Josh Geyer: Hello, and thank you for joining the webinar today. We're going to give folks another moment to log in. We'll be starting soon.

[Silence from 0:00:12 to 0:01:18]

All right. Let's get started. Hello, everyone, and welcome to the 2024 Better Buildings Summer Webinar Series. This series presented by the Better Buildings Initiative is dedicated to bringing you the latest actual insights from leading industry experts, helping you explore the topics, technologies, and trends that affect your organization, as well as efforts to accelerate decarbonization and energy efficiency adoption. Today's webinar is called "There's a Heat Pump for That: Multifamily Decarbonization Solutions."

Before we dive in, there are a few housekeeping points I would like to cover. Please note today's webinar will be recorded and archived on the Better Buildings Solution Center. We will follow up when today's recording and slides are made available.

Next, attendees are in listen-only mode, meaning your microphones are muted. If you experience any audio or visual issues throughout the webinar, please send a message in the Q&A box located on the bottom of your Zoom panel.

So, my name is Josh Geyer, and I'll be your moderator for this webinar. I work in the HUD Office of Environment and Energy and serve as the Multifamily Sector Lead for the Better Buildings Initiative. Today, I'm looking forward to highlighting the ways that heat pumps can and should be part of your decarbonization strategy. This webinar will explore what the decarbonization and energy savings benefits of heat pump technology, identify some of the challenges for designing, financing, and implementing heat pump systems, and highlight some best practices for installing heat pumps in multifamily buildings.

Electrification is a core component of decarbonization, and heat pumps are the primary electrification technology that will enable the transition away from fossil fuels in buildings. Because the technology has been underutilized in the past and is going through a period of rapid expansion and evolution, we know it can be difficult to decide where to begin a heat pump installation project at one or more of your properties. We hope that you leave today's webinar with a greater understanding of the current state of heat pump technology and the confidence to incorporate heat pumps into your decarbonization and energy efficiency strategies.

Today, we will hear from two speakers with extensive experience in decarbonizing multifamily buildings with heat pump technology. We'll then have time for some – for our speakers to address audience questions before we wrap up.

Today's webinar is presented by the Better Buildings Multifamily Sector. In February, 2022 HUD was excited to join the Department of Energy to launch our newest challenge to multifamily housing providers, the Better Climate Challenge. Partners that join the Better Climate Challenge commit to the ambitious goal of reducing their portfolio-wide greenhouse emissions by at least 50 percent within 10 years.

HUD and DOE are partnering to support this transformative market leadership program in the multifamily sector. Together with the DOE National Labs, we are providing technical assistance to help partners overcome barriers to decarbonizing their portfolios, forums for peer-to-peer exchange, and a national platform that demonstrates partners' leadership in addressing climate change. If your multifamily organization is interested in joining the Better Climate Challenge and being a leader in decarbonizing the US multifamily building sector, please contact me. My e-mail is on the last slide. You can also learn more about the Better Buildings Multifamily Program by visiting the Better Buildings Solution Center website.

Today, we will be using an interactive platform called Slido for Q&A. Please go to www.slido – that's S-L-I-D-O – .com on your mobile device or by opening a new window in your internet browser. Today's event code is #DOE. Feel free to send questions or comments for our panelists by typing them into Slido anytime during the presentation. You can also upvote other attendees' questions by selecting the thumbs up icon for questions that you like, which will result in the most popular questions moving to the top of the queue. We'll address your questions at the end of the two presentations.

We have a couple quick polls to get started with to better understand who is joining us in the audience today. Please take a moment to answer those questions about your organizational background and familiarity with heat pumps. Again, you can visit Slido and we will see the results in real time right here.

Great. Most folks are a little experienced. I count myself in that group as well.

Okay. And I'm assuming we're gonna transition to the second question momentarily.

I see we haven't added AI bot as one of the options yet.

"Other." That's very interesting. I think if folks want to comment on the Slido about – who said "Other" – what your role is, I think that'd be really interesting to see.

Great. So, I'm gonna move on to talk about today's excellent presenters. As people answer those questions, I'm excited to introduce our two awesome presenters. We'll hear from Maria Cecilia Quiñones Peña from Elevate and Step Sanborn from Smith Group. Thanks to both of you for being with us today.

To begin, I'm pleased to introduce Maria Cecilia Quiñones Peña. Maria is an Associate Director on the High Performance Buildings Team at Elevate, a nonprofit organization dedicated to designing and implementing efficiency programs that lower costs, protect the environment, and ensure the benefits of energy efficiency reach those who need them most. In this role, Ms. Quiñones-Peña provides tailored services to property owners, managers, and developers to meet their high performance property goals. Maria leverages her experience to evaluate and support implementation of energy and water efficiency, renewables, resiliency solutions, electrification, and decarbonization. Please welcome Maria.

Maria Q. Peña: Good morning. Can you all hear me?

There's the video.

Josh Geyer: Yeah.

Maria Q. Peña: Hi, everybody. Good morning. Let's just go on to the next slide, please.

Thank you, Josh, for that intro. I want to just kind of briefly summarize what I'll be talking about today. Obviously, this is a presentation on heat pumps but I thought it would be really interesting to listen to what it looks like in real-time application. So, I'm going to tell you the story of how we are actively decarbonizing a property called Lake Grove Village Apartments in Chicago, Illinois. Next slide.

Before doing that, just a little bit about where I work. I work at a nonprofit called Elevate. We design and implement programs that

reduce costs, protect people and the environment, and ensure the benefits of clean and efficient energy use those who need them most. So, we're essentially at the intersection of climate justice and affordable housing. We are headquartered in Chicago, where I'm at, but we work nationally. Next slide.

One of the, I guess, coolest things that we're working on at Elevate is building decarbonization. We really strategically started doing this back in 2020 – rough time to start doing anything, but we did it. And our goal was to essentially seek – we just wanted to end combustion of fossil fuels in buildings, in affordable housing in the Midwest. That's where we started. We thought cold climates were just not getting enough attention and it wasn't happening. Our goal was to do it equitably, to equitably electrify buildings and reduce carbon emissions to avert the worst impacts of climate change. Additionally, we want to reduce utility costs for both the owner of a building and residents living in them, add central cooling if it doesn't already exist, and improve indoor air quality for residents. Next slide.

And the way we think about decarbonizing buildings is kind of with four major pillars. Obviously it starts with energy efficiency. Then we try to electrify those existing systems in a way that's equitable, like I mentioned before. We add renewable electric supply typically in the form of rooftop solar. And then last but not least, we're realizing this is a very – much more important thing than we initially thought it would be but it's managing electricity loads. So, that means enrolling folks in dynamic rates or pricing, also using smart devices to just be able to be flexible and manage loads since electrification can result in added use of electricity, obviously. I want to mention that today Elevate has over 40,000 – yeah, more than 40,000 households in Illinois enrolled in dynamic pricing programs, a lot of those, and dozens more on peak – excuse me – on peak time pricing programs. So, we're very familiar with that concept. Next slide.

So, about the project. This is it. This is Lake Grove Village Apartments. It's kind of a complex of eight different buildings. You can see three of them are 10-story towers that you see kind of on the far end. And then you have five smaller, three-story apartment buildings, each with 16 apartments. All in all, there's 458 apartments in this complex. So, it's quite a huge, huge campus. This was built in 1972, just to give you a sense of the construction, and it is owned and developed by Jonathan Rose Companies. I want to mention that Lauren Zullo with Jonathan Rose Companies is on the chat and is totally willing to answer any questions you

might have from the owner/developer's perspective in this process. Next slide.

So, how we started was actually, I should say, back in 2019 where Jonathan Rose Companies essentially hired us to do what we're calling an energy efficiency assessment. Decarbonization wasn't quite the word just yet. And then in 2022, they were like "Hey, we got your recommendations but we really want to understand how to electrify and ultimately decarbonize. Can you kind of update our assessment?" So, that's what we did in early 2022. And at the same time, Elevate, we really pushed to find funding to make those projects happen. So, once we finished the assessment, we were like "Hey, Jonathan Rose Companies, are you – can we incentivize you to do the work that we're recommending with this bit of money essentially?"

So, the next step – you can kind of see the next steps throughout, but I want to focus on the decarbonization assessment for just – for a few minutes, just because it kind of set the tone for the rest of the, I guess, last two years. Next slide.

So, this is a decarbonization assessment. This was conducted on all eight buildings on the campus, so it's kind of a massive undertaking. And you can see ECMs, energy conservation measures, WCMs, water conservation measures. We had it all, even renewable energy measures on there as well. But at the very bottom, you see EM-10, which is electrification measure. You can see we provided – obviously aside from – every row is a recommendation, but we also were very intentional about not only outlining our estimated costs of what we think it's going to cost to do it but are there any other incentives out there? What are the impacts on not just the owner's utility costs but also the residents? We're really invested in making sure that electrification, again, is an equitable process. So, just to kind of focus on the very last row on the electrification measures – if you go to the next slide, please.

This is a blow up of that recommendation. So, EM-10 you can see at the very top kind of highlighted green. The rows that are underneath that are just a sum of that green row. So, here you have it broken down by HVAC is EM-10A. so replacing the gas boilers, AC, make-up units with heat pumps. The next one is domestic hot water system, replacing that with heat pumps. 10C is replacing the gas stoves with electric models. And finally, 10D was replacing the gas dryers. So, essentially our goal was to fully electrify these properties.

And again, this is just – even though we did an assessment for the entire campus of eight buildings, including the 10-story towers and the three-story buildings, we only really saw it plausible to fully electrify the three-story buildings. So, that's what this is. The problem was that – well, the electrification, let me just kind of – one more thing. The electrification scope was based on a couple of things that Jonathan Rose was really like in tune with. Essentially, they really wanted to keep the space and water heating on the common area meters. And the reason for that is because they didn't want to transfer the cost of decarbonizing, the cost of electrifying to residents. They were really intentional about ensuring that these homes are being preserved as affordable housing.

The scope also included shifting space cooling from what used to be paid by the resident or on the residence meters to the common area meters. And then it shifted cooking from the residence meters to common area meters as well. Actually, that's backwards. It's shifting cooking from common area meters to residence meters. So, in this case, the residents were no longer – through decarbonization, the residents were no longer paying for their cooling but now they're paying for their cooking.

But here's the big problem and why you see this huge red circle in the middle of the screen, is that doing this was not great for Jonathan Rose Companies. We estimated that this would – fully electrifying the three-story buildings would result in an annual cost increase of about $22,000.00. So, we really needed to think through how do we meet these goals of preserving the affordability of these buildings electrifying but also not have it be such a huge loss for the building owner? Next slide.

So, again, I think really wanting to explain who was paying for what at first to understand how we were preserving affordability. Our goal, again, was to decarbonize, but it cannot increase the residence utility bill. So, here you – in this table, you see kind of the end use on the very far left. You have space heating, cooling, water heating, cooking, and then finally the clothes washer and dryer, which is communal, not individual. And then you have who pays for what before we did work and then who pays for what after. So, you can see here the space cooling previously was – the resident was accountable for paying for that, but with decarbonization it's now on the owner. And then cooking, previously – because it was gas and gas was central – the building owner was responsible for paying for the cooking gas. But as a result of electrification, the residents are responsible for it now. Next slide.

And so, yeah, we're kind of dealing with an issue and trying to figure out how to meet all of these goals, how to – all of it, the cost, the technology. We're wondering is there a heat pump for that, essentially? So, next slide.

Turns out there is a heat pump for it if we really think through how to include the four pillars of decarbonization, how to make it all happen, but also be very clear and intentional about when it happens. So, here is this table that essentially outlines the four buckets of decarbonization. You have on your far left the top is energy efficiency, then electrification, solar, and then finally, bill management.

And you can see here as a result of energy efficiency the building owner was essentially going to come out break-even. This is for one three-story building, by the way. So, they were going to be saving $800.00 as a result of doing energy efficiency measures. The tenants were also going to be saving a little bit of money, $883.00. But electrification is really what made things complicated. As a result of electrification, the building owner is now losing money, $10,000.00 – more than $10,000.00 annually. The tenants are still doing okay. But if we pair energy efficiency and electrification, the building owner was losing a little bit less money, but that just was not good enough for us.

So, we're like "Okay, let's add solar." Adding solar to this property would actually reduce the building owner's utility bill impact, but they're still losing $5,981.00 per our estimates. The residents are still doing okay. So, we're like "Great, this is equitable for the residents, but the building owner is still not okay." So, then we actually took a look at what it means to remove natural gas from the building, changing the electricity rates, other types of bill management strategies. And that's where the big bucks came in. This is where we estimate the building owner can save roughly $13,000.00 annually. And that's what gets this property out of the red from doing these decarbonization improvements.

So, all in all, total decarbonization, aka doing energy efficiency, electrification, solar, and then also doing some bill management strategies means investing an estimated $600,000.00 to do all of this. There was incentives that were out there – or, are out there that fully covered all of this. I should say that at that point, we had a program called Building Electrification Program and we're just ready to give money to make this work and prove that

electrification can happen. So, we were a significant piece – Elevate was a significant piece of the incentive stacking.

And then here the owner cost savings were $7,000.00 annually. The residents were also coming out winning with – by saving $2000.00 amongst the 16 homes. And yeah, the payback was not great, but this is also like – we knew this was also proving electrification. And that's the reason why we were looking at one three-story unit as opposed to all five or even the whole campus. Jonathan Rose has experienced electrifying and decarbonizing buildings on the coast, not so much in the Midwest. So, we're really trying to prove the concept here. Next slide.

And so how do we pick which of the three-story buildings? Well, we took a look at how much energy each of those buildings use. We also took a look at how old the existing systems are and that's essentially how we chose the building, based on that. We also wanted to be very strategic about the tenants that live there and making sure that they were aware of what's happening and tenants were willing and able, and through conversations with the property manager onsite, we knew that this specific building was very flexible and the residents were willing. So, that's how we chose 3526 South Lake Park Avenue. Next slide.

So, a little bit more about the systems. You can see the building that we chose is – there's a yellow arrow highlighting it. So, it's literally right next to Lake Michigan. Lake Park Avenue is basically the street before you get to Lake Shore Drive and then there's the lake. So, the scope of our electrification work focuses on this one three-story building that's 16 apartments. The existing systems include two central gas-fired hydronic boilers from 1998. The distribution system is a fin-tube baseboard hydronic system. There are 16 in-unit through-wall sleeve AC units. So, it's a little different from a window AC but kind of built in and it stays there year round. One gas-fired water heater and a storage tank. One rooftop unit that provides heating for the hallways and ventilation. Sixteen gas stoves, one for apartments, and then four gas clothes dryers. Those are all the natural gas systems in this property. Next slide.

This is a little bit of a beautiful visual of this building in the depths of a Chicago winter. Next slide.

So, kind of moving on to the next step. Once we kind of laid out the project financing and how we can braid the funding together and make it work, we moved on to requesting proposals from

contractors and ultimately bid selection. And I should say all along Elevate was part of kind of supporting Jonathan Rose and leading this decarbonization process. We were their technical arm and expertise to make sure this was happening on the ground. Next slide.

And this is the rest of the project team. So, you obviously see Jonathan Rose Companies, the building owner/developer. You see us. You see the property management company, Prairie. Ultimately, Nick & Eddie Construction was chosen to select – or, to do the construction and bidding for this. They also have subs like DNR Electric and others. ComEd was – is the utility company for this location, so they were pretty much a huge funder and also partner in this.

And I should say kind of a funny story is that ultimately Nick & Eddie Construction was chosen because in this time we were trying to do this work, if you all remember, shipping was a nightmare and things were just not getting – equipment was not getting delivered. So, Nick & Eddie did a really smart thing where they just pre-ordered a ton of heat pumps before this happened, so they had a warehouse full of them. We're like "Hey, this is going to work out with the schedule." Plus they're really great contractors. Next slide.

So, here's the construction scope. Again, the goal was to fully electrify, replace all fossil fuel equipment. So, we replaced – just to focus on the heat pump piece, we replaced the existing natural gas boilers – if you remember, there's two from 1998 – the hydronic distribution system and the in-unit through-wall air conditioners. One more thing. And the rooftop make-up air unit with cold climate air source heat pumps. And "cold climate" is kind of the most important keyword, I feel, from this description. We also replaced the central natural gas domestic hot water system with heat pump water heater, a SANCO unit. We're replacing the clothes dryers, the gas stoves with electric models. We also did have to upgrade the electric service and systems at the property. And we – last but not least, as kind of an energy efficiency measure, but we also as part of our assessment identified that the ventilation systems were just not on par. So, we wanted to make sure that we retrofit those in order to meet the models that we estimated. Next slide.

So, we're kind of at the final step: design and construction. We're actually at the very tail end of construction now. Next slide.

So, this is it. This is what it's looking like. This is a heat pump. What you see on the left was the existing system. So, you see one of the two – you actually see both big boilers here on the left. You have a through-wall AC unit in a typical apartment kind of on the middle top. And then you see the rooftop system at the bottom. And all of that is being replaced with 16 either two-and-a-half or three-ton cold climate air source heat pumps for the apartments. We're also using four three-ton multizone cold climate air source heat pumps to condition the common areas. Next slide.

Just a little bit about what else is going to replace. Again, the natural gas domestic hot water system is being replaced with one big SANCO system. The clothes dryers are going to be electrified. Next slide.

The stoves were put in. Here's the – on the right you see the electric model. Next slide.

As I mentioned, the electric services needed to be upgraded, both tenant and common area electric panels, and then also the ventilation systems. Next slide.

I'm at time, so I'm going to skip the resident engagement, even though it's a crucial part. But this was really important. And the construction costs ultimately ended up being $1.3 million. We were able to find funding of $1.315 million. So, $15,000.00 is effectively the money that Jonathan Rose had to put up. This is not going to happen ever again. Our funding has run out but this is proving that electrification can happen. And we're trying to really convince others to do the same. Next slide.

I think just a little bit about challenges. I know we're at time. Sorry, one more minute. Lack of funding to do all of the energy efficiency opportunities first, including the envelope, was really challenging. Addressing utility-owned equipment, the transformer, we're a month, I don't know, maybe almost a year waiting for a transformer to be put in. So, we've been done with construction but waiting on the utility to do their piece. Complicated utility billing structure, which not a lot of us realize is happening. And then solar is the next step. And I'll just skip the next slides for the sake of time and answer any questions at the end. Thank you. Sorry, Sett.

Stet Sanborn: No problem. This is all great information.

Josh Geyer: Yeah, excellent. Thank you so much, Maria. Just a reminder to the audience, go ahead and type your questions into slido.com and we'll address them at the end of the session.

Our next speaker is Stet Sanborn. Seth is a Vice President and Mechanical Discipline Leader for Smith Group's San Francisco office. He leads Smith Group's National Climate Impact and Performance Analytics team. Stet has served on ASHRAE's task force for building decarbonization for the last three years, has been appointed to sit on the newly formed Center of Excellence for Building Decarbonization. Stet also serves on MEP 2040 steering committee, the US DOE's Design and Construction Allies Working Group on Decarbonization, as well as the US DOE's Stor4Build consortium steering committee on market adoption of thermal energy storage technologies. That's a lot of words. He was the coauthor of the ASHRAE Advanced Energy Design Guide for Zero-Energy Multifamily Buildings and has been a contributor to several design guides related to heat pump applications, decarbonization, beneficial electrification, and grid edge applications. Please welcome Stet.

Stet Sanborn: Awesome. Thanks, Josh. And thanks, Maria.

So, I'm going to take a little bit of a deep dive into the system options that might be available to you as you're starting your journey, similar to what Maria just described.

On the next slide, I did want to highlight the Joint ASHRAE Department of Energy Advanced Energy Design Guide for Zero-Energy Multifamily Buildings. It rolls off your tongue. I'm sure you all already have your copy. But if you have no idea where to start, this free document – and we have a link available on the screen – it's a free document but it gives you really good package strategies for whichever climate zone you're in. So, if you're in a cold climate like Chicago or even colder, Minneapolis, or if you're in a mixed climate, maybe hot/humid like Atlanta, there's different strategies of combinations of both the envelope as well as the systems that might be available to decarbonize your projects. So, I just wanted to highlight it because if you don't have the budget to have a team do a whole bunch of deep analytics on your project, luckily, the Department of Energy already did, and so they can provide some really great guidance. Next slide.

So, especially when we start to talk about retrofits for these systems, there's a lot of options at your disposal and not all of them are the same. So, I'm going to go through just kind of a snapshot of

some of the different strategies that we see out in the market and some of the pros and cons of those.

So, if you have an apartment building or multifamily building that has the typical sort of closet furnace, maybe you've got an air conditioner coil hybrid in there as well, we're seeing a lot of market shift towards – or, at least in the early stages mini-splits, unit-for-unit mini-splits. That was mainly for folks that were trying to keep the conditioning, heating and cooling loads on the tenant meter from a billing purpose standpoint. But we've also seen quite a bit of VRF installations. In large part, we saw those as retrofit options because of the ease of routing the refrigerant lines through existing buildings. It didn't require as much disruption. But we have started seeing some pushback in the market and concern over, one, just the total volume of refrigerant charge in those systems and leakage, but mainly the challenge around operations and maintenance. Typically, when you pick a VRF or a mini-split vendor you have to buy their entire package. So, you can't hot swap a head with a condensing unit from a different brand. And so, that's something to consider for property owners, whether they want to have a dedicated sort of commitment to a certain vendor.

On the next slide, we are seeing some new innovations in that space as well. And this is to address the sort of "I want to decarbonize my entire portfolio – entire project but I want to do it with one system." So, we're seeing some of the VRF and mini-split manufacturers are offering now within their what we call multi-split line, which is essentially a single outdoor unit combined with multiple indoor units. This can allow you to do heating, cooling and domestic hot water production off of a single outdoor unit. So, we see this as the more simplified way of going forward, but it gives your domestic hot water the benefit of the heat pump as well. Next slide.

Now, I mentioned earlier that some of the challenges that we're seeing, especially in the mid-rise and above space are the sort of – the risk of going with VRF and being tied to a single vendor. So, we are seeing renewed interest in hydronic distribution. So, if we go back maybe 15 years or further, a lot of our multifamily buildings had hot water and chilled water piping or a condenser water loop running through the building. We're seeing a lot of interest in going back to hydronics because it offers a lot of flexibility in terms of keeping the refrigerant and the heat pump self-contained, simple, on the roof, and it's packaged. And then you have the flexibility to change fan coils out with whomever is the right price point for you today and going forward.

So, a lot of renewed interest in the air to water heat pumps, especially in the cold climate market. We had a whole session for cold climate heat pumps at the last Better Climate Challenge Summit. So, keep your eyes – or, your ears tuned because we're probably going to have more of those coming up. But one of the nice things about the air-to-water heat pumps is they can do what we call a temperature reset. They can go to a lower supply water temperature for heating in the shoulder seasons and save your occupants or the building operator a ton of money. Next slide.

When we look over at the domestic hot water side, this is where the bread and butter for multifamily is. Space heating and cooling is really important, but when we look at the energy breakdown of multifamily buildings, domestic hot water is the big energy user. Before you go and buy a heat pump for your project and before you look at a boiler and just buy a heat pump of the same size, we really, really, really, and I cannot stress this enough, encourage you to update or fix your hot water distribution and recirc system. There's a ton of energy waste that goes into poorly designed or poorly operating recirculation systems in multifamily buildings.

And so, we provided a link here for a whole nother presentation on all the things that you can do to optimize your recirc loop. And that's from controls, timing schedules. It's for even the mixing valves that you're using to make sure you don't get crossover from the hot to the cold side or vice-versa. All those strategies come together to actually save you a tremendous amount of energy before you buy your heat pump. Just like Maria mentioned earlier, we want to focus on efficiency measures before we throw in a heat pump or else you're going to overspend on the heat pump side. So, save the money first; buy a smaller heat pump. That's my motto if I could march around the world. Next slide.

Next – yeah, thanks.

So, when we look at domestic hot water systems, we kind of have three flavors, if you will, depending on whether you're doing a garden-style walk up, maybe a mid-rise or a larger-scale development. On the far left, sort of unit-by-unit air-source heat pumps. These can be located oftentimes in a closet when they're ducted. I don't personally recommend putting them in a small closet without having the air supply ducted in and out because the closet will get very cold. Even when it's louvered, there's a risk of sub-cooling that closet and going into electric resistance mode, which you don't want to have happen.

In the middle option, much like you have mini-splits for your heating and cooling, you can get essentially a split unit for domestic hot water as well. This one happens to be a hydronic split. So, it's a Monobloc heat pump that just sits outside with hot water lines coming back to an indoor storage tank. So, very small footprint on the inside that takes advantage of moving the condenser or the evaporator outside. On the far right, we're seeing a huge uptick in the marketplace for large central domestic hot water heat pumps. And these can be roof mounted. In this case, it's a ducted unit that goes indoors.

But there's a lot of opportunity when you do centralized systems that you can get some benefits of heat recovery. So, in the summertime months, while you're making a lot of hot water, you're also making something cold on the other side of the heat pump. So, it could be cold air or for water-to-water units, you could actually offset some of your building cooling load. So, there's a tremendous opportunity for energy savings annually when we look at some of these heat recovery sources for domestic hot water. Next slide.

Now, one of the things – and I already saw a bunch of questions in the comment section – or, in the Slido that "What about cold climate? What happens?" That is a totally legitimate question. When air-source heat pumps are in cold climates, as their air temperature outside is going down so is your performance and so is your capacity. Both of those things are going down essentially linearly with outside air temperature. And so, it's really, really important that when your design team is selecting a heat pump that they're taking into account that degraded or derated performance for outside air temperature. However, that's not our only option at hand to overcome some of those performance challenges. Next slide.

So, anybody who's heard me speak before or worked on a project with me knows that I love wastewater heat pumps. So, these are a class of heat pumps that take the sanitary discharge from your building – so, think of it as your waste, but mostly shower waste, and it's really a high-grade – at least from a thermal standpoint, really a high-grade source to extract heat from. And so, if you imagine in a multifamily building, everybody or a lot of folks are showering for that morning peak and there's a huge effluent flow of high-quality hot water coming down, typically above 75 degrees. Well, you can actually get a water source heat pump that extracts that heat from their waste line and then takes the heat and heats your domestic hot water. Don't worry, the poop doesn't travel

back and forth. The heat pump keeps it segregated. But you get far better performance out of a wastewater heat pump than you would an air-source heat pump, especially in cold climates.

And so, if you reference back to that advanced energy design guide, we did all the simulations, we did all the comparisons, and we actually tell you which climate zones work best for which type of heat pump on domestic hot water. So, it's a great resource if you haven't heard of these things before. Next slide.

One of the key things, though, that comes up, and this is really important, and Maria brought this up as well, is making sure that we understand that we're picking the right piece of equipment and that we're achieving cost parity or providing some benefit to the tenant or the building owner. Not all heat pumps are the same. And so, I'm going to do just a really quick example looking at domestic hot water for a simplified 200-unit apartment. Next slide.

If I were to achieve the domestic hot water flow rates with sort of the bimodal distribution that we see in multifamily projects, if I'm going to do that with a traditional R-134a heat pump – so this is a pretty traditional refrigerant – for that load profile, I would need four of those heat pumps plus almost 3000 gallons of storage to be able to meet that load every day. But the number that I want to draw your attention to is in the middle of the slide at the very bottom where you see a 176 kVA – that's 176 kVA – that's the connected load. That's what the panel board sees when you plug this equipment in. And to Maria's point earlier, one of the big challenges, especially in retrofits, is trying to reduce our connected load so we don't impact upstream electrical infrastructure. So, different heat pumps are going to have different connected loads, even though they can all supply that same performance that we're looking for.

So, on the next slide, you'll see what going from a 134a machine to a CO2 heat pump does. So, these are commercial-scale CO2 heat pumps meant for large scale domestic hot water systems. I can make the same amount of heat but with far less equipment because a CO2 heat pump performs very well at low outside air temperatures, and it loves making really hot water. So, a typical CO2 heat pump is going to make 165 to 180 degree water when it's really happy, even when it might be 12 degrees below zero outside. It loves cold climate hot water production. Because I can make really hot water, the tank size and the tank volume can be much smaller. So, this is a great solution for those of you that are space constrained in your projects and are trying to do a retrofit. But I

want to draw your attention again to that middle of the slide at the very bottom. Instead of 176 kVA, just by changing the type of heat pump I have, I'm going down to 138 kVA. That's a substantial difference of what the switch gear is going to see and ultimately what the transformer is going to see. So, if you are electrically constrained on your site, consider looking at multiple options for heat pumps to see which ones actually can stay under that electrical connected load limit that you might be experiencing.

Now, on the next slide, we're going to see the power of poop. So, doing the exact same heat production, if I, instead of doing air source equipment, if I'm doing a wastewater recovery heat pump, I can actually go with two units, a little bit more storage volume because this particular heat pump typically wants to make 140 degree water instead of 180. But it's extracting heat from 70, 75 degree water that's leaving your building. That's amazing heat.

And the most important part of that is if you look at the very bottom, you'll see that the connected load is now half of the other – the first heat pump that we looked at. So, they're all heat pumps. They all work. But each heat pump is going to have a little bit of nuance in what the impacts are to your building. And it's really important for your design team to be considering all these options when they're proposing solutions for you. Next.

So, the last part I want to talk about is how we start a process. We actually start from cost parity and we drive towards what efficiency do we need to hit? Rather than just picking something off the shelf that's available, let's start out and see "Well, how much do my utilities cost? And can I find the right heat pump for that mix?" Next slide.

So, we all know that a fossil gas boiler is far less efficient than a heat pump. And as I mentioned, you might see a heat pump sufficiency from two – a COP of two in a cold region in the winter, maybe lower if you pick the wrong heat pump, all the way up to four and a half if you pick one of those heat recovery wastewater heat pumps. Next slide.

So, if I look at the cost for a certain region, I want to target a heat pump selection or a coefficient of performance for that heat pump that I know is going to produce a lower cost utility to provide hot water. And it's different in every region. So, for the Bay Area, where I live, I need to set a coefficient of performance of 2.7. In Chicago, you might have to hit a three or above. Now remember that in cold climates, that definitely means you want to be looking

at wastewater heat recovery. And in Denver, because of the balance of utilities there, you're going to have to see a really large COP to get cost parity. So, we always want to focus on cost parity as well as efficiency and find those other efficiency measures that support that work. Next.

There are a couple of additional resources. And I think, Josh, I'm not sure if you guys are going to go through these, but I think that's it for my slides.

Josh Geyer: All right. Thank you so much.

Stet Sanborn: Yeah.

Josh Geyer: So, now we – so, first of all, thank you, Maria and Steph, for your amazing presentations. Before we transition to Q&A, I want to encourage you to download our additional resources handout shared in the Zoom chat box. The handout contains links to resources from Better Buildings and our speakers on today's topic. We hope you find this useful.

So, now we're going to open the floor for your questions and a group discussion with our panelists. I also like to remind you that we have an additional guest for our Q&A, Lauren Zullo from Jonathan Rose. Lauren works at Jonathan Rose Companies as the Director of Sustainability and she can help to answer any questions you may have related to the property management side of building decarbonization. Please go to slido.com and continue to enter your questions there. So, we'll start with our most popular question. "Can you further explain the bill management strategies that made a big financial savings for the project? Could this have been completed without the electrification investments?"

Maria Q. Peña: Yeah, I've been trying to answer these questions on Slido and I think I've been unsuccessful. But yeah, so the bill management strategies included removing the pretty large natural gas bill. That's one. And then two is changing the electric, the electricity rate essentially from a non-heating rate to a heating rate, in addition to removing electric demand and capacity charges. So, it's really managing both the natural gas and the electric side. This is all on Lauren's side, on the building owner's side. We have yet to enroll residents in any type of dynamic pricing program or peak time pricing program that can further kind of help them manage their costs and ensure flexible loans. And none of this could have been done without electrification. You have to electrify to get rid of

your natural gas bill. You have to electrify your space heating system to move to a heating rate, for example.

Josh Geyer: Great, thank you. Okay. So, I guess – so, there's a question here. It says "Does energy efficiency also include load reduction measures prior to electrification?" I think that that definitely is the case. Do you want to – does anyone want to add anything more to that?

Maria Q. Peña: Yeah, I can say that specifically for this project, we were very, very intent in finding funding to retrofit the ventilation system. It was super significant because we found that it was pulling a lot of conditioned air out of the building. So, doing that was really huge. And then, also getting rid of the through-wall AC units was a huge point of infiltration for the building. So, getting rid of that and replacing it with the typical wall material was also really big. What I didn't get to say is that we wish we had done more around air sealing and insulation, but time and budget just didn't allow us to do that. Just – yeah.

Stet Sanborn: I would just chime in that a big component on the equipment sizing side is based on your ability to do peak load productions. So, we've often always thought about energy efficiency measures in terms of their annual benefit. But one of the biggest things that we can do in electrification retrofits is look at peak load production. So, whether it's insulation, whether it's air sealing, whatever the strategies we're looking at, we want to also – as well as their annual benefit – we want to look at how much smaller can they make the equipment that we're replacing our existing equipment with? We never want to go into a project and do a one-for-one swap out without rechecking the load calcs. You end up with ridiculously oversized equipment. You'll pay through the nose for it and it's going to operate far less efficiently because it's going to short cycle. So, always do efficiency first, please.

Josh Geyer: Always, always.

Lauren Zullo: Can I add –?

Josh Geyer: Go ahead, Lauren. Yeah.

Lauren Zullo: Josh, just one thing kind of from the owner's perspective, and this is outside of just Chicago, but kind of with a national portfolio and kind of purview across a lot of states: Insulation, air sealing is an expensive project and we're seeing that it's significantly less incentivized than many of the electrification measures. And so, I think it's one of those things where as you're putting a whole

project together and a package together, it can be really challenging and you need the help of a strong consultant and a strong design team to help you navigate finding the right balance, as Stet said.

One thing I'm optimistic about is in several states we're starting to see pilot programs where you may see the electric utility thinking about incentivizing a window project, for example, or starting to move towards that demand reduction, I think in recognition that one day they're going to have trouble meeting the generation capacity needed for all of the – to manage the peak electricity loads. And so I think we're starting to see some movement in that direction to help incentivize that. So, I'm optimistic that will change.

Josh Geyer: And just to add on to that – so, like we know that for the two IRA rebate programs, for the measure-specific program that there's a $1600.00 rebate for air sealing but there's – if you can get to at least 20 percent modeled savings with your insulation and air sealing project, you can get a $4000.00 incentive. So, that's the threshold that you really want to be trying to hit. So, this was answered in Slido but it's an important one to talk about. "Using air source heat pumps in Chicago means you will be using electric resistance heating a great deal of the time. How does that impact utility costs and scope to emissions?" Or is that even true?

Maria Q. Peña: It's not true. I think –

Stet Sanborn: It doesn't have to be true.

Maria Q. Peña: – someone else posted. Was that you Stet?

Stet Sanborn: Oh, I didn't post, but I have lots of feelings about it. *[Laughs]*

Maria Q. Peña: Oh, okay, well someone else said that's completely false, which we agree with. It's not the case for all properties. In this case, we did model out what it looks like, how the heat pump performs and how the coefficient of performance reduces as it gets colder. And we like to specify specifically a coefficient of performance at five degrees Fahrenheit to be greater than 1.75 minimum for it to have the best performance. Obviously there will be some electrical resistance happening a couple of days out of the year, but if we're ready for it and if we also braid in other strategies like solar, for example, we can help manage that.

Josh Geyer: I would strongly – so, I would strongly say that there are a lot of people in the market, people who are working – whether you're engineers or designers, architects who are working off of heat pump knowledge that is 10 years out of date. And so, I really encourage you, if you're thinking you can't use heat pumps when it gets cold, you should really look at what's going on in the market because it has changed drastically in the last less than a decade.

Stet Sanborn: And some of the words that you're going to want to hear – so, there's definitely heat pumps on the market that you can buy that will perform horribly in Chicago, unfortunately, but there are some amazing ones that will work just fine in Minneapolis and Duluth, wherever you are. But some of the key words that you're going to be looking for are "cold climate heat pump," like a designation as a cold climate heat pump. Those are typically going to include an inverter-driven compressor so they can actually modulate down to those very low temperatures and perform very well. And they have typically a smarter control package on them that's actually going to let them respond to that cold outside air temperature. So, there are – there is technology available, especially in the residential market. When we get up to large commercial buildings, it's a whole nother world. But that'll be a – that's a whole nother chat.

Josh Geyer: So, I want to bring up – maybe a couple of questions up, but I want to bring up this one. This person says, "I was told yesterday that refrigerant fluids will be changed soon. The newer fluids will require equipment redesign, significant costs, and will be flammable. How will this impact costs for units, fluids, gas detection and insurance?" And also probably global warning potential. I'm going to put that in there too.

Stet Sanborn: I can tackle that one. So, it is true that R-410 is getting phased out through EPA, and that's the that's the most common refrigerant that we see in mini-splits and things like that, is R-410. It has a pretty significant global warning potential. So, when it leaks, especially if you have a poorly installed system that leaks profusely, you actually might be having a worse impact on the environment than the energy efficiency savings that you had. So, it's actually really important to focus on leakage and proper installation. Most vendors are moving to either R-32, which is an A2L refrigerant – it is mildly flammable. It's not super extreme. It is mildly flammable. It does not require a significant change from an R-410 heat pump. It's almost a drop in replacement because the 410a actually has R-32 already in it. So, there's not a huge change to go to R-32. If they're moving to R-454b, which is the other – there's kind of two refrigerants on the market; they're kind of fighting it out. 454b

does require a little bit more change, but I would not expect to see a 50 percent increase in equipment, at least once the market opens up. So, those pieces of equipment are coming on and all the market – all the vendors are transitioning over. So, it's – right now you're in an awkward position in probably the next six months where the product is just coming onto the market. That's the fuel switch – that's the refrigerant switch. But once the entire market switch is over, it's – I would say it's going to be a moot point.

Josh Geyer: And just to put it – just to flag, again, if you haven't updated your knowledge or assumptions about this, it is changing on a sub-annual basis.

Stet Sanborn: Yeah.

Josh Geyer: You really, really, really need to make sure you're in the know.

Stet Sanborn: And you can – you can you actually can get yourself ahead of the curve if you're super nervous. That's one of the reasons that I love CO2 heat pumps, especially in cold climates, is that it has a GWP – or global warming potential – of one for the refrigerant. It is essentially regulatory-proof. There is there is nothing better on the market. And every time somebody changes something on refrigerants, they're trying to get towards one. And so, not only do CO2 heat pumps perform exceptionally well in cold climates, they are also already at the target of where the EPA wants to be in 25 years. So, you can save yourself some heartache. Go with the CO2 heat pump.

Josh Geyer: Yeah, that's awesome. So, for the last question, can we just talk a little bit – there's a couple of questions about this, but in terms of what are the considerations for this project or other projects in terms of minimizing tenant disruption? And then after installation, what do we do to like make sure the tenants have all the information they need to operate their systems?

Maria Q. Peña: Yeah, that's one piece I wish I would have had more time to dive into, but engaging residents was really important, not just for Elevate but also for Jonathan Rose Companies. Obviously, we did have a couple of tabling events pre-construction, during construction to just make sure tenants were getting their questions answered. We know specifically getting rid of gas stoves is a very personal thing for people and we wanted to be very culturally sensitive on that change. Most residents were very open. I think people are just excited to have something new and that looks cool but also functions and it functions quickly, it gets the job done.

During construction – sorry, before construction, we also sent out a survey to residents – Elevate did – just to understand where people are coming from, where they're at and in order to kind of manage during the construction process how to meet them there. After construction, we're also going to send another survey to understand people's comfort, sensitivities, anything of the sort. Elevate is also planning if – we haven't talked about this, Lauren, but having another kind of tabling event to just make sure that residents have somewhere to go. In addition to the contractors obviously doing trainings on how to use the thermostat and things like that, we're leaving leave-behinds. And just – really just the flow of information, we want it to be vast, make sure people really know how to use our system because if they don't know how to use it, then all of our estimates go out the window. So, we're really intentional about that piece.

Josh Geyer: Great. All right. So, thank you both again so much. I would just add that as a former gas stove and now current induction stove owner, I know the gas industry would love for you to be comparing the gas to electric resistance, but that is not the proper comparison. The comparison is to induction. And it's like a comparison with an old gas clunker to an electric car. It's way – induction is way faster, more responsive, more efficient. It's superior futuristic technology. Get rid of your gas stove. Thank you. All right.

So, next. So, this webinar is part of the 2024-2025 Better Buildings Webinar Series. As you can see, we have a great lineup of presentations through August. Visit the Better Buildings Solution Center to learn more and register. One webinar you may find particularly useful in the next month is called "Financing the Future: Innovative Solutions for Decarbonization." If you have more questions about the web of financing decarbonization projects, this might be a great next step. Hopefully, this webinar may clear up the impact heat pumps can have on achieving your decarbonization goals and the promise that they bring to any scenario. If your organization plans on using heat pump technology in the future, you may be interested to hear about DOE's commercial heat pump accelerator. Through this program, DOE is supporting the development and adoption of heat pump package rooftop units, or RPUs, which will help achieve energy efficiency goals.

One primary focus of the accelerator is the commercial building heat pump campaign, which provides resources and guidance for

implementing heat pump technology into building portfolios. If you're a building owner or operator, utility company, or other supporting organization, you're likely to be eligible to join this campaign and gain additional support. If you're interested in hearing more about the commercial heat pump accelerator, please visit the Better Buildings Solution Center website.

With that, I'd like to thank our presenters, Maria and Stet, for taking time to be with us today, and Lauren for providing additional Q&A. I encourage you to follow the Better Buildings Initiative on LinkedIn and Twitter for all the latest news. You will receive an e-mail notice when today's recording slides and transcripts are available on the Better Buildings Solution Center. Thank you, everyone. Have a good rest of your day.

[End of Audio]

There's a Heat Pump for That: Multifamily Decarbonization Solutions

Additional Resources

Learn more about the topics discussed on the webinar by visiting the resources below.

Better Buildings Resources

- Better Buildings Commercial Building Heat Pump Accelerator website
- Better Buildings Commercial Building Heat Pump Campaign website
- DOE Efficiency Hot Water Distribution in Zero Energy Ready Multifamily Buildings document

Explore more resources on the Better Buildings Solution Center

Other Resources

- Lawrence Berkeley National Laboratory Decarbonizing Homes – Residential Building Systems website
- Lawrence Berkeley National Laboratory Heat Pumps with Phase Change Thermal Storage: Flexible, Efficient, and Electrification Friendly document
- Elevate Building Electrification website
- Elevate What Is a Heat Pump and How Does it Work to Save Energy article

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