building envelope to reduce the energy demands in the building. And even if you're not pursuing net zero, investment in the building enclosure is the most cost-effective and dependable way to achieve energy savings, in my opinion.

I say "dependable" because unlike motors or energy recovery wheels, insulation has no moving parts and can't break and throw off the building's energy performance two or five or ten years down the road. Next slide. A little bit more about the building envelope of this community center, and I use the terms "building enclosure" and "building envelope" interchangeably; I don't mean to confuse, they mean the same thing.

So the building envelope consists of the parts of the building that separates the inside from the outside, so walls, windows, roofs, doors. At Lubber Run we have a 36 percent window to wall ratio. The window U-value is around .37, the solar heat gain coefficient, .24. It has primarily an east-west building orientation, and we've used for the above-grade walls a Thermomass Concrete Sandwich Panel system that I'll explain a little bit later. We also completed a blower door test, and there's quite an extensive vegetated roof.

A blower door test, just to explain that a little bit more, that measures the air leakage, and we do that to make sure that all of the heating and cooling from our mechanical systems that we're creating doesn't just leak out uncontrollably through cracks and imperfections in the building enclosure. One thing I also want to note is it's very common that when I ask a design team – not this design team, not on this building, but on other projects.

When I ask them to give me a summary on the energy conservation measures of a building that we have in design, I very often receive a summary just on the HVAC improvements. Most of the time, there's no mention of the building enclosure, and I think that's a real missed opportunity. That's why I'm really excited about this Building Envelope Campaign, because I think it has such a potential to promote deeper energy savings opportunities in the enclosure that in my experience are often overlooked in typical construction. Next slide.

Here are some photos of that Thermomass Concrete Sandwich Panel that we used. I'll try to describe this a little bit more. On the left side is sort of a further-away photo. I want to draw your attention to that center photo, more of a close-up of what you're looking at. What this is, is one side of the wall that is being built. The insulation is right next to this rebar, and this is getting set up for a concrete pour. So the next thing that's gonna happen is a plywood form will be put up next to the rebar and they'll pour concrete.

There you can see there are little pegs sticking out of the insulation to secure those together. Then on the other side of the insulation is

the same thing, kind of a mirror image. Next slide. This is what it looks like after the pour and the forms are removed. You can see on the left the concrete that is on either side of that one piece of foam insulation, and then in the right photo is just a little bit further along in construction. So one thing that is a benefit of this system is that we also get a good amount of thermal mass in the building. That'll really help keep the temperature in the building relatively constant and help reduce our heating and cooling loads. Next slide.

So now I'll show a demo of the Building Envelope Campaign Tool, but before you hit Play, you can hit Pause; I just wanna note a couple things. I'm doing this demo just to give you an idea of the kind of information that you'll be entering, and a peek at the results that spit out. A couple of things I want to note. One is that when I captured this recording, the tool was still under construction and development, so it'll look a little bit different than when you join the campaign and use it for yourself, which is encourage you to do.

My overall main impression is that the tool is just really surprisingly easy to use. There are relatively few data points to enter, which I really appreciated. So go ahead and hit Play. This is the main landing page, and first thing that you do, just enter in the name of your building. I selected New Construction instead of Retrofit. It's set up to be 4A Mixed-Humid, which happens to be our climate zone, and you can see our area in Virginia is highlighted in yellow.

We're in a more suburban area, and there wasn't a community center option for this, but we do have a good amount of office space, so I selected Medium Office; it's the closest thing. I just wanna show you a little bit of process here, too, so I pulled all of the data points out and created a spreadsheet and sent this off to the architects for the building to fill in some gaps and information I didn't have. So I thought that was a really useful way to do this, and I was able to have that side by side as I was filling this out.

So then you start entering in the building info; the conditioned floor area, the building type, the number of floors, how far it deviates from north. The next area is you're putting in the surface area of the walls, including the windows, on the north side, the south side, the east side, the west. I was actually able to pull most of this information out of our LEED Green Building Application. The building's pursuing LEED certification, and I was able to get a lot of this from there. Then you put in the window area for all the different sides of the building.

The next section is about the code in place at time; this is all auto populated. If you have questions, you can click on the handy little information to learn a little bit more about what these are. So for example, window U-factor, they're looking for the U-factor of the window assembly. I selected Yes because we did perform the blower door test, and then on the right you have your new building and your design case. So we put in the R-value, the roof R-value, the window U-factor, the window solar heat gain coefficient, and then the building airtightness value.

I put in .3; we actually performed a little bit better, we hit .17. Then you sign your life away, hit Submit, and then you have instant results. That's one thing that I really liked about this tool is that you had instant results. You can see a 28 percent improvement compared to your code-built building. I think that this section on energy savings is actually not going to be in the new tool, but below this, there is a energy performance breakdown that Simon had talked about a little bit earlier.

He went into more detail about that, so I'm not gonna go into a lot of detail, but you can look at your different performances of the different parts of your building – your roof, airtightness. And then there's information, they're giving me information about windows, suggesting I can improve some things on the window. You can look at, for example, R-5 windows. You click on that, there's a technology brief so you can consider, especially if you're in design, maybe some other technologies. Then they have case studies, and then they have information on other things.

So if I wanna know more about walls – insulated metal panels, spray foam insulation, structural insulated panels – and then at the bottom, there are more case studies to dive in a little bit deeper. So that is the demo of the tool. If you go to the next slide, I'll just share my main take-aways. So here are my main take-aways, first, just noting that third party certifications are really useful to recognize and legitimize some of the good energy efficiency work that you are putting into these buildings, so I'm really pleased to see a campaign that's really around the building enclosure.

Second, that it's just really easy to use. I think that probably the data gathering will be the most time-intensive fore-project. Again, if you're already doing LEED certification, you can pull from that. But the tool itself is really simple. I liked in the results page that it was instant, that I could change things, that there were easy to access information on resources and some recommendations. And then I think most of all, from the building owner's perspective, I really like the idea of using this tool to guide a discussion with the

design teams for new projects, specifically on the building enclosure, that as I noted before is just so often overlooked. Next slide.

So there's my information. Thanks again to Hayley and Simon for including me today and including me in the Building Envelope Technology Team.

Hayley McLeod:

Thank you, Jessica. So okay, we have about 15 minutes left for wrapping up and Q&A, which is great. We are going to start a quick poll just to ask at this point are you interested in joining us, and to collect a bit of contact information from you so that we can follow up with you more easily. So if after attending this event you would consider joining The Building Envelope Campaign, you can indicate whether you would as a participant, as a supporter.

There's, "Probably, but I need more information," and then "Not at this time," which would make me sad. But then, if you're any of those first three and you'd like to provide your name, email address, and affiliation, we can follow up with you directly. So that will stay open. Remember that you can toggle between the polls and Q&A session, and we are going to get into our Q&A. So again, if you entered late, if you go to Slido.com, enter BBSummit, choose us from the dropdown – it's Unsealed.

And then remember that you guys can vote on the questions that you want answered. Hopefully we'll be able to get to all of these, but there is a long list. Be sure to vote, so that we can answer the questions that you definitely want answered. It looks like the first question is going to be a Simon question, so are there resources available to help identify the applicable U and R values for existing building materials which may be unknown?

Simon Pallin:

Yeah, I read that, and I started smiling. It's a really good question, and within the resource, I think somewhat; not fully, and I think that this is great feedback. This campaign will run for a while, and we will keep updating resources that's needed, so that kind of feedback is just great. I think it's a really good point. The way the tool does now is that it assumes, like I said during the presentation of the tool, that whatever was the code during the construction, that would be the assumption of the U-factor and R-values.

But of course there are ways that you could somewhat try to estimate these values without tearing down the walls or roofs and so forth, so I think the team will go back and look at the resource and see if that is clearly presented. Thanks for that point.

Hayley McLeod: Okay, thank you, Simon. Our next question that's bubbled up here is, can your program help a city doing limited budget envelope upgrades (roof, windows) as opposed to gut renovation? I will take a stab at this, but then Jessica or Simon, if you have anything that you would like to add to my response, please feel free. But the short answer I think is yes. I mean, you don't lose anything by entering your building information into this building assessment tool.

And you may be surprised by the amount of improvement that you get from a roof or window upgrade, depending on the geometry of the buildings and how old the windows or roof is, and that kind of thing. So I would definitely encourage you to enter your building information in here, and then take advantage of the resources that are available to you and see if maybe there's something else that you could do within a limited budget. Jessica or Simon, do you have anything to add?

Jessica Abralind: I would imagine it would be very useful for that. We have some buildings that we are planning retrofits for, and like I said, I think the building enclosure is often missed in those retrofits, so I think it's great that whoever asked the question, that they're looking at those improvements and not just HVAC replacement. I think yeah, you could, for example, do a blower door test – they're really pretty inexpensive, in my opinion – and go such a long way in reducing wasted energy and improving the comfort of buildings.

So doing a blower door test, and you could capture that in this tool and the energy improvement of that and show the value to those that are making decisions. Same thing with windows; you can put the improved window that you're considering in, so yeah, I think that would be a great fit.

Hayley McLeod: Okay, thank you. Next question is, can you clarify the sectors that are allowed to participate in the campaign? Commercial buildings is sometimes vague. So Simon, do you wanna answer this one?

Simon Pallin: Yeah. Let's see here. Commercial buildings is somewhat vague. Yeah. Hayley, I think that's – I mean, I can talk around it, but I mean, when you talk about commercial buildings, is that the question, what kind of buildings are allowed to participate?

Hayley McLeod: Right. I can take a stab at it; I was just trying to share the wealth.

Simon Pallin: Yeah.

Hayley McLeod: So it's commercial buildings and multifamily residential, so this does not include single family residential, and that dropdown menu where you can select your building type, that's an existing list of DOE prototype buildings. So commercial is sometimes vague, but it is kind of intentionally broad here. This is going to include hospitals, and schools, and office buildings, and if you don't see your building type in that dropdown menu, we encourage you to select what you think is closest, and then feel free to reach out to us and we can help you with that, if you don't see your building type in the dropdown.

Next question? Yeah, there we go. Oh, okay, this screen has changed. Are floors considered in the BEP calculations? I see roof performance but nothing for loss through floor, which would be different over slab versus garage, so that is a Simon question.

Simon Pallin: Yes. Slab is currently not accounted for in the tool, no, but obviously, floors are part of the inside of the building envelope. But slabs are not.

Hayley McLeod: Okay, thank you, Simon. As an architect/enclosure consultant –

Simon Pallin: And maybe – Hayley, I wanna add to that, too – is that slabs are really complicated to retrofit or do anything about. In new construction, that's one thing, but for existing buildings, you're very limited to what you can do for an existing building on the thermal performance on the slab foundation.

Hayley McLeod: Okay. Sounds good, thank you. Next question is, as an architect/enclosure consultant excited about this campaign and hoping to become involved, would it be better to join as a participant or a supporter? So if you have a building or a project in mind, either upcoming or from the last 18 months, that you would like to enter into the assessment tool, then I would recommend signing up as a participant. If you just want a few more resources surrounding the campaign, you can sign up as a supporter, and you are always welcome to switch between the two.

When you are prompted on the website to join as a supporter or a participant, it's just an auto-filled email that goes to the campaign email address, which I will check, so if you have any additional questions, you can certainly ask there. Like, "I'm signing up as a supporter, but I think I may switch to a participant in the future," and then I can give you additional information about that. So great question. Our next question is ORNL studies how that insulation placement in mass walls (interior versus exterior) can have a

substantial performance effect. How does your program address that?

Simon Pallin: So the tool accounts for thermal mass, so as I showed in the tool, you are able to change the materials of your roof and wall. And depending on where you put it or the material that's on the exterior side and so forth, the tool will account for the impact of thermal mass or thermal inertia as an overall performance.

Hayley McLeod: Great. Is this related to Building Energy Asset Score, or is it completely separate? It is completely separate. Okay, sorry; the order shifted in order. For advanced entries, can you toggle anything to change from commercial only to I assume that's multifamily to mixed use? I would think that the assumptions for the thermostat impacts would change. I think we maybe need a little more information surrounding that question.

Simon Pallin: Can you toggle in anything to change from commercial only to mixed use? Well, the thing is that the thermostat is set – I mean, you can change the thermostat set points and thermostat setbacks. There is a built-in schedule that corresponds to the DOE prototype buildings, and the schedule corresponds to what type of building you selected. You cannot change this schedule, but it is built-in in the tool. But you can change, obviously, the temperatures or setbacks and set points.

Hayley McLeod: Okay, great. I think we have time for one or two more. So am I missing the option to insert variable values for wall assembly, such as if the building has an addition with different materials and R-value?

Simon Pallin: Yeah, so we need to have a tool that is not too complicated, and yes, of course, we could allow the user to define the R-value on the east side, or a portion of the east side, and west side, and so forth. But you have to put in sort of an average R-value of your walls and roof here. Again, we needed a tool that was generating realistic performance estimations, but still not too complicated for the user.

Jessica Abralind: I could jump in there too, Hayley. I think one thing to note is that this isn't gonna replace your energy modeling software that you'll be doing. It's just a way to look specifically at only the building enclosure, as opposed to the building enclosure and the building performance overall. I look at it as more of just sort of like a schematic; like a very early-on design tool to inform those conversations. Simon, just interested to hear what your thoughts are on that perspective, too, but that it's not replacing the detailed energy modeling work that your design team is gonna be doing.

Simon Pallin: Correct; thank you, Jessica.

Hayley McLeod: Great. Okay, we have a couple more things that we need to wrap up for Better Buildings, but I did see one question pop up at the bottom under Latest Question that I wanted to answer about timeline, and so, yes. Any buildings that have been completed since January 2019 are eligible to be submitted for recognition in this campaign, so that's the last 18 months and the next 12 months will be included in our first round of recognition. So we know things are slowing down but think about the last 18 months for us.

Okay, so thank you very much. I'm sorry we didn't get to everyone's questions, but they've just been rolling in. We encourage you to reach out to us on our website, which is ec.ornl.gov, and then we have I think a quick video about the Solution Center, but we also maybe ran a little long on our Q&A, and there may not be time for that. So I will let Andrea decide. Okay, I guess we're skipping it; sorry for running over on our Q&A.

We do have a few additional resources for you here, and so when these slides go out, these links will be live and you will be able to access these. Next slide. We also wanted to put a plug in for the Better Buildings Summer Webinar Series, which has a really great lineup this year, and my talking points are jumping around. Sorry about that. But this series starts in July. Our partners will discuss some of the most pressing topics you're facing and share best practices and innovative new ways to approach sustainability and energy performance.

To register, go to the Better Building Solutions Center and click on the Summer Webinar Series. Next slide. So it's 12:30 exactly. It is lunchtime on the East coast. I would like to say a big thank you to Jessica and Simon for joining us today, and if you'd like to learn more about the resources discussed please check out the Better Buildings Solution Center, or feel free to contact any of us if you have specific questions at our emails, which are shown. And if you are ready to join the campaign, please head on over to ec.ornl.gov and sign up. Thank you very much and have a great day.

[End of audio]